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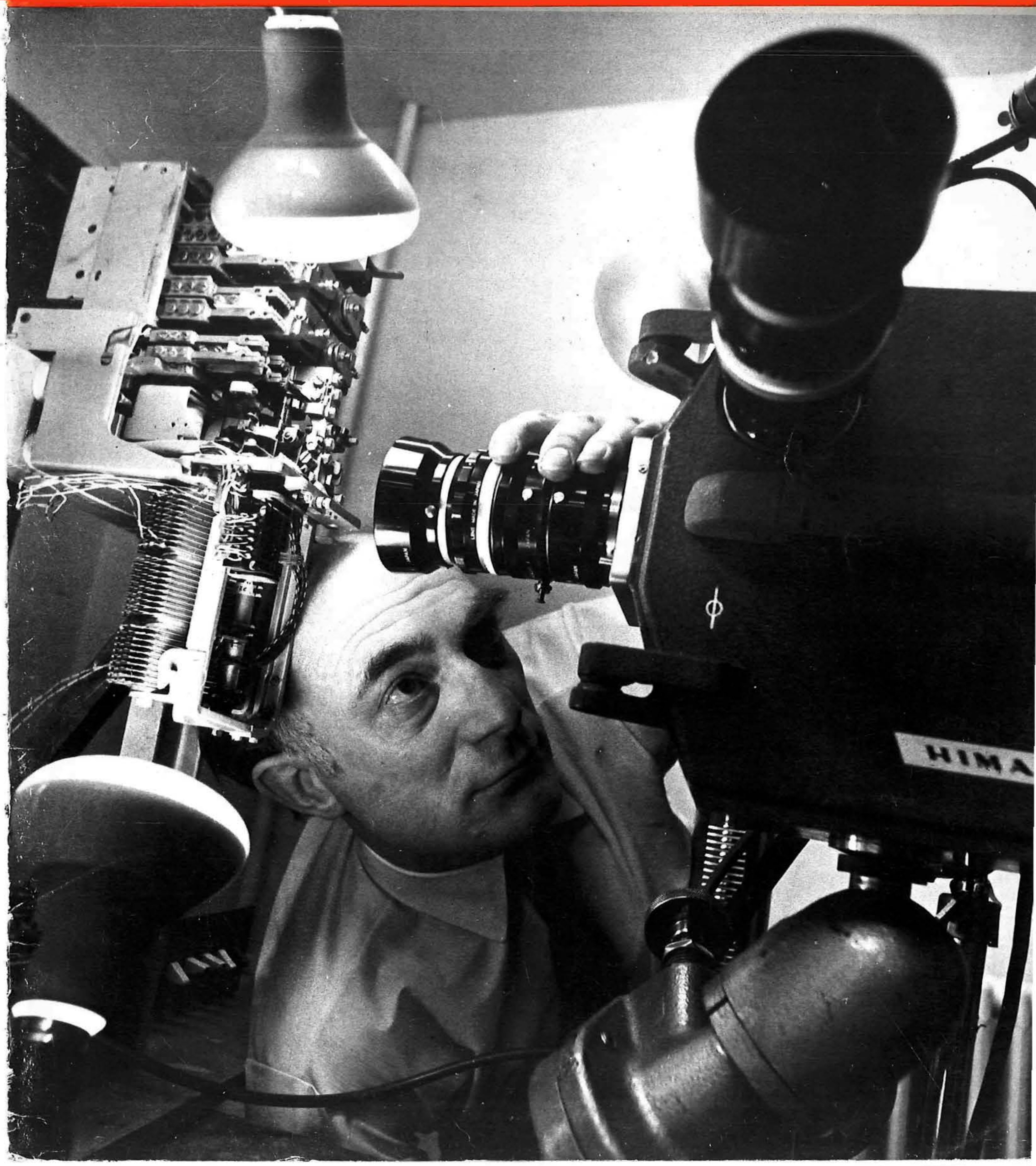

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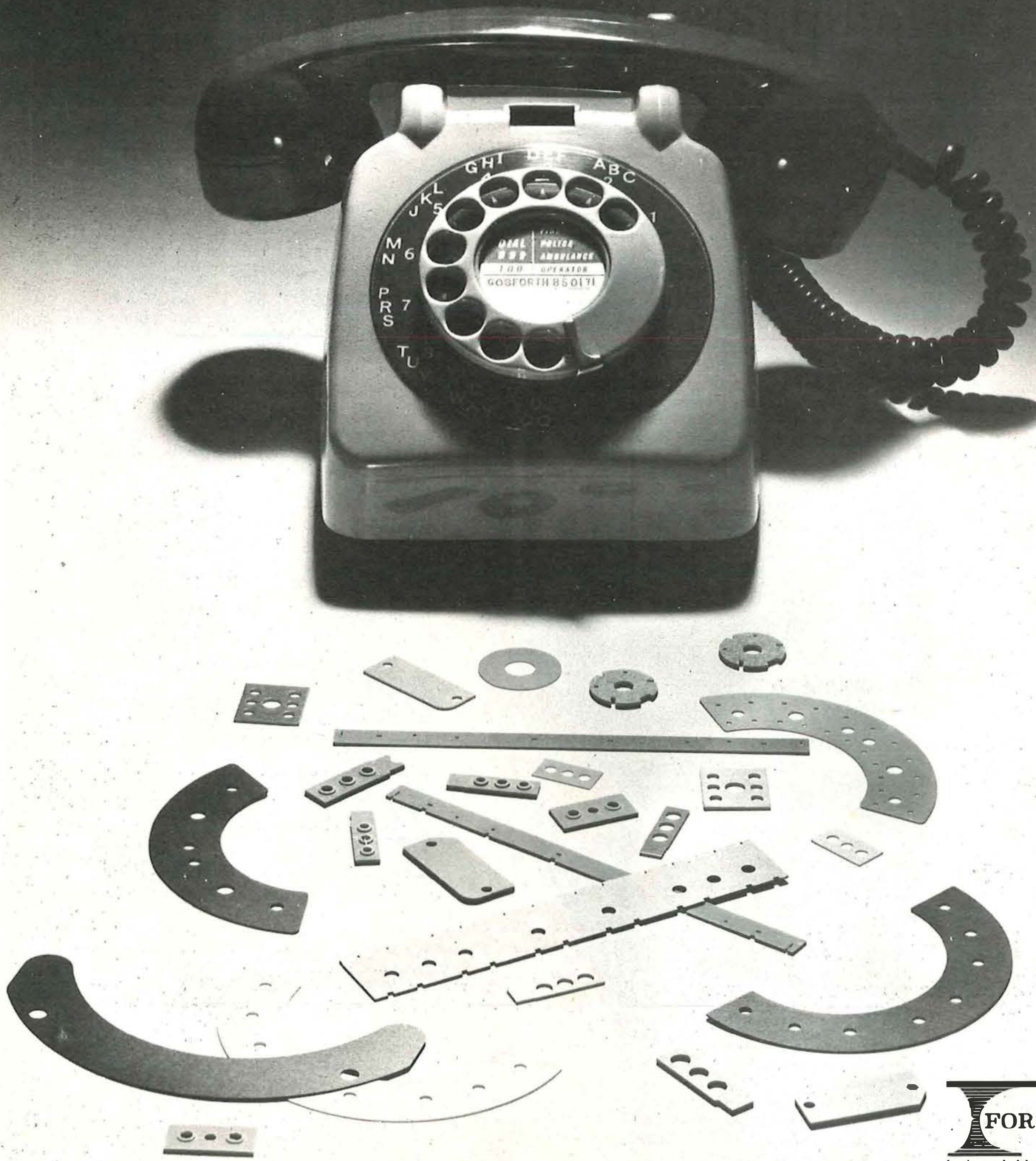


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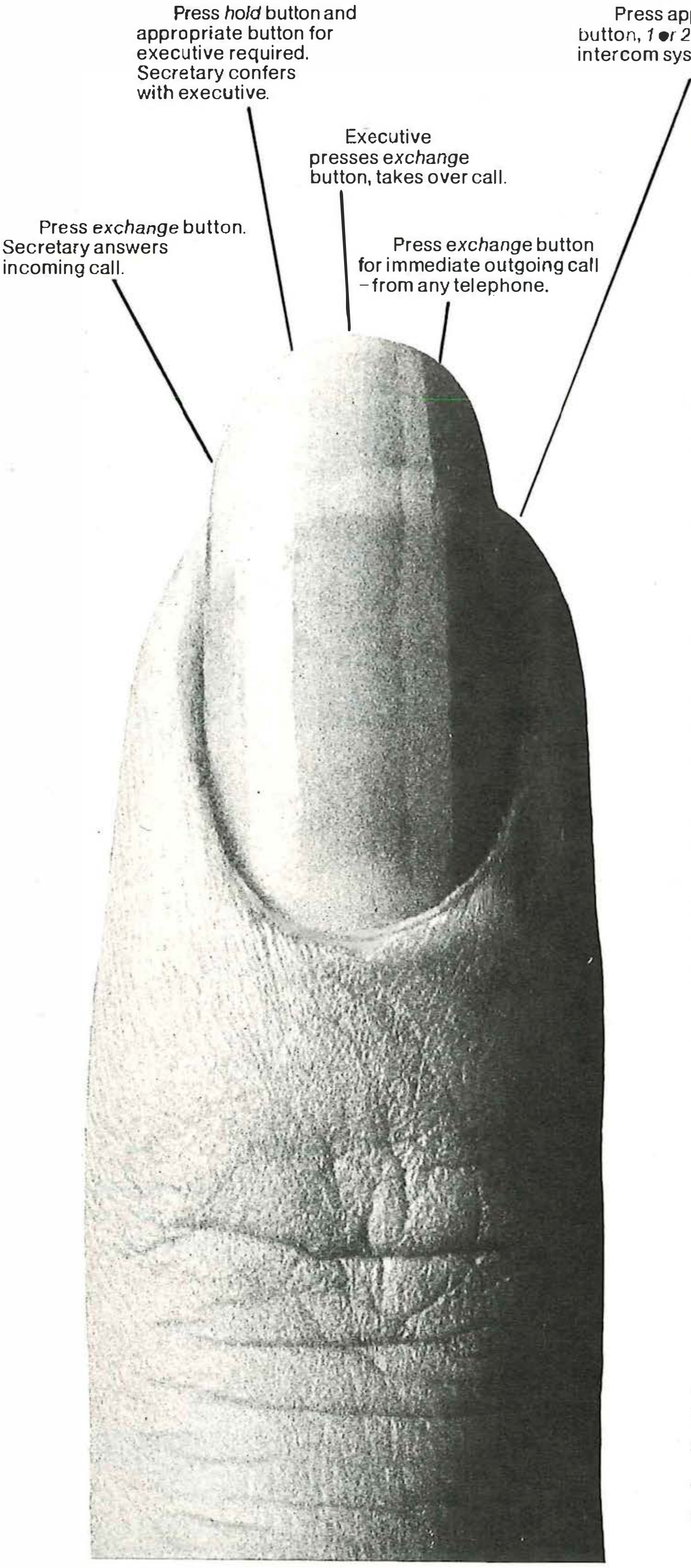


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| Type No. | CNY22 | CNY23 | CNY42 | CNY43 | CNY44/46 | CNY47 | CNY47A |
|---|---|---|---|---|---|---|---|
| Encapsulation | 5-pin plastic | 5-pin plastic | 4-pin plastic | 4-pin plastic | 4-lead TO-12 hermetically sealed | DIL-6 plastic | DIL-6 plastic |
| Min. breakdown voltage (peak) | 4kV | 2.8kV | 4kV | 2.8kV | 1.5kV | 4kV | 4kV |
| Min. transfer ratio | 25% | 50% | 25% | 50% | 30% | 20% | 40% |
| $V_{CEO}$ max. | 30V | 50V | 30V | 50V | 50V | 30V | 30V |
| Turn-on time | 5μs | 5μs | 5μs | 5μs | 2μs | 5μs | 5μs |

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The new publication examines the different winding factors in high-frequency transformer design. Practical aspects of winding and assembly are also considered. A copy of this publication is available from Mullard Limited (quote Ref: CPS/512).

M.012

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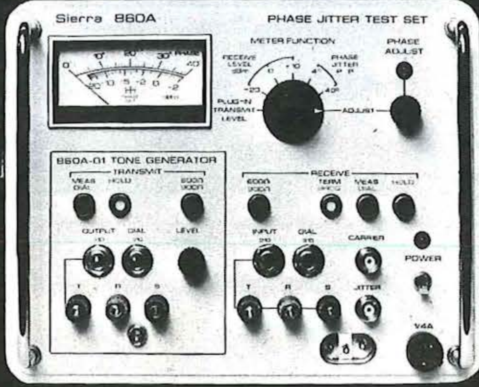
# NEW DATA TRANSMISSION TEST SETS.

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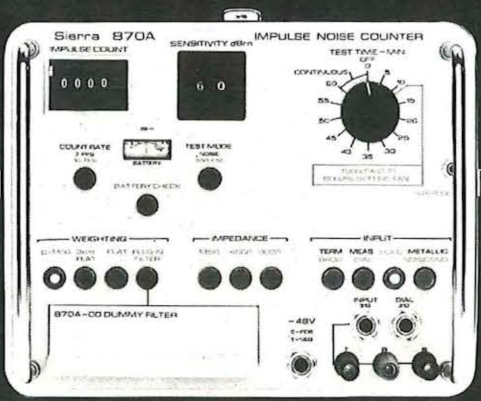


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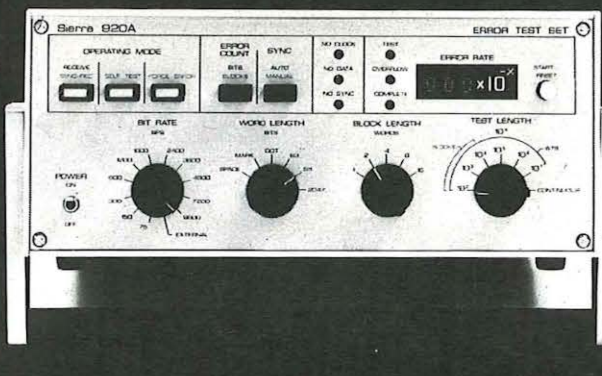


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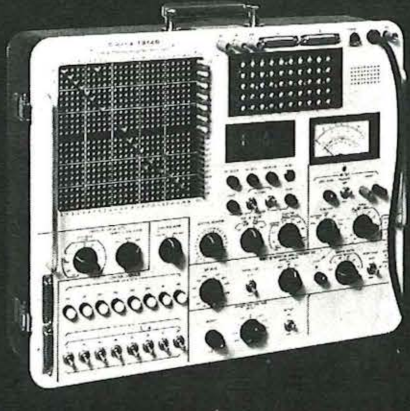

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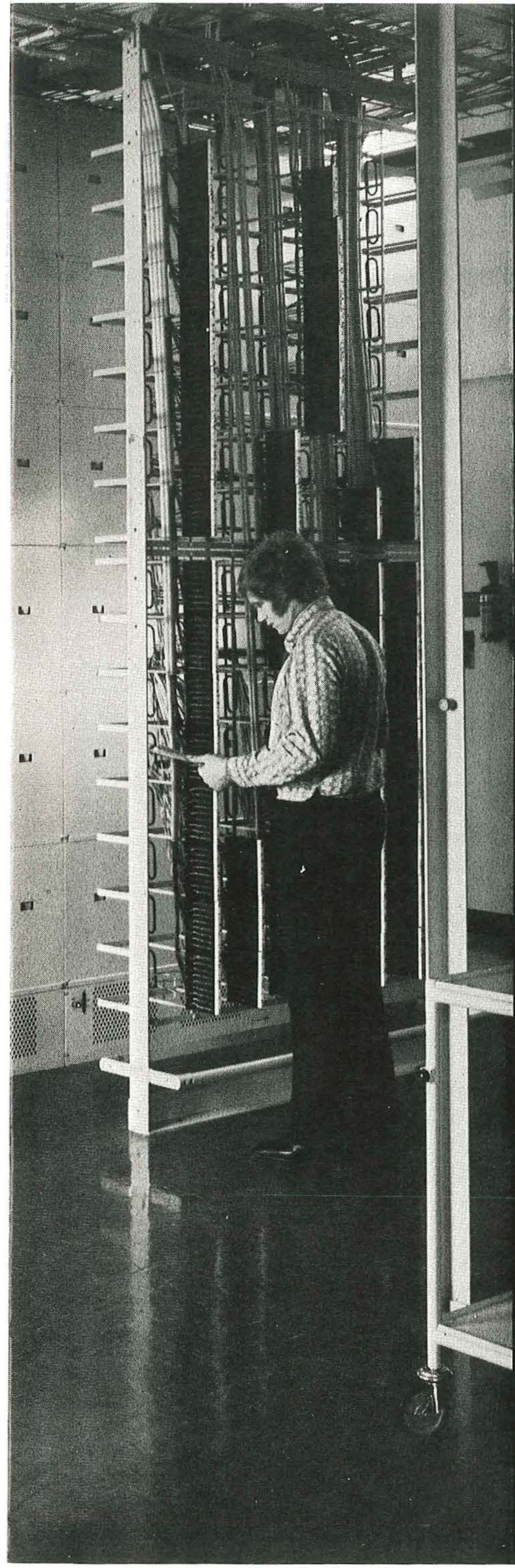

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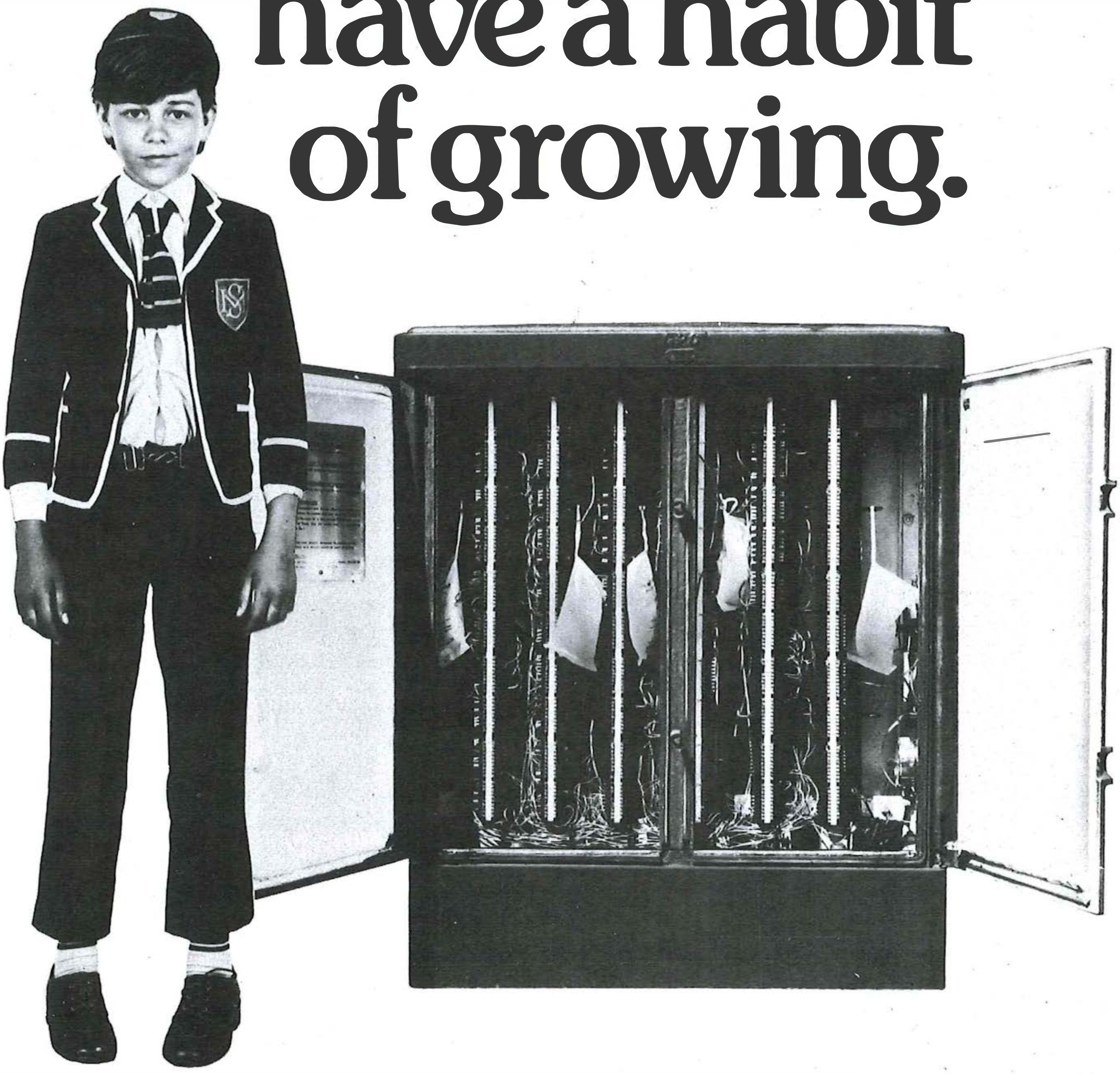

You won't need a cost accountant to tell you that growing out of a cable network is more expensive than growing out of a suit of clothes.

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# Preparing to send data in packets

Within the next twelve months the United Kingdom expects to become the first country to operate a fully packet switched data communications system for public service. Amid widespread national and international interest the Post Office is entering the final stages of preparation for the start of its experimental service which is designed specifically for the transmission of computer data.

Known as the Experimental Packet Switched Service (EPSS), the new service uses techniques by which data is routed as separate blocks of electrical signals. These self-contained blocks, or packets, traverse the network one after the other at high speed, providing a more efficient use of transmission links. (See Telecommunications Journal, Spring 1973.)

At present, when data is transmitted over the public telephone network a continuous two-way path is set up between a terminal and its central computer for the duration of the call. In practice, customer data is usually generated intermittently, and this leaves periods in which no data is transmitted. As data will be transmitted in packets by the EPSS there will be no need for a continuous path between the two communicating parties. It will also be possible to interleave packets – that is, slot the signals from one sender into the intervals between the signals of others – to make very efficient use of the communication channels within the network.

Details of plans and procedures for the EPSS were explained at a recent seminar to report progress on the project to more than 30 customer organisations who are taking part. The participants – computer manufacturers, banks, time-sharing bureaux and research and educational organisations – are members of the EPSS Liaison Group set up by the Post Office to assist in working out details of using the service.

A recent addition to the participants is the Post Office Data Processing Service which intends to use the EPSS in co-operation with National Giro, the Post Office's banking service. Statements produced at the National Giro Centre, Bootle, for business customers in London will be transmitted in packet format to the Post Office's Barbican computer centre for subsequent delivery on magnetic tape to the account holders.

The Post Office plans to begin its EPSS next Autumn with the opening of a packet switching exchange (PSE) in London. An exchange in Manchester will be brought into service a month later and a third exchange, at Glasgow, will follow that in a few weeks. The PSEs will be available for use for a minimum declared period, known as "the hours of service". At the start of the experiment these will be four hours per day, five days a week, but will be increased every three months, ultimately to reach 22 hours a day, every day.

**Post Office telecommunications journal**

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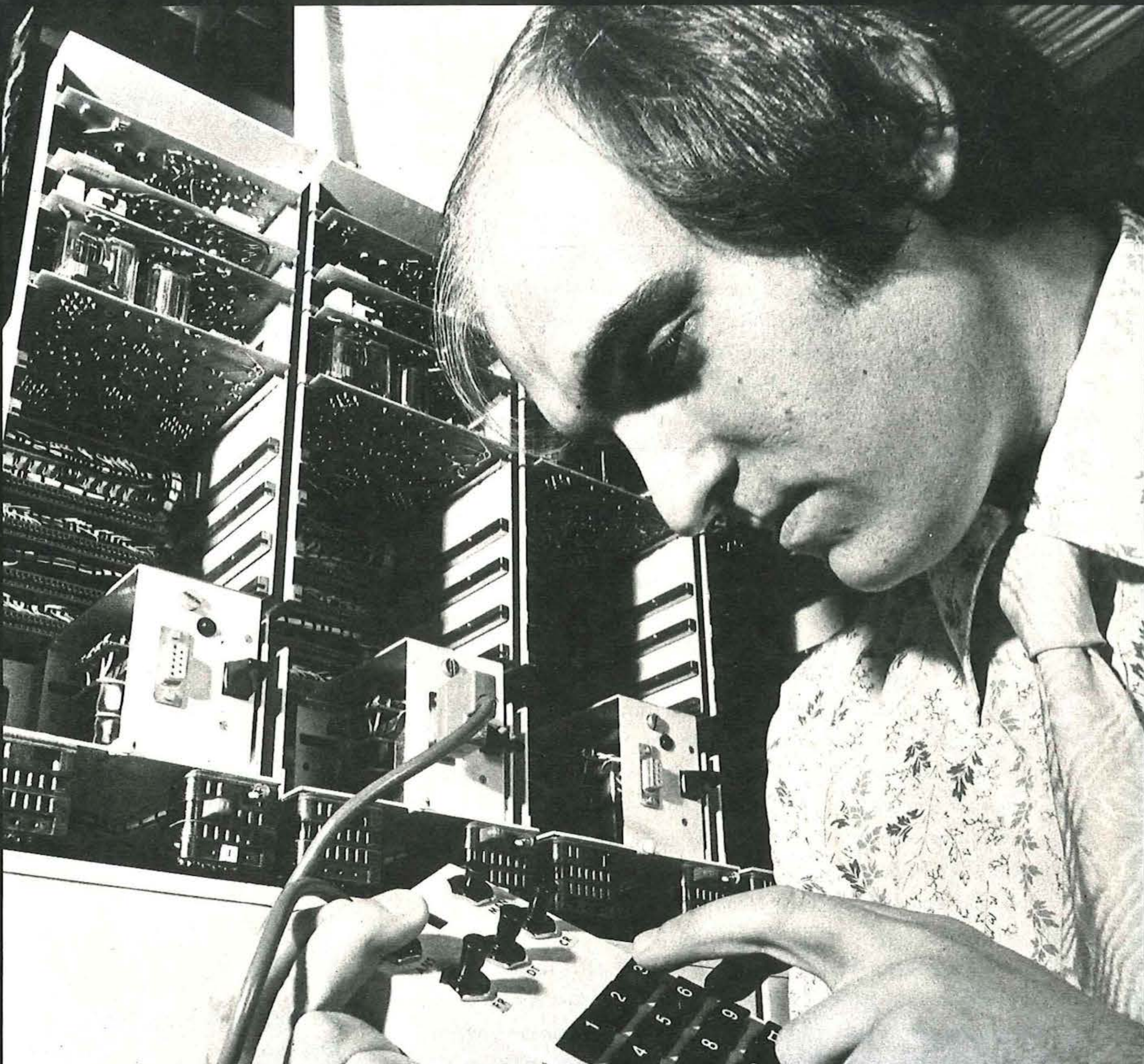
**Cover: A high-speed camera is focused on the small supervisory lamp of a two-motion selector used in Strowger exchanges. The film, which will be used to check the effects of vibration on the lamp's filament, is being made in the Circuit Laboratory at Telecommunications Headquarters. (See page 16.)**



# Do-it-yourself call transfer

**RT Farrow**

**Trials are being held of an improved service for telephone subscribers who require their incoming calls to be transferred to other numbers at certain times. The service enables a user to set up the automatic transfer of his calls to much wider areas than before.**

A DOCTOR ON call must make himself easy to contact at all times. He may therefore need telephone calls to be put through to him while moving between home, surgery, clinic and hospital. The businessman, too, who works from more than one office may find it useful to have his incoming calls redirected from one number to another at certain times of the day as he changes locations.

Call transfer facilities offered by the Post Office help to meet the communication requirements of these men on the move. The existing service is largely manual in operation, and users depend on the telephone exchange operator to receive their incoming calls and advise callers to dial another number. The telephonists handle more than 77,000 transfers a day, and difficulties in exchange staffing created by peak demands at the beginning and end of each working day are creating increasing cause for concern. In addition, despite a tariff increase last year, the service is still uneconomic in its present form.

Several methods of automation have been examined in the past, including a system used in Australia which requires the user to rent two lines. An incoming

**Left**: In the new call transfer service, telephone numbers to which a subscriber may require his calls to be redirected are stored in an electronic unit at the telephone exchange. Here a Technical Officer inserts a number into one of the units at Cambridge Central exchange.

**Right**: Using a multi-frequency keyphone on a special circuit, an exchange operator changes the call transfer arrangement to a second number for a user who has left his telephone after setting up a transfer condition.

call received on one line is set up automatically on the other line to the number to which calls are being diverted, and both calls are then linked by equipment at the user's installation. Transmission losses incurred by this method, however, were unacceptable to the British Post Office. Answering units which play a recorded message to the caller provide a partial solution to the transfer problem, but the message cannot be changed remotely and incoming calls are metered.

An automatic system was introduced at some exchanges in the 1960s, enabling transfers to be controlled by the user. However, its success has been limited because calls can only be transferred to other numbers on the user's own exchange.

Now the Post Office is carrying out trials of a new service which provides automatic transfer over much wider areas than hitherto – generally to any exchange which can be dialled at local call charges from the telephone which has the transfer facility. Incoming calls can be diverted to any one of nine preselected numbers, at the same time leaving the user's telephone free for outgoing calls.

As well as offering improved facilities for subscribers, the service now undergoing trials could help to solve some of the limitations and problems of the existing call transfer facilities.

The new service is made possible by a call transfer unit (CTU) developed by Pye TMC. This electronic device is linked to the exchange equipment of the subscriber whose telephone has the transfer facility and when an incoming call is received a second call is set up via an outgoing exchange line to another pre-selected telephone number.

Initially the user advises his local Telephone Area office of the numbers – with a maximum of nine – he requires on the service. Each number is then inserted into the electronic memories of the CTU by exchange maintenance staff, using equipment which consists basically of a 12-digit keypad and sender, a digit display and control keys. The stored numbers are each allocated a single-digit code corresponding to digits on the telephone dial.

To set up a transfer condition the user switches a special key connected to his telephone and, without lifting the receiver, dials the single digit allocated to the required number. His telephone bell will ring for two seconds to indicate that the instruction has been accepted. Incoming calls are then automatically routed to the selected number until the transfer instruction is cancelled by again operating the special key.

Anyone dialling a number on which calls are being transferred will hear ringing tone, then a recorded message from an answering machine linked to the CTU. The message informs the caller that he is being transferred, and is followed either by a further ringing tone as the call goes through to the new number or engaged tone if that line is already in use.

Calls can be transferred to only one number at a time. However, after setting up a transfer and leaving his telephone, a user may wish to change to a second and, perhaps, a third number during the course of a day. A facility has therefore been provided which enables the transfer arrangement to be changed by the exchange operator.

Using a multi-frequency (MF) telephone on a special circuit, the operator keys the user's telephone number followed by the single digit code allocated to the number to which calls are now to be transferred. A two-second ringing tone indicates to the operator that the switching has been successful.

Development of the CTU equipment has been based on modern electronic techniques which give high reliability. It uses five integrated circuits together with bipolar transistors and relays provided for interfacing with the telephone exchange equipment. The largest integrated circuit measures only 0.23 by 0.22 inches and contains the equivalent of some 2,600 transistors. The equipment is powered from the exchange 50-volt supply, but standby power is also provided in the equipment to prevent information being lost during any transitory loss of exchange power.

The CTU is capable of transferring calls to any exchange in the telephone network, but in practice the distance between the line on transfer and the transferee is restricted by tariff and transmission limitations. Records taken in large conurbations have indicated that if transfer is restricted to the local call areas, transmission standards will be exceeded on less than two per cent of calls in non-Director areas and less than eight per cent of calls in the London Director area.

Trials of the new service are currently being held at non-Director exchanges in Tunbridge Wells, Warrington and Cambridge. Further investigations are being conducted into possible technical complications in the equipment's use in a Director area. If the trials are successful, introduction of the new service could begin in 1976. Market research has already indicated that there is a large potential market for the improved facilities provided by the equipment.

Mr R. T. Farrow is a Senior Telecommunications Superintendent in Service Department at Telecommunications Headquarters. He is responsible for equipment aspects of the subscribers' enquiry and directory enquiry services.

# Trunk calls bit by bit


## D Pearman



**Detailed plans are being formulated for the introduction of digital transmission into Britain's inland trunk telephone network. The practicability of also introducing digital switching at trunk switching centres is being studied with the long-term aim of handling trunk calls wholly in digital form between the originating and terminating local exchanges. In digital transmission rapidly taken samples of the speech signal are converted into a binary code and transmitted as a stream of discontinuous bits. The method was first used by the Post Office to increase the carrying capacity of cables on short distance telephone routes. An all-digital main network would offer considerable economic advantages over existing techniques and could provide several service benefits.**

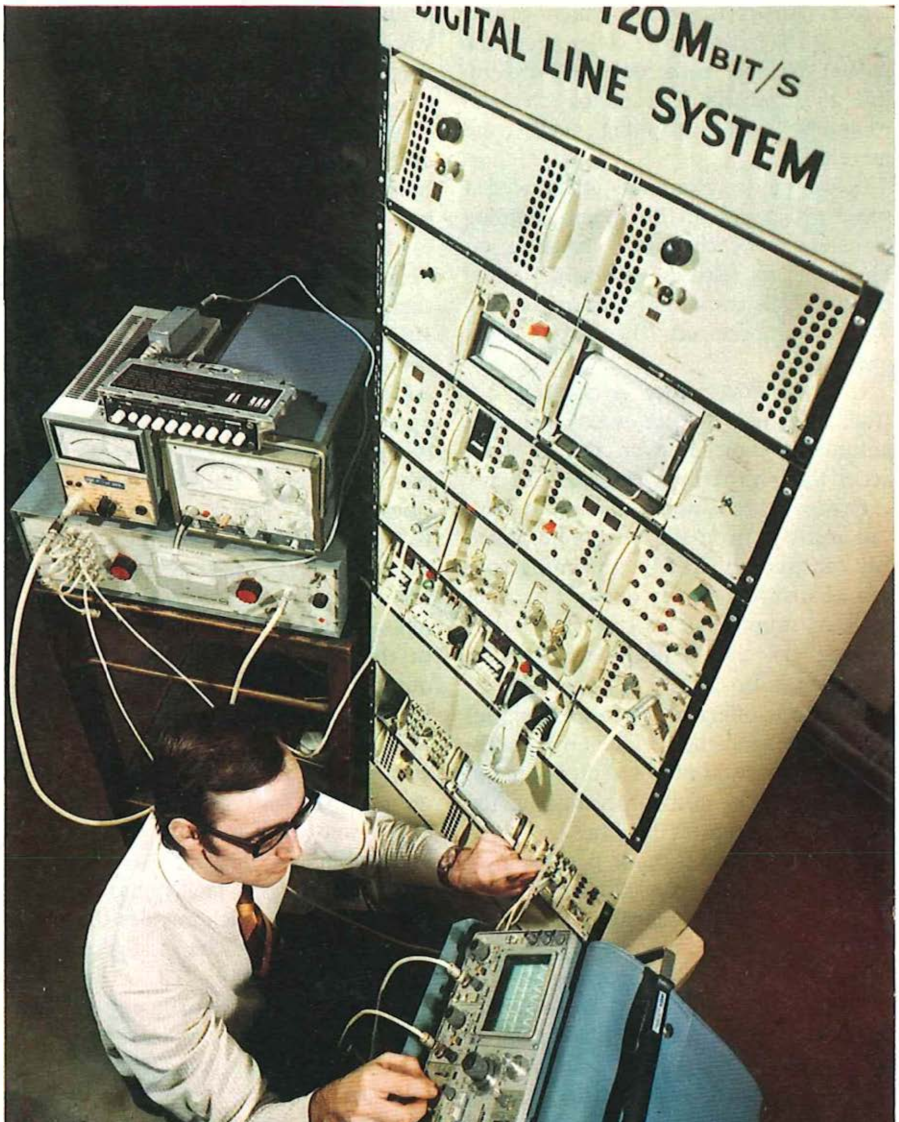

IN THE EARLY days of Britain's trunk telephone service calls had to be booked and were then manually connected, often after long delays, by operators at each switching stage throughout the country. As circuits became cheaper and more plentiful calls started to be connected "on demand" and operator-dialling to automatic exchanges became possible over longer distances.

In the early 1950s "trunk mechanisation" eliminated the need for operators at intermediate centres, enabling most calls to be connected under the control of a single operator. Charging arrangements were simplified, and in 1958 subscriber trunk dialling (STD) was introduced at Bristol. Subsequently, STD was extended throughout the rest of the country, thereby enabling most trunk calls to be made without the intervention of an operator.

Technical restraints meant that a small residue of less commonly connected calls, amounting to about five per cent of the total, still could not be dialled. To eliminate these, a separate "transit" network of special exchanges and trunk circuits was started in 1971 and is progressively being brought into use.

Subscriber-dialling access to some international routes (ISD) was started in London and other large cities in 1963 and 1964, with access to further countries added later, and it is now being made available at more exchanges throughout the country, assisted by the growth of the transit network.

The process has been one of continually exploiting the service and economic opportunities made possible by technological advances, particularly those in transmission and signalling, to




**Experimental trunk telephone systems providing digital transmission at 120 Mbit/s over standard coaxial cables will undergo field trials next year between Guildford, Portsmouth and Southampton. Tests are carried out here on line terminal apparatus for one of the systems.**

Engineers check a roadside repeater installation during work on the 120 Mbit/s experimental digital transmission system at Guildford.

meet increasing customer demand – which is itself stimulated by the improved and cheaper service available.

In the 1960s it was recognised that the high growth rate being experienced was likely to continue for a considerable time and that the existing techniques might be inadequate to meet future levels of telephone traffic and facilities likely to be demanded. New technical methods were emerging and it was decided in 1967 to set up a United Kingdom Trunk Task Force (UKTTF) to produce a strategic plan for the trunk network for the period from 1975 to about the end of the century, taking into account all likely technological developments in transmission, switching, signalling and control processes.

The UKTTF produced comprehensive interim and final reports. Among its recommendations was that a long-term objective should be the introduction of an overall digital transmission and switching capability, local exchange to local exchange, into the trunk telephony network. Another was that high-capacity digital transmission systems should be developed as quickly as possible and introduced into the network in a planned manner as soon as technically and economically satisfactory systems were available. A third recommendation was that digital switching should be introduced into the trunk portion of Group Switching Centres (GSCs) in conjunction with the planned introduction of digital line plant, and that the digital switching equipment used should be capable of having both digital and frequency division multiplex (FDM) line systems connected to it.

It will be apparent that the emphasis was on digital working, starting first with transmission systems, then with trunk switching and leading eventually to trunk calls being handled by digital means all the way from the originating local exchange to the distant local exchange.

The concepts of digital communications and binary codes have become familiar in comparatively recent years because of computers and data transmission, but they are far from being newcomers to telecommunications. After all, teleprinters have been in existence for a long time and there was Morse earlier still.

The advent of telephony, however, introduced the concept of conveying from point to point a continuous electrical representation of the variations of speech. Until recently all transmission paths used such methods (analogue transmission), interconnected at exchanges by continuous switching paths (space switching). The coaxial cable and microwave radio routes which carry the bulk of trunk circuits employ FDM analogue transmission referred to in the UKTTF recommendations.

Digital transmission of speech came into use with the advent of pulse code modulation (PCM), used first on short distance routes to increase the carrying capacity of paired type trunk and junction cables. This method samples the speech waveform amplitude at short intervals and encodes each sample into binary code for transmission as a stream of discontinuous "bits", the bits from several different simultaneous connections being interleaved in time sequence on a single path. Separation and reconstruction into separate analogue waveforms takes place at the distant end.

The next stage was to explore the possibility of connecting PCM circuits in tandem without converting to analogue form at an intermediate switching stage. This involves switching the time-separated bits representing a particular conversation by time-division switching, and two experimental time-division exchanges have been on trial at the Empress and Moorgate exchanges in London. It is the development of such digital transmission and switching methods that the UKTTF had in mind in making its recommendations.

The task force reached its conclusions after extensive study of the technical options available, making extensive use of computer techniques to determine optimum cost solutions for the traffic it forecast would have to be carried by the network at various dates in the future – for trunk telephone calls a 13-fold increase in 30 years was envisaged. These studies forecast significantly reduced costs for the main network interconnecting GSCs by using digital transmission and switching, and led to the recommendations quoted earlier in this article.

In addition to economic advantages, an all-digital main network could facilitate or provide a number of service benefits, in particular in transmission quality and in facilities which can exploit end-to-end digital transmission techniques, typically high speed digital data transmission. Hence it will also make easier the provision of facilities associated with information transfer and already obtainable by other means, such as signalling and network management. The UKTTF considered the methods of ▶

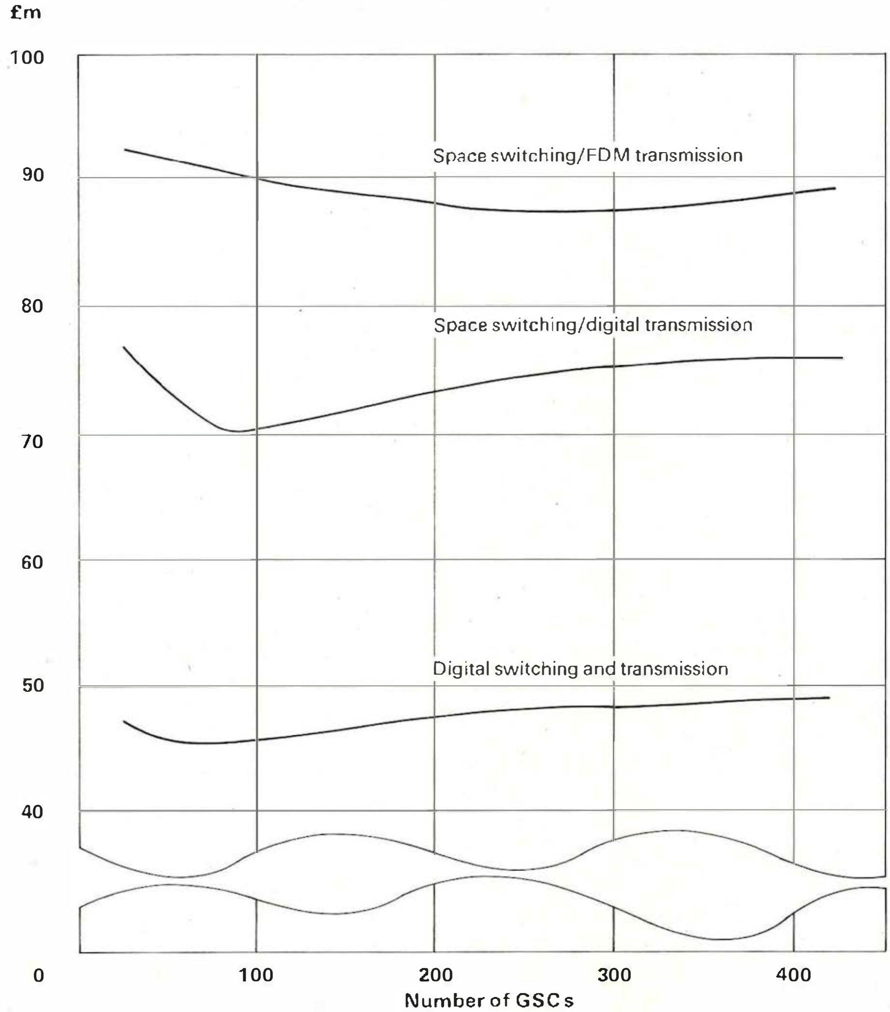



**Figure 1: Main network annual charges at 1986, reproduced from the UKTTF report.**

implementing such changes but was not required to develop a detailed strategy or to establish the cost of the transition. This is a major undertaking now and over the next few years.

It is worth noting that the move towards an all-digital network is a general trend in many countries. In the USA in particular a digital electronic exchange has been developed for installation within the next few years in the long-distance toll network, and replacement of all crossbar trunk exchanges by digital exchanges is planned before the end of the century. While planning for an integrated switching and transmission system, the USA sees economic advantage in proceeding with digital switching in the near future, even in a predominantly analogue transmission environment.

The figures produced by the UKTTF, as shown in figure 1, relate to hypothetical situations in which, for instance, all switching is digital and transmission is either wholly digital or wholly analogue. In practice there will be a mixture of these for many years in which the efficiency of utilisation of some plant could be low and the costs arising from the need to provide interface equipment between digital and analogue sections could be high. Hence the strategy and control mechanisms for implementation need to ensure that the most advantageous path is taken to the final goal.

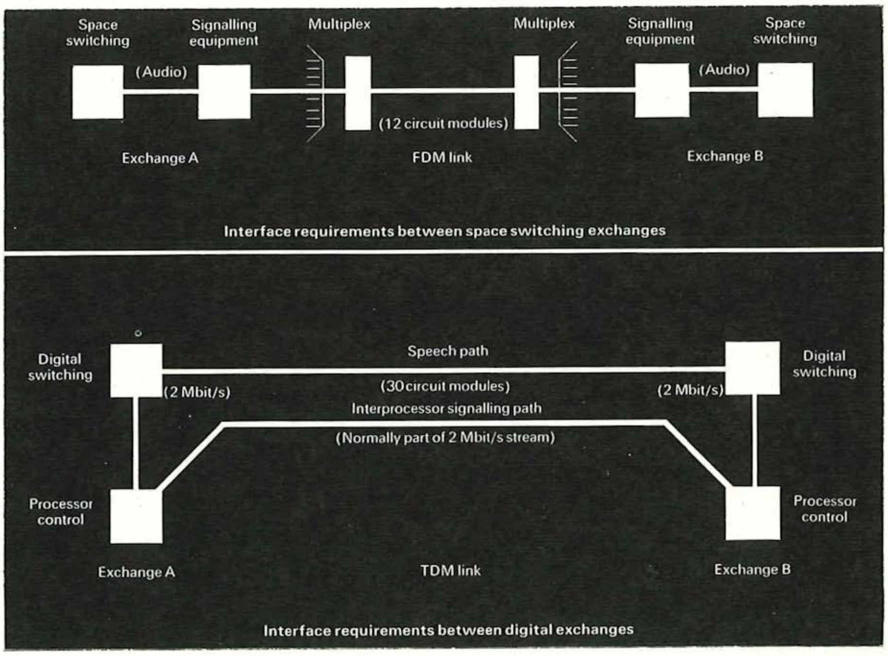
It is proposed to introduce processor control of switching, and signalling between exchanges over common instead of individual channels, concurrently with the provision of an integrated digital trunk network, since both these techniques offer important advantages in their own right.

The resultant "before and after" situation for a single direct link between two exchanges is shown in figure 2, but the Post Office is concerned with something like 6,000 such traffic routes interconnecting about 400 Group and Transit Switching Centres equipped with Strowger or crossbar equipment of varying ages and varying capabilities for further extension. It is therefore a complex job to examine the alternative ways in which we might proceed, and a schematic representation of the strategy being adopted is shown in figure 3.

The various aspects which provide the basic information are shown by the left-hand series of blocks. Taking development progress as an example let us first consider transmission. As we have seen, the UKTFF forecast that the use of digital rather than analogue transmission systems would produce annual charge cost savings when employed with the present space switching exchanges. Accordingly the development of digital transmission systems suitable for use in the main network has been initiated.

The basic digital module for both switching and transmission will be approximately 2 Mbit/s and, with the time frame divided into 32 slots using 30 for speech and the remaining two for

**Figure 2: Summary of interface requirements.**



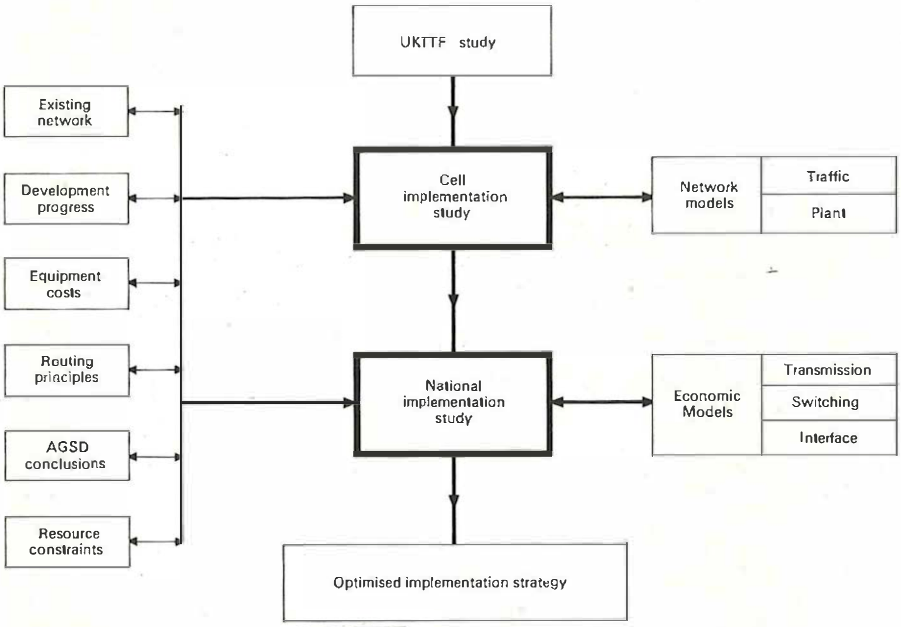



**Figure 3: Development of the implementation strategy for a telephony integrated digital network.**

signalling and control. A 30-channel transmission system suitable for use on audio cable, and intended primarily for connecting local exchanges to their GSCs, is being developed by industry for subsequent field trial.

Higher capacity systems for long distance applications are now being developed on both cable and microwave radio, first at 120 Mbit/s and giving 1,680 channels for the initial build-up of digital transmission, and subsequently at higher capacities. Waveguides and optical fibre systems, which are essentially digital in application, are in the research stage.

Turning to switching, the unit planned for the future main network is the digital GSC version of System X, the future family of switching systems which is the subject of much intensive consideration by the Post Office and the telecommunications industry.

The first main study stage is the cell implementation study (in the centre of figure 3), which is a sampling exercise in depth for the purpose of formulating general principles. It is a study of various areas of the country (referred to as cells) which have been selected as representative of the network as a whole. This is a practical, down-to-earth planning exercise in which various tactics for introducing digital plant in the cells are explored, taking account of all the actual local circumstances and consideration of adjacent and remote cells.

The representative sampling has been adopted because it would be beyond the range of sensible modelling techniques to study the whole network in detail for all practicable tactics. Three cells are under study, and the adequacy of this sample to establish the best methods of approach will be assessed as the investigation proceeds.

The main problem is to minimise disturbance to the existing network and the cost of interworking between it and the digital network as the latter is introduced. Broadly speaking, two main approaches have so far been proposed for the introduction of digital plant. They are, in effect, distributed and concentrated methods of introduction, respectively.

The distributed approach proposes that digital switching is first introduced at the busiest and most important centres in the country, together with a complementary provision of digital transmission plant in the surrounding junction network. The thinking behind this approach is that such centres would quickly justify interconnection with digital line plant, thus enabling the full benefits of digital working to be obtained between them. Hence a nationwide high performance network would be created fairly quickly between the busiest centres and customers.

However, the larger part of the traffic to and from a particular centre is with customers in surrounding GSC areas which, with the available digital switching units distributed around the country, would still be served by space-switched units and therefore involve inter-working costs. This leads to consideration being given to the concentrated approach in which available digital plant would be directed into limited areas to conform with communities of traffic interest, thereby limiting the inter-working costs to the balance of traffic leaving or entering the designated area.

A combination of these main approaches may be the best course, but in any case the implications of two alternative lines of action have to be considered. Growth of the system has to be catered for in any case, and this can be done either by taking the growth on a new digital exchange and keeping in service the existing space switching exchange, or by replacing the existing exchange completely by a digital exchange. Either normal replacement criteria or accelerated replacement criteria could apply, but factors such as the available manufacturing capacity and Post Office resources in the early years will influence the outcome as well as the service and long-term economic considerations.

The general principles determined from the cell studies will be applied to a national implementation study so that the implications for the main network as a whole can be evaluated. It will then be possible to determine the most beneficial course of action within the forecast restraints on the various resources involved. This will lead to a recommendation for an optimised implementation strategy, together with the estimated patterns of capital expenditure, annual charges, equipment quantities, manpower requirements, and so on, that would be involved.

In parallel with this activity, development trials and first production installation of digital transmission equipment will be proceeding, as will the system definition and development of the digital GSC as part of the System X family. This will lead to the ordering, manufacture and installation of digital plant to serve the initial centres, with the objective of establishing these in the early 1980s.

At the start of this article the past evolution of the trunk telephone service was outlined. A major change in the system is now being evaluated which represents something quite different from the evolutionary past and on a scale of complexity and effort of a different magnitude. The end product should provide the best means of meeting the continuing growth of trunk telephone traffic with the kind of service the Post Office would wish to give and the public will undoubtedly demand as the turn of the century approaches.

**Mr D. Pearman** is a Deputy Director in Network Planning Department at Telecommunications Headquarters. His main responsibilities include circuit utilisation, switching and economics, and traffic matters.

# A step up in digital capacity

## WG Simpson

An installation engineer tests a 30-channel pulse code modulation regenerator unit.

**A 30-channel pulse code modulation system will be used as the basic "building block" in future Post Office digital telephone transmission systems. The system complies with an international specification and will take over from the present 24-channel PCM systems for new installations, starting in 1978.**

DIGITAL transmission of speech has been used by the Post Office since 1968 when the first 24-channel pulse code modulation (PCM) systems were introduced. These systems are used to carry junction and trunk telephone circuits of about 16 – 40 km in length and make use of existing audio cables. For PCM, the loading coils are removed from a number of the pairs and replaced by digital regenerators operating at a speed of 1,536 Mbit/s. The resulting increased capacity has enabled additional circuits to be obtained very economically over these distances compared with the alternative of laying new audio cables. There is the further advantage of avoiding the need for new duct, which is an important point in congested city streets. Planners have found the system so attractive that some 1,000 systems a year are now being purchased.

The advantages of digital techniques in longer distance transmission and in exchanges have been studied. (See Telecommunications Journal, Summer and Autumn 1971 and the preceding article in this issue.) It is clear that in the long term the trend will be towards a general use of digital transmission and switching.

A key building block in a digital network is the primary multiplex which converts a number of analogue speech signals and the associated signalling information into a stream of digital signals. The basic format of this digital stream must be the same in all applications – short or long distance national transmission systems, switching systems or international transmission systems – to allow a digital network to evolve in a systematic fashion.

Studies of these aspects by the European Conference of Post and Telecommunications Administrations (CEPT) and the International Telegraph and Telephone Consultative Committee

(CCITT), in which the British Post Office played a prominent part, have resulted in a specification for a 30-channel PCM primary multiplex. The Post Office has decided to use this multiplex as the basic building block for its national digital network.

The new equipment is being developed by industry for field trials in 1975 and is expected to be in service by 1978. The existing 24-channel systems will be retained in service, but all new systems will be of the 30-channel type.

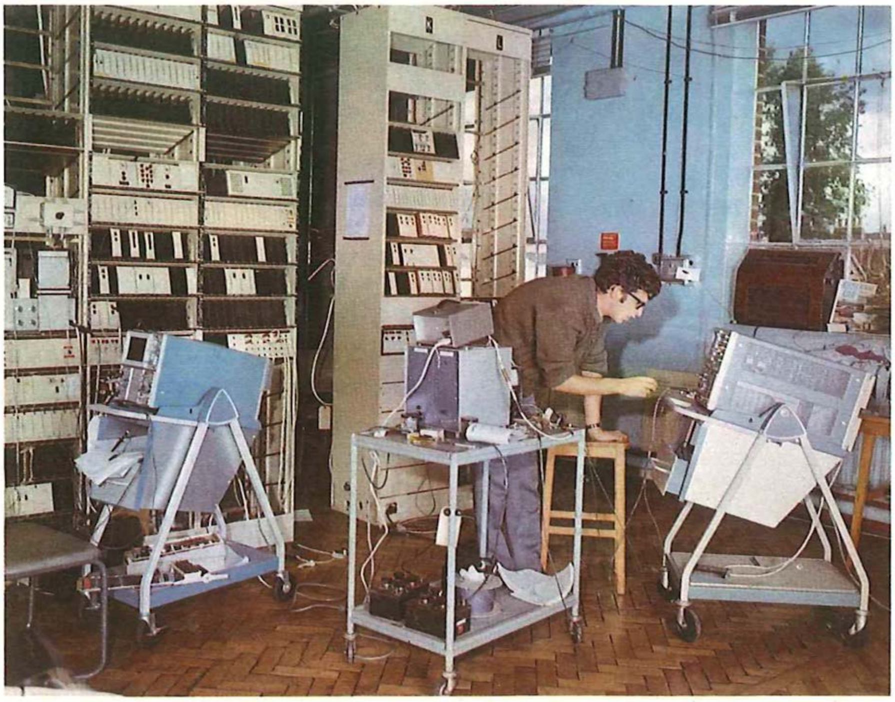
Apart from the increase in the number of speech channels, the new system differs from the 24-channel system in three major respects, namely the number of bits used for each channel, the signalling/framing arrangement and the line code.

The number of bits used to describe the amplitude of each speech sample is increased from seven to eight. In a PCM system the value of the waveform representing the speech signal is sampled 8,000 times every second, and the value of the sample is then represented by a binary code. The assignment of a extra bit doubles the number of codes available from 128 to 256, which gives a more accurate representation of the amplitude of the sample and has the effect of reducing the noise resulting from the coding/decoding process. This makes it possible for calls to be routed over up to 16 PCM systems – more than enough to cater for the most complex international connection.

The 24-channel system also had eight bits allocated to each speech channel but the eighth bit was shared between its primary function of carrying the signalling information for the circuit and a subsidiary one of framing (keeping the transmitting and receiving multiplex equipments in step with each other). In the new system these functions are separated and individual eight-bit time slots are allocated for the signalling and framing functions. In the initial applications of the system the signalling time slot is further subdivided to give four signalling channels for each speech channel. This will make it simpler to provide for complex signalling functions.

Future signalling systems between processor controlled exchanges will be able to use this signalling time slot as a whole to cater for larger numbers of circuits, and not just those of a single primary multiplex.

The regenerators needed on audio cables to replace the loading coils will be similar in many respects to those now being supplied for use in the 24-channel system. They will, however, have automatic equalisation which will simplify the task of procurement and installation (on the 24-channel system a selection has to be made from 16 types of equaliser) and will use a variant of the alternate mark inversion line code known as high density binary (HDB 3). This code, which imposes no restriction on the information it carries, will be of particular value for data transmission purposes. When the stream of information contains long sequences of zeros regenerators using the alternate mark inversion code may function incorrectly because they rely on the mark impulses to operate a timing circuit. In the HDB 3 code the fourth zero in a sequence is replaced by a mark impulse. This is recognised as a substitute for a zero because it has the same polarity as the last mark received – called a "bipolar violation" because it violates the normal rule that alternate marks have opposing polarity.



**Prototype 30-channel PCM multiplex equipment is under evaluation at Taplow repeater station, Berkshire.**

In the 24 circuit system errors are detected by observing bipolar violations as these could only be caused by a transmission error. The use of the HDB 3 code prevents this method being adopted for the new system. Instead the framing signal, which is always the same sequence, is checked for errors.

The larger number of channels, the extra bit per speech channel and the changes to the signalling/framing arrangements gives a total speed of 2,048 Mbit/s for the digital stream out of the new primary multiplex compared with 1,536 Mbit/s for the present system. It will, however, still be possible to retain the same spacing between the regenerators and, indeed, to expand with the new 30-channel system cables which are already partially filled with 24-channel systems.

The new equipment will at first be used in the same way as the 24-circuit system it replaces – that is, for short distance junction and trunk circuits. Soon afterwards it will increasingly become used to multiplex the circuits to be carried over the high capacity – 1,680 channels – 120 Mbit/s coaxial cable system now being developed for the longer distance trunk network. When digital telephone exchanges are introduced the new 30-channel primary multiplex will provide the interface to the analogue parts of the network.

The new designs have taken account of the expanding and vital role which the multiplex will be playing in the network. Special attention has been given to reliability, one contribution being a much greater use of integrated circuits. The complex coders and decoders, which are time-shared between all the channels, are regularly checked for correct functioning during the framing time slot when not otherwise in use.

Digital techniques are destined to play a steadily increasing part in the transmission networks of the future. The new 30-channel system will be the first appearance in the network of a new range of digital transmission items now envisaged for the trunk digital network.

**Mr W. G. Simpson** is head of the Line and Radio System Division in Network Planning Department at Telecommunications Headquarters.

Courtesy of the City of London Police

# A long arm of the law

## JE Barrett

**A national computer unit has been set up, with Post Office help, to provide a central source of information for police enquiries. Police stations gain rapid access to the computer records over a nationwide network of private circuits.**

A CAR is seen leaving the scene of a murder. The eye-witness is able to give the police a broad description of the vehicle, but is unsure of its make. She does remember the registration mark.

A constable radios the witness's information to his station. Here the vehicle registration mark is entered on the keyboard of a computer terminal. Within a few seconds the terminal operator receives a reply giving a full description of the vehicle concerned. It had been reported stolen earlier in the day.

The speed and efficiency with which this vital information is communicated and processed is made possible by the Police National Computer Unit (PNCU). At the Unit's centre in London a computer currently stores records of stolen vehicles and will later hold others, such as vehicle owners, fingerprint indices, the names of known criminals, etc. A nationwide network of Post Office private circuits links the computer with 200 terminals at police stations to provide them with rapid access to the stored records. Ultimately, the network is planned to serve 800 terminals.

The PNCU became operational early this year following more than four years' planning by a team of personnel from the Post Office, Metropolitan Police, the Home Office and various computer firms. Members of the team have worked closely together to produce the computer programs which give police throughout the country access to records hitherto not quickly available to them.

In the past a police enquiry, say, about the owner of a vehicle might take hours to resolve. The local licensing authority would have to be asked to check its records, and the enquiry may have arisen after office hours. The time taken by this process clearly held up the investigation in progress.

The speed at which the computer replies to a police station terminal varies according to the type of message, but for a stolen vehicle enquiry it is only a few seconds. This fast response is achieved despite the fact that the computer must refer to the records of more than 100,000 vehicles and that the system must cater for a message rate of many thousands per hour.

The PNCU system is based on a dual-processor Burroughs B6700 computer with a total storage capacity of 36,000 million binary digits (bits). Terminals in the police stations are either dataprinters which are similar to teleprinters, or visual display units which have a television-like screen and a keyboard similar to that of a typewriter.

Two types of Post Office private circuit have been provided to link the terminals to four data communications processors (DCPs) controlling the interface with the computer's central system. Telegraph lines operating at a speed of 110 bit/s serve the dataprinters, and the VDUs use multipoint circuits which operate at 1,200 bit/s. A multipoint circuit allows one main communications highway to be shared by up to 12 VDU terminals.

To afford a measure of control over the network, a DCP never accepts "unsolicited" messages from the VDU terminals but rather carries out a polling process in which it sends an enquiry signal down each line in turn. Basically the enquiry asks "do you have a message for me?" The polled terminal replies automatically, and if the response indicates "yes" the DCP prepares to accept the message. If the response is "no" the DCP moves to the next line and repeats the enquiry procedure. The polling process is continuous, and when the DCP has polled all its terminals in turn it returns to the first line in the cycle and starts again.

To communicate with the computer a VDU terminal operator types the message on his keyboard and presses a send key. The VDU then waits to be polled. The DCP operates so quickly – it can handle five million instructions per second – that there is no perceptible delay before it polls the terminal and the message is transmitted. The operator then waits for the result of his enquiry, which will be shown on the VDU screen. Output from the computer's central system to the terminals takes priority over input. If the computer has a message to send to a terminal it causes the DCP to interrupt its polling routine and to select the appropriate line.

It is not possible to send direct current (dc) signals over Post Office amplified routes, so modems are employed on the network serving the VDUs. The modems, rented from the Post Office, simply convert dc signals produced by the terminals and the DCPs into audio-frequency signals suitable for transmission and reconvert them into dc signals at the receiving end.

Dataprinter terminals are served by lines which are designed to carry double-current telegraph signals and therefore do not require modems. However, for long sections, the circuits are multiplexed on to speech channels of telephony carriers. This is possible because the bandwidth of the telegraph circuits is considerably narrower than that of the speech circuits.

By using multi-channel voice-frequency (MCVF) equipment it is possible to derive 12 dataprinter channels from one speech carrier. The multiplexing is carried out in Post Office equipment located at the PNCU communication control centre and various telephone repeater stations around the country. The computer is unaware of this multiplexing and the lines appear to it to be dc telegraph circuits.

Dataprinters are not polled and have an entirely different method of operation from the VDU terminals. Each character of a message is sent down the line as it entered on the dataprinter keyboard. When the operator enters an "end of text" character, a lamp on the dataprinter indicates that the DCP has received the message. The DCP operates so fast that, between collecting each character, it can continue its polling process on the VDU lines.

An important feature of the PNCU is the provision of standby facilities in the event of partial network failure. If a private circuit serving a VDU terminal goes faulty, use can be made of the public switched telephone network for transmission at a reduced signalling rate of 600 bit/s. For this purpose some lines on the DCPs are allocated for standby use and an auto-answer facility is incorporated within the computer's central system.

If a private circuit goes faulty the VDU operator can switch his equipment to standby and then dial up the standby number allocated for his use. The DCP will detect ringing current on this line and, following a series of messages and

**On a terminal in New Scotland Yard's information room, a police officer receives details from the central computer of an abandoned vehicle.**

responses between the DCP and auto-answer component, the system eventually establishes which terminal is calling. Security checks are then carried out by the system before the terminal is allowed to gain access to the central system.

The DCP will update its memory to reflect the fact that messages from a terminal are to be expected on its standby line, and this line will be polled in the normal way. A network manager has over-riding control of the auto-answer facility, and can choose to allow its automatic operation without intervention, to inhibit its initiation or to terminate transmission at any time. He can do this by means of a network management terminal, which is one of several control-mode terminals located at the communications control centre of the Unit.

The network management terminal has many facilities, one common use being to set up a terminal when it has been restored to service after a fault. To do this the network manager keys in various commands to update the central system and to instruct the DCP to start re-polling the restored terminal. Another use of the network management terminal is for interrogating the central system to establish the state of a terminal or line. For example, the network manager may wish to know which terminals are out of service or which lines are connected to a particular DCP. Load sharing between the DCPs can be effected from the terminal, using a central system facility known as reconfiguration to move some lines, and their terminals, to an alternative DCP.

If the network management terminal should go faulty, its functions are taken over by a system management terminal. The main function of this terminal is to ensure efficient running and sharing of resources for the central system and applications processes.

The size and scope of fault handling and reporting procedures which have been built into the PNCU is reflected in the fact that the network management terminal can receive more than 200 different messages to indicate the state of the network and the data communications sub-system.

Normally, however, when the computer system and network is running smoothly the network manager would not expect to receive any of these messages. But, clearly, the more information that can be given about a fault or transient failure, the easier will be the task of remedying it or preventing a major failure. The whole of the computer's central system has been designed with this in mind so that the integrity of the stored data is absolute.

**Mr J. E. Barrett** is on secondment from the Post Office to the Police National Computer Unit where he is responsible for the design of software for network administration and error handling.

PO Telecommunications Journal, Autumn 1974

# Progress with TXE2

DAE Carter
and AJ Palmer

RAPID STRIDES have been made in providing small-to-medium sized electronic exchanges, known as TXE2, under the Post Office programme to modernise Britain's telephone network. Since the first production electronic exchange was introduced in 1966 at Ambergate in Derbyshire more than 500 TXE2 exchanges have been brought into service.

These exchanges currently provide sufficient capacity for about half-a-million telephone customers' lines and the numbers continue to grow. An annual order rate of about 100 new exchanges and 100 extensions to existing equipment is expected over the next five years, involving a capital outlay of some £40 million.

When the TXE2 was introduced it was intended to be the standard installation for local exchanges with approximately 600 to 2,000 lines. Following detailed economic studies the capacity has since been extended to cater for local exchanges serving 400 or more lines provided that the ultimate capacity of a single unit will not exceed 7,000 lines and the traffic to be handled is within certain limits related to the switching capacity of the equipment. A second exchange unit with identical capacities can be provided if required to meet growth. This meets the requirements for local exchanges in most small towns and rural areas where there is a high proportion of residential customers.

Another important development of TXE2 has taken place to meet situations where it is necessary to provide telephone service quickly. A mobile version of the exchange, designated MXE, has been introduced which can be moved around the country to provide service where it is urgently required, as part of the Post Office's drive to reduce the waiting list for telephones. The MXE can also be used to meet emergencies, for example, in the event of interruption to normal operation at an exchange due to fire or flooding.

Electronic equipment is well suited for mobile exchange applications because it is lighter in weight, more compact, has fewer moving parts and is more reliable than existing mobile exchange equipment. A 1,000-line MXE consists of two trailer units, one containing the control and power equipment and the other switching equipment, providing more than twice the capacity of existing mobile exchanges. Increased capacity can be provided by the addition of a third trailer to cater for a maximum of 2,000 lines. The first MXE came into service last year at Padgate, Lancashire, to provide lines for new telephone customers and to cater for growth in Warrington new town. Believed to be

One of the trailer units of a TXE2 mobile electronic exchange is equipped at the Beeston, Nottingham, factory of Plessey Telecommunications.

the first of its type in the world to go into operation, this MXE is providing service pending the provision of a new permanent exchange at Padgate.

In the light of practical experience gained in the field, the original design of TXE2 equipment has proved to be basically satisfactory. Some minor changes have been necessary to meet service requirements and to overcome some capacity limitations.

One significant change to meet current Post Office requirements concerns the register which receives the digits dialled by a caller and controls the setting up of a call. The original register was designed for an exchange with a four-digit self-contained numbering scheme. Where required it permitted the direct routing of calls to nearby exchanges following the examination of up to three digits of the number dialled.

The current register provides for a local numbering range containing four, five or six digits and for the examination of up to four digits of the number dialled. The latter facility allows access to adjacent switching centres over direct junction routes to be obtained by dialling the national or local code as appropriate. These improved facilities now permit TXE2 exchanges to be included in linked numbering schemes with minimal additional cost because the number of switching stages is constant, irrespective of the length of the customer's telephone number.

The integration of all exchanges into numbering group linked numbering schemes – that is, where all exchanges in a group share a common national code – and the use of national code dialling procedures for access to exchanges outside the home numbering group (as a long-term objective) will eliminate the need for local code dialling and individual exchange dialling instructions.

With so many TXE2 exchanges now in service, the advantages of electronic equipment compared with Strowger electro-mechanical equipment are being realised in practice. For the Post Office one of the major advantages is that the planning, design and installation of new exchanges and extensions to existing equipment are easier and quicker to carry out. Basically this is because the equipment is of modular design and, being more compact than Strowger, it occupies less space.

The key components of the TXE2 are miniature reed relays which are used to switch speech paths through the exchange. The precious metal contacts of a reed relay are enclosed in an hermetically sealed glass envelope to prevent contamination and ensure long life with minimum maintenance effort. With the reduction in maintenance requirements TXE2 equipment lends itself to eventual part-time maintenance by specialised staff from a central control point.

Other benefits of TXE2 include a simplified procedure for tracing calls and in-built facilities for measuring exchange performance. It also allows complete flexibility in the allocation of customers' telephone numbers, enabling full use to be made of the fitted number capacity of the exchange. For example, it is not necessary to reserve spare numbers for a private branch exchange (PBX) to cater for expected growth. Additional PBX lines can be provided without the need to change the customer's number as is often the case with Strowger exchanges.

Another important customer facility is the ability of the TXE2 to initiate automatically a second attempt if the original path through the exchange proves unsuccessful. Electronic switching equipment operates much faster than Strowger thus allowing the second attempt, using an alternative path through the equipment, to be carried out without any additional action by the caller or delaying completion of the call. The alternative path gives a greater chance of effecting a successful connection than at Strowger exchanges where, particularly in less busy periods, the same path through the equipment is often encountered on successive calls.

The likelihood of encountering background noise while a call is in progress is also substantially reduced with TXE2 exchanges. This is because the enclosed contacts of the reed relay provide a quieter speech path than the exposed contacts in Strowger exchanges.

The present service being given by the TXE2 has fully justified the decision by the Post Office to go ahead with the provision of electronic switching equipment for local exchanges. It will soon be followed by the introduction of the larger version of the electronic exchange, known as TXE4. (See the article on page 24 of this issue.)

This step forward in telecommunications is a tribute to the co-operation and development work carried out by both the Post Office and the telecommunications industry.

**A Post Office engineer makes final wiring connections at the Taff Wells TXE2 exchange near Cardiff. The equipment was manufactured at STC's factory only one mile away.**


**Mr D. A. E. Carter** is head of a group in the Local Exchange Systems Planning and Design Division at Telecommunications Headquarters.
**Mr A. J. Palmer** is a Senior Telecommunications Superintendent in the same group.

# Manpower needs planning


## PA Long



**An important aspect of personnel work in Post Office Telecommunications is planning to ensure that staff recruitment and development will meet the future needs of the business.**


A NUMBER of major changes have taken place in Post Office Telecommunications in recent years, and most of these developments have had important effects on staffing. The setting up of separate Telecommunications and Postal Businesses, enormous growth in the telephone system, increasing mechanisation and computerisation, and improvements in staff productivity have each affected the numbers, levels and types of Telecommunications staff employed, which currently totals about 240,000.

The overall effect of the changes has been that for several years the number of staff has increased by only 1-2 per cent annually, although Britain's telephone system has grown steadily by about 8-9 per cent each year. However, the relatively low overall growth rate in staff numbers masks some more pronounced changes in specific groups. For example, the number of operator service staff has fallen with the widening availability of subscriber trunk dialling (STD), but management posts have considerably increased.

Most changes have taken place reasonably smoothly as far as staffing is concerned, but the size and complexity of operations will continue to increase in the years ahead. Therefore the future in terms of manpower needs to be as carefully planned as that for equipment and services.

How does the Telecommunications Business plan its manpower? The first stage consists of forecasting the total number of posts, of various types and skills, that will be needed in each location in the future. This can be done by studying the projected plans for the telecommunications network and then applying predicted productivity ratios to calculate the number of staff required to undertake various tasks. Allowances must be made for constraints of finance and accommodation, as well as for any forecast changes in job responsibilities. The results of this study are known as demand forecasts.

When it is known how many staff of various types will be required at each location in the future, the next stage is to decide how to obtain this manpower. Some people are already in post and will remain there. Others are employed at present but will leave, either to transfer to a new post within the Business, perhaps on promotion, to retire or to resign. Some of the posts do not yet exist. To make realistic plans for the future each of these groups must be quantified to calculate how many posts will need to be filled by transfer or recruitment.

Once an estimate of vacancies has been produced, consideration must be given to how they will be filled. The four main ways of filling a post are by transfer, in-line promotion, special selection (including limited competition) and recruitment from outside the Business. The proportions of vacancies which may be filled by each of the last three methods depends mainly on union agreements and on the availability of suitable talent.

The number of people remaining in their present jobs together with those filling vacancies by one of the above methods will be the total number of people employed. The whole process of planning the provision of staff to meet manpower demand is known as manpower supply planning. It includes various feedback lines which are built in to allow management to change its plans or manpower requirements to take account of potential difficulties in finding suitable staff. Manpower supply planning may therefore be regarded as two closely interwoven procedures, namely the forecasting of vacancies and planning to fill those vacancies.

Most vacancies requiring to be filled result from the loss of existing staff, who leave the Post Office mainly by one of two routes. Many retire each year after a lifetime's service, but a considerable number resign voluntarily after only a few years. The relative importance of these two types of losses varies from grade to grade, and from time to time.

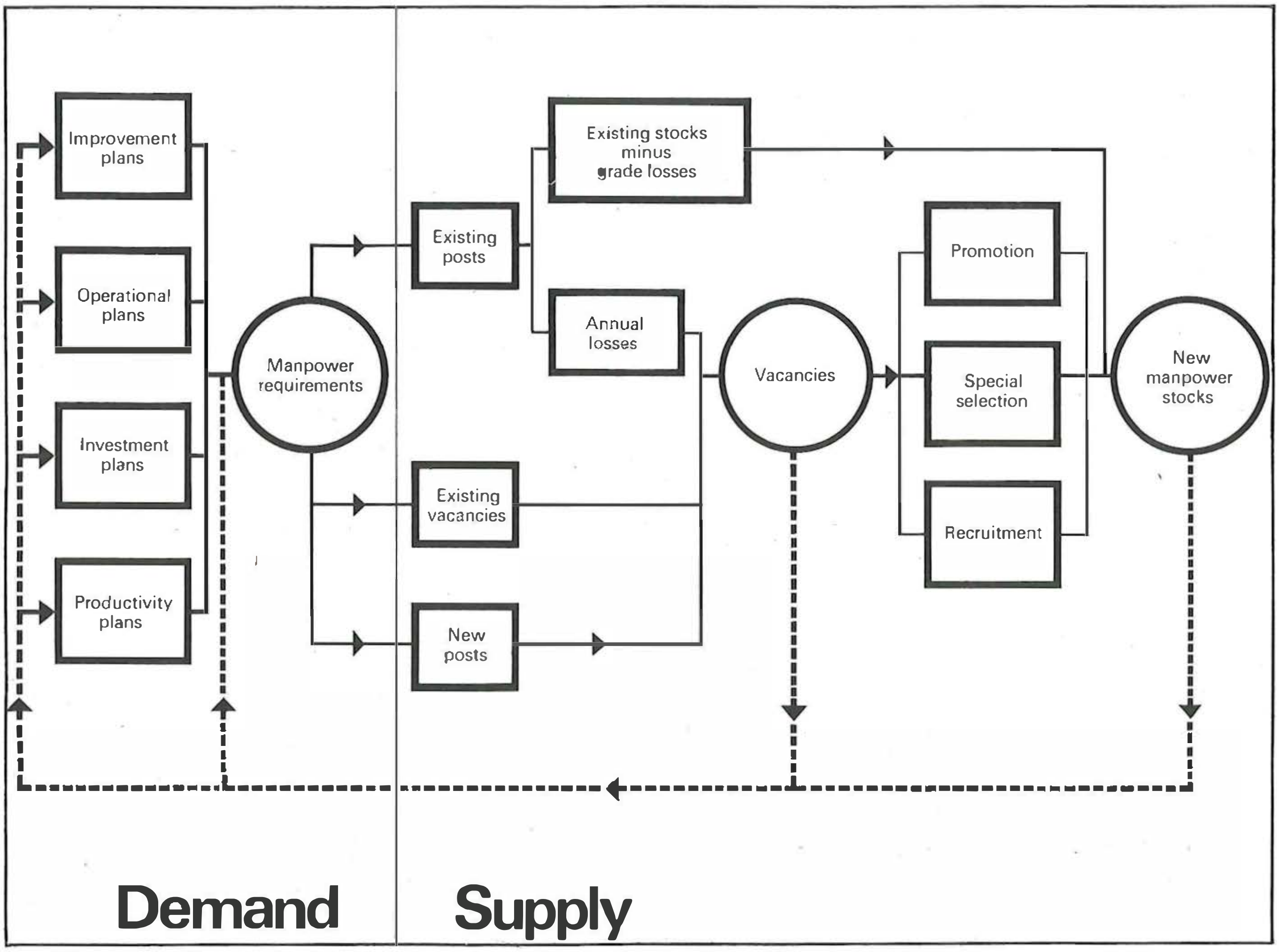
Generally, resignation is the main source of losses to the clerical and operator service functions, whereas retirement is far more prevalent in management and engineering grades. Thus when planning for operating and clerical work the main energies are concentrated on the forecasting of resignation. For the remainder, retirement is a more important factor to be considered.

Forecasting of resignation is based almost entirely on historical trend, because various studies have shown that this is an effective method. Local employment conditions have surprisingly little effect on resignation rates.

Staff retirements are comparatively straightforward to forecast, because they happen within a very restricted age range. It is relatively easy to move from a knowledge of the number of people approaching or over 60 years of age to a reasonable forecast of the number of retirements over the next few years. For example, from the age distribution for staff in the traffic management grades, it can be predicted that the retirement rate will be high between 1978 and 1988 and again beyond 2000.

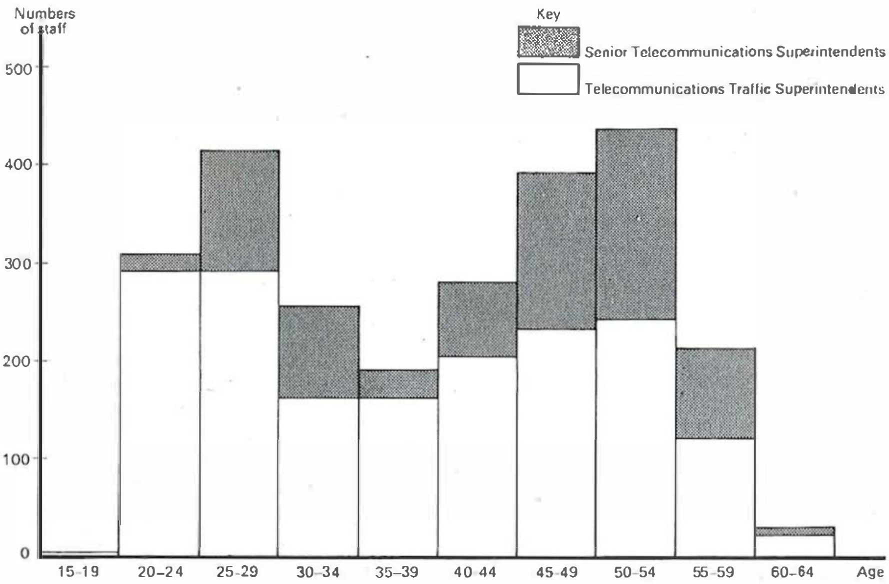
Thus staff losses from the Business over the next few years can be forecast and used, together with estimated new posts, to arrive at the number of vacancies to be filled year by year. Of course, these forecasts may not be exactly correct, because most losses depend on decisions by individual people. Consequently, plans for providing the staff required must be reasonably flexible.

Prospects of maintaining satisfactory staffing in the future will be improved if it can be ensured that the vacancy rate never goes to extremes. A very high vacancy rate can lead to people being




**Above: The manpower planning process. It includes feedback lines to allow management to change its plans or manpower requirements to take account of potential difficulties in finding staff.**

**Below: Current age distribution among traffic management grades in Post Office Telecommunications. It indicates that the retirement rate will be high between 1978 and 1988 and beyond 2000.**




over-promoted because of a shortage of suitable staff. In any case, it strains the recruitment, training and promotion machinery, and lowers efficiency temporarily, if jobs are being filled by people lacking the necessary experience. Conversely, a low vacancy rate creates fewer opportunities for promotion, which saps morale and might result in the best of the younger staff leaving the Business.

The most effective way of ensuring a reasonably stable vacancy rate is to attain age structures within individual grades which will maintain themselves over time, because this will ensure that the number of people reaching retirement will remain constant over time. The particular form of age distribution to be chosen will depend very much on the personnel policies to be followed.

To summarise, full use must be made of all planning techniques not only for equipment, as at present, but also for staffing. Manpower planning is a means of analysing future needs of the Telecommunications Business and of planning recruitment, development and training to meet those needs. Lack of such planning can be costly in human as well as financial terms.

Above all, the manpower planner must always realise that he is dealing with people, not just numbers. He must therefore advocate policies that will not only meet the needs of the Business but will safeguard the interests and aspirations of everybody in it.

**Mr P. A. Long** is head of the Manpower Supply Division in the Personnel Department at Telecommunications Headquarters.

# Proving ground for the developers

HG Smith

FOR FIFTY years now engineers at Post Office Headquarters responsible for the development of telephone exchange systems and customer apparatus have been provided with the support service of a well equipped Circuit Laboratory. It provides a practical proving ground for circuits and systems where tests can be applied to reveal how a new design is likely to perform in field service, and to investigate failures under realistic service conditions backed by the wide resources of a laboratory.

The laboratory's main function has remained unaltered through a half-century of technological evolution, and there is no significant system or apparatus either in operation or planned to which it has not made some contribution. These activities have included work on the early automatic telephone exchanges of proprietary types, the 2000 and 4000 types of Strowger automatic exchange, and more recently the TXK crossbar and TXE electronic exchanges. In addition, the laboratory made substantial contributions to the development of trunk mechanisation and subscriber trunk dialling (STD).

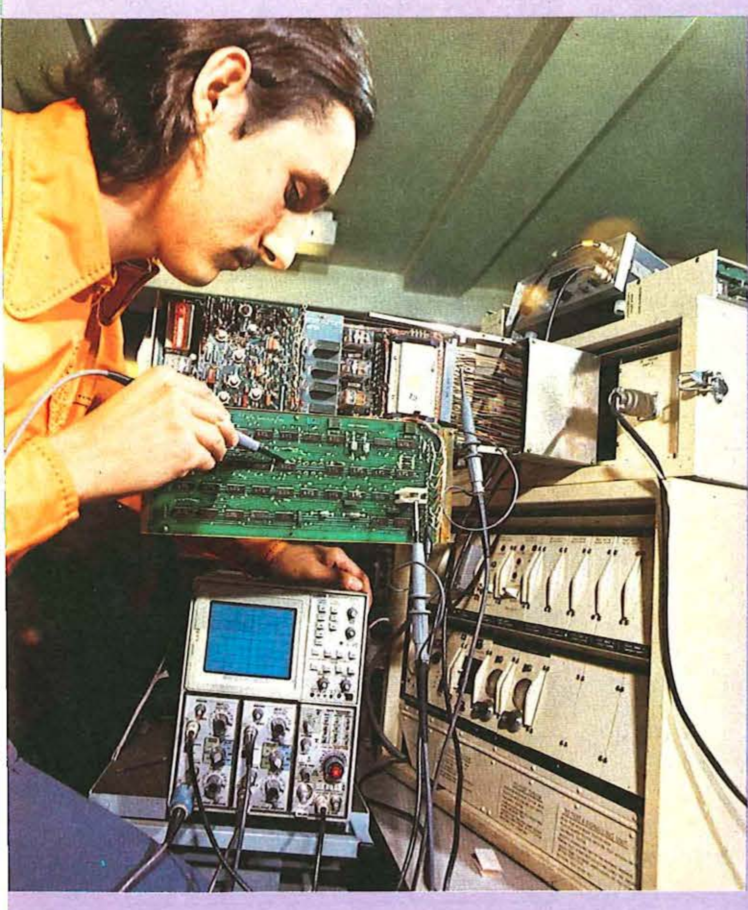
Although existing primarily to assist engineers in exchange and customer apparatus development, the laboratory extends services to other departments at Telecommunications Headquarters whose needs do not justify setting up their own facilities. For example, it also

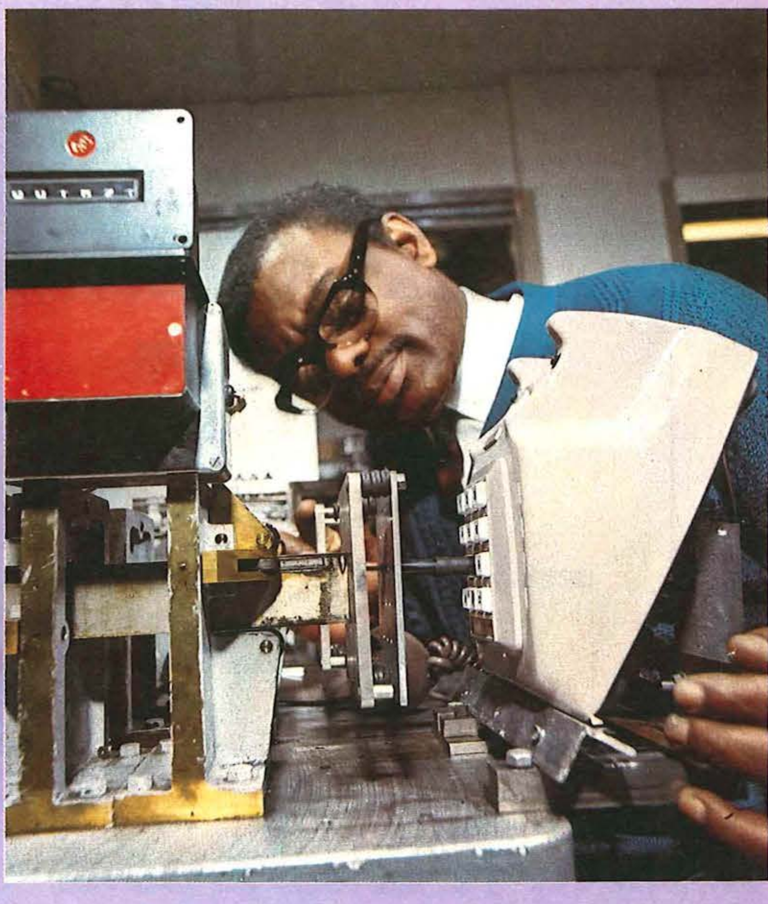
**Below, left to right:**
A manufacturer's sample of AC9 signalling equipment undergoes performance testing in the Circuit Laboratory of the Post Office Telecommunications Development Department.

A key of this push-button telephone (Keyphone) is repeatedly depressed on a bench rig during laboratory tests on its mechanical operation. A meter records the number of times the key is operated.

Electrolytic capacitors are placed in a cabinet in which the humidity and temperature are closely controlled. These environmental tests are carried out to assess the long-term reliability of the capacitors.

"At the third stroke"—announcements for the Speaking Clock telephone information service are re-recorded from a master tape on to one of the magnetic drums used to operate the service. The Circuit Laboratory has carried out similar work for overseas administrations.





carries out investigations for the Service Department of field problems – such as faults in exchange systems – which may necessitate redesign work, assists in field trials of new systems and provides nationwide maintenance of magnetic drums used in register-translator equipment for large STD exchanges.

Scientists are not employed by the laboratory, nor does it overlap the work of the Research Department or the laboratories of the Materials Sections of Purchasing and Supply Department. The approach to its work has always been practical, and it insists on models and prototypes for test being properly constructed and as far as practicable accurately simulating production equipment which the Post Office would obtain from the manufacturers. To this end the laboratory has model shop facilities where equipment can be built and wired.

From the early days the construction capability has been invaluable for work beyond that for which the laboratory was set up, and a considerable amount of equipment has been built for field service. For example, development of testers for new systems tends to lag behind that of the systems they are intended to service. However, the test equipment is required as soon as a system has been built and commissioned, and to meet this need the laboratory's workshops can quickly produce small numbers of testers to rudimentary documentation. This capability was also put to good use during the Second World War when the workshops constructed large numbers of equipment for the armed services, primarily for air defence.

In the early 1920s it was decided that the Post Office would use the Strowger step-by-step system for its telephone exchanges and, initially, the laboratory's main work was the evaluation of manufacturers' proprietary systems. A theoretical evaluation of the designs would be carried out by headquarters development engineers, but the final proving of the electrical and mechanical soundness rested with the laboratory.

Although the development engineer specified the features to be tested, the laboratory decided how to perform these tests and the group doing the work would not only observe and report on the specific points required but also on any other relevant details revealed during the tests. When, later, a higher degree of system standardisation was achieved and Post Office involvement in design work became greater, the laboratory still guarded its position of independence, holding itself free to report impartially on its work.

The need for close co-operation between the circuit laboratory and Post Office Headquarters development engineers has always been a controlling factor in its location. It was established in 1924 at King Edward Building, in central London, with a staff of three, and by the end of that year the concept of simulating realistic field conditions has led to the employment of eleven minor grades to carry out the bulk of testing work. The laboratory continued to expand with the increase of new systems, and today it employs 25 major grades and 160 minor grades.

In 1953 the laboratory moved into Armour House in St Martins-le-Grand, where the accommodation included a large room with high ceilings into which racks of equipment of every system the laboratory was required to work on could be installed. The development and evolution of each system extends over a long period, and this apparatus hall presented an interesting cavalcade, from pre-2000 type UAXS to STD register-translators. Surrounding the main apparatus room were numerous smaller rooms used for offices, life testing rigs, power plant, workshops, stores, photographic work and all the other fringe facilities needed by the laboratory.

By the middle 1960s the need for high-ceiling accommodation for the installation of racks of equipment was reducing, but there was a growing need to test smaller electronic systems and sub-systems. So in 1968 the laboratory moved for a second time, to London House in Aldersgate Street. At this time ▶

reorganisation of the old Engineering Department led to a rationalisation of the laboratories of various Branches. To the Circuit Laboratory (operated by the Telephone Exchange Standards and Maintenance Branch) were added the smaller laboratories of the Telephone Electronic Exchange Systems and Subscribers Apparatus Branches.

Integrating the work of the three laboratories was fairly simple as there was much common expertise, but the final rearrangement of the accommodation has still to be completed. Ultimately, the laboratory will be spread over three locations, with the major part in London House, with customer apparatus and attachment evaluation in Armour House, and with workshops and stores at Holloway in north London.

It has been necessary to retain the apparatus hall in Armour House because of the need to house full-size racks of apparatus. Additionally, Armour House now accommodates two large "silence cabinets" which form part of a self-contained test house for the subjective evaluation of new-style telephone instruments. The "silence cabinets" are basically rooms sound-proofed to a high degree in which two people communicate with each other by telephone so that instrument performance can be evaluated under strictly controlled conditions.

The recruitment of major grades for the Circuit Laboratory has never presented a problem as the diversity and highly practical nature of the work makes it attractive to staff. However, there is no large pool of minor grades from which laboratory staff can be drawn, and the highly satisfactory arrangement of drawing on staff with experience in Telephone Areas is rarely possible. From early days, therefore, the laboratory has recruited and trained its own apprentices.

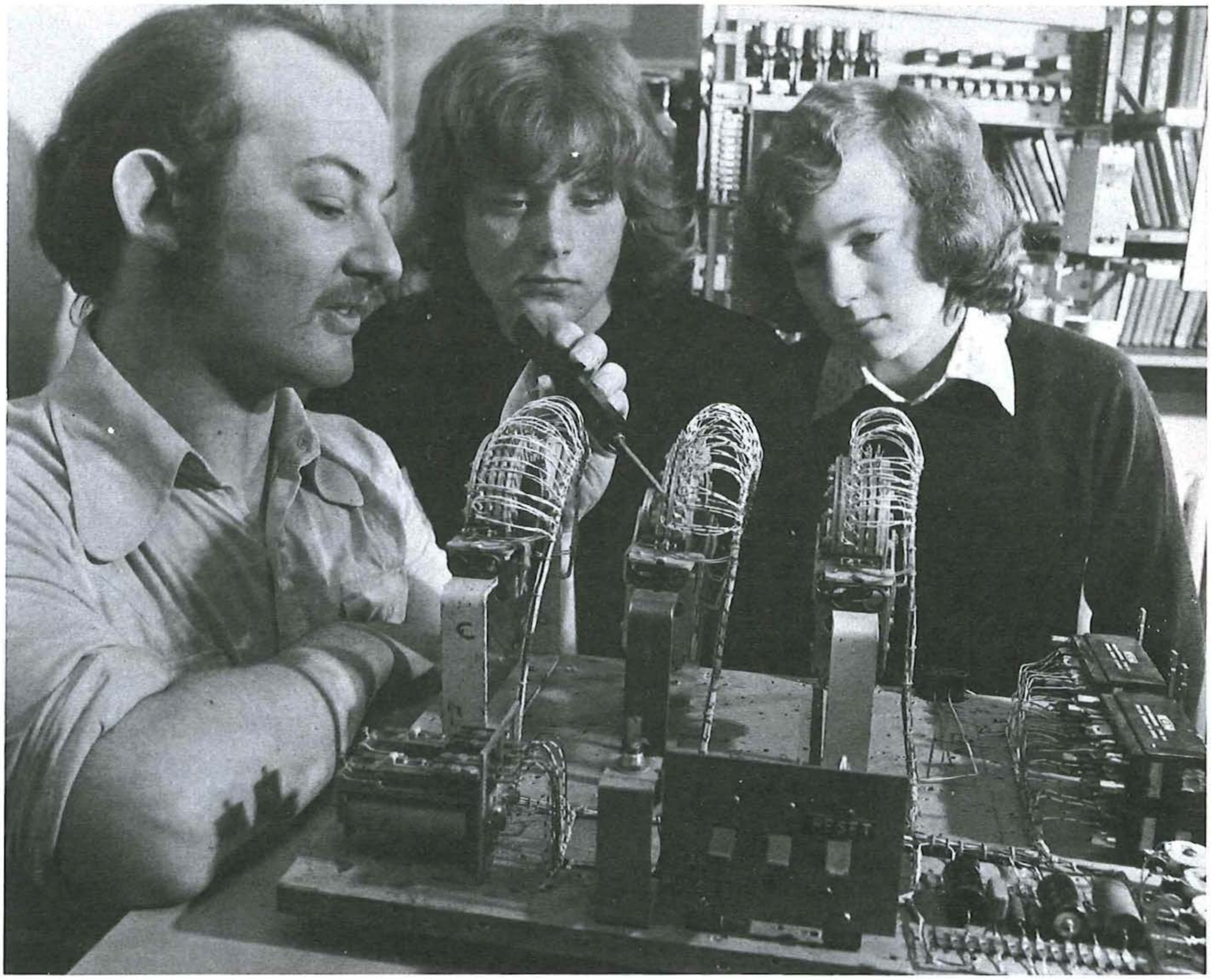
There are between 30 and 40 Telecommunications Technician Apprentices (TTAs) on the laboratory strength at any one time. Training is mainly "off-the-job" in a purpose-built area, and the apprentices' training period also includes a substantial period in an Area receiving on-the-job tuition, as well as block release for technical studies. The laboratory has a very good record for further promotion of its young entrants, and many present-day senior engineers can trace their progress from a start as a Circuit Laboratory youth-in-training.

The Circuit Laboratory has served the Post Office well during the last half-century. It has always been an adaptable organisation, capable of taking on work at the forefront of rapidly advancing technology, yet, maintaining expertise in older systems now out of the limelight. There seems every likelihood that the next 50 years will be as successful.

**Mr H. G. Smith** is head of a section in Telecommunications Development Department responsible for electronic component standardisation and operation of the Circuit Laboratory.

PO Telecommunications Journal, Autumn 1974

**In the laboratory's training section Telecommunications Technician Apprentices receive guidance on an exercise to design and construct a pulse generator for testing a circuit.**



# International service looks to the future


## EL Bubb and AH Blois

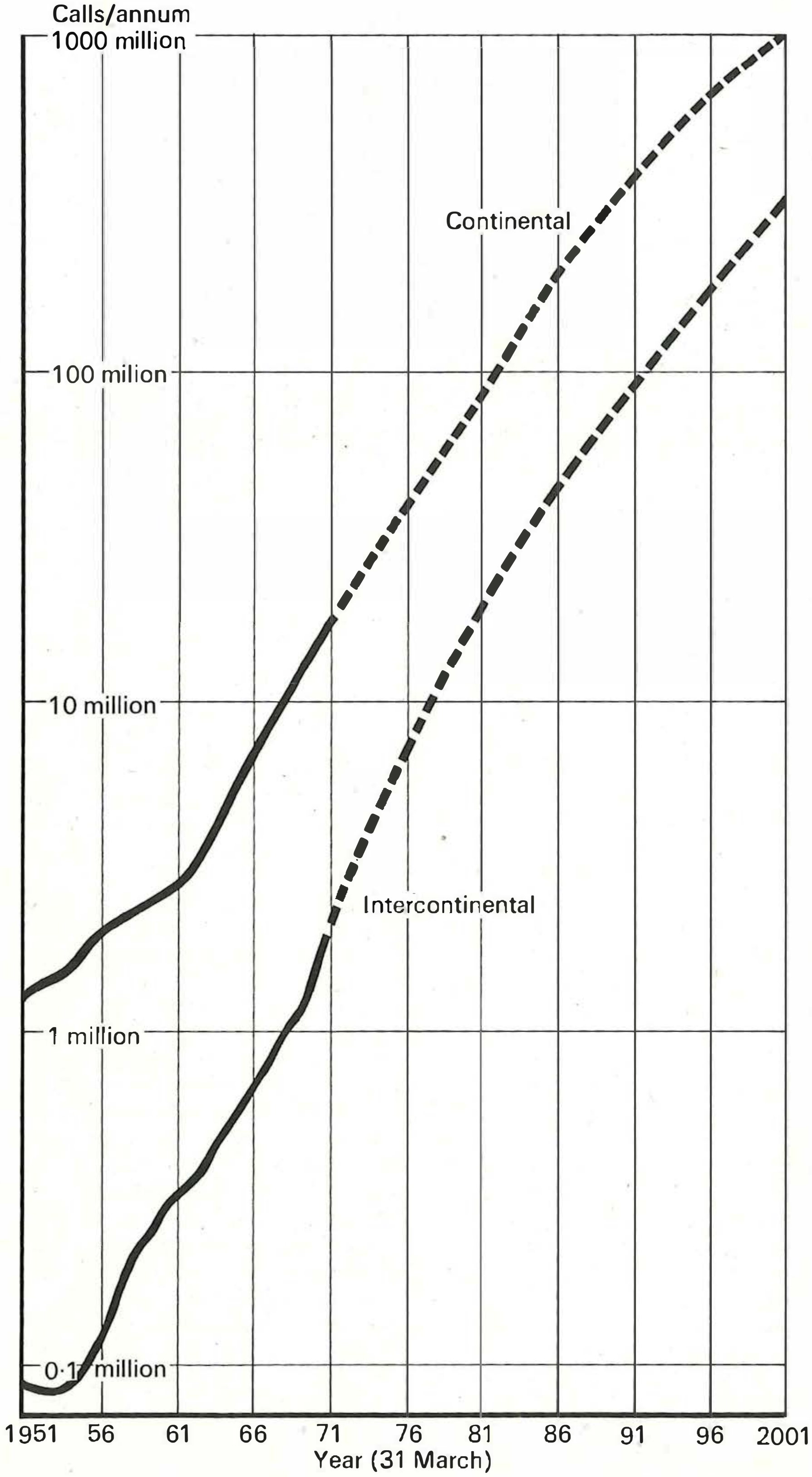

**The number of calls handled by the Post Office's international telephone service is increasing rapidly each year. A study has been carried out to forecast growth patterns up to the turn of the century, and to make recommendations on the size and shape of the future UK international network.**

IN RECENT years sophisticated technology has produced wideband submarine cable systems and satellites for telecommunications. These developments have simplified and lowered the cost of providing large numbers of international telephone circuits and, together with other developments, have enabled international subscriber dialling (ISD) to be provided in the United Kingdom, first to Europe and then to other continents.

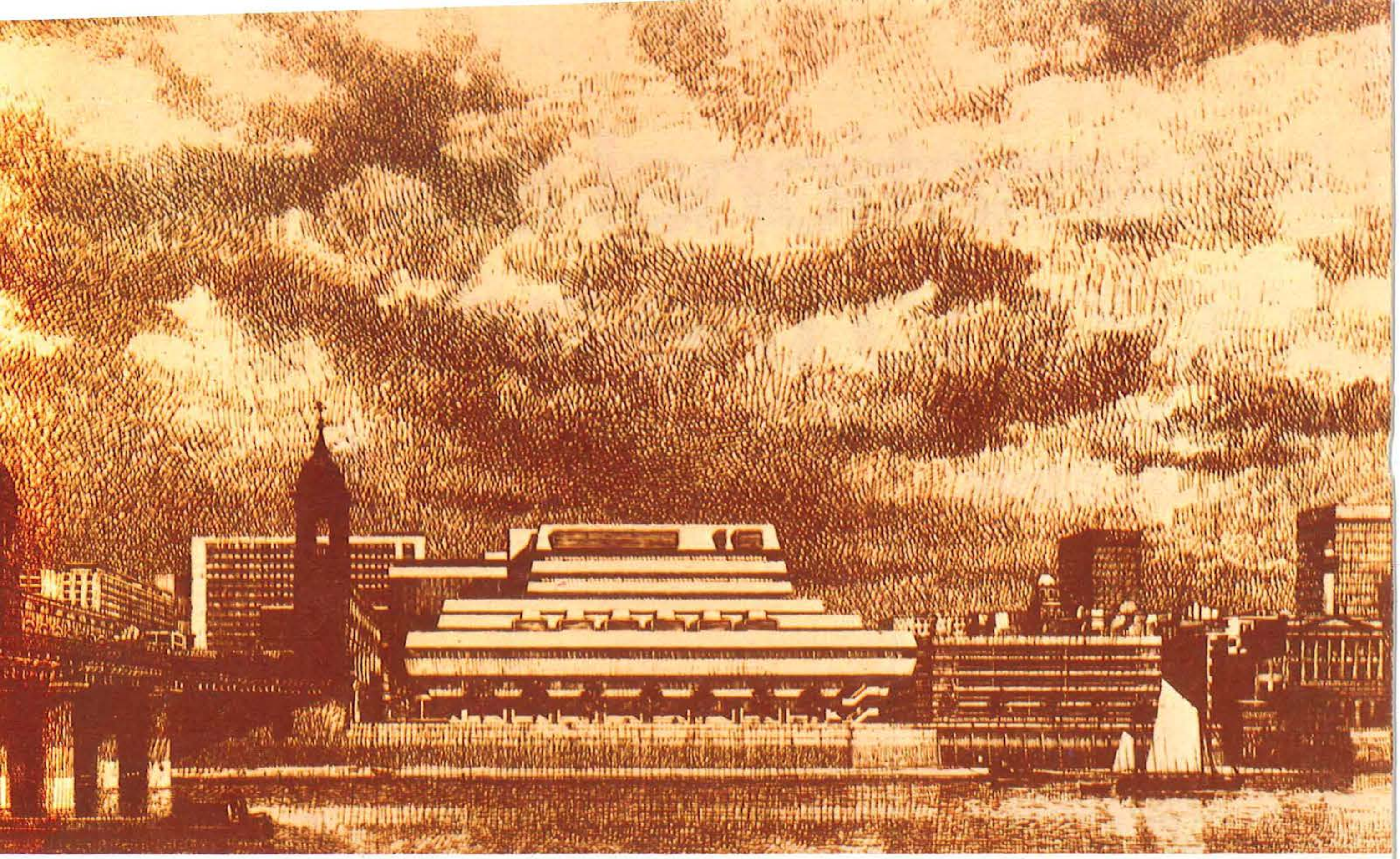
Initially it was possible to offer a fully automatic service only to subscribers in London, who make about 60 per cent of all Britain's international calls. However, the service was rapidly extended to other large cities, and the rest of the country is steadily being covered as the necessary access equipment is installed at inland trunk switching centres.

At present more than 60 per cent of all international calls from the UK are dialled by subscribers. This figure should rise to 90 per cent by 1980 as plans to extend the availability of ISD both in this country and to other countries, such as Australia, are realised.

Calls the subscriber cannot yet dial or on which he requires operator assistance are handled in 16 switchrooms, most of which are in London. Decentralisation started recently with the opening of switchrooms in Brighton, Leicester and Glasgow as part of a £1 million Post Office scheme to simplify and speed up ▶




**Forecasts of effective international telephone calls originating in the UK.**



**Artist's impression of Mondial House, a large new international switching centre now taking shape on the waterfront of the River Thames.**

operator-connected calls from places outside London.

Partly as a result of the improved service being offered, but also because of increasing world trade and travel, UK international telephone traffic is growing by about 25 per cent each year. To plan for orderly expansion of its international service, especially at this rate, the Post Office needs to know the likely situation 20 or 30 years ahead. Therefore the External Telecommunications Executive (ETE) and other Headquarters Departments responsible for development and planning set up a small study team within ETE to examine and make recommendations on the size and shape of the future network.

The team first assessed how much telephone traffic there would be in future years and then how it would be spread over the year and the daily pattern. It also determined where calls would come from and their destinations, both within the UK and around the world. Only then was it possible to shape the network and to see how best to exploit the developing techniques of digital transmission and processor controlled switching equipment.

Estimates of future traffic were based on daily records of calls originating in the UK, which are collected for international accounting purposes and provide a long historical record. The study took into account likely changes to this pattern, such as the release of traffic at present suppressed because of congestion and lack of automatic service, the emergence of new international trading patterns and the transfer of traffic to and from other message services such as posts and telex.

Automation of the intercontinental telephone service has been slower than that of the continental service, and separate forecasts were therefore made for each service in the study. By 1991 the total number of international calls originating in the UK is expected to grow to about 20 times the present level, with the intercontinental element expanding at almost double this rate. Forecasts become increasingly speculative as they are extended, but a further trebling in size looks likely by the turn of the century.

In addition to traffic originating in the UK, the study team was also concerned with incoming calls terminating in this country and with international transit traffic. Incoming traffic differs in some respects from originating traffic – for example, in the time at which the traffic peaks – and consequently some aspects of the incoming traffic required separate study. International transit calls are likely to be a reducing proportion of the total traffic as direct routing between countries increases, but there will be a continuing need to handle this traffic.

The amount of equipment required in the network depends on the number and duration of those calls which have to be handled during the busiest period, that is, the busy-hour. Although busy-hour traffic will be directly related to the number of calls each year, it will also depend on such factors as business and social patterns, service policy and on certain technical characteristics of the network. By taking account of these factors it was possible to forecast future total busy-hour traffic within a band of upper and lower limits.

As the study developed further evidence became available which suggested that the traffic levels would probably be nearer the upper limits of the forecast, at least until 1991. This means that some 45,000 erlangs will need to be switched in 1991, by which time the increase in traffic each year will be greater than the whole of the present switching capacity.

The forecast can be seen a little more in perspective when compared with inland trunk telephone traffic. At present international calls originating in the UK represent about two per cent of inland trunk traffic. By 1991 an increase to about six per cent is forecast, and perhaps double this figure at the turn of the century. These large increases appear credible against a background in which the telephone service currently accounts for 50 per cent of all inland messages – that is, by telephone, telex, telegram and post – but only three per cent of international messages.

As already mentioned, in planning for the future it is important to know where the telephone traffic will come from and its destinations. In forecasting these distributions the problem was mainly one of changes in communities of interest. For example, at present some 55 per cent of UK international calls are concentrated within a four-mile radius of inner London while the rest of the capital accounts for 10 per cent. The remaining traffic is thinly dispersed over the rest of the country.

The study concluded that over the next 30 years the proportions in London would decline slightly, but that the main users of the international telephone service would remain in the South East, despite efforts to spread the population and industry over more of the country. In addition, some 16 countries – 12 of which are in Europe – account for more than 90 per cent of the international traffic while the remainder is shared among some 75 other countries.

When considering the networks which should be built up to carry the rapidly growing services a number of factors need to be taken into account. The optimum arrangement will depend on the quantities of traffic and on the direct economic and other less easily quantified consequences of the various systems configurations which could be adopted. The problem is further complicated by having to expand from the present configuration in which all international traffic is handled by two switching centres in central London.

The network study has not yet been completed, but certain principles have emerged. Even with the additional circuits which will be needed to carry the vast increases in traffic, it is unlikely that the landing areas for submarine cables will differ very much from the present geographical pattern. Only a limited number of suitable sites are available, and a complicated "bird's nest" of undersea cables must be avoided. On the other hand, as expansion in the use of satellite transmission takes place it is likely that new sites will be required for additional earth stations. The cost of both the national and international networks associated with the submarine cable and satellite "landing areas" will influence the location, size, number and manner of use of the switching centres.

The 16 or so countries which account for the majority of the UK international traffic will require very large groups of circuits. Routes of this size may be split between a number of switching centres without incurring undue penalties in terms of additional circuits. However, with the other countries which have low levels of traffic only small numbers of circuits will be required for each route. Because of the non-linear relationship between traffic and circuits at this level, significant penalties are incurred if routes are divided, and hence the number of switching centres used for this traffic should be kept to a minimum.

The higher cost of international circuits compared with national circuits results in a shift in the balance of advantage between bothway and unidirectional operation. In the case of large routes the optimum can be obtained by operating a small proportion of the circuits in the bothway mode. Bothway operation of a larger proportion of the circuits is, of course, necessary on the smaller routes.

Weighing against network economics are such considerations as ease of network management and flexibility to meet deviation from forecast growth patterns. These considerations tend to favour a network of switching units serving UK geographical areas. Here, of course, the traffic pattern or distribution across the UK is important. As already explained, indications are that in London international calls will continue to be highly concentrated in the central four-mile circle, whereas outside the capital traffic will be fairly evenly and widely spread. The difference in concentration is so marked that the two situations need to be considered quite separately.

In London the volume of traffic on the major international routes could justify connecting some international circuits directly to the inland trunk centres. A proposed alternative, however, is direct connection of local exchanges to international switching centres. (Incoming traffic is already routed in this way, but in this direction there are no problems of charging or of separating inland and international calls.) International switching centres for this traffic would, as now, be most economically located in or near central London.

The wide diffusion of provincial traffic indicates a continuing need for separate international switching centres. In the case of the larger international routes, traffic levels are sufficient to support the siting of these centres in the provinces. For the smaller routes amalgamation of their traffic with the corresponding London stream is the most economic solution. Transit traffic, which is mainly associated with the smaller routes, should follow the same pattern.

By 1981, with almost universal ISD, operators will need to be involved only if assistance or a special facility such as a personal or credit card call is required. Intervention on incoming calls will only be needed when distant operators are experiencing difficulty. Even so, if the assistance traffic is allowed to grow at the same rate as the total traffic, the manpower requirement of the service would become excessive. Growth in the number of calls requiring operator intervention could be restrained and the time required to deal with each call reduced by action in the areas of tariff policy, operating procedures, publicity and technical development.

Reasonable targets for the end of the century would be less than three per cent of outgoing and one per cent of incoming calls requiring operator assistance. If these targets can be achieved the international operating force should not need to rise above three times its present size.

**International telephone control centres are being provided to simplify operator-connected calls from places outside London. This centre at Leicester covers the Midlands and East Anglia.**

**Mr E. L. Bubb** and **Mr A. H. Blois** are heads of sections in the External Telecommunications Executive of the Post Office. They were members of the team responsible for the long-range study of the international telephone service.

# Managing with computers

## DI Wild

**Computer terminals give Post Office Telecommunications staff at different locations ready access to central computer facilities. Initially provided to assist the work of scientists and engineers, terminals are being used in increasing numbers for a wide range of management tasks in Regions and Telephone Areas.**

AS THE SIZE and complexity of modern business increases so, too, docs the information which managers have to assimilate and analyse. Furthermore, only certain parts of this information form the basis for making any one decision, and careful scrutiny is therefore needed to extract the relevant data.

The application of scientific management techniques helps to improve the quality of decision making, but these methods usually require further analysis of already large amounts of information. A computer is one of the range of tools which the modern manager can use to assist him in this work.

At one time direct access to computers was the exclusive field of the data processing professional. Now, following the continuing development of suitable computer techniques and terminal equipment, the business manager can use the full facilities of a computer in his office. These facilities are also becoming more readily available to local management throughout the country as knowledge is acquired of the advantages in using remote terminals to gain access to a central computer.

Terminal computing in Post Office Telecommunications really started in 1961 when a computer was installed in the Research Department at Dollis Hill for use by engineers and scientists on an "open shop" basis. The success of this arrangement prompted the installation of a more powerful machine at Telecommunications Headquarters (THQ) for telephone exchange simulation studies. Simulation is a technique used in this instance for exploring the potential call carrying capacity and efficiency of a proposed design of exchange, in which the computer is programmed to behave like the exchange.

In the late 1960s terminal access was arranged to a commercial computer bureau in response to demand for immediate computer facilities by engineers working at locations remote from the central computer. Demand has continued to grow to the extent that there are now nearly 200 remote terminals in use at telecommunications locations up and down the country.

During the time in which these "open shop" facilities have been available in the business, the range of work has widened considerably. Initially the facilities were used for complex scientific calculations. Later a project team investigated the application of computer techniques in the exchange planning field and recommended the provision of terminals for design staff at Regional Headquarters (RHQs).

It was not long before other problem-solving applications were found for the terminals by regional staff. Much of this use lay outside the design groups, so control of the terminals was moved to the management services units who were able to devote resources to support this work. Advisory officers were appointed to provide local advice and assistance to users and to stimulate the development of work and projects. Since then terminal computing has penetrated further throughout the business, using both Post Office computers and those of commercial bureaux. Terminals are now in operation in most of the country's 62 Telephone Areas and others are being installed at a steady rate.

As a further step in providing a nationwide service for staff who need ready access to computers in their day-to-day work the Post Office recently put into operation a powerful IBM 370/168 machine (see Telecommunications Journal, Spring 1974). It is taking over the work of five existing Post Office computers and will also handle the work previously placed with commercial bureaux. The computer can serve 600 terminals, 200 of them simultaneously, and this time-sharing facility will eventually handle the work of about 3,000 users in Post Office buildings throughout the country.

The simplest type of terminal is basically an electric typewriter which the operator uses to communicate with a central computer over the Public Switched Telephone Network by means of Post Office Datel 200 service. Instructions are typed by the operator in a rigidly defined syntax, called a language, and the computer responds with messages which are transmitted to the user's terminal and printed out either in numerical form or in plain language. These terminals differ from the visual display types currently being used for trials of the remote input of information for major telecommunications computer projects, such as payroll and telephone billing.

A terminal enables the user to store large quantities of data in the distant computer and to gain rapid access to this information when required. It also provides the user with fast response to problems by enabling him to employ centrally stored computer programs – that is, sequences of instructions for specific tasks – to carry out extensive calculations entirely under his own control. For example, the engineer or scientist who has constant access to a computer can feed in information and receive immediate answers throughout the time he is devoting to a problem.

The programs used by Post Office Telecommunications originate from three main sources. Computer manufacturers and operating companies offer a basic "library" which may be of general application to their customers. Typical programs are for accounting and discounted cash flow purposes, mathematical forecasting techniques and the analysis and design of electronic circuits. Of increasing importance are programs which enable a user to extract information very rapidly from a large computer file of data.

"Library" programs have also been developed by the Post Office for use in most areas of the business, although the scientific origins of terminal computing mean that there is still a strong bias towards technical work. Among these are programs which assist regional offices to ensure the economic provision of telephone exchange equipment. The design engineer feeds into the computer exchange characteristics, such as the number of telephone lines and rate of calls, and receives statements of the quantities of equipment required.

Currently on trial in two Regions is a program which analyses the main-

**Information for analysing faults on telephone plant is input to a central computer from a terminal in the North Central Telephone Area, London.**

tenance costs of motor vehicles and provides the results in several days instead of months needed by manual procedures. Four-monthly labour and material cost information for each vehicle is processed by computer to provide Area and workshop total costs, together with costs by occupational group within each Area – such as fitting, installation and maintenance staff. A bonus provided by the program is that accurate, age-related cost information is produced which can then be used to determine vehicle replacement policies.

In Telephone Areas one of the least agreeable tasks facing installation control staff is the six-monthly count of spare pairs – that is, those telephone circuits existing in the distribution network but which have not yet been allocated for use. The count is carried out by staff methodically inspecting records for each distribution point (DP). As the average Telephone Area has about 30,000 DPs, this is a tedious task and takes several weeks to complete. The total number of spare pairs is subtracted from sales forecasts of telephone demand to give the number of circuits which external planning staff must provide to cater for that demand.

Following successful field trials, a spare plant return program, called SPRET, is now in use which eliminates manual calculations and provides the required information almost immediately. Details of allocated circuits are input each day, via the Area terminal, to the computer which stores the information and prints the spare plant return when instructed to do so. Additionally, detailed analyses of DPs or cable route can be printed on demand.

**A powerful IBM computer recently put into operation by the Post Office can serve about 600 terminals. Here a user's file of data is loaded into the computer's disc file.**

Another program available to Regions, but also capable of use in Areas, is a manpower planning model which simulates the movements of staff through a manpower system. Called PARSON (promotion and recruitment simulation), it interprets policy information to forecast losses due to retirement, resignation, etc, so producing estimates of the numbers of recruits and promotees needed in the future. The model can thus be used to assess the effects of various policies and external conditions on future staffing of the business.

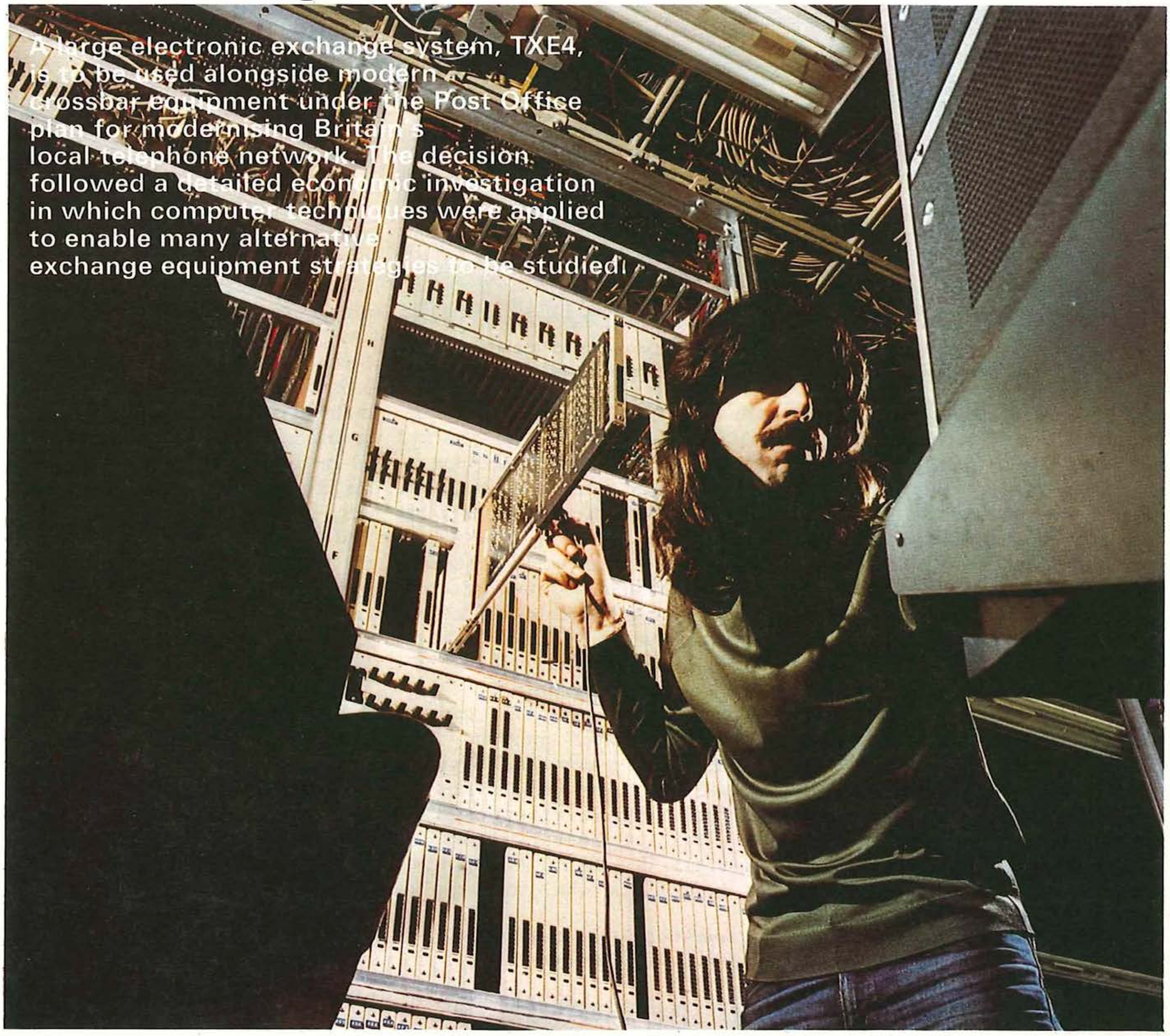
Managers may also write their own programs to solve problems. Training is given by the Post Office Data Processing Service (PODPS), which provides the computing facilities for the Telecommunications Business. PODPS also maintains a staff of experts who can advise users on technical computing matters and assist with the programming of large jobs.

Effective use of computer terminals in the Telephone Areas poses several problems. Although each Area does basically the same work and performs the same functions, their different geographical, economic and telephone density characteristics, as well as the individual personalities of local managers, impose variations on work processes. Given these differences, it is inappropriate for THQ to develop all computer programs which may then meet the specific requirements of only one Area but which would be unsuitable for others. It may often be more relevant to develop such programs locally, incurring increased development costs but obtaining a more useful end product.

Although computer terminals are now in fairly wide use in the Telecommunications Business, general education in the potential of computers as a tool of local management is essential to stimulate the effective and economic use of Area terminals. Experience to date has shown that, given enthusiastic support from an enlightened management, the computer terminal can make a worthwhile contribution to the running of a Telephone Area.

**Mr D. I. Wild** is a Senior Telecommunications Superintendent in a group in Telecommunications Management Services Department responsible for scientific and management computing throughout the Post Office.

# Exchange modernisation – steering towards the decision



A large electronic exchange system, TXE4, is to be used alongside modern crossbar equipment under the Post Office plan for modernising Britain's local telephone network. The decision followed a detailed economic investigation in which computer techniques were applied to enable many alternative exchange equipment strategies to be studied.

KR Crooks

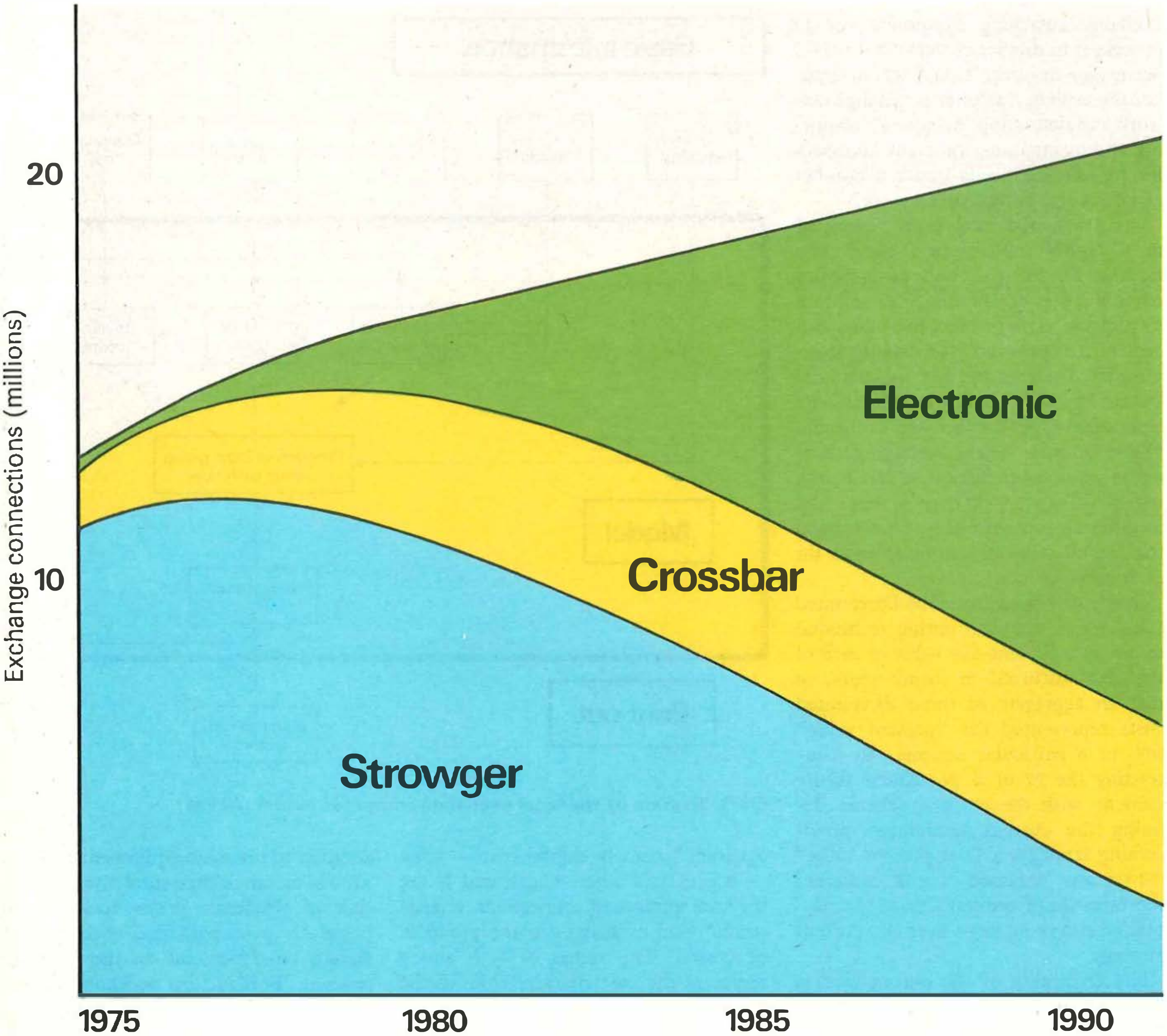
**Above: A printed circuit board on a TXE4 experimental exchange is checked out at the New Southgate, London premises of Standard Telephones and Cables.**

THE POST OFFICE plan for modernising Britain's local telephone exchanges includes an improvement in the quality of automatic service, replacement of most Strowger electromechanical equipment with modern systems, and the use of large electronic exchanges (TXE4) alongside crossbar equipment already being supplied. The plan involves a programme of renewal that will have made considerable progress by 1980 but which will not be complete until near the end of this century.

Decisions of this magnitude are not arrived at lightly, for the scale of investment required is very large. A detailed economic investigation was therefore undertaken to examine the alternative exchange equipment strategies feasible to the Telecommunications Business that would provide the necessary improvement in service. Answers were necessary to many questions which would point to the economic viability of each scheme. For example, should Strowger plant continue to be replaced only when it becomes worn out or should it be replaced earlier? What modern equipment should be used, and when should the task be completed?

Such questions pose formidable problems which must be solved if modern systems are to be installed on a scale that will make their benefits available both to the Post Office and its customers. To this end expert opinions were sought from all fields of the Business as well as from Britain's telecommunications industry to ensure a sound foundation for the ultimate decision.

The investigation embraced a large proportion of the country's telephone customers. More than 80 per cent of the total national connections on some 1,600 Strowger exchanges were considered for accelerated replacement with a modern




**Planned penetration of large exchange connections.**

switching system. The systems available for the replacement of Strowger underwent separate study with regard to their technical and environmental suitability. These systems were crossbar (TXK1 and TXK3) and electronic exchanges (TXE2 for small exchanges and TXE4 for large exchanges). An essential ingredient in the process of deciding which strategy to pursue was a detailed cost study of the relevant factors. It was necessary to account for the various capital costs involved for each of the switching systems as well as the annual operating charges for maintaining them. The differences in the costs between systems played a significant part in the choice of the final strategy.

An assessment was required of the economic advantages of replacing Strowger plant at different rates and hence completing the plan earlier than its natural life span might dictate. This meant the accelerated replacement of Strowger equipment and the consequential re-use of apparatus that had not fulfilled its useful life. However, it was important that decisions made as a result of this study should be compatible with plans being made for the introduction of the advanced switching system of the future, often referred to as System X. For this reason it became apparent that, of the alternative modes of replacement under investigation, the schemes using the principle of "whole exchange replacement" would be the most suitable. This would avoid the creation of hybrid exchanges involving a mixture of Strowger, modern systems and later System X equipment.

To determine the capital cost of each of the 1,600 exchanges individually might produce very accurate results but the enormous amount of information required and the time that would have been needed to process it made this approach impractical. Instead the study considered exchanges in groups. The exchanges were divided into Director and non-Director network groups (other groupings were also investigated) and each network group was then further divided into switching system groups. The principle of grouping exchanges in this manner brought the data to manageable proportions while retaining a close representation of the networks under study.

It was decided to use a computer to cope with the large number of calculations and to enable them to be repeated so that many strategies could be studied. This led to the development of a computer model – that is, the representation of a system, network or other quantifiable situation in mathematical terms, such that algorithms or equations can be composed to describe that situation.

A local exchange model (called ALEM) was developed to enable the computer to accept information about telephone ▶

exchange switching equipment and to process it to predict changes that would occur year-by-year. Its task was to simulate the evolving telephone exchange network and determine the costs of acquiring and maintaining the plant necessary for its growing needs under a number of alternative future plans.

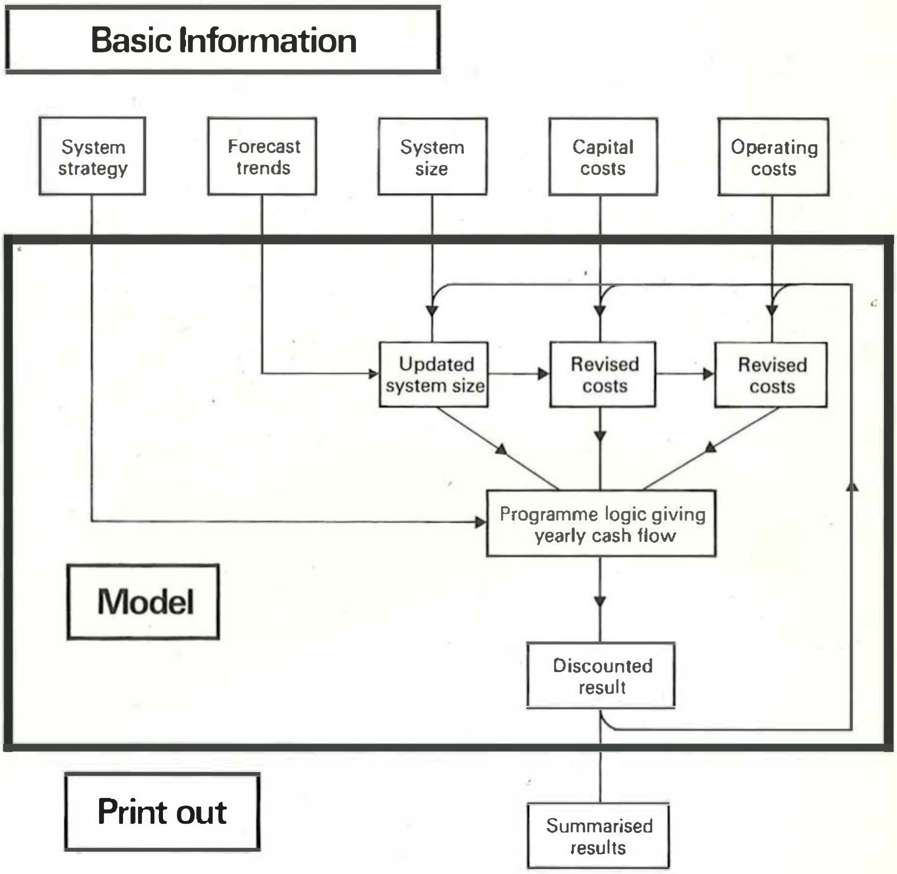
The ALEM model has been developed to a highly sophisticated stage with facilities for taking account of numerous equipment, programming and printout circumstances. However, the basic concept of its operation was first to determine from current and forecast costs and system growth data, the developing equipment quantity needs up to the end of the century. Then, specifying alternative equipment futures – that is, the use of different switching systems and in different proportions – it determined the capital costs and running costs for each scheme.

Finally, the model used the Discounted Cash Flow (DCF) accounting technique to obtain a present-day value of each of the costs incurred in future years, so that an aggregate of these discounted costs represented the "present value" (PV) of a particular scheme. By contrasting the PV of a postulated future strategy with the PV of a scheme defining the current equipment provisioning strategy, a "net present value" (NPV) was obtained which indicated the measure of profitability of the postulated future strategy over the current strategy.

The credibility of the output from a computer depends on the credibility of the input, so for ALEM much effort was directed at obtaining the best possible input data. Of particular importance were the areas of system growth and capital and running costs, and extensive consultation with experts in these fields led to the derivation of much of the input data. This included calling rate, connection, capital and running cost (including maintenance effort) data at the start of the study, together with year-by-year profiles as to how these factors were expected to change over the 30 years covered by the study.

The purchase price of the equipment for a group of exchanges in a given system can be estimated quite accurately by the use of three price tags. These refer to a unit price for, first, the number of added exchange connections; second, the number of average calls originated by the exchanges (traffic carrying capacity); and, third, a constant price independent of connections or telephone traffic.

The unit prices are related by a simple linear formula known as a "capital cost




**Block diagram of the local exchange computer model (ALEM).**

equation", namely capital cost = a.Cx + b.E + c.N where Cx, E and N are the total number of connections, erlangs (traffic) and exchanges in the group to be costed. The values of a, b and c represent the cost characteristics of the particular system being considered. It is interesting to note that the per exchange constant c has a small value for a system such as Strowger, where the switch control is vested in dispersed traffic carrying components, but a large value for common control systems such as TXE4.

Similarly, a relationship exists for the effort required to maintain exchanges. Formulae for each system have been derived which relate the total maintenance manhours required for a group of exchanges – that is, maintenance manhours = p.Cx + q.E + r.N where p, q and r describe the maintenance characteristics for the exchange system. Again this formula is designed for use in bulk calculations where Cx, E and N refer to the total connections, traffic capacity and number of exchanges in the group.

Many other subsidiary capital and running costs needed to be accounted for to complete the picture. These were for such aspects as power plant, accommodation, training, spare parts and documentation. Being minor items they were brought to account as a percentage addition to the main equipment costs.

It was assumed that, similar to the concept of wholesale prices versus retail prices, the price paid for new equipment should be dependent on the quantity ordered. This in turn depended on the strategy adopted. Therefore before the costs for each postulated strategy were finalised, factors were applied to vary the unit price paid according to the increasing or decreasing volume of equipment required by the strategy.

As the model progressed through its computation, it made available for printout the results of each definitive stage of calculation. Profiles for each year to the end of the century were produced for system penetration, equipment expenditure, manpower requirements, etc. These were of value when, in consultation with experts in the costing, planning, purchasing and financial fields, the reasonability of the results were being assessed. This enabled potential problems to be identified and dealt with.

The profiles were also used in presenting the results of each strategy study, for although the net present value was the primary objective, the ramifications on labour requirements, annual expenditure, etc, were also important. Another advantage was that trouble shooting in the model was eased, for the profiles enabled a check on the step-by-step


**A plug-in electronics unit for TXE4 is checked by automatic equipment designed for production line testing.**

processes which may reveal the area of error in the data or logic.

The prime role of the model in the studies has been to reveal the financial effects of each course of action open to the Telecommunications Business. In this it was not seeking for a single optimum solution but, in conjunction with the many commercial and industrial consequences, to provide the decision takers with a short list of options or strategies available for implementation. This short list was presented with a ranking order of relative profitability or NPV of one strategy versus another.

The probability of the ranking order being disturbed can be examined by sensitivity tests. These tests determine the effect on the NPV if a given input parameter, say capital cost or connections growth, etc, changes by a given percentage. For example, if the capital cost of a particular switching system was to be increased by five per cent then the NPV of a given strategy might rise by £6 million.

The studies have evolved over a period of many months, identifying sensitive areas for further research. During these months improved data has been used in the computer model, and as a deeper understanding of the processes involved has been acquired, the logic of the model has been improved. Throughout this time the studies have consistently shown that the greater the use of TXE4 as the replacement switching system the greater the potential economic advantage to the Post Office. Crossbar systems were also included in the studies and although they may be more economic than Strowger plant for exchange replacement, they ranked lower than TXE4 as the modern telephone exchange switching system of the future.

Providing a new telephone exchange represents a considerable capital investment, with its planning and installation period spanning many years. Therefore it is necessary to begin the task of replacing Strowger exchanges with modern systems as soon as possible if the service improvements and enhanced facilities are to be provided in a reasonable time. The decision to go full ahead with TXE4 and crossbar exchange equipment has been made, and considerable effort is now being directed towards implementing this Post Office plan for modernising the telephone system in this country.

**Mr K. R. Crooks** is head of a group in Operational Programming Department at Telecommunications Headquarters responsible for local exchange equipment strategy.

# The year in figures

| | 1973–74 | | 1972–73 | | 1971–72 | |
|---|---|---|---|---|---|---|
| | Result | % growth over 72–73 | Result | % growth over 71–72 | Result | % growth over 70–71 |
| **TELEPHONE SERVICE** | | | | | | |
| **Size of system** | | | | | | |
| Total working connections | 11,903,627 | 8·7 | *10,947,102 | 9·2 | 10,028,158 | 8·8 |
| Total working stations | 19,136,847 | 8·7 | 17,600,368 | 8·9 | 16,157,467 | 7·9 |
| Call office connections | 76,600 | 0·4 | * 76,281 | 0·5 | 75,905 | 0·1 |
| Shared service connections | 2,087,950 | 2·9 | 2,028,904 | 7·7 | 1,883,893 | 9·7 |
| % of connections on auto exchanges | 99·6 | 0·4 | 99·2 | 0·2 | 99·0 | 0·2 |
| **Growth of system** | | | | | | |
| Net demand for connections | 1,355,540 | −5·3 | 1,431,029 | −0·8 | 1,442,917 | 32·4 |
| New supply of connections | 1,456,524 | 2·5 | 1,420,911 | 9·5 | 1,297,068 | 19·5 |
| Waiting list | 109,610 | −45·2 | 200,066 | −8·2 | 217,975 | 79·5 |
| **Penetration** | | | | | | |
| Stations per 1000 population | 342 | 8·9 | 314 | 8·6 | 289 | 7·0 |
| **Traffic (in millions)** | | | | | | |
| Inland effective trunk calls | 2,138 | 10·0 | 1,944 | 14·4 | 1,699 | 12·0 |
| Inland effective local calls | 12,707 | 9·6 | 11,595 | 12·2 | 10,330 | 11·9 |
| Continental: outward calls | 23·84 | 13·1 | * 21·08 | 14·1 | 18·48 | 11·7 |
| Inter-continental: outward calls | 5·23 | 22·2 | 4·28 | 24·0 | 3·45 | 53·3 |
| **Telephone usage** | | | | | | |
| Calls per connection | 1,302 | 0·7 | * 1,293 | 3·2 | 1,253 | 3·4 |
| Calls per head of population | 265 | 9·1 | * 243 | 11·5 | 218 | 13·5 |
| **Exchanges** | | | | | | |
| Local manual | 30 | −37·5 | 48 | −30·4 | 69 | −19·8 |
| Local automatic | 6,215 | 1·2 | 6,140 | 0·7 | 6,099 | 0·6 |
| Local electronic | 462 | 23·9 | * 373 | 91·2 | 195 | 119·1 |
| Local crossbar | 211 | 42·6 | * 148 | 92·2 | 77 | 126·5 |
| Automanual and trunk | 375 | 2·7 | 365 | −1·3 | 371 | −1·6 |
| **TELEX SERVICE** | | | | | | |
| Total working lines | 49,220 | 13·7 | * 43,292 | 14·6 | 37,774 | 14·7 |
| Metered units | 363,481,000 | −1·4 | 368,703,000 | 4·3 | 353,534,000 | 9·4 |
| External originating traffic | 38,028,000 | 15·6 | *32,893,000 | 14·1 | 28,841,000 | 14·4 |
| **TELEGRAPH SERVICE** | | | | | | |
| Inland telegrams | 7,252,000 | −0·7 | 7,303,000 | 6·6 | 6,847,000 | 2·7 |
| External telegrams: UK originating | 7,461,000 | 5·8 | * 7,049,000 | 0·1 | 7,040,000 | 4·8 |
| UK terminating | 6,997,000 | 3·3 | * 6,777,000 | −2·0 | 6,917,000 | 4·6 |
| UK transit | 5,438,000 | 1·2 | * 5,501,000 | −4·4 | 5,755,000 | 6·9 |
| **TELECOMMUNICATIONS STAFF** | | | | | | |
| (Part timers count as half) | | | | | | |
| Total | 242,086 | 0·8 | * 240,105 | 2·6 | 233,965 | 0·7 |
| Minor engineers | 107,892 | 2·2 | * 105,531 | 4·9 | 100,550 | 2·3 |
| Telephone operating force | 49·155 | −2·88 | * 50,608 | 0·1 | 50,575 | −4·0 |
| Clerical staff | 29,120 | 1·8 | * 28,595 | 0·5 | 28,452 | −0·6 |
| Other staff | 55,919 | 1·0 | * 55,371 | 1·8 | 54,388 | 2·9 |

* Revised figure

# Moving ahead - despite setbacks

**The Post Office report and accounts for 1973-74 show that the previous year's record for the supply of telephone connections was broken, the waiting list was virtually halved, and a record number of new trunk circuits was provided. Important new additions were made in the international network, and the completion of the Cantat 2 submarine cable more than doubled the number of cable circuits across the North Atlantic.**

DURING the first half of the year 1973–74 business increased in all the main sectors of the Post Office. Productivity improved, plans proceeded satisfactorily and service quality was maintained – and in some cases marginally improved – despite severe staff shortages. In the second half the picture changed dramatically, mainly because of the energy crisis, the three-day week and labour disputes in other industries. The rate of growth dropped – by as much as half in the case of trunk telephone calls. Revenue therefore fell short of expectations, but inflation gathered pace and costs rose very fast.

On the telecommunications side the difficulties were made worse by a decision (in December 1973) by the then Government to cut the 1974–75 capital programme severely. Even in the second half of the year, however, telecommunications services continued to expand, and taking the year as a whole the results were good. The following summary of the Post Office report and accounts for 1973–74 outlines the progress and achievements made despite all the problems encountered.

**Inland services:** With a record supply of exchange connections, the total at the year end was 11.9m, and the waiting list was reduced from 200,000 to 109,600. The number of telephones in service reached 19.1m. Inland telephone calls increased by almost 10 per cent, to a total of 14,845m, and steady progress was made towards full automation. By the end of the year more than 99 per cent of local calls and 87 per cent of trunk calls could be dialled direct by customers.

Efforts to improve the automatic service continued with the installation of fault-finding and other modern electronic equipment. Particular areas of serious congestion were given special attention and generally the quality of service was maintained or marginally improved. The percentage of local call failures due to plant deficiency or congestion fell from 2.5 in 1972–73 to 2.4. The failure percentage for STD calls fell from 6.5 to 6.0.

The telex and data transmission services continued to grow rapidly. The addition of 5,900 stations, representing an increase of 13.7 per cent, increased the telex network to 49,200 at the end of the year. The number of data transmission connections increased by 21 per cent to 29,605.

**Expansion:** Capital expenditure on telecommunications fixed assets, at £695m, was 13 per cent more than the previous record figures achieved in 1972–73. Expenditure of this magnitude is essential not only to provide for future growth but also to improve the service to existing customers.

A record increase in exchange capacity sufficient for 1.43m more connections was provided during the year and the local network was augmented by 1.5m cable pairs. More than 16,000 long-distance and 80,000 short-distance circuits were provided between exchanges.

Last year good progress was made with preparations for the large-scale production of the TXE4 system for new large local exchanges by two additional manufacturers, and the contract with the initial manufacturer was extended. The industry has been notified of orders for 40 specific exchanges having a capital value of £30m.

**International services:** Britain's international telecommunications services handled more business than ever before during the year despite mounting difficulties due to delays in the delivery of switching equipment and completion of exchange projects, and to staff shortages.

Although there was a large increase in calls during the year, further significant deterioration in the quality of service was avoided, and in some respects it was improved slightly. This was achieved by the extension of dial service to more countries overseas and from more places in this country, by the outstationing of operator services to selected provincial cities, and by the promised attack on plant shortages.

Further progress was made in providing extra switching equipment and lines as part of the £115m programme to improve services. At Edgware in London two new international exchanges were well advanced by the end of the year. The Post Office is already planning additional plant to carry growth into the late 1970s and beyond.

Other notable achievements included the completion well inside the target dates of the Cantat 2 submarine cable between the UK and Canada, the introduction of a new cable to Denmark, and the development of a £5m programme for services to oil and gas production platforms in the North Sea. Direct dialling of telephone calls was extended during the year to Spain, bringing to 18 the number of other countries which can be reached by international subscriber dialling (ISD) from the UK. The number of UK centres with ISD facilities was increased from seven to 18.

By the year end 97 per cent of telex calls could be dialled direct from the UK. This facility was extended to Peru, Panama, Alaska, the Philippines, Argentina, Kuwait, Fiji, Puerto Rico, Jordan, Taiwan, Lesotho, Nicaragua, Dominican Republic, US Virgin Islands and Madeira.

Further major projects are planned. ▶

The Post Office Board has decided that there should be no arbitrary limits on capital expenditure for international services, whatever limitations there may be on capital expenditure as a whole.

**New products and services:** The range of products and facilities continues to be improved and extended where there is market potential.

Keyphones – push-button telephones – continue to be provided in increasing numbers on special customer-owned proprietary switchboards. Test marketing was successfully completed for keyphones which are directly interchangeable with dial telephones and can be connected to any type of exchange or customer switchboard. Arrangements are being made for their progressive introduction in selected areas, and there will also be customer trials of a Trimphone with a keypad instead of a dial.

Plans are being considered for extending the Post Office radiopaging system which went on trial in the Thames Valley in 1973 and which has now 1,100 users. Extension of the Datel services included a development contract for a future Datel 4800 Service, which will enable data at 4,800 bit/s to be transmitted over private circuits and the public telephone network.


The stylish design of the Trimphone is combined with the advantages of push-button dialling in this new-look telephone.

**Technology:** Development of the 60 MHz (10,800 circuit) analogue coaxial cable trunk transmission system was completed and the production phase has begun. Future development of trunk systems will emphasise digital transmission.

The development of an ultra-long-life transistor of increased performance reached the pilot production stage. The new device will lead to substantially increased circuit capacity in submarine cable systems.

An accurately-aligned duct route for the field trial of a 30 to 100 GHz waveguide system has been laid on a 15 km route along the A12 road, with a terminal at the Post Office Research Centre, Martlesham. Terminal and repeater equipment made by the Post Office and by contractors has been completed and the waveguide is being made to a Post Office design for the field trial which is to start next year. When fully developed, the waveguide will be able to carry about 300,000 telephone circuits or 200 both-way television channels.

PO Telecommunications Journal, Autumn 1974

# MISCELLANY

## New generation

One of a new generation of high-capacity submarine telephone cables will be installed between Britain and Belgium in 1977. Known as NG 1, the 45 MHz system will provide 3,900 circuits on a 63-mile link running from St Margaret's Bay near Dover to Veurne in Belgium.

Europe's biggest-ever undersea telephone cable, it will be used primarily for communications between Britain and Belgium, Germany and the Netherlands, and for British communications which pass through these countries to other parts of Europe.

It will also carry telephone calls, telex and telegram messages and computer data between Britain and Denmark, Sweden and Norway until a big new cable linking Britain with Scandinavia comes into service, probably by about 1980.

Costing in total nearly £3m, the cable system is being financed by the Post Office and the telecommunications administrations of Belgium, Germany and The Netherlands. It will be made in Britain by Standard Telephones & Cables.

## Island link

Post Office telephone engineers have fitted a telephone on Steepholm Island, an uninhabited islet in the Bristol Channel. Steepholm is a bird sanctuary and field study centre being set up by the Kenneth Allsop Memorial Trust in memory of the broadcaster and naturalist.

An 18 year-old warden appointed to be the sole inhabitant of the island was unable to start work until some means of communication with the shore had been provided. After failing to re-establish a war-time Army phone link by submarine cable, the Post Office brought in radio-telephone equipment to form a link between an old Army nissen hut on the island and the roof of Weston-Super-Mare telephone exchange.

## Degrees of success

Of the 43 degrees awarded this year through the Post Office University Studentship Scheme eleven were first class honours. Degrees were gained by 42 men and one woman, all in their early 20s, who will take up managerial and scientific posts in engineering grades within the Post Office.

This is the fiftieth year of the Scheme, through which 289 young people have graduated. Each year the Post Office offers University Studentships leading to degrees in communications, engineering and science – with the Post Office paying all educational fees and salaries.

## Data facility

Computer users may now send data abroad at 2,400 bit/s over public telephone circuits to countries where an International Datel 600 service is authorised. This facility results from a Post Office decision earlier this year agreeing to the connection of privately-supplied modems to the public telephone system under certain conditions.

The conditions are that the modems may operate only at 2,400 bit/s with 'B' type modulation specified in CCITT Recommendation V26, and may be used only for international data transmissions. The Post Office has given permission for a number of private modems to be offered to computer users for operation under these special conditions.

CCITT Recommendation V26, for 'B' type modulation, is becoming the accepted standard for international data transmission at 2,400 bit/s. A new Post Office modem conforming to this recommendation is due to be available next summer, and will be used to extend the Post Office's Datel 2400 services provided for sending computer data over Britain's telephone system.

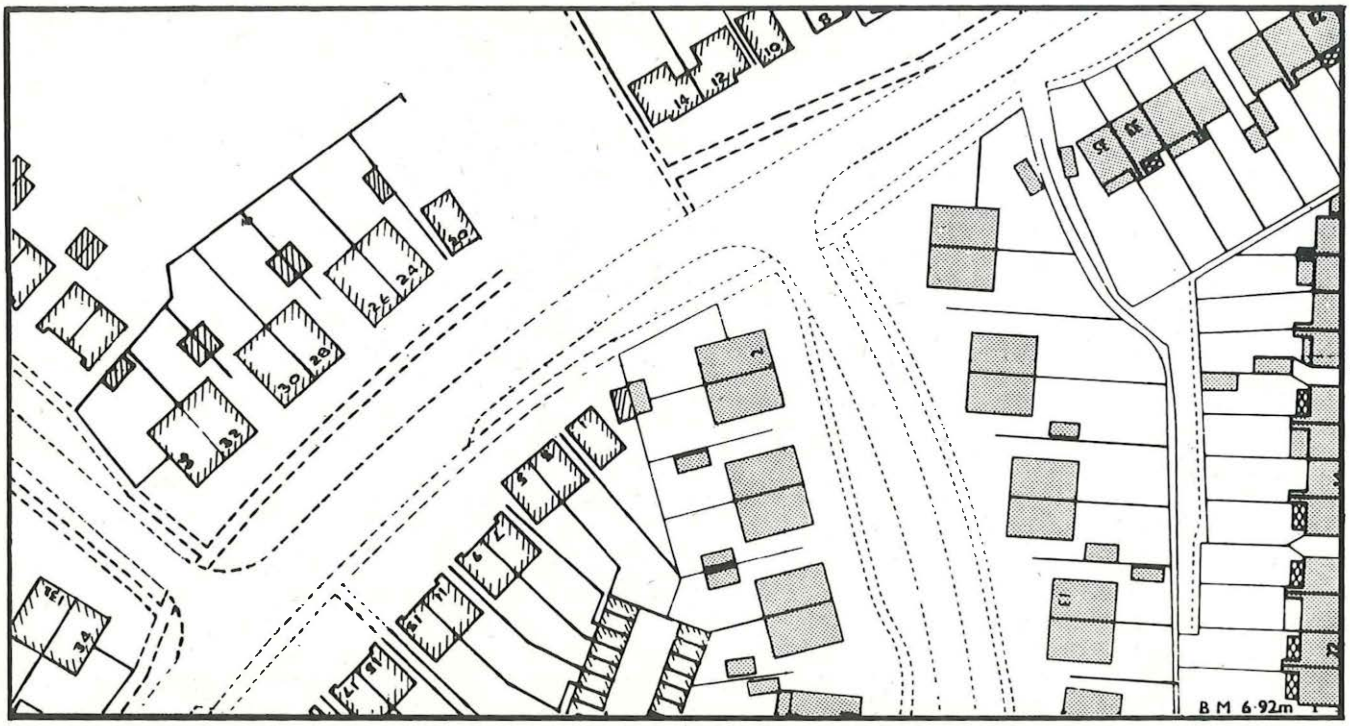
Modems currently used in the Datel 2400 services were developed before international standards for data transmission at 2,400 bit/s over the public telephone network had been drawn up, and the Datel 2400 Dial Up service is at the moment restricted to inland calls.

## Supercable progress

Contracts have been placed by the Post Office for the first stage of the 60 MHz supercable which will provide high-capacity trunk telephone links between Birmingham, Manchester and London. The cable has 18 coaxial pairs and is capable of carrying almost 100,000 telephone conversations simultaneously. (See Telecommunications Journal, Autumn 1973.)

The first leg is a 156 km link between Manchester and Birmingham and it will be supplied and laid by two consortia. The contract is divided between the two groups – Standard Telephones & Cables/Pirelli General, and Telephone Cables Ltd/British Insulated Callender's Cables.

Main laying operations will begin early ▶

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**Mr E. Fennessy, Managing Director of Post Office Telecommunications (centre) and Professor J. H. H. Merriman, Post Office Board Member for Technology (far right), inspect a repeater box being used in field trials of 60 MHz transmission equipment at Marlborough, Wilts.**

next year and the Birmingham-Manchester section should be completed by May 1976. The section is due to come into service in the Spring of 1977. Initially, the Post Office plans to equip it to carry 20,000 telephone conversations at once.

As the number of telephone calls increases, extra transmission equipment will be added to the cable until it reaches its maximum carrying capacity. Throughout the entire length of the cable the Post Office is providing an additional underground duct for the speedy provision of a further high capacity system to meet future needs.

The 60-MHz line system uses frequency division multiplexing occupying the frequency spectrum between 4 and 60 MHz in which 12 broadbands of 900 circuits each can be assembled to give the capacity of 10,800 telephone circuits on two coaxial pairs. In view of the probable use of digital transmission methods on the trunk telephone system within the working life of the cable, the Post Office has specified a stringent performance.

## University Fellowship

A Teaching Fellowship in Telecommunications, in the Electrical Engineering Division of the Engineering Department at Cambridge, has been established following an agreement between the University and the Post Office. Over the next five years the Post Office will cover the salary costs of the Fellowship, which is to be known as the "Post Office Teaching Fellowship in Telecommunications".

The Fellowship, in support of the Systems Engineering Group, is designed primarily to reinforce the specifically telecommunications component in the undergraduate teaching for the Electrical Sciences Tripos Part II, which is the final year course for electrical engineering specialists in Cambridge. There will also be some involvement in post-graduate research work and the supervision of PhD projects.

## A vital communication

To demonstrate the job opportunities in Britain's telecommunications services for school leavers of up to and including 'O' level standard, the Post Office has produced a film entitled "A Vital Communication". The 22½-minute 16 mm colour film is available on free loan to interested bodies such as school career officers and parents' associations.

With actress June Barry playing the part of a careers mistress, the film passes through a series of locations showing various people at work and in training. They include inland and international telephone operators, drawing office tracers, motor mechanics, clerical staff, and apprentice telephone engineers.

## Carphone service grows

Motorists equipped with car radiophones can now make telephone calls from their cars within a 3,000 square mile area of the Midlands, which takes in Wolverhampton Birmingham, Coventry, Rugby, Northampton and Banbury. Previously the Post Office car radiophone service was available only in London and South Lancashire.

The Midlands is the first of five new centres to be provided with the service under a £600,000 project. An East Pennine service covering Leeds, Doncaster and Sheffield, and a Scottish service covering Edinburgh and Glasgow, are due to start in mid-1975.

By early 1976 the final two services – Avon and South-East Wales (which takes in Newport, Cardiff and Bristol) and a Tyneside service (which includes Newcastle, Durham, Teesside and Darlington) should be working.

Car radiophone users will be able to make or receive calls when they are within range of any of the service areas. Until recently users could make or receive calls only in their "home" area. For example, a customer on the London service could not make calls when in the South Lancashire area.

The existing London and South Lancashire services have been modernised to make this new facility possible, and it will be available in all the new radiophone service areas.

## Calling Spain

Laying of the British shore end of a new submarine telephone cable between the UK and Spain has been completed following the laying of the Spanish shore end. The cable will have a capacity of 1,380 telephone circuits and is the same basic design as that used in the Cantat 2 transatlantic link – a 14 MHz transmission system with a 1.47 in diameter lightweight coaxial cable.

The shore ends extend two miles out from the Spanish landing point and nearly 3.5 miles out from the southern coast of Cornwall. They have both been terminated for quick recovery next March when the Cable and Wireless cableship Mercury will lay the main span of the 475 nautical-mile link.

Due to come into service next summer, the new cable will be the second direct cable link between Britain and Spain. It is needed to meet the growth in telephone and telex traffic between the two countries. The cable will also provide an alternative route for communications between Britain and Italy through Spain and between Spain and countries in Northern Europe through Britain.

## Contracts

**Marconi Communication Systems** – £1½ million for PCM equipment. Most of the 24-channel equipment in this contract is destined for the London Telecommunications Region, but some will be used in the Eastern Region and Scotland. The equipment in the current order destined for Scotland will include a version designed to protect the line systems from high induced voltages, such as those caused by lightning.

**Standard Telephones & Cables Ltd** – More than £350,000 for echo suppressors, to be installed at the new international exchange at Mondial House in London. The new equipment will be available for use by December 1976.

**GEC Telecommunications Ltd** – Nearly £1.4 million-worth of PABX6 private automatic telephone exchanges. The exchanges will be installed by the Post Office in commercial and industrial concerns throughout the country. The PABX6 is an unattended exchange with a maximum of five public-exchange lines and 20 extension telephone lines.

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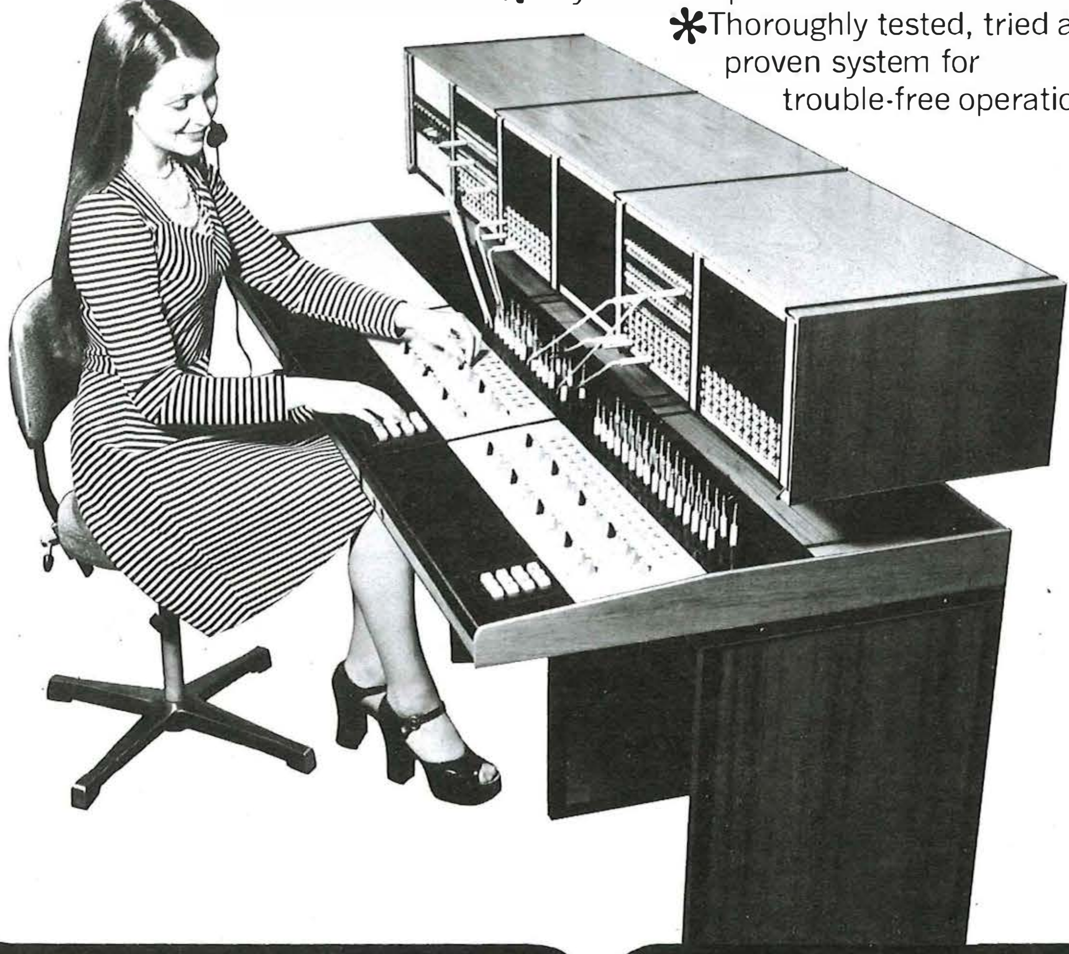

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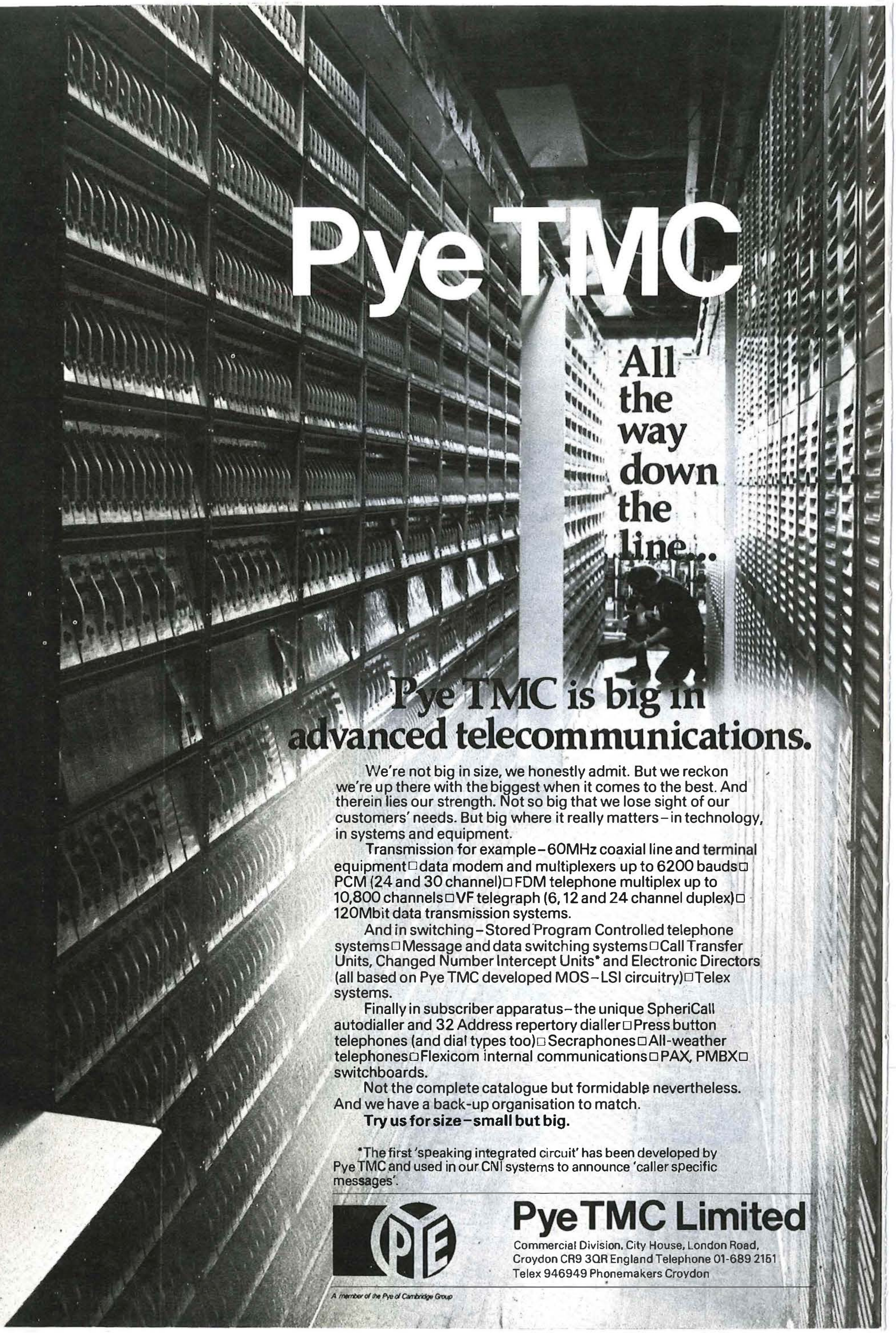
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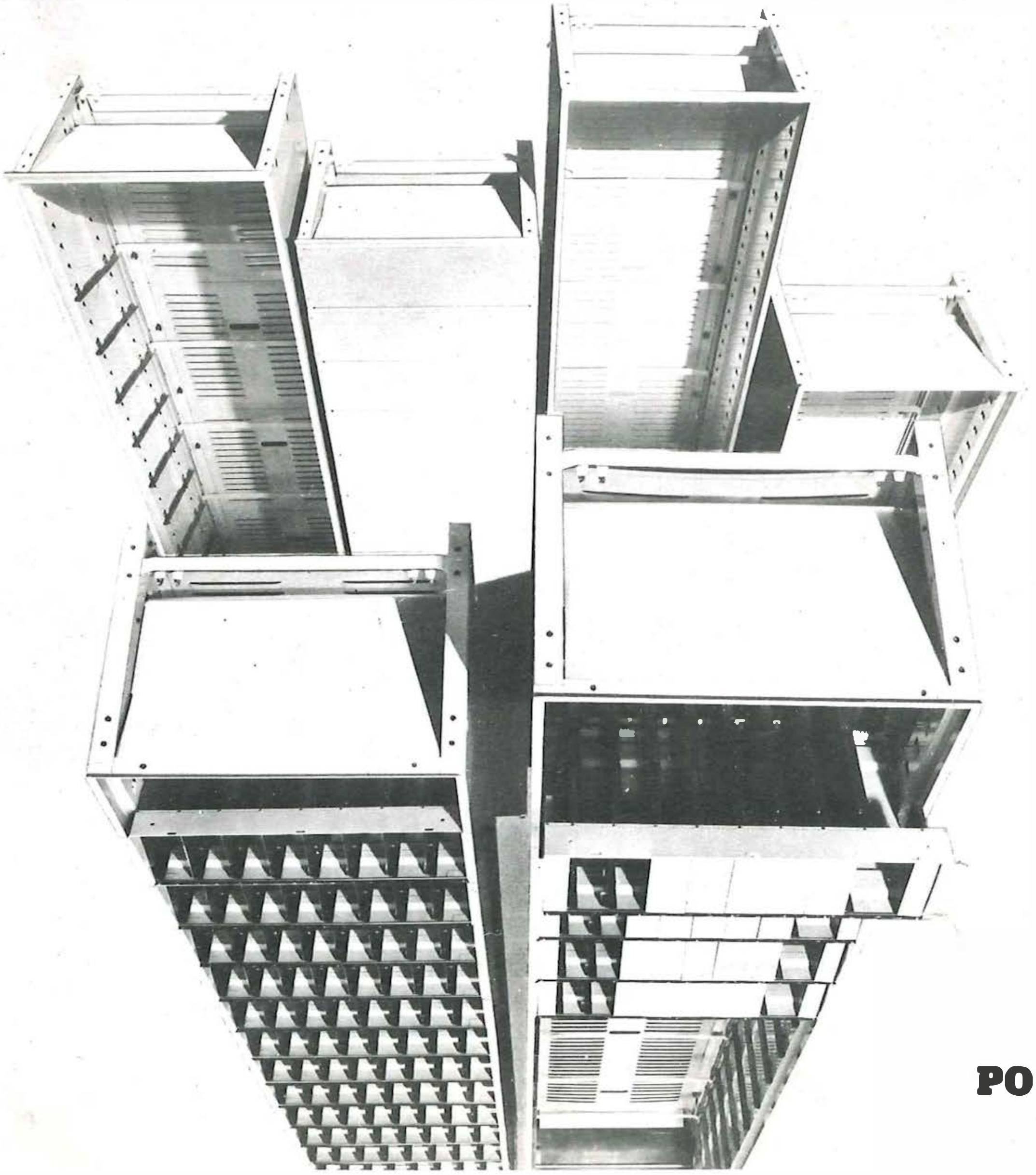

**PO approved**

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