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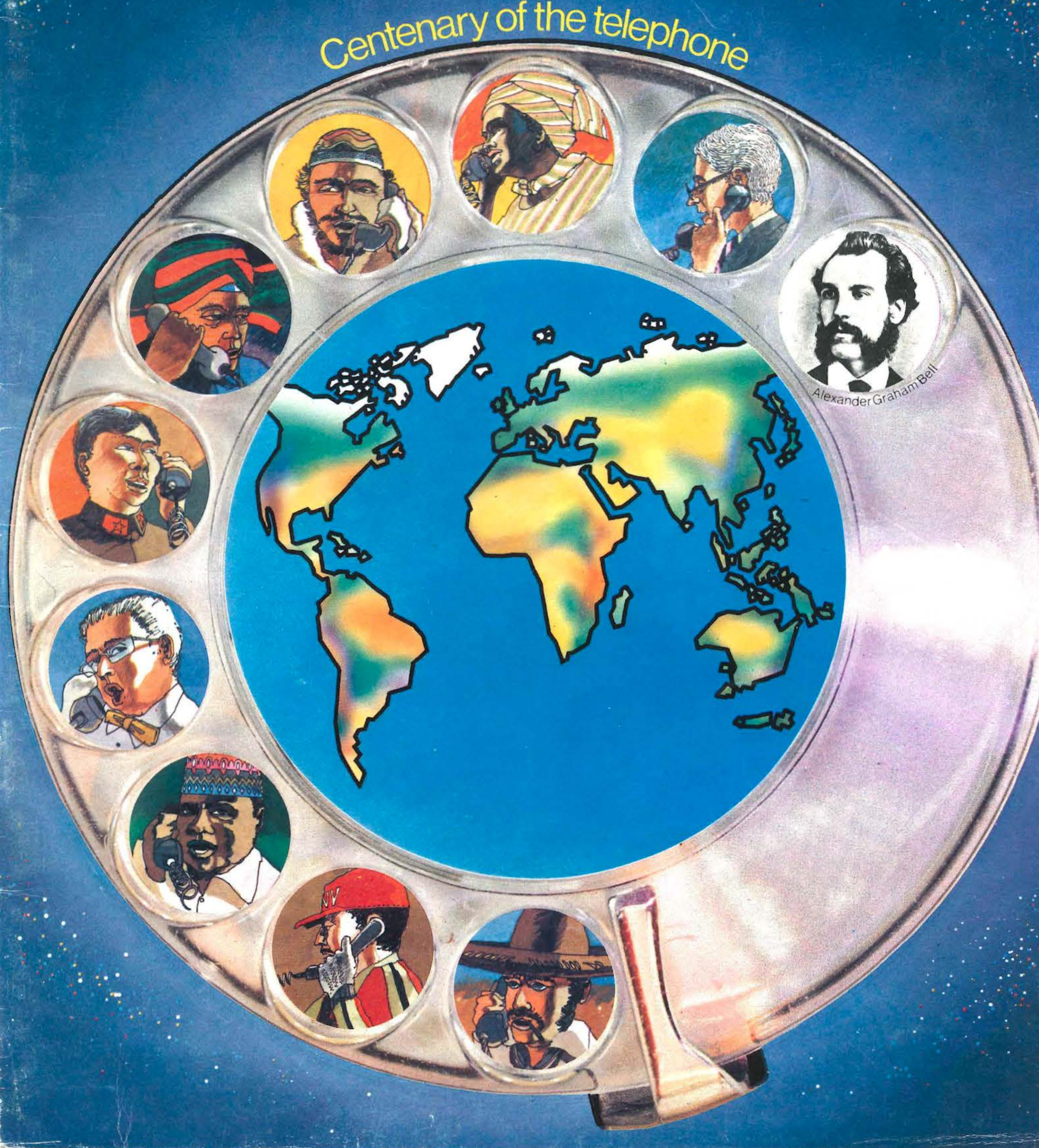

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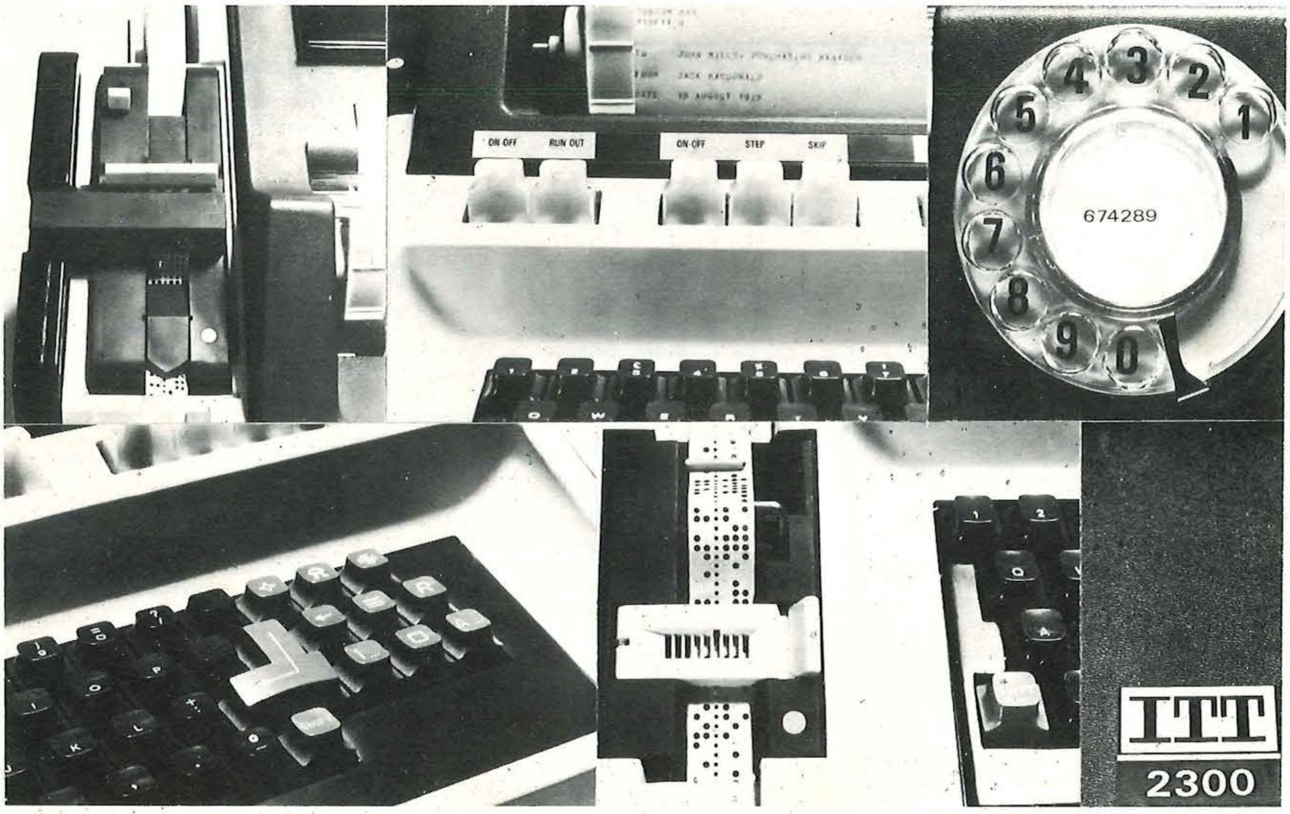

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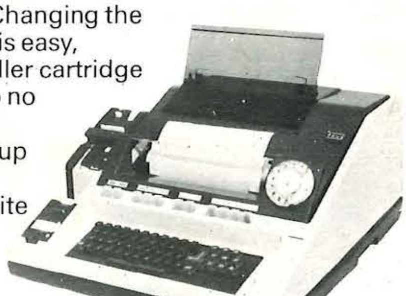

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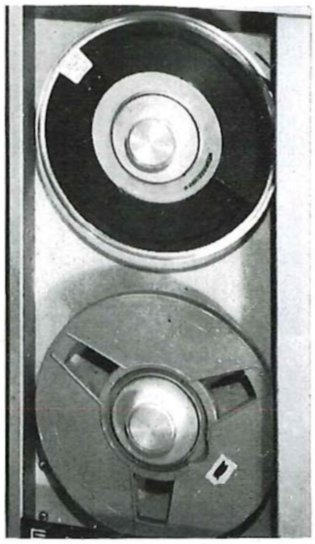

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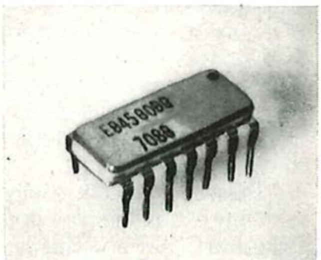

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The man who set the world talking

BY THE year 2000 some 1,500 million telephones around the world will be carrying more than a million-million calls a year. This forecast represents a four-fold increase in the present size and use of the global network, and was made recently by Sir Edward Fennessy, Deputy Chairman of the Post Office and Managing Director, Telecommunications.

Opening a conference to celebrate this year's centenary of the birth of the telephone, Sir Edward said that the network of the 21st century would be almost entirely automatic. It would also provide a wide range of ancillary services, placing at the disposal of mankind vast resources of information.

With the global system continuing to develop at such a spectacular rate, it seems difficult to believe that only a little over a century ago a young Scotsman wrote to his parents: "Such an idea as telegraphing vocal sounds would to most minds seem scarcely feasible enough to spend time working over. I believe, however, that it is feasible and that I have got the clue to the solution."

The man, of course, was Alexander Graham Bell, and the following year, 1876, he transmitted the first intelligible words by telephone. In doing so he launched possibly the most far-reaching technological development in the history of mankind.

While the telephone was still very much in its infancy Bell also prophesied with remarkable accuracy how it would be used to serve the public. Referring in 1877 to networks of gas and water pipes in large cities, he wrote: "In a similar manner it is conceivable that cables of telephone wires could be laid underground, or suspended overhead, communicating by branch wires with private dwellings, counting houses, shops, manufactories, etc. etc., uniting them through the main cable with a central office where the wires could be connected as desired establishing communication between any two places . . ."

The mind that conceived the telephone clearly understood how it could be used. It is unlikely, however, that Bell or his contemporaries experimenting in the same field could have foreseen the full impact of their work or the development that would be made in 100 years. How mankind will in the next century employ this gigantic global communication system is not easy to predict. But as Sir Edward Fennessy stated recently: "We – the engineers and system planners – can only follow the objectives of Alexander Graham Bell and seek to improve communication between people."

● To mark the 100th anniversary of the telephone, Telecommunications Journal carries a special centenary section in this issue (see pp 11–26)

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In with the old, out with the new

GT Draper

TUCKED away off the busy Borough High Street in South London stands a four-storey Victorian building which was once the home of the old HOP manual exchange. Although there is nothing very remarkable about the building's exterior, once inside it soon becomes clear that the place is something special.

Known generally as the City Telephone Area Piece Part Depot, it houses about 40 staff whose work includes renovating telephones, breaking down exchange equipment and mending coinboxes for City Area while a Senior Technician spends most of his time replacing the bearing pins on 2000 type selectors which are sent specially from Strowger exchanges all over the country.

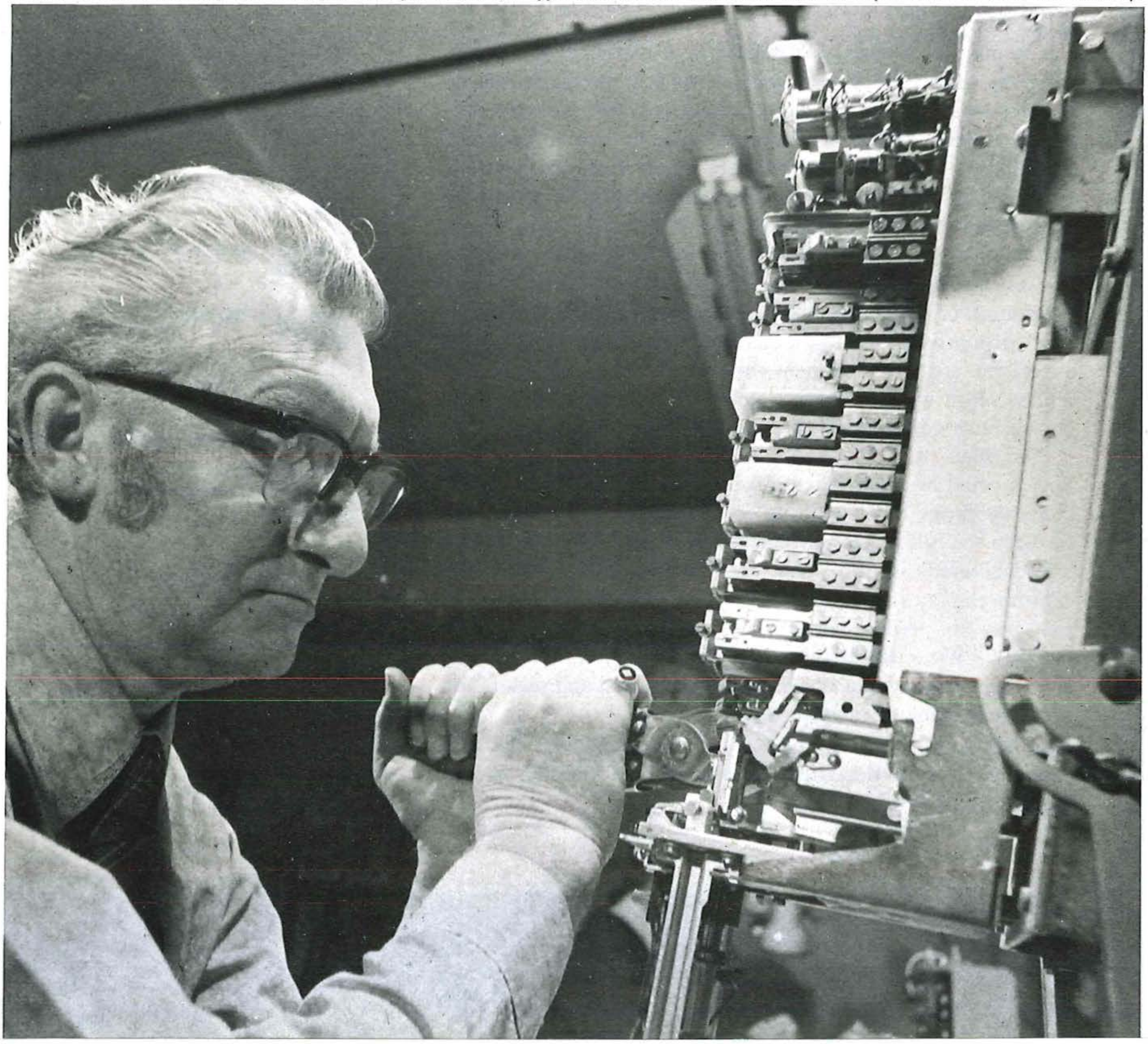
Also on a national basis is a service which includes making up any special telephone cords for meeting specific requirements. A typical example may be provision of extra length cords for a customer who, for instance, wants more than normal mobility when using the telephone. This work is of particular interest because most of it is carried out by blind or partially sighted staff. The Depot has, in fact, long been associated with staff handicapped in this way and the quality of their work is of the highest standard.

Most Telephone Areas carry out work similar to that of the Piece Part Depot but few, if any, undertake such a wide range of tasks. Currently more than 8,000 different items are held, ranging from tiny screws to larger pieces of exchange equipment. Bulk supplies come from Birmingham Supplies Depot but recovered apparatus is also broken down.

The Depot was established just before the Second World War to supply exchanges in the London Telecommunications Region with replacement parts for non-standard equipment. In 1946 the work was expanded to include telephone renovation and this meant extra staff had to be recruited. As a result of an arrangement with the then London County Council Rehabilitation Centre, blind and partially sighted men were employed for the first time.

Five years later, however, most of the work was transferred to Birmingham and this resulted in the blind and partially sighted staff either being transferred or retrained on other duties such as cord repairs and the breaking down of equipment. At present there are two blind and three partially sighted men working at the Depot together with others who also have disabilities which restrict them from other employment. An interesting and im-

Senior Technician Wally Walder replaces a pin in a 2000 type selector. Selectors are sent for repair from all over the country.



portant facility in this respect is the lift which gives an audible as well as visual signal at each floor. This enables the blind staff to know where they are in the building.

The blind and partially sighted staff carry out their cord repairs under the supervision of a sighted Technician. Their work normally involves replacing frayed and worn terminations and average output is between 400 and 500 cords per week. Close by them on the ground floor old apparatus such as selector spring sets, is broken down, sorted and boxed for re-issue. Items such as relay springs which need new contacts fitted are separated and despatched to the Birmingham Factory where this type of work is done.

Another part of the ground floor is used by staff working in the telephone "wipe up" service. As subscribers move away – and in City Area there is a high percentage of business users often with extensive telephone systems – the old equipment is recovered, collected and delivered to the Depot where it undergoes complete overhaul.

Old telephones are fitted with new cords, bells and dials and any scratch marks on the casing are removed. It takes an average of two to three weeks for each telephone to go through the complete process at the end of which it is as good as new. As soon as each tele-▶

Top: Dials from the "wipe up" section are sent to Technical Officer Bert Heanes for repair.
Centre: Fred Dawkins one of the blind staff at the Piece Part Depot repairs switchboard cords.
Bottom: At work in the Piece Part Depot, Lorenzo Bennett makes an adjustment to a telephone dial.

Ted Braidwood uses the buffer machine to polish up a telephone casing.

A fault is cleared on a repertory dialler.

phone is ready it is packed into a plastic envelope and collected for return to the appropriate section stock in City Area. Between 20,000 and 30,000 telephones are "wiped up" in City Area each year.

On the first floor is the City Area centralised coinbox maintenance centre. Staff here have long since ceased to be amazed at the lengths to which vandals will go to damage the boxes. Of the many different objects found jammed in the mechanisms, Yale type keys far outnumber anything else, although lolly sticks, spoons, pieces of plastic and foreign coins are frequently used to try to damage the equipment.

One major job likely to be occupying staff in the future is the conversion of the coinbox mechanisms to take 5p pieces. Between 30 and 40 additional men will be temporarily redeployed from the fitting staff to tackle this work which even in City Area, the smallest geographically in the United Kingdom, is formidable. Overall there are about 650 kiosks and 2,500 renters coinboxes which would need to be converted.

A small room on the third floor is where the Senior Technician carries out his unique repair service replacing the bearing pins on 2000-type selectors. Although some areas now have the special tools necessary for this job, in the main the selectors come from all over the United Kingdom at the rate of about 20 a week. In the same room two Technical Officers repair dials which have been sent up from the ground-floor "wipe up".

To the fourth floor comes equipment such as repertory callers and loudspeaking telephones which are suffering from the type of baffling fault that sometimes occurs on electronic equipment. In the test area they are put through a thorough and searching examination to identify the problem. Once this has been completed the equipment is repaired and returned ready for service as soon as possible.

This, then, is the City Area Piece Part Depot. It may be old, but the fact that it has a particularly low incidence of sick leave is a good indication of the sort of team spirit that has developed and which helps give the place its own distinctive character.

Mr G. T. Draper is an Area Engineer in London's City Telephone Area responsible for the Piece Part Depot and installation and maintenance of customers' apparatus.

Waveguide - the long distance traveller by tube

DW Morris

The practicability of providing hundreds of thousands of long-distance telephone circuits by piped underground microwave radio has been proved in Post Office trials of circular waveguide systems.

IN COMMON with most areas of technological development, progress in the field of long-distance inland communications is highlighted from time to time by a significant step forward when a new concept, often long worked on in the shaded labyrinths of "research", emerges as a practicable realisation.

The latest concept thus to emerge in practical form is the long-distance circular waveguide – a type of underground piped microwave radio system which uses millimetric radio waves in the frequency range 30-110 GHz or more for transmitting an enormous volume of digital signals down a tube no bigger than a car exhaust. The traffic capacity is so large that hundreds of thousands of two-way telephone circuits together with colour television pictures, telex messages and computer data can be carried at the same time.

The long estabilished coaxial mode of transmission utilised in a coaxial pair necessarily involves losses in the two conductors and in the associated insulators which increase significantly with frequency. This means that practicable systems tend to be limited to short-wave frequencies and require repeaters at about every kilometre.

The line-of-sight "free space" mode of transmission used in microwave radio relays avoids such losses, but its application is limited by frequency allocation restrictions and mutal interference problems. There is also the problem that at frequencies above about 30 GHz excessive propagation losses due to rain, water vapour and oxygen in the atmosphere render systems at these higher frequencies impracticable.

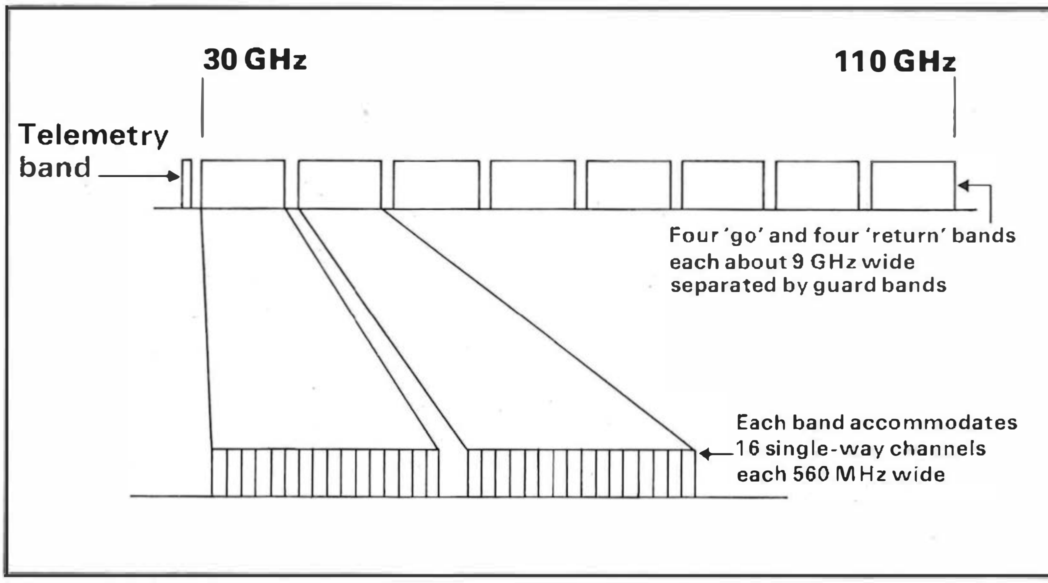
With the circular waveguide a number of transmission modes would be possible, most of them involving significant currents in the waveguide wall and therefore losses which increase with frequency, but there is one particular mode (designated TE01) which requires virtually no wall currents for its transmission other than relatively small "focusing" currents. As a result, losses could be very low and would tend to decrease with frequency as the focusing becomes more effective.

The possibility of using the TE01 mode to propagate millimetric waves along a circular waveguide created prospects of a transmission medium which would have low loss over an enormous bandwidth and none of the limitations associated with "free-space" transmission. When first postulated it was commonly believed that, to avoid the increase in loss which would result from any interaction between the radio wave (propagated along the centre of the waveguide) and the guide wall, the exploitation of these near-ideal characteristics would require precision-made copper tubes laid in dead straight lines – a requirement neither technically feasible nor economically viable.

Despite this the potential advantages inherent in a transmission system using the TE01 mode were such that in 1966, following experiments both in the United Kingdom and abroad, notably in the USA, an investigation began in the Post Office Research Department at Dollis Hill to explore the possibilities and to determine the feasibility of such a system.

By the end of 1968 the basic feasibility of most of the fundamental units needed for a system had been estabilished and demonstrated in the Dollis Hill laboratories. In the following year the investigating team moved out to the 100-acre site at Martlesham – now the headquarters for Post Office Research, where there was ample space to set up "field" experiments.

In due course sufficient knowledge, both theoretical and practical, had been built up for a full-scale trial to be contemplated, and it was decided to install a field trial waveguide system between the Research Centre at Martlesham and a telephone exchange site at Wickham Market, a small country town about 14 km away. The production and installation of this system, comprising 14.2 km of waveguide installed inside a steel duct and equipped at each end with repeaters for several radio-frequency channels and all necessary ancillary equipment, was completed last year.



Sub-division of the waveguide spectrum into operational channels.

From the beginning of this 10-year project emphasis was placed not only on technical feasibility but also on reliable practicability and economic viability and to this end contacts were established at an early date with British industry and with various other Post Office Departments and Regions as well as with Universities. These have all taken part in the various ▶

aspects of planning, designing and implementing the field trial and other relevant investigations. For example, detailed planning of the route was undertaken by staff in Colchester Telephone Area using rules evolved in Research Department and the factory production of waveguide, developed from the small-scale construction techniques used in Research Department, was in the hands of British Insulated Callender's Cables (BICC).

This close liaison with industry and other Post Office Departments and Regions, together with the experience gained from the field trial and the knowledge in depth acquired by Research Department in the course of their comprehensive investigations, has enabled early consideration to be given to the definition of a practicable operational system.

Such a system, capable of being planned, produced, installed and maintained by the Post Office and industry, is based on the 50 mm internal diameter glass-reinforced-plastic (GRP)-jacketed helix waveguide. Approximately 16 km of this waveguide was produced for the field trial system using manufacturing techniques and facilities developed and owned jointly by the Post Office and BICC.

Precision manufacturing processes are used to ensure that the basic transmission loss of this fundamental component of the system is maintained at less than 3 dB/km at all frequencies from 30 GHz to over 110 GHz. The waveguide itself is made in three-metre lengths, and pre-jointed in the factory into nine-metre lengths before being transported to the installation site for final jointing. A precision sleeve-type joint, used both in the factory and on site, ensures that the waveguide transmission characteristics are not seriously affected by the joints.

Also available is a waveguide assembly which enables sharp corners to be negotiated. It comprises a waveguide taper to reduce the internal diameter from 50 mm to 18 mm, a length of 18 mm I.D. dielectric-lined waveguide suitably curved to turn the corner within a two-metre square, and a second taper up to 50 mm again. The total loss incurred in each such assembly – several of which were incorporated in the field trial – is 0.25 dB.

When selecting a route for the installation of a waveguide system it is unnecessary to think in terms of long straight lines. A satisfactory waveguide route can be achieved simply by so arranging any number of straight runs and smooth curves as to yield as

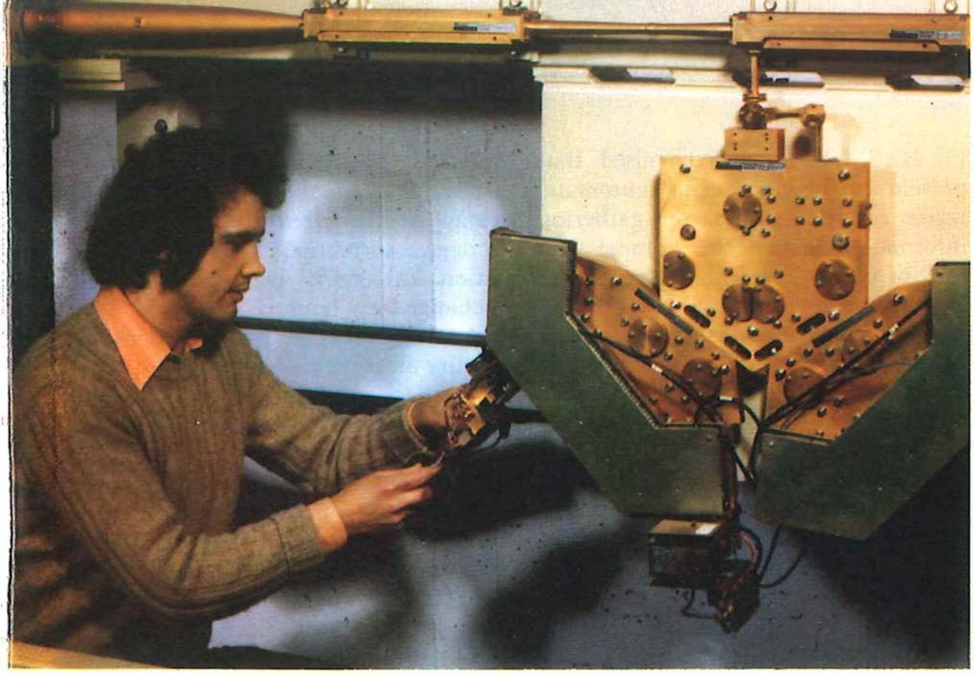
Section of the Martlesham-Wickham Market field trial route. The waveguide winds its way across country through the fields.

direct a route as possible consistent with restricting the number of very sharp bends and corners. Each sharp bend or corner gives rise to additional losses in the waveguide (over and above its basic loss) and, although tolerable by itself, it is desirable to avoid as far as possible the accumulative losses which would be incurred in a route containing a large number of these rapid changes of direction.

In practice it has proved fairly easy, both in the field trial in the Eastern Region and in subsequent simulated planning exercises in the Midland Region, to select satisfactory routes along roads and across country with few sharp bends and corners. When planning a route into the centre of a large town or city, it is inevitable that more corners than usual will be required, but a simulated planning exercise based on actual conditions confirmed the feasibility of achieving a serviceable route in such a situation.

Although the waveguide is relatively stiff in short lengths it is sufficiently flexible for its straightness when laid to be influenced by its immediate supporting structure. It is important, therefore, that its installation along the selected route avoids wriggles and undulations which could adversely affect the wideband low-loss characteristics made available by the precision manufacturing and route planning.

This is achieved by housing the waveguide inside a duct produced from commercial quality seam-welded medium-gauge steel pipe. Adequate smoothness at the duct joints is ensured by jig-welding although alternatively a suitable design of mechanical sleeve joint is available. When installing the duct underground by trenching, the trench bottom is levelled so that the pipe's inherent straightness is maintained. When moleploughing is used this technique automatically ensures a smooth lay.



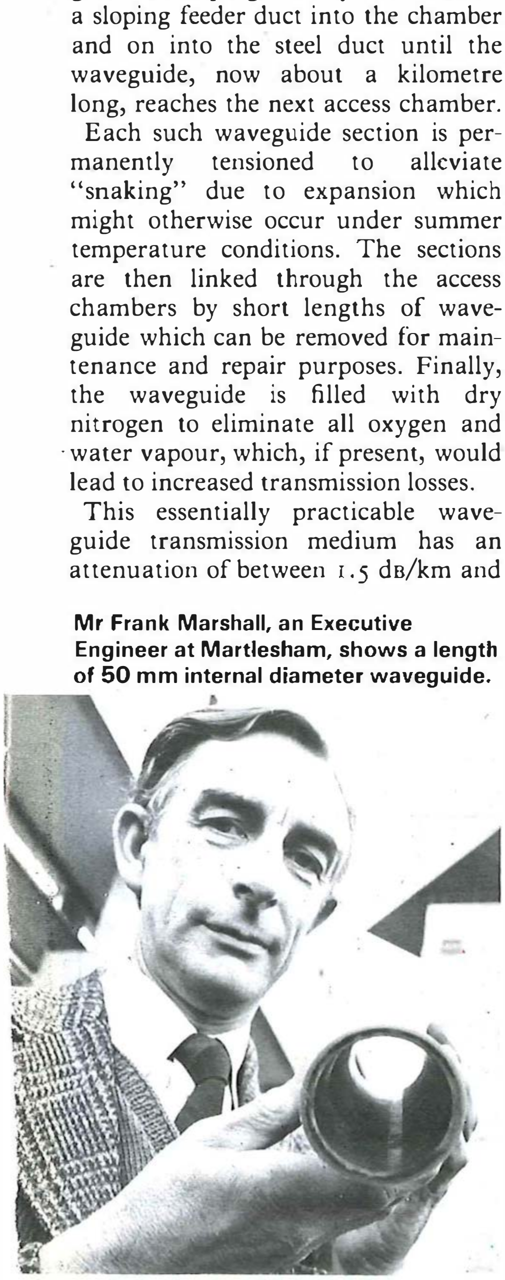
Inside the repeater station the waveguide terminates in a band-branching unit (mounted horizontally), and connected to the unit are two channel-separating units. Here, adjustments are made to one of the two channel radio frequency heads fitted to the 41–50 GHz channel separating units.

At about every kilometre along the route a chamber provides access to the duct for the insertion of the waveguide. At this point the nine-metre lengths of waveguide are jointed above ground and progressively moved down a sloping feeder duct into the chamber and on into the steel duct until the waveguide, now about a kilometre long, reaches the next access chamber.

Each such waveguide section is permanently tensioned to alleviate "snaking" due to expansion which might otherwise occur under summer temperature conditions. The sections are then linked through the access chambers by short lengths of waveguide which can be removed for maintenance and repair purposes. Finally, the waveguide is filled with dry nitrogen to eliminate all oxygen and water vapour, which, if present, would lead to increased transmission losses.

This essentially practicable waveguide transmission medium has an attenuation of between 1.5 dB/km and 3.0 dB/km over the whole of the frequency spectrum between 30 GHz and at least 110 GHz so that with the appropriate solid-state repeater sources, it offers a transmission system with normal repeater spacing of at least 20 km and an operational bandwidth of 80 GHz or more.

Mr Frank Marshall, an Executive Engineer at Martlesham, shows a length of 50 mm internal diameter waveguide.



By using half the bandwidth for each direction the single waveguide has a transmission capability of roughly 40,000 Mbit/s each way, viz almost 500,000 telephone circuits or some 300 television channels or the equivalent in any mixture of digital traffic. This ultimate capacity will not be fully required for many years and therefore the total bandwidth is so subdivided that it can be exploited economically at a rate dictated by traffic growth.

The available bandwidth is branched into eight bands (four in each direction) and subsequently each band as it is required provides up to 16 single-way radio-frequency channels. Each channel can carry up to four digital streams each at 140 Mbit/s at which level the system interfaces with the rest of the digital network.

Practicable design techniques for the necessary band-branching and channel-separating units have been developed by the Marconi Company, who produced the units required for the field trial system. Similarly equipment for individual channels such as radio frequency sections, modulators, dedemodulators and digital baseband circuits was developed and produced jointly by industry and the Post Office, and with the high-speed digital and millimetric devices now available commercially, the equipping of the lower frequency channels of a waveguide system presents no technical problems.

Further development work now in hand will ensure that equipment for the higher frequency channels will be available commercially well in advance of requirements to satisfy traffic forecasts.

At every repeater station each radio frequency channel is translated down to digital baseband for digital regeneration. It is then normally re-modulated and translated back into a radio frequency channel for onward transmission along the waveguide. Alternatively, however, it can be made available at the 140 Mbit/s level, for example to enable digital traffic to break in or out via coaxial cable.

This facility, allied with the non-critical nature of the large repeater-spacing, allows a useful degree of flexibility for overall network planning. A waveguide repeater station for instance may be located advantageously at less than the minimum spacing to facilitate the economic incorporation of digital traffic from a nearby centre.

Other aspects of integration into the national network, such as power and accommodation, supervisory facilities, protection switching, maintenance and repair techniques, have been the subject of joint studies and have been shown to present no major problems.

Thus, as the long-distance circular waveguide begins to emerge as a fully-engineered realisation, what does it offer for the immediate future? It is a transmission system simple in concept, elegant in its engineering, and with low costs per channel. It can easily be expanded to meet future needs with an ultimate capacity to satisfy these for many years to come and there are few repeater stations and minimum restrictions in respect of their location. It is a radio-frequency telecommunications highway which is out of sight, requires no towers, and is compatible with modern ideas of conservation.

Any beyond that? As time goes on devices at even shorter wavelengths are likely to become available. This raises the question of the feasibility of waveguides of reduced size and increased operating bandwidths – the same basic concept but with new engineering problems. Will they, too, prove to be soluble?

Mr D. W. Morris was formerly a head of section in the Millimetric Waveguide Systems Division of Research Department. He played a major role in the investigation and development of long-distance waveguide systems until his recent retirement.

Putting traffic analysis in the picture

DS Peakall

Remotely controlled cameras for photographing traffic meter readings at telephone exchanges are being used in a computer based scheme to record and analyse changes in the volume and flow of traffic on large numbers of circuits.

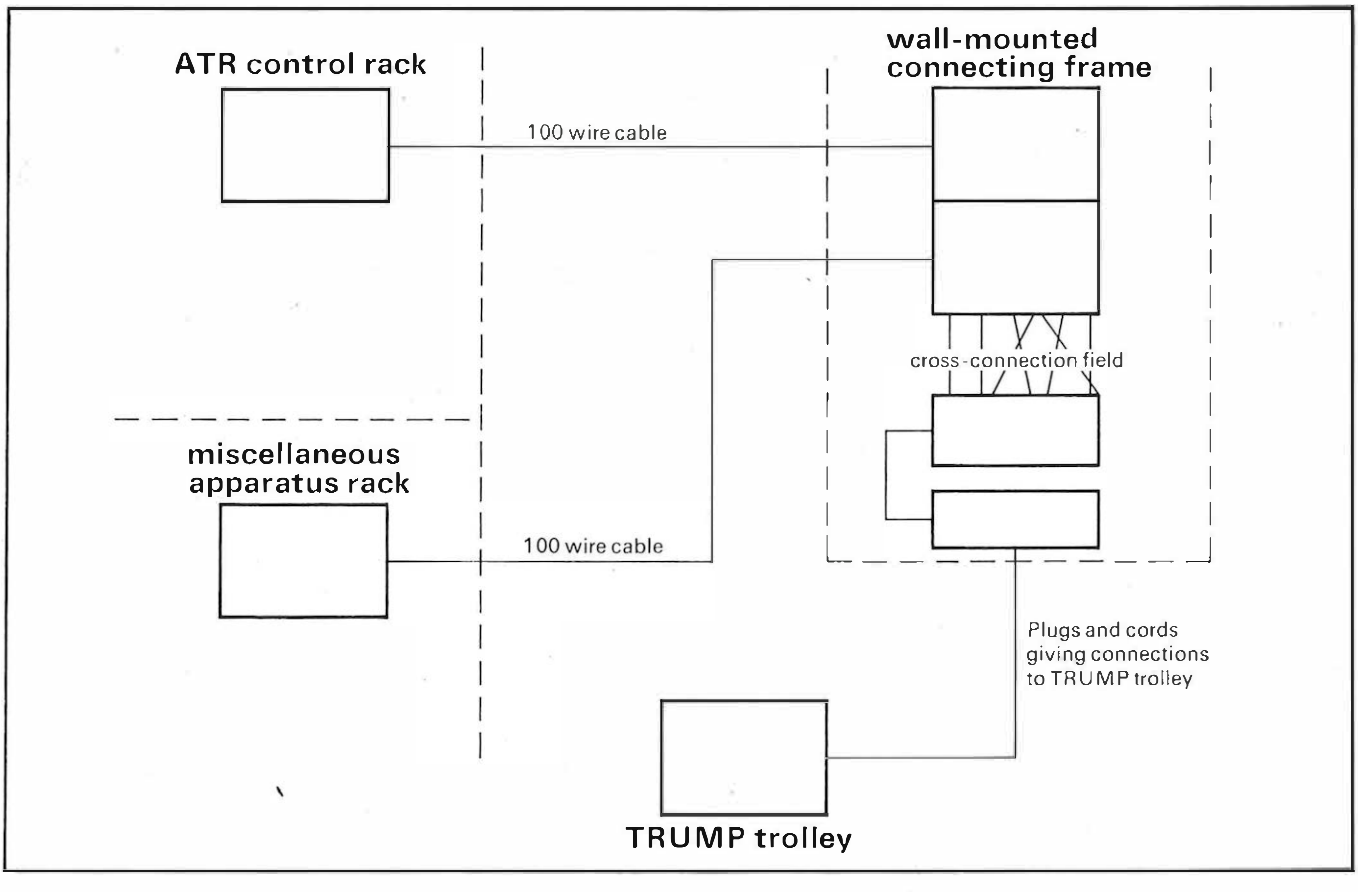
IT HAS long been recognised that present methods of using automatic traffic recorders (ATRS) for gathering information about the volume and flow of traffic in telephone exchanges leave much to be desired. Changes in telephone use caused, for example, by tariff revisions, often have temporary or permanent effects on the pattern of traffic flowing through the entire United Kingdom telephone network. As a result individual Telecommunications Regions and Boards and Telephone Areas have developed and implemented numerous schemes whereby auxiliary information may be obtained. One of these schemes is called TRUMP (traffic recording using meter photography), and has been designed primarily for use at group switching centres (GSCs).

The story began in 1970 when a study team in Eastern Telecommunications Region (ETR) was asked to investigate ways and means of recording and analysing traffic flows at exchanges in ETR, particularly at Cambridge trunk exchange. The study team's second report, issued in 1971, contained two important recommendations: first, that quarter-hourly records should be taken to determine with greater certainty the hour at which traffic records should be taken; and, secondly, that a programme of research should be undertaken to determine route busy hours and the traffic in them. It was also important to derive correction factors for application to traffic measured in the exchange busy hour.

The study team realised the impracticability of using exchange staff to read ATR meters at 15-minute intervals all day on five days a week, and suggested that, at Cambridge trunk exchange, a scientific camera operated by remote-control could photograph ATR meters every 15 minutes between 0900 and 1200 hours and from 1400 to 1700 hours every day for a week. The photographs obtained during the week would form input documents to a computer system and a tabular output would be produced at ETR's headquarters at Colchester, via an on-line computer terminal. This would show traffic carried on each route under investigation every 15 minutes, 30 minutes, 60 minutes and 90 minutes. It would also isolate and display the traffic measured in the busiest of each of these periods.

As with most new systems certain problems became apparent after the trials at Cambridge. The traffic recorder had not been modified for simultaneous time consistent busy hour (STCBH) working, so it was necessary to record over two weeks in order

The system of interconnections between the TRUMP trolley and telephone exchange equipment.



to measure all outgoing routes. It was also found that photographing the ATR meters "in situ" on the existing control racks was unsatisfactory and as such a massive amount of data was generated it was impracticable to process it using the relatively slow computer system.

ETR decided therefore that any extension of the scheme would first require substantial modifications, including the development of a portable unit to carry duplicate meters, camera and control equipment, and a new suite of computer programs on a more sophisticated (and preferably in-house) computer. The portable unit would also make it possible to record other types of traffic such as overflows. ETR further resolved to investigate only at exchanges where traffic recorders had been modified for STCBH working.

As a result of this seven portable trolleys, designed by ETR in conjunction with THQ Photographic Unit, were built by Reading Area Workshops and wired and tested in the Oxford Telephone Area. Basically, they are each equipped with a camera, associated control equipment, a matrix of 100 meters, and access panels. The trolley camera has a capacity of 200 exposures – 25 feet of 35 mm film can be loaded into the film cassettes and it is focused on the 10x10 meter matrix. The meters are housed in a light box which is illuminated by four fluorescent tubes.

The design of the box prevents any significant reflection from the tubes to the camera lens, and also minimises the penetration of incidental light from outside sources. The camera control consists of a uniselector counter driven from the same 30-second pulse train that operates the traffic recorders. At every 30th pulse – at 15-minute intervals – a relay is operated to apply the output of the camera power unit to the shutter release solenoid. The camera operates and the film is wound on mechanically by one frame.

A connecting frame mounted on to a convenient wall provides a flexibility point, since any trolley meter can be connected via any circuit from this frame to any control or miscellaneous apparatus rack. To achieve this, a cable is provided between each control or miscellaneous apparatus rack and the connecting frame, terminated on jacks at both ends. Cord connections are used to patch the required ATR or overflow meter to the frame and the trolley meter access point required. Minor modifications to the ATR control racks are required, the most important

Computer data produced from the TRUMP films is edited on this terminal at Telecommunications Headquarters which works on-line to the Dollis Hill Computer Centre in North West London.

of which are to the master control rack to obtain a 30-second pulse supply and to permit continuous running of the automatic traffic recorders.

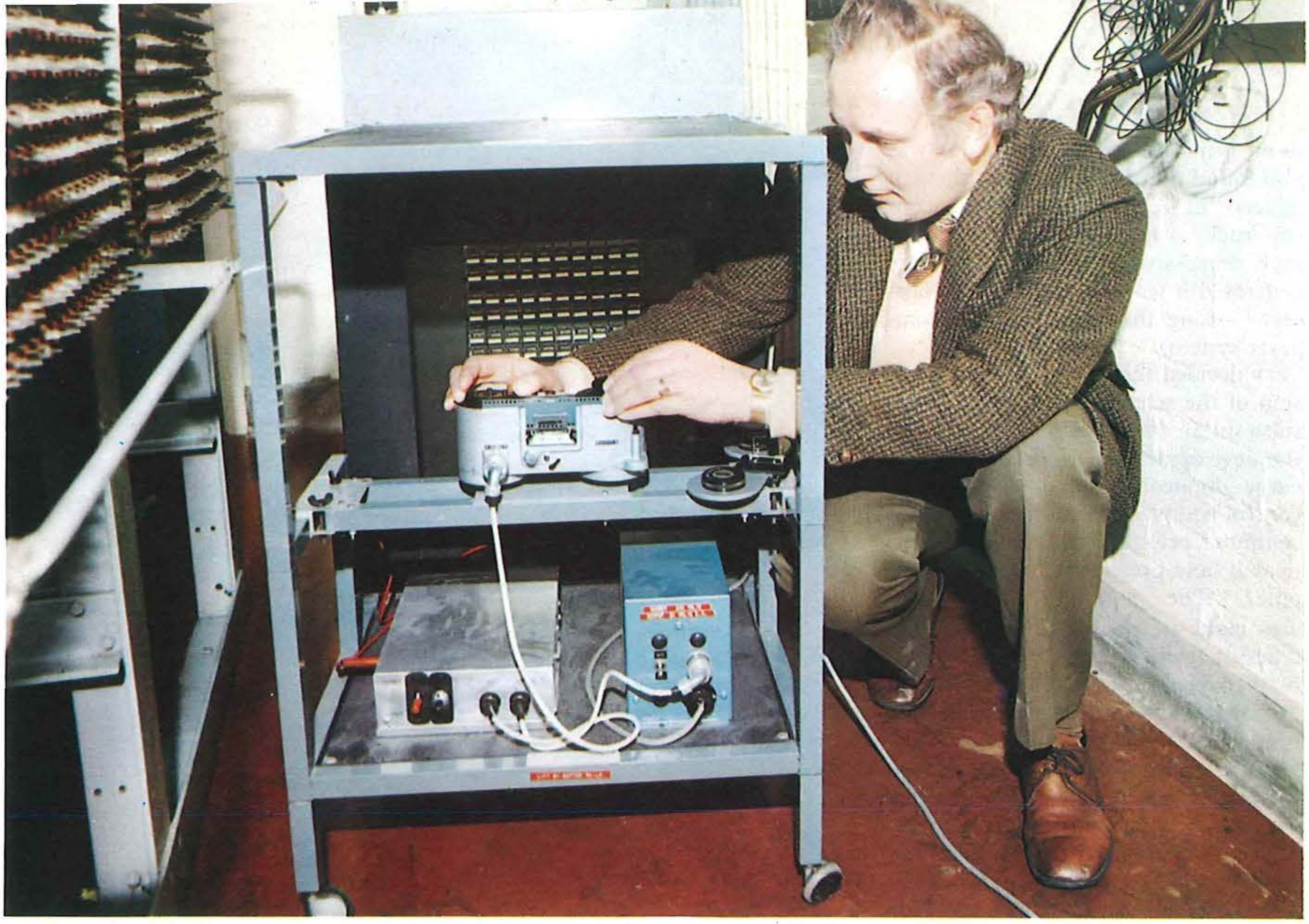
A portable synchronising unit is provided, consisting of a uniselector, driven by the 30-second pulse from the ATR master control rack. This lights a group of six lamps sequentially – each lamp in turn remaining illuminated for 30 seconds once in every three-minute cycle. One of these lamps, preferably of a distinctive colour, is designated the start lamp, and while this is illuminated the ATR start key should be operated. This allows three-minute interval synchronism to be maintained, which is particularly important when re-starting after an ATR failure. It also ensures that the camera only operates when the meters are stationary.

While TRUMP was being developed, basically similar ideas were being followed in South Eastern Telecommunications Region, resulting in the Traffic Recording with Automatic Meter Photography (TRAMP) scheme. The experience from both TRUMP and TRAMP has made possible a large measure of integration between the two and the film processing and data handling procedures are now virtually identical.

The arrangements for setting up TRUMP runs vary considerably from Region to Region and this situation is expected to continue until the trials evolve from being purely experimental and are placed on a regular interval basis. The fact remains however, that the basic procedure is used with minor variations by all current TRUMP users. When an Area (or Region) decides on a location and timing of a TRUMP run, a schedule is drawn up for submission to Network Planning Department (NPD) giving the names of groups, routes and levels to be analysed, together with the number of circuits, the critical traffic and the TRUMP meters to be associated with each of these groups, routes and levels.

NPD can then have this information punched on to paper tape by Dollis Hill Computer Centre (DHCC). This tape is used to create a constant data file on the Post Office computer at DHCC and this is held on magnetic tape until required for a run of the TRUMP suite of computer programs.

Meanwhile, the TRUMP trolley is transferred to the GSC under investigation and the ATR meters connected to ▶



Film is loaded into the camera on a portable unit specially designed for the TRUMP scheme. The camera records readings on the unit's meters which can be connected to any control or miscellaneous apparatus rack in the telephone exchange.

the trolley meters via the wall-mounted connecting frame, according to the schedule determined at the Area office. After exchange staff have checked that the camera is correctly focused and all meters are working, the trolley is ready for operation. It is usual nowadays to use time switches to switch on and off both mains power supplies and the ATR(s), and under normal circumstances, the trolleys require no further attention other than to change the film in the camera at a set time during the week.

If the ATR fails during the day, the camera continues to function although, of course the information it is photographing will not be processed. Exposed films are sent directly from the Area to the Photographic Unit of Purchasing and Supply Department (P&SD) in London and thence to NPD who are responsible for all data processing from this point.

The conversion of the raw data from 35 mm film to punched cards is currently being done by external computer bureaux. Plans are under consideration to bring all data preparation in-house, perhaps by using a system which encodes information directly on to magnetic tape, but until this possibility becomes reality, enlarged prints are produced from the films, and these act as documents for the data preparation bureaux girls who punch and verify the cards. The cards are sent to DHCC and loaded on to the system using a program which vets the information on each card, rejecting invalid cards and checking that each data item is in an acceptable format for the main suite of programs.

The main suite of computer programs is then brought into action and a tabular output is produced showing the analysis of each group, route and level on a separate sheet. The traffic quantities in erlangs are shown for each quarter hour ending 0915–1200, 1415–1700 and 1845–2230 for each of the five days recorded, together with running hourly averages and weekly quarter hourly and hourly averages. The busiest hour on the route for morning, afternoon and evening periods and the busiest of these three hours is identified, and a calculation is done to find the lowest acceptable weekly average hour figure, which is closest to the highest weekly average hour figure, Output is returned to NPD who arrange for it to be photo-reduced and duplicated and distributed as arranged by the Area or Region.

TRUMP has proved most useful in determining the route busy hours and traffic levels of a large number of circuit groups in a short period of time (showing economic and time savings compared with standard methods). This confirms the best periods for conventional recording, and has highlighted the need for afternoon and evening records to maintain the network. The ideal frequency for taking TRUMP records at a nominated GSC has yet to be determined, but the idea of taking a complete record initially and follow-up partial records at regular intervals thereafter has much to commend it, since subsequent records could include only those groups, routes and levels which are proving troublesome. This would enable quite considerable savings in data preparation and computer processing to be made.

It has always been intended that TRUMP should serve merely as an interim system until some more sophisticated means of traffic recording and analysis has evolved. NPD and the users agree that the films and punched cards must be replaced by a better recording method. In the meantime, 14 similar portable trolleys are being constructed by the Post Office Factories Division and these trolleys will be made available on a national basis during 1976.

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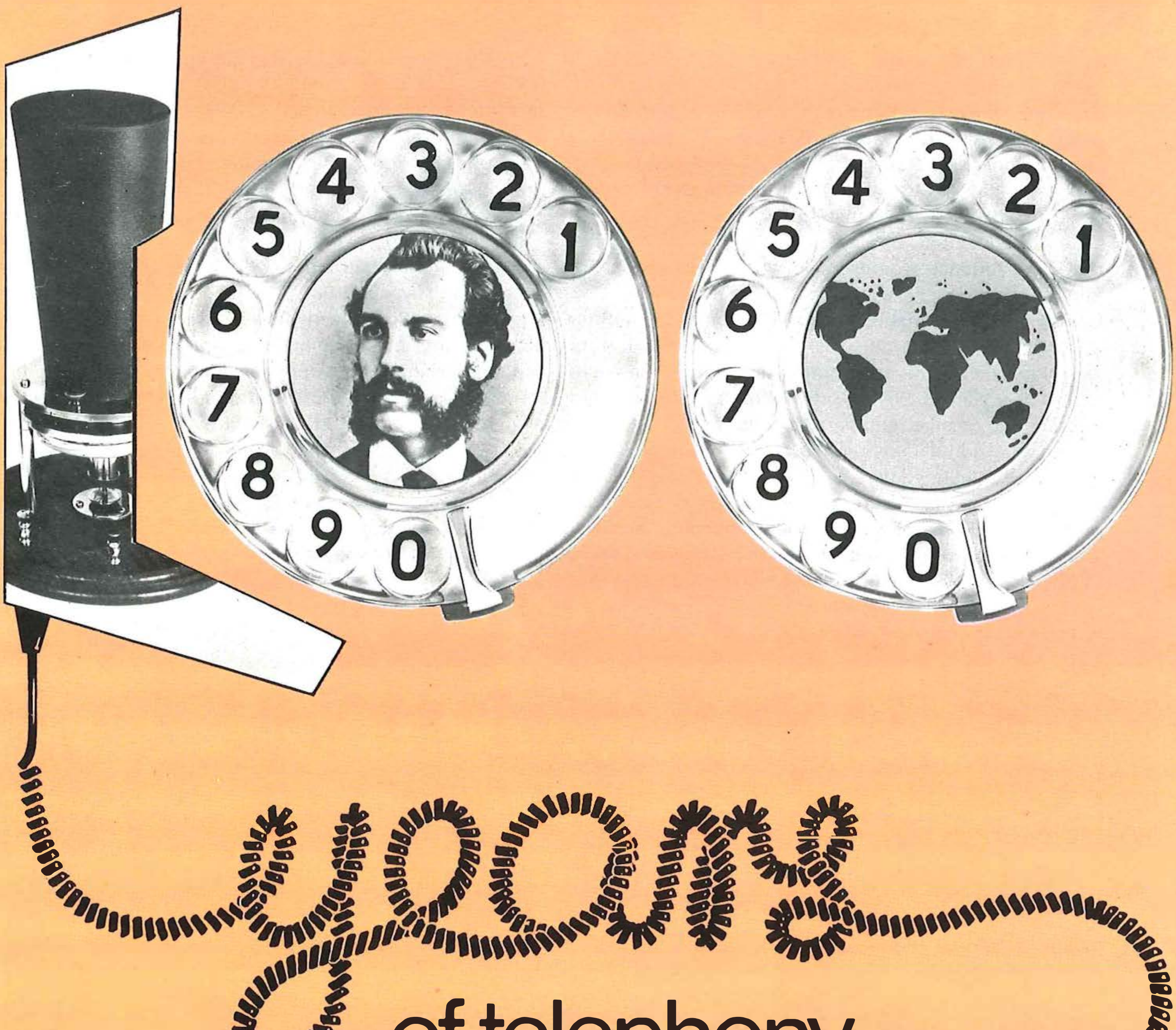
PO Telecommunications Journal, Spring 1976



100 years of telephony

On 10 March 1876 the first intelligible words were transmitted over a telephone by Alexander Graham Bell. Since that momentous day the art of telephony has developed from a single link between two primitive instruments in the same building to the almost universal availability of connection between 300 million telephones in all parts of the world.

In the following pages we retrace some of the highlights in the history and development of the telephone, examine its social impact and take a look at possible future trends in telecommunications.

From a boarding house in Boston

THE WORD "telephone" was first used in 1796 for a purely acoustic method of commünication, and the essentials of the telephone receiver were, in fact, known before the work of Alexander Graham Bell. However, a telephone needs a transmitter, and no previous inventor appears to have realised that an electromagnetic receiver could also be used as a transmitter for speech.

Born in Edinburgh, Bell emigrated to Canada and later moved to America where he filed his patent application for a telephone on February 14 1876. This claimed electromagnetic and variable resistance types of transmitter, although only the former was described in detail. Ironically, later that same day another application for a telephone was filed by Elisha Gray, who described an electromagnetic receiver and variable resistance transmitter having a horizontal diaphragm attached to a metal rod in a vessel of acidulated water.

Bell's patent was issued on March 7 1876; Gray's application, being only a provisional specification and filed later, was rejected. Three days later in his boarding house in Boston, Bell was about to test a new liquid transmitter with his assistant Thomas Watson holding the receiver at the other end of the line in another room, when he called out "Mr Watson come here, I want to see you". Watson entered saying that he had heard every word clearly.

Both before and after Bell had published his work, others claimed to have anticipated his invention. None of these claims was substantiated, and 18 years of litigation resulted in Bell's patent being upheld.

The new invention arrived in Britain in July 1877 when Mr W. H. Preece, who later became Sir William Preece and Engineer-in-Chief to the Post Office, brought in the first pair of practical telephones. However, in these early days the Post Office had an extensive telegraph network and it was not too enthusiastic about the new art.

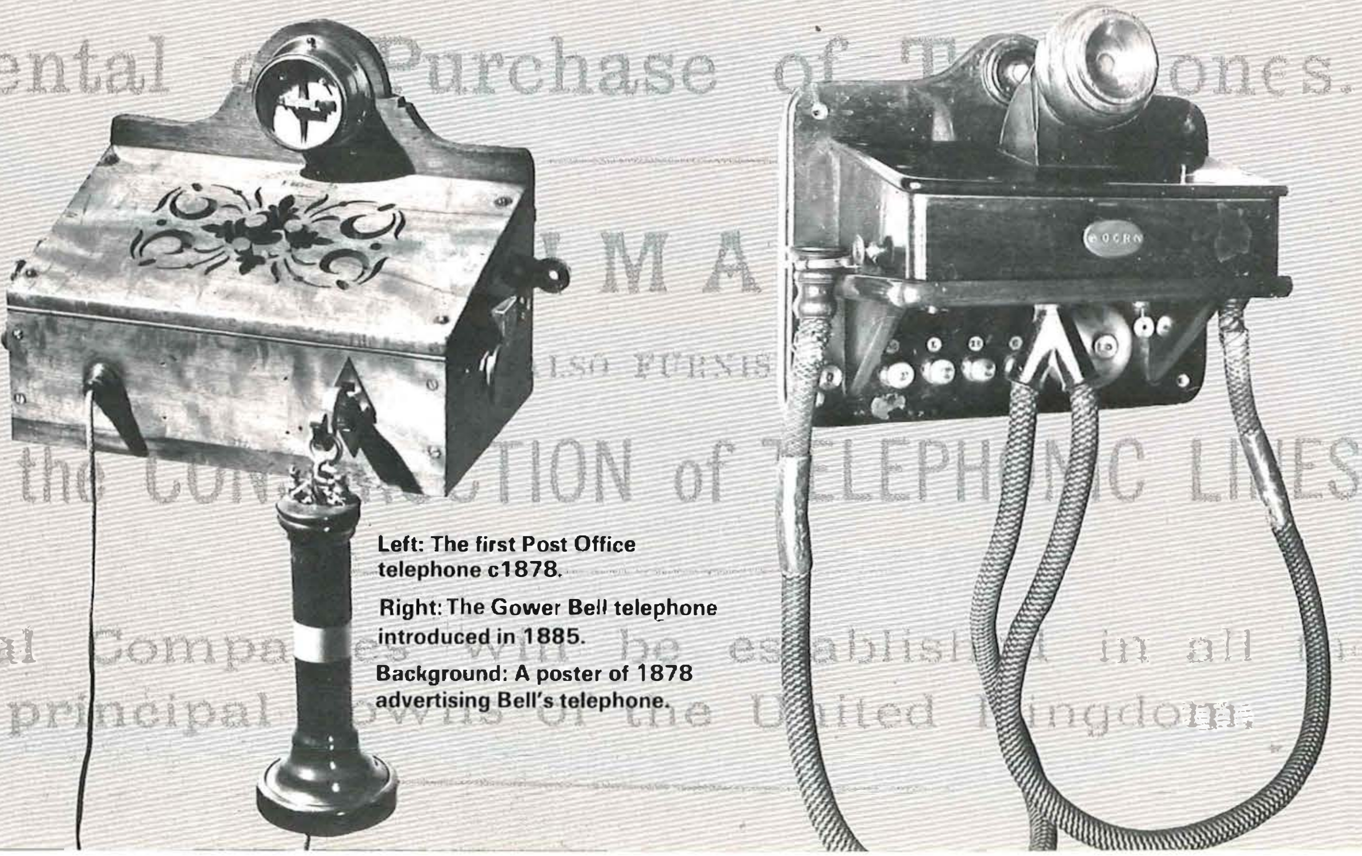
The Telephone Company was set up in 1878 to exploit Bell's patents in the United Kingdom, and the telephones first employed were a pair of electromagnetic instruments, one serving as a microphone and the other as an earphone. However, the customer could make do with one instrument by making clear that he had finished speaking and was transferring the instrument to his ear.

Bell and Watson had made great improvements in the electromagnetic instrument but, being entirely "sound powered", it was not very sensitive as a complete telephone connection. Meanwhile Thomas Alva Edison and his assistants had developed and patented a design of variable-resistance microphone which used carbon in the form of a cake of compressed lampblack as the active element. The increased sensitivity of this microphone provided a strong challenge to Bell's company.

Competition by the Edison Telephone Company, set up in the UK in 1879, was short-lived. Others had been working on the variable-resistance principle and the outcome of one of these, the Blake microphone, became available to The Telephone Company. Its combination with the Bell earphone gave advantage to The Telephone Co. and it merged with the Edison Company in 1880.

At this time the Post Office had started to offer its telegraph customers the option of fitting a telephone set for use over the same lines, and first used a carbon pencil microphone patented by Louis John Crossley. This was based on the discovery of Professor David Hughes that a very sensitive microphone was formed if a pencil of carbon was held vertically between the recesses in two carbon blocks. Microphonic action took place by variation in resistance of the two carbon-carbon contacts.

A more satisfactory arrangement, developed by Frederic Gower in the USA, was patented in the UK in 1880. This used eight carbon rods in a radial formation held



Left: The first Post Office telephone c1878.

Right: The Gower Bell telephone introduced in 1885.

Background: A poster of 1878 advertising Bell's telephone.

approximately horizontally between a central carbon block and eight smaller carbon blocks. The current passed through four rods in parallel to the central block and then out through the other four rods in parallel.

The thin pinewood diaphragm to which the blocks were attached was mounted nearly horizontally just below the top surface of a teak box which also contained the other parts of the telephone set. Speech entered through a mouthpiece in the top. These sets used as earphone an electromagnetic device also developed by Gower originally as a dual-purpose microphone/earphone, which was mounted in the instrument case with "speaking tubes" to both ears. These telephones were used by the Post Office for many years.

One of the most notable inventions in telephony was made by Henry Hunnings, a country curate in Yorkshire, who discovered that crushed coke made very good material for a variable-resistance microphone. Hunnings patented his invention in 1878 and this arrangement has provided the basis for all subsequent varieties of telephone microphone of the variable-resistance type used in the UK and most other countries.

Another important development was made by Clement Ader in France in 1879, who produced a dual-purpose instrument using a large ring-shaped magnet which served also as a handle. He also produced a smaller version with a flat circular magnet magnetised across a diameter and this proved the prototype for all compact forms of telephone earphone until the late 1930s.

Service emerges

The first telephone exchange in the UK was opened by The Telephone Company at 36 Coleman Street, London EC3, in 1879 with eight subscribers. By the end of that year two more exchanges had been opened in London and the number of subscribers had risen to 200.

For £20 a year the subscriber received two Bell telephones, one as a transmitter and the other a receiver, and a battery for power. A bell indicated an incoming call and a push-button was used to ring the exchange. At first boys were employed at the primitive exchanges to take messages and read them to the called subscriber.

During these early days the only way of running telephone wires from point to point was to string them on telephone poles, and the growth of the system led to huge concentrations of wires at exchanges. Not only did the wires look unwieldy, they were particularly prone to damage or even collapse.

Telegraphs had been transferred to the State in 1870, and although ten years later telephone systems were judged to be within the Post Office telegraph monopoly, early exploitation of the telephone was left largely to the private companies operating under licence. However, the Post Office did start to offer customers who had Wheatstone ABC telegraph instruments the option of fitting a telephone set.

A Post Office telephone exchange system was opened at Swansea on March 1881, existing ABC telegraphs being replaced by telephones, and was followed in Aug-

Piecing together the past

An old iron bracket, a piece of parchment, a brass door knob and terminals discovered in a junk shop . . . these were just a few of the odds and ends gathered together by two Assistant Executive Engineers in Norwich Telephone Area to make a piece of telephone equipment believed to be unique in Britain.

The two men are well known local telephone historian Eric Clayton, and his friend Peter Abel. Between them they have made exact replicas of Alexander Graham Bell's first transmitter and receiver. They are based entirely on original sketches and measurements obtained from the Institute of Electrical and Electronic Engineers in the USA.

Mr Clayton decided to start from scratch when it became obvious that photographs of supposed replicas of Bell's first working telephone differed in several details. He wrote to the IEEE and received the specifications needed, but almost immediately there were construction problems. Mr Abel came to the rescue by obtaining wood to match the original and as well as making the cylinders and base for the acid transmitter, he also made the wooden framework for the receiver.

Meanwhile Mr Clayton was busy cutting a suitable yoke from an old iron bracket, the coil core from an old electric bell, the armature from a thin iron door stay, and wire for the coil from an old Western Electric relay. The diaphragm was made from a piece of parchment supplied by a caligraphist and the terminals were those from the junk shop. Collecting the pieces and putting them together took about two months.

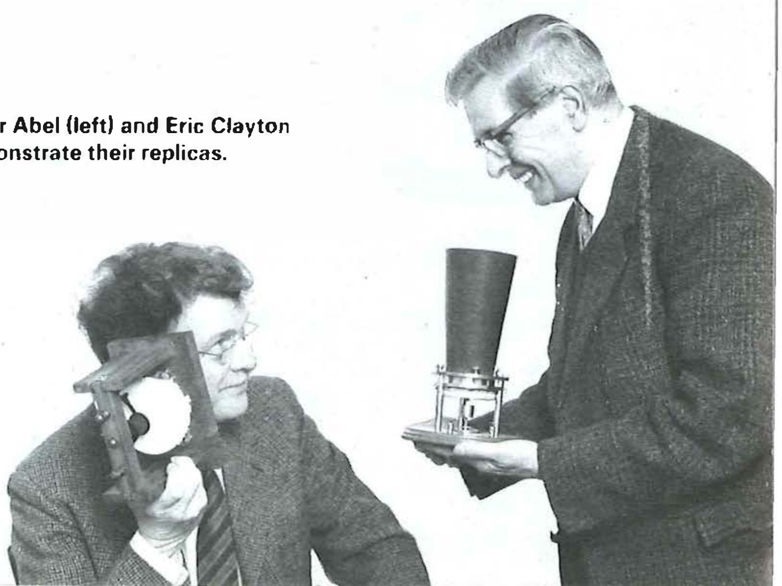
Making a replica of the liquid transmitter proved even more difficult as it was made mainly from solid brass. Obviously cost was a major problem so the hunt began for suitable items which could be fashioned for the purpose. Scrap metal merchants were contacted and a visit was made to a Lowestoft boat building yard – but to no avail.

Eventually sheet brass was used and Mr Abel made these parts by hand with the final shaping done on a lathe. The speaking funnel was shaped from the side of an oil drum and other parts ranged from the brass door knob of an old chest of drawers to a brass knuckle joint of a car.

At one point the scheme nearly foundered because a suitable piece of metal for the main mounting plate could not be found. Fortunately a friend found the right item among his model engineering junk boxes and work was able to continue. The platinum needle was made from a radio experimenter's item and mounted on the diaphragm.

At last the final pieces were in position and all that was needed to recreate the historic scene of 100 years ago when Bell called to his assistant was a little diluted sulphuric acid in the cup beneath the diaphragm.

Mr Clayton and Mr Abel have, in fact, offered their painstaking work to the General Manager of Norwich Telephone Area and it is being used for display purposes during the Bell Centenary celebrations.



Peter Abel (left) and Eric Clayton demonstrate their replicas.

ust that year by a Post Office telephone exchange at Cardiff. During the following few years numerous telegraph exchange systems situated in various parts of the country were converted to telephone working.

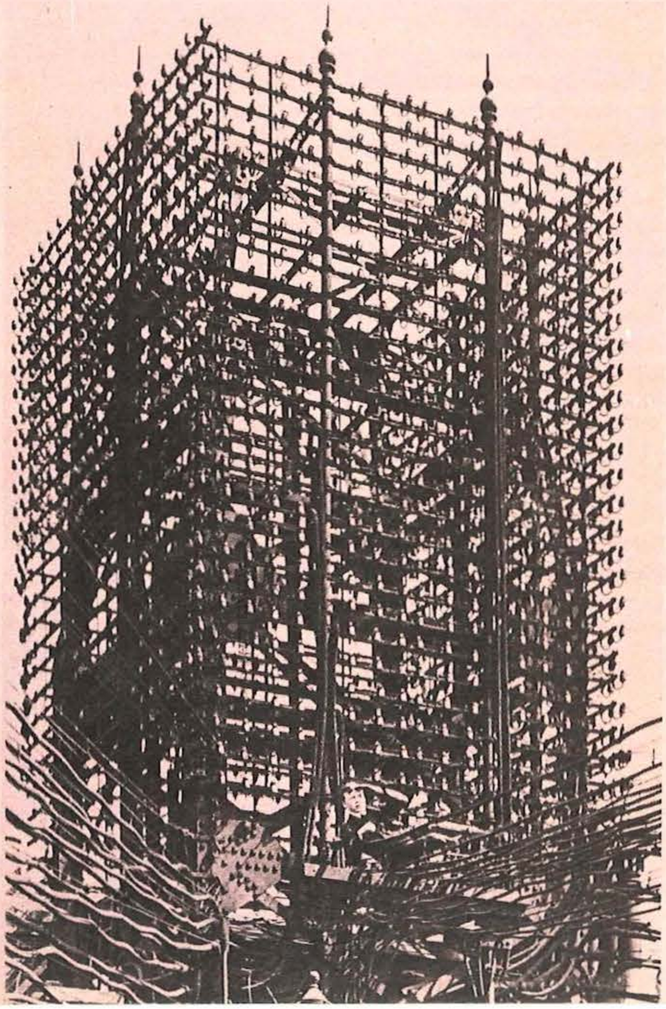
By 1888 there were seven major telephone companies operating in the UK, together with the Post Office and several municipal operations, running 282 exchanges and handling 242,000 calls a day between 21,500 subscribers. Competition was intense and the service was bedevilled by too many companies running systems that were not connected to each other, with equipment that was quite often incompatible.

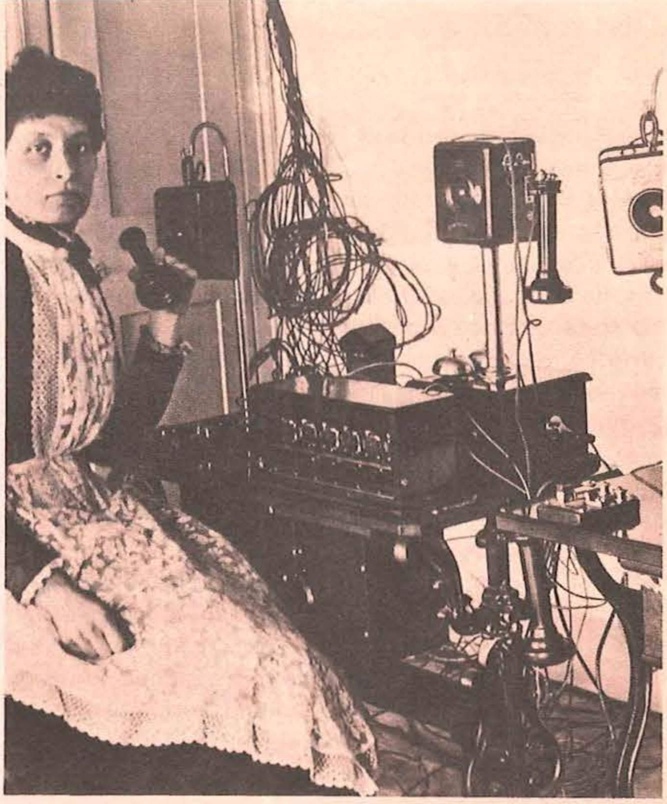
An important turning point was reached when the principal companies amalgamated as the National Telephone Company. During the last few years of the 19th Century this company gained control of almost all the local telephone services outside the Post Office system.

In 1896 – the year the telephone dial was invented – the Post Office bought the network of long-distance trunk lines and invested a further £5 million in development. By 1905 all the London telephone network had moved to the Post Office, leaving the rest of the country divided between the big two – the National Telephone Company and the Post Office.

Most of the licences granted in the 1880s to private companies expired by 1912, and negotiations started to bring all the telephones, apart from two municipal networks, under the wing of the Post Office. That year the Post Office took over from the National Telephone Company 1,565 exchanges of which only 231 had more than 300 subscribers.

The scene on the roof of a London telephone exchange in 1909 showing the cumbersome distribution frame and heavy overhead wires.





An operator at work among a tangle of wires at Croydon exchange in 1884.

The Network Grows

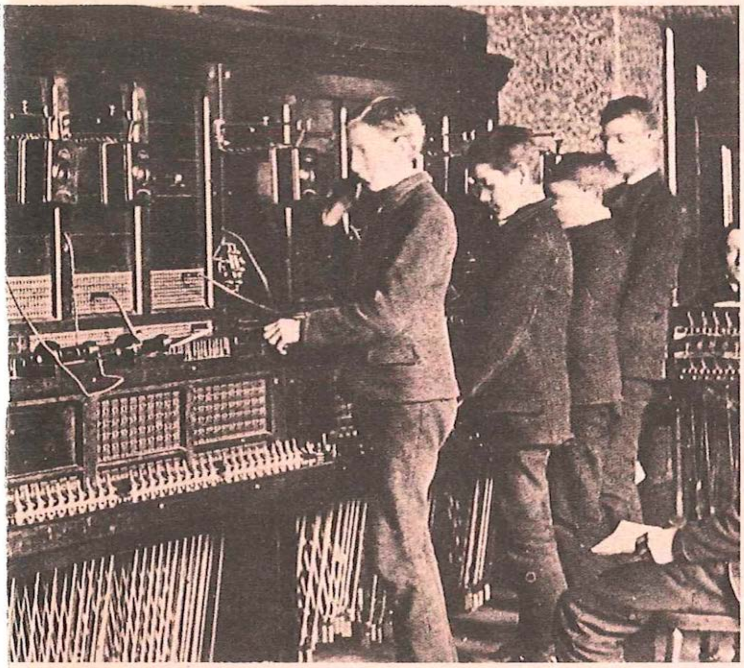
For some years before the formal transfer, in 1912, of the National Telephone Company's system to the Post Office the requirements of a comprehensive telephone service were extensively studied, and the prospects of automatic equipment wholly or partly replacing the telephone operator were clearly evident from demonstrations. Britain's first public automatic exchange was opened at Epsom on May 18 1912. The system – first designed by Kansas City undertaker Almon B. Strowger – used Keith line switches and two-motion selectors, and had an initial capacity of 500 lines. Subscriber control was effected by a switch-hook and a rotary, ten-hole governed dial.

A 500-line Lorimer type exchange system using a power-driven 100-point rotary switch with switched wipers was opened at Hereford in 1914. The exceptional feature of this system was the use of a four-lever calling device on which the calling subscriber composed a four-digit number and then initiated the selection process at the exchange by throwing a further lever.

Later that same year an 800-line Western Electric Rotary system was opened at Darlington. This was similar to the Lorimer system in the use of power-driven rotary-selector switches, but introduced an important new concept, the register, to receive the subscriber's signals from a rotary dial and to store them for subsequent control of the switches.

Although the First World War delayed the growth of a newly unified telephone network in Britain, further important automatic systems appeared during and after the 1914–18 period. By the early 1920s the Strowger step-by-step system had become well established in two versions, and several large provincial installations had been completed.

Subsequent history of the UK telephone switching system over the next 40 years is, essentially, the progressive development and standardisation of the UK



Boy operators at Sunderland telephone exchange at the turn of the century.

version of the Strowger system. This process began formally in 1923 with the signing of the first exchange agreement with the, then, four manufacturers of switching equipment.

The first move towards an integrated approach in linking several exchanges with an associated junction network was the development of satellite exchanges around a main exchange to serve the centre and environs of a large provincial city, using a linked numbering scheme. Early examples were established in 1925–1927 at Leeds, Edinburgh and Sheffield.

Telephone development of large cities such as London was early seen to be a major problem. The key factor was the transitional period – inevitably spread over many years – of manual and automatic inter-working in a highly interconnected network where most calls involved a junction connection from originating to destination exchange. This transitional period should involve only the minimum disturbance to subscribers, any number change being confined to a subscriber's own exchange conversion to automatic working.

It was clear that these requirements were incompatible with the direct control of route-selection switches by the subscriber's dial in the step-by-step system. The first solution to the problem of dissociating numbering and routing was the Panel system developed for the American Telephone and Telegraph Company, and plans were launched to manufacture a version suitable for London, with an initial installation at Blackfriars.

Considerable long-term problems would have had to be solved if centres of London and other large cities had been developed with the Panel system while environs and the provinces retained Strowger working. These problems were avoided by the availability of a storing and translating facility to work in association with the Strowger system, forming the Director system. It was decided in 1922 to adopt the Director system, and thus the two-motion selector, as the basic switching element for all UK urban exchanges. Five years later the first Director exchange was opened in London.

The numbering plan for London and other Director areas – Birmingham, Manchester, Liverpool, Edinburgh and Glasgow – used seven digits, presented to the user as the first three letters of the exchange name plus four numerical digits. Development over the last few years of direct international dialling forced the abandonment of mixed letter and number schemes, because in different countries the numerical equivalents for particular letters were different. All-figure numbering thus became essential, and was introduced in 1966.

The rapid advances in electronic techniques made during and immediately following the Second World War encouraged both the Post Office and manufacturers to direct their efforts towards a policy of a progressive change of the network from Strowger to electronic. In the event, the first round of developments based on time division multiplex techniques proved unviable economically and difficult to achieve technically. The parallel space division approach using reed relays as the switch block was clearly more promising, and development concentrated in this field. From this work emerged the very successful TXE2 and later the complementary TXE4 systems.

By the late 1960s growth in demand for telephones had created a shortfall in the capacity of the network and the Post Office embarked on a major programme of investment. TXE2 was used to the fullest extent, but was initially limited to exchanges up to about 2,000 lines. For larger exchanges a 5005 crossbar system and a derivative of the Pentaconta crossbar system – designated BXB – were adopted.

To get the quickest application of both systems into the network it was decided to use the 5005 crossbar for non-Director area and Group Switching Centre exchanges, and to use BXB for Director area and trunk transit exchanges. This policy has been implemented progressively since 1966 and there are now 5,244 Strowger, 652 TXE2, 270 TXK1 (5005) and 86 TXK3 (BXB) exchanges operating in the network. With the continuing programme of modernisation the electronic TXE4 exchange is being introduced from 1976 onwards, progressively taking over from crossbar the provision of large exchanges.

Towards STD

During the early days of the UK telephone system the trunk service operated by the Post Office was quite distinct from the local services. By 1912 there were 287 trunk exchanges serving 40 to 50 trunk zones, but three years later only 72 trunk exchanges remained separate from the local exchanges and the number of zones had been reduced to nine.

"On demand" trunk service was introduced in 1930, based on a new transmission and routing plan in which zones were divided into groups. The principal exchange in each group, being the group centre, had operational control of originating trunk traffic for all group exchanges.

A new switchboard, the sleeve-control board, was introduced in 1933 to permit any position and any cord

The Queen dials the first STD call in December 1958 from Bristol to Edinburgh.

unit to be used to handle any type of trunk circuit. Soon after came the 2VF signalling system to provide automatic calling, clearing and supervisory conditions over the audio path on circuits where d.c. signalling was not available.

The next step towards full automatic working was the progressive introduction of through operator dialling, which permitted an originating controlling operator to set up calls automatically over two or more links to a terminating automatic exchange through switching equipment at zone-centre exchanges. This stage began with the opening in 1954/5 of two large automatic trunk exchanges in London followed by similar exchanges in other important centres.

Trunk transmission and routing at this stage followed essentially the 1933 plan, and the stage was thus set for the introduction of subscriber trunk dialling (STD). Essentially this required the introduction of a register-translator at the originating group centre to replace, as far as possible, the controlling trunk operator. STD opened at Bristol in December 1958.

Initially the extent that STD was available to replace operator control of calls was limited by overall transmission requirements to calls having no more than one intermediate GSC two-wire switching point – that is, local – GSC – GSC – GSC – local. The cost per channel mile of trunk transmission fell rapidly as broadband systems or microwave radio relay and coaxial cable were developed and brought into use. And with the large growth in trunk traffic it became economic to provide direct GSC – GSC routes on an increasing scale.

Even so, a significant percentage of possible trunk connections would remain unavailable to STD with two-wire switching. This restriction had been recognised from the outset of planning for STD, and plans had been prepared for a basic network to be introduced using four-wire transit switching at some main switching centres. The new network was planned to include 37 transit-switching centres, nine of which (the old zone centres) were to be fully interconnected.

The transit network conforms to a new transmission plan that is compatible with recommendations of the International Telegraph and Telephone Consultative Committee (CCITT) for the national elements of four-wire international circuits. Several such circuits can be switched four-wire into the transit network to form a chain of circuits of satisfactory quality and stability.

Following detailed studies of long-term forecast growth, a plan – the London Sector Scheme – was devised for introducing a measure of decentralisation into the handling of long-distance traffic that originates or terminates in the London Charging Group – that is, the 350 Director exchange units serving some two million exchange lines within 20km of Oxford Circus. Seven new sector switching centres (SSCs) are being introduced to handle long-distance traffic for exchanges outside the central area (see Telecommunications Journal, Summer 1974).

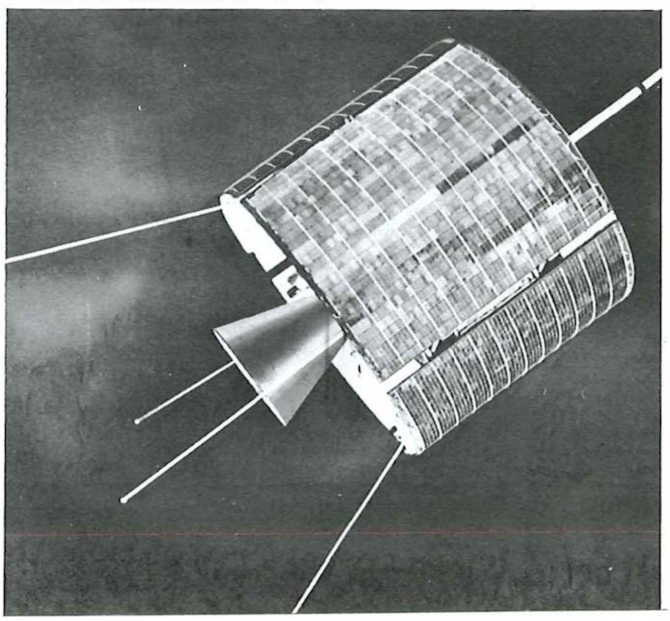
Calling the World

Telephony in the UK started to reach beyond its own shores as early as 1891 when an international service was opened with France. The first services used undersea cable circuits across the Channel and were handled as trunk calls in a "foreign" section of the London inland trunk exchange. In 1933 a separate international exchange was opened at Faraday building, circuits still two-wire switched to the inland network.

The introduction of high-frequency radio circuits involved rather different operating techniques, so a separate exchange was opened at Wood Street. An exciting step had been made in 1927 when a London–New York radiotelephone service began, and by 1930 Londoners were also calling Australia, Cape Town and Buenos Aires.

A new era began in 1956 with the laying of the first transatlantic telephone cable (TAT 1) between Oban in Scotland and Clarenville in Newfoundland. Traffic on this cable and the subsequent CANTAT and COMPAC (Canada to Australia) cables required four-wire transit switching to UK inland zones outside London and to Europe. The traffic was handled semi-automatically, under the control of a single operator, by means of a four-wire switching unit at Kingsway, London.

Early Bird, the first commercial communications satellite which was launched in 1965.

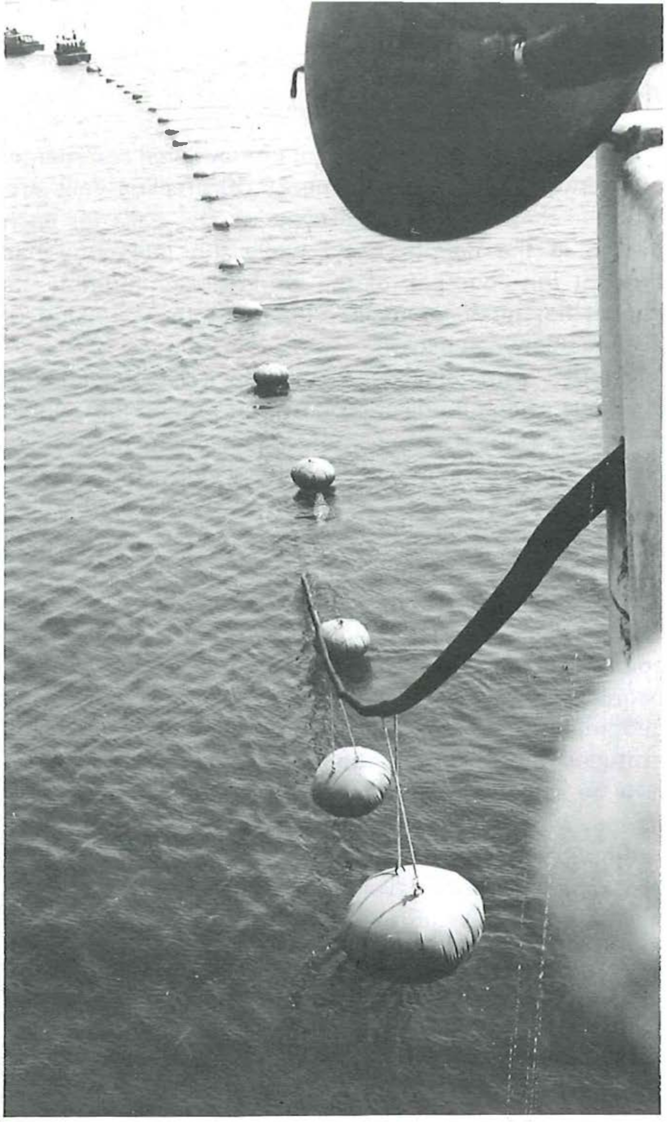


TAT 1 and subsequent ocean cable systems showed that stable and high-quality intercontinental circuits could be provided as the foundation for a world-wide telephone network with fully automatic subscriber dialling. In 1960 the CCITT established a study group to consider the basic requirements of a world-wide network, and a new international routing and transmission plan was produced during 1960–1968.

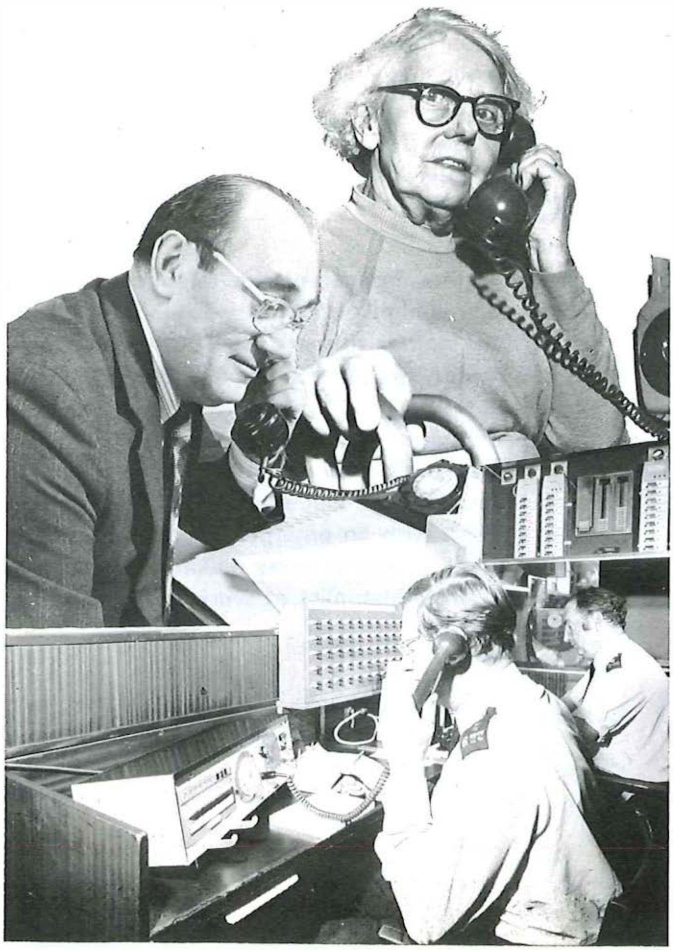
During the 1960s the CCITT studied the requirements for signalling on international circuits in a fully automatic network and defined two types of associated-channel signalling system (CCITT No. 4 and No. 5). With longer term trends towards large routes and to processor-control of switching, CCITT No. 6–separate channel signalling – was also introduced.

In this period space communications developed into service, the first commercial satellite, Early Bird, being launched in 1965. Today more than 60 per cent of the world's foreign telephone traffic is carried by satellites. International subscriber dialling, introduced in 1963 from London Director exchanges with STD facilities to Paris automatic exchanges, today provides direct dialling from the UK to 26 countries.

Among the requirements that contribute to the great complexity of modern international switching centres is the need to provide comprehensive accounting, traffic analysis and maintenance services, and for these to be highly automated and adaptable to commercial data processing. The first modern "gateway" exchange to be installed in the UK was the Wood Street installation opened in 1970. Rapid growth in international traffic has required other centres to be opened, and work is now in progress on a new installation for Mondial House.



The cableship "Alert" anchored off Widemouth Bay in Cornwall as the shore end of the TAT III transatlantic cable is towed towards the beach in 1963.



How the world became a village

TO THE lonely pensioner in a remote corner of the countryside the telephone can mean the difference between life and death, while to the international businessman it can be the vital link in clinching a major deal on the other side of the world. More often it is used simply to call a friend, order a taxi or find out the time.

In fact, the telephone has probably done more to change the world's way of life than any other single invention. Just consider these facts: It took more than 4,000 years for man to move from the invention of the wheel to the first motor car, yet in 100 years a process which began with the carrying of a faint message from one room to another has developed so spectacularly and to such an extent, that now a telephone user in Britain can be linked in seconds with most of the world's 300 million telephones.

Superficially telephony's most immediate impact has been to make geographical distance an outdated concept. With the telephone, Jerusalem or Canberra are as close as the house next door and this factor alone has revolutionised the conducting of international commerce.

Currently within Britain some 16,000 million calls are made each year – the equivalent of 284 calls for each person in the country. And while the telephone has brought the countries of the world closer together its impact has been far deeper than just the shrinking of distance between people.

Together with television and radio it has opened up channels of communication between groups that would otherwise seldom come into contact. A hundred years ago a Cornishman might well have gone through life without ever speaking to a Scot; the ways of Northerners were something of a mystery to Londoners. And the news and scandal of the town seldom reached the village population.

But modern communications – both transport and telecommunications – have changed all that. Access to other people's views and knowledge have hastened social and geographical levelling and made fundamental changes in attitudes towards information. Man's innate curiosity can now be satisfied more fully. His telephone can lead him directly to the storehouses of the world's information.

Although Bell probably had sound theories as to how his brainchild might develop, even he could not possibly have appreciated the full implications of his equipment. Certainly he foresaw that "... the telephone would be a major factor in the new urbanisation ... without the telephone system the 20th century metropolis would have been stunted by congestion and slowed to the primordial pace of messengers and postmen. And the modern industrial age would have been born with cerebral palsy".

But it was not all bouquets even in those early days. There were some who were dissatisfied with the performance of the new device. In 1890 Mark Twain who was evidently having difficulty in hearing over the lines of the Hartford Telephone Company wrote a letter to the New York World newspaper that read: "It is my heartwarm and world embracing Christmas hope and aspiration that all of us – the high, the low, the poor, the rich, the admired, the despised – may eventually be gathered together in a heaven of everlasting rest and peace and bliss – except the inventor of the telephone!"

Some have also objected to the telephone for its intrusions into personal privacy: Bell himself is said to have refused to have one in his study! Others have criticised it for its adverse effect on letter writing – a civilised and cultivated art in Victorian times. Sociologists fret about its over rapid intimation of trouble and disaster and its use as a means of promulgating dissent and disagreement. The instability and rapid collapse of the Wall Street Stock Market in 1926 was probably stimulated by the use of the telephone for panic selling of shares.

Professor Colin Cherry has speculated as to whether the telephone, with other means of world communication, augers for ill or good, but concludes that effective communications are essential for the creation of "a better world order through varied, flexible, and overlapping federations of countries according to a host of specific, defined mutual interests".

Overall the evidence in favour of the telephone is clear and overwhelming. It satisfies economically a vast range of human communication needs for social, business, industrial and governmental purposes because it provides rapid two-way interactive communication directly between people in a manner not possible with mass-communication media.

It can carry a child's greeting to a distant grandparent, emergency services like the fire brigade and ambulance can be alerted in seconds or ultimately a call on the international "hot line" could head off nuclear disaster.

As American sociologist Sydney Aronson has written: "... it has helped to transform life in cities and on farms and to change the conduct of business both legitimate and illegitimate; it imparted an impulse towards the development of a 'mass culture' and 'mass society' at the same time it affected particular institutional patterns in education and medicine, in law and warfare, in manners and morals, in crime and police work in the handling of crises and the ordinary routines of life ..."

It does not matter to a telephone user that his call may travel via satellites thousands of miles above the earth, cables two miles below the Atlantic, radio links across Britain or through a local exchange that is a miracle of electronic technology. What is important is that the telephone gives him the social advantage of instant communication day and night.

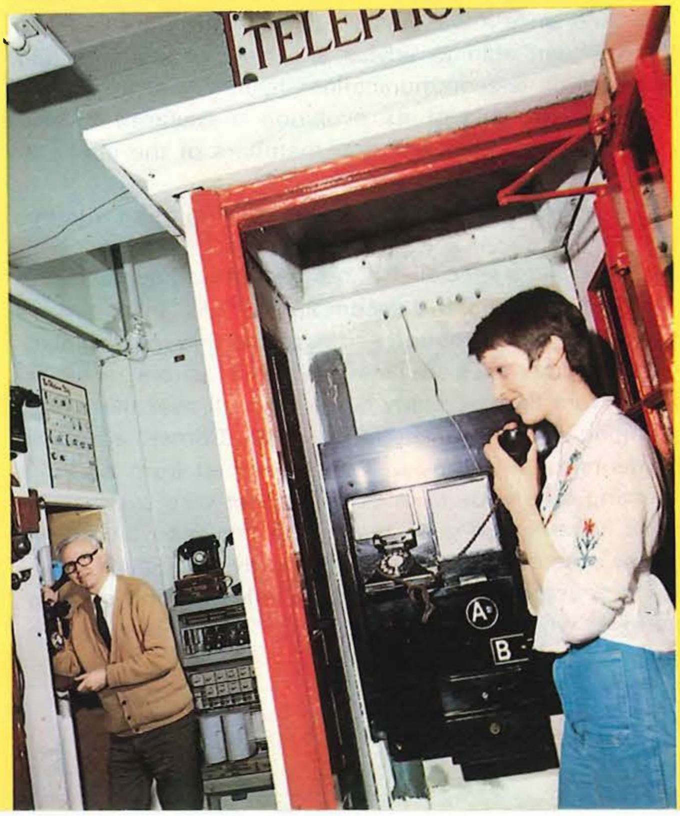
The enormous impact of the telephone on the community is highlighted in the issue of a special set of four stamps to mark the 100th anniversary of Alexander Graham Bell's first telephone. In values of $8\frac{1}{2}$p, 10p, 11p and 13p the stamps are the Post Office's first special issue of 1976.
The $8\frac{1}{2}$p stamp shows a mother at home making a social or domestic call, the 10p shows a policeman dealing with an emergency call, and on the 11p stamp is a district nurse making a social welfare call. An industrialist at work appears on the 13p stamp.

Saved for posterity

Two Post Office men who recognised the historic value of old and outdated telecommunications equipment, have played major roles in ensuring its survival. They are REG EARL and PETER POVEY, curators of the Post Office Telecommunications Museums at Oxford and Taunton, respectively, and they describe here how their collections have developed.

Above: The telephone that started the Post Office Telecommunications Museum at Oxford . . . Curator Reg Earl demonstrates the wallphone which became his first exhibit.

Below: Oxford exchange telephonist Ann Ginn and Mr Earl re-create a typical telephone call of the 1930s. This working exhibit includes a UAX 5 which links a kiosk and wallphone.



Buried treasure in the snow

WHEN I picked up the pieces of an old National Telephone Company wall phone from a snow-covered rubbish pile in the exchange yard at Oxford, a dozen or so years ago, I had no idea that the foundation stone was being laid of a new and important Post Office Telecommunications Museum. At the time – the middle of the freezing winter of 1962–1963 – I was a maintenance Technical Officer in the Oxford Area.

I had in fact, salvaged, an NTC telephone number three manufactured by the Standard Telephone Company in about 1910. For the want of a better home the instrument was screwed to a wall in Oxford exchange where it soon attracted so much interest from staff and visitors alike that it was obvious there was a need for a permanent display of historic telecommunications equipment. And although I still had only the one exhibit the word soon got around that I was starting a telephone museum and before long linemen and other members of the staff were offering me various examples of obsolete telephone equipment.

In the beginning the exhibits were not well displayed but with the acquisition of rare and valuable items such as Post Office telephones numbers 16 and 88, and an original Bell telephone, it became essential that proper accommodation was provided.

The present General Manager, Mr Peter Buck, readily agreed to the provision of a small purpose-built room in the exchange basement, and in July 1970 the new accommodation was formally opened by the Viscountess Hall of Cynon Valley, wife of the then Chairman of the Post Office. Then in 1974 an extension was opened by Mrs Dorothy Golothan, wife of the then Regional Director. With the exhibition continuing to grow it soon became difficult to run the museum on a part-time basis, and in April 1975 I was appointed full-time curator.

There is little point in operating a museum unless it is open to the public and for this exhibits have to be presented attractively and systematically. It is possible for instance to set out the smaller exhibits in chronological order beginning with early telegraph equipment followed by replicas of Bell's instruments.

The evolution of the telephone is then shown up to the present day keyphone. The oldest exhibit is a clockwork Breguet Dial telegraph instrument, *circa* 1850, looking like the Wheatstone ABC instrument. Other early electric telegraph apparatus includes a double-plate acoustic sounder, with single needle, developed in 1852 by John Tilston Bright and often known as a "Bright's Bell", and a clockwork morse inker made in 1907.

Among the museum's larger exhibits are working examples of a simple 22-line PAX manufactured by the General Electric Company about 1930 and two Post Office rural automatic exchanges – UAXs 5 and 12. Two early teleprinters are interconnected so that visitors may, if they wish, send messages to one another – a feature enjoyed by schoolchildren – and often by the not so young! During 1976 it is hoped to have working again a switchboard section from the country's last manual exchange at Abingdon, and also one of the few remaining kiosks No. 1 – introduced by the Post Office in 1921.

The smaller working exhibits include a house-exchange system of the 1920s, a small switchboard using a Macadie keysender as used by PBX operators in the early 1930s and several phones of the same period.

Most visitors come from schools in the area although students and staff from the University and other adult training establishments make use of the museum's facilities. And since it was given a permanent home in 1970 I have been able to advise all levels of students and teachers on telecommunications history, and to provide visual illustrations of its evolution. Assistance is also given to other museums and members of the public in identifying early equipment.

The Oxford museum also has something of an international reputation. A Canadian insulator collector, who recently paid a special visit, has donated a fine collection of North American telecommunications insulators – mostly of glass, although earthenware, thin modern plastic and rubber ones are included. Other visitors, including many from the University come from all over the world.

Among items displayed in "Curiosity Corner" are some unidentified telephone bell gongs turned from wood; a toasting fork made from 600lb copper wire by an overhead construction gang during the first war; a battered house exchange telephone of the early 1920s unearthed in the countryside near Oxford recently by a pole erection gang, in what must have been a million to one chance; and, of course, the inevitable dial with reversed figures on its number plate.

When items are put on public display inquisitive visitors may want to know the history of every piece there, and so to acquire this knowledge the curator must have access to a library of historical and technical text books. The museum at Oxford has from the start built up such a library and a large part of the time running the museum is taken up by attention to its archives. A photographic library is also maintained and so too are press-cuttings where they relate to the Oxford Area.

Still in everyday use at the Oxford Museum is this small switchboard, Macadie keysender provided for PBX operators in the early 1930s and loudspeaking receiver used in Blenheim Palace at the turn of the Century.

History in a cardboard box

ALTERATIONS to Taunton telephone exchange in 1957 gave me an opportunity to put on display some of the obsolete telecommunications equipment I had obtained in the immediate post-war years and had stored in cardboard boxes. Bookcases and other furniture were used as display cases, but despite the makeshift arrangements response was most encouraging and this proved to be the modest beginning of the Post Office Telecommunications Museum at Taunton.

During the next 10 years the museum expanded rapidly and soon became too big for its home in the exchange. With this in mind it was decided that the town's new exchange should incorporate accommodation specially for the museum. As a temporary solution, however, it was moved to its present setting in an old building next to the existing exchange.

There are, of course, special problems involved in planning a telecommunications museum. Over the years equipment has been designed to operate from a wide range of electrical supplies. These include direct current of various voltages and polarities, as well as alternating current of various voltages and frequencies and, occasionally, of non-standard wave form. Any of these supplies may be needed for working exhibits. And provision must also be made for a large number of inter-connecting circuits. Naturally the whole arrangement must be completely flexible to allow for changes in display.

Telecommunications has evolved, and is continuing to evolve, at an extraordinary rate and as a result equipment can, in some cases, be conceived, developed, brought into service, superseded, scrapped, and may even totally disappear within a span of 10 years. In these circumstances an important function of a telecommunications museum is to earmark older equipment of potential historic interest for preservation.

A typical example of this is the subscriber trunk dialling equipment from Bristol Central exchange. Bristol was the first place to have STD and calls were processed by electronic equipment of a type which was then considered to be very advanced but which is now no longer used.

Important new developments like this are extensively publicised but in contrast, when equipment reaches the end of its working life it generally quietly disappears and, if it is to be saved, a curator must make sure he keeps his ear to the ground to know what is going on.

Because there have been so many developments in telecommunications within living memory, much useful information can be gathered from older members of the staff and from people who have retired. Information obtained in this way proved very useful when, a few years ago, the museum acquired a small automatic telephone exchange that had originally been installed in Zelah in Cornwall in 1930 and had served that community for 37 years.

It had been well maintained but much of the work that had been done had detracted from its value as an historic exhibit. In many cases original parts had been systematically changed for more reliable modern equivalents, and modifications had been made to provide additional facilities, such as the 999 service introduced in 1937.

It took two years to find the parts needed to restore the exchange to its original state but today it is possible to dial calls through it from telephones of the period.

Telecommunications is a service run by people to meet the needs of people, and whenever possible I try to present the human as well as the technical side of the story. For example, a switchboard of 1900 could have been displayed just with a descriptive label, but when this type of switchboard was new it was used in a small town or village and would, as likely as not, have been installed in the living room or parlour of a private house.

To help people visualise this domestic setting an early telephone exchange has been reconstructed and visitors can peep through an open doorway to see the switchboard with all its accessories in a typical setting – complete with gas light and Victorian sewing machine. On special occasions, operators dressed in period costume answer calls from telephones in the museum or chat with visitors through the open doorway.

A number of exhibits are well over a 100 years old and though this may seem ridiculously new by comparison with the neolithic flints or the Etruscan vases in other museums, in the time scale of telecommunications it is ancient history. One of the oldest exhibits in the museum is a section of the first transatlantic telegraph cable laid in 1858 by ships which still carried sails.

Above: A visitor to the Taunton museum operates the Macadie keysender. On the wall is a poster of the 1930s.

Below: Peter Povey holds a giant CAT10 water-cooled valve used on the first transatlantic telephone circuits in 1927.

Looking ahead to the next century

As men of telecommunications reflect on 100 years of telephony, it is appropriate also to look ahead to the coming decades. The possible direction of future developments, together with some of the trends which may influence and challenge technology are outlined in the following summary of an address given recently to the Institute of Electrical Engineers by Professor J. H. H. Merriman, Post Office Board Member for Technology and Senior Director, Development

OBSERVABLE trends in telecommunications are easily stated. They concern growth, the basic characteristics of the services and the emerging possibilities of engineering and scientific innovation. Growth is clearly related to a compound of factors, among which rates high the set of parameters associated with general economic prosperity. But it is also influenced by other more subtle factors such as social custom, habit and geography.

The trends easiest to identify are those connected with technology, and here the short-term forward projection seems fairly clear. There will, for example, be a progressive move away from electromechanically based exchange systems towards processor controlled microelectronic digital exchanges. There will be a move in transmission systems to exploit the new technologies of waveguides and fibre optics. New techniques of broadband communication will penetrate trunk and junction systems and also the tendrils of the local network.

The customer network will no longer be simply a telephone, but a modular flexible device giving access to a wide range of speech, data, vision and facsimile services. Standing behind these, technologies can be foreseen that will provide greater route security and added flexibility to select this widening range of services.

Services that will be provided can also, reasonably surely, be forecast as embracing not only voice-to-voice communication between individuals but conference facilities, group communications as well as access to information, facts, figures and pictures. The border lines between the technologies of computing, control, communications, entertainment and education will become increasingly indistinct, and this may be expected to have profound effects upon the services they sustain.

In a sense, technological prediction is easiest to make. The practical limits seem to be determined, increasingly, not by the engineering means but by the economic, legal, organisational, sociological and managerial constraints that societies will impose.

In short, the future appears to be one in which there is ample ability to conceive, create and construct a variety of possible new telecommunications services, applications and facilities. However, the cardinal difficulties will be those of deciding which options should be undertaken, which of the often conflicting approaches to these options can be standardised, and by what means shall basic decisions be taken in the face of increasing complexity, interdependence and "globality".

Looking first at technology-based trends in relation to the possible environment of the 21st Century, there are reasonably secure scientific bases for expecting further continuing significant reductions, in real terms, of the cost of the main arteries of long distance transmission. Techniques implying further significant improvements in quality control of materials and manufacturing processes in transmission media, both cable and guided wave, appear to be capable of being developed commercially.

Device development appears to present no fundamental obstacles, either in terms of transmission performance or life. Devices operating reliably in the tens of GHz region can be foreseen. Alternative basic technologies – analogue and digital – exist already and are competing vigorously so that alternative or "escape" routes for ongoing transmission development can be predicted, with the possibilities of optical fibre transmission awaiting exploitation in long, medium and short range systems.

It is, indeed, possible to postulate with confidence an engineering infrastructure for the 1990–2010 period that contains transmission options based on current systems, enhanced by wideband "thick route" inter-city waveguide connections, supported by a raft of junction and local systems using optical fibre technology.

If present growth in demand for intercontinental systems continues, its satisfaction may well present severe challenges to basic engineering and science. In space communication the challenge may be presented by the limitations of radio frequency spectrum occupancy and allocation in the geostationary orbit. Extrapolating present growth rates forwards suggests that currently available allocations in the 4 and 6 GHz bands, together with foreseeable demands for orbital positions in the operationally desirable mid-Atlantic and mid-Pacific positions, will approach exhaustion in the mid-1980s.

Future growth therefore depends upon the extent to which firm regulatory processes can be internationally determined, on the extent to which frequency allocations in hitherto unused segments of the spectrum can be scientifically proven, commercially exploited and regulated, and upon advances in satellite station-keeping and aerial pointing accuracy. It depends also upon the extent to which a global girdle or "bus-bar" highway of inter-satellite links could be created.

For these reasons continuing development in complementary high-capacity undersea cable systems must be expected. By the end of this century digital/analogue systems operating at 1 G/bit/sec could become feasible, and engineering suppositions for the early decades of the 21st Century could include under-oceanic cable systems with "distributor" nodes, including digital switches feeding into multi-destination distribution cables if geography and traffic flow required it.

Repeaters for a modern, high-capacity undersea cable system are assembled at an STC factory.

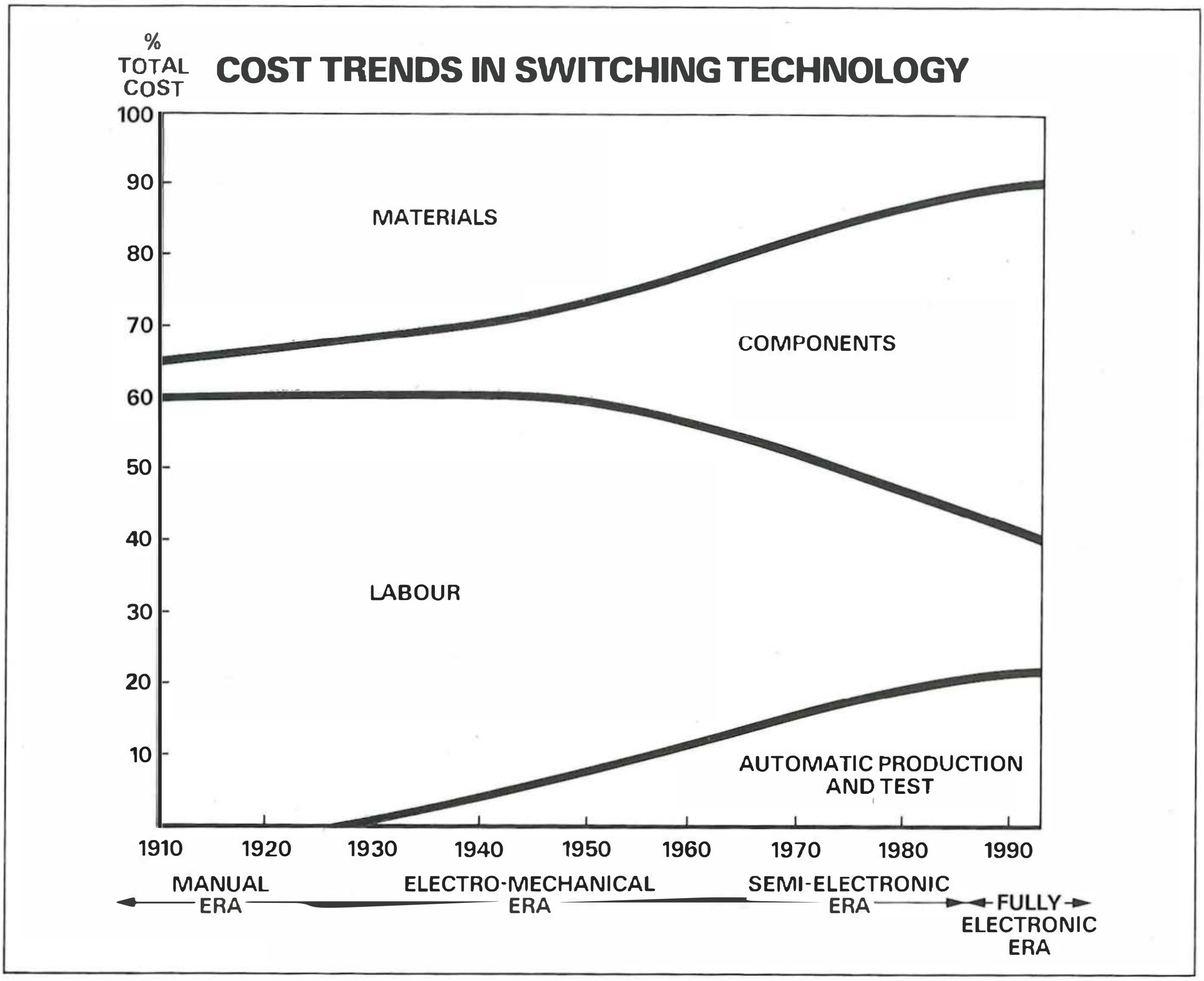
The pace and direction of switching system development will, in engineering and scientific terms, be governed by a growing urgency and need to move towards systems that have lowest whole life costs, yet maximum whole life flexibility. In the early decades of the future, discrete switching machines at local, trunk and transit exchange locations will become progressively electronic, digital and software controlled, with the degree of digitalisation initially being greatest at the high traffic density centres and lowest at local levels.

Associated with this we must expect progressive software-controlled supervisory, management and accounting support services. But the as yet unresolved issues for the further decades may well hinge around two engineering development areas. The first of these concerns the changing balance of hardware and software in real-time control situations like telephony – or any other form of multi-party telecommunications – switching. The second concerns the extent and character of digitalisation in switching machines at lower levels of size and traffic.

Many experiments and developments in the world suggest that the downward tumble of cost-per-function in microcircuit technology is carrying down with it the threshold of size and traffic at which digital design becomes viable, even in an analogue local line environment. But if, as we now begin to be justified in saying, current local line assets may be economically extended by superimposed digital systems, then the possibility becomes stronger of securing still further increases in cost effectiveness and added service opportunities.

It is possible to visualise the present discrete and tightly drawn boundary of the exchange becoming blurred. We can foresee dispersed sub-controlled elements of the exchange being outhoused in community areas, in large subscribers' premises, as well as the possibility of a measure of decentralisation and devotion to smaller sub-units capable of a high degree of flexibility and reliability.

If the engineering future of telecommunications depends, as suggested, increasingly upon microelectronic technology, then a conflict could well develop out



of the distinctively different life times of telecommunications and other products – entertainment, domestic, computing and control – containing microelectronics, the former being, typically, 20–25 years and the latter 5–7 years. This may well force design to become increasingly modular and structured so that devices of succeeding species can be incorporated with minimum interference to supply, commissioning and operation.

Out of the accumulated experience of the past century, there are several readily identifiable trends that may present a growing challenge to telecommunications technology. First, there is the influence of "globality". Only in the last five years have most countries of the world been exposed to international automation in telecommunications. This has come about not just by leaps forward in undersea and space telecommunications. It is possible because of the lengthy and detailed work by the international bodies concerned with system planning, standardisation and regulation.

The ability to inject any change into this system is limited by the growing sense that in telecommunications this is one world, and a shrinking one. The time taken to generate new standards or regulations for new techniques and services thus imposes constraints upon the freedoms of individual operating agencies and nations. Yet the pressure for new services, facilities and opportunities is great and we must expect it to increase.

However, it could be that we are approaching a limit beyond which further detailed definition of the global system is less profitable. Indeed, for definable new classes of service it may be more sensible to define special-purpose, dedicated "overlay" systems, provided also that the definition includes specific means whereby traffic can enter or escape from them into the existing telecommunications environment.

A second influence that may challenge technology is that of changing need. The emergence and growth of telex, Datel and facsimile are forerunners only of what seem most likely in the 21st Century. It is not foolish to postulate a demand for office-to-office document transmission, nor for overnight automatic document handling and transmission. The basic technology for the services is available, but the challenge to engineering is that of design to performance and prices, particularly, acceptable to the market.

Other evidence of changing need is to be found out of the growing conjunction of some aspects of traditional broadcasting and telecommunications in which the domestic television set is used as an alpha-numeric display service for news, message exchange or a data retrieval service. Services such as the British Viewdata, Oracle and Ceefax, the French Tictac and Japanese Still

Frame Television are already being widely demonstrated.

A third need already emerging is that for multi-party communication. Many varieties can be visualised – for example, multi-addressed single message distribution, either spoken, printed or for visual display. Given suitable development of automatic overnight printing system/display systems, partial replacement of physical distribution of newsprint, information bulletins, advertising material seems practicable.

Another form of multi-party communications that can be foreseen is the business conference, with or without vision. Confravision or its equivalent exists in a number of countries, and work on standardisation of formats is in hand to enable global interconnection. A multi-party service that could be desired in telephony is to "add on others" to an established call at the will of either of the original two-party callers. However, it raises severe issues of engineering and operational system design, some particularly intractable if possible intercontinental usage is also imagined.

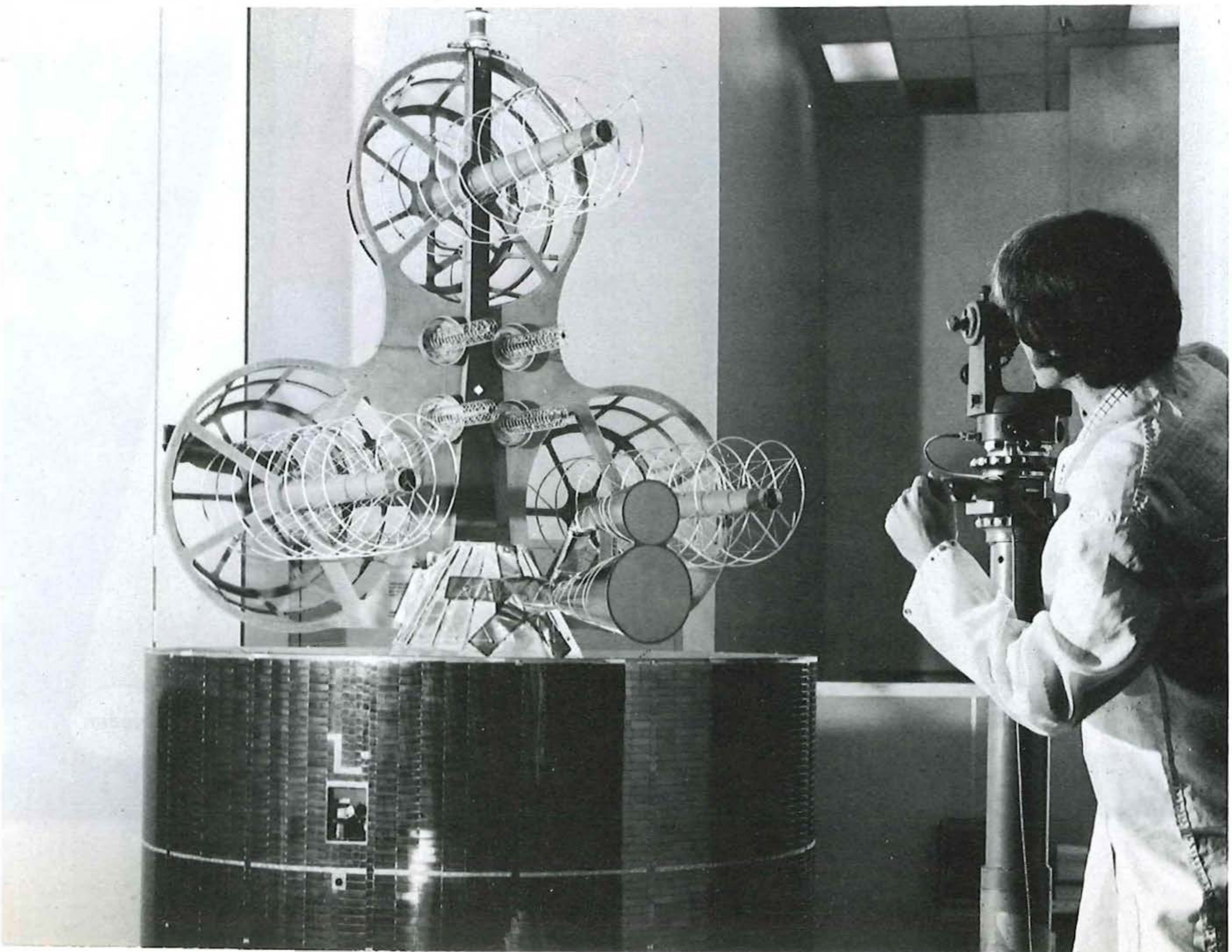
Developments in computing technology and application, too, may well influence technological development, but probably the greatest external influences will be those stemming from growth, whether of new customers, traffic levels or additional services. In many countries the approach to saturation – in terms of households yet to be connected – is a significant factor in business and technological planning. It raises important questions stemming from issues such as the changing ratio of resources devoted to renewal of growth, and the changing significance of current assets and the utilisation of assets.

These issues have already generated new approaches that exploit the potential of whole-system design and of design that recognises the growing importance of rationalisation and modularity with careful attention to "interface" control and specification. We would expect to see this trend continuing and becoming of greater significance in the 21st century.

Looking to the long-term future in general we can foresee a broadening range of technical opportunity that can be directed to existing services and launching new services that should enable our successors to maintain the outstanding record of continuing service cost reductions in real terms. However, we can also foresee increasing complexity in the decision taking process that is implied by questions such as which new service or design should be selected, and when should it be implemented.

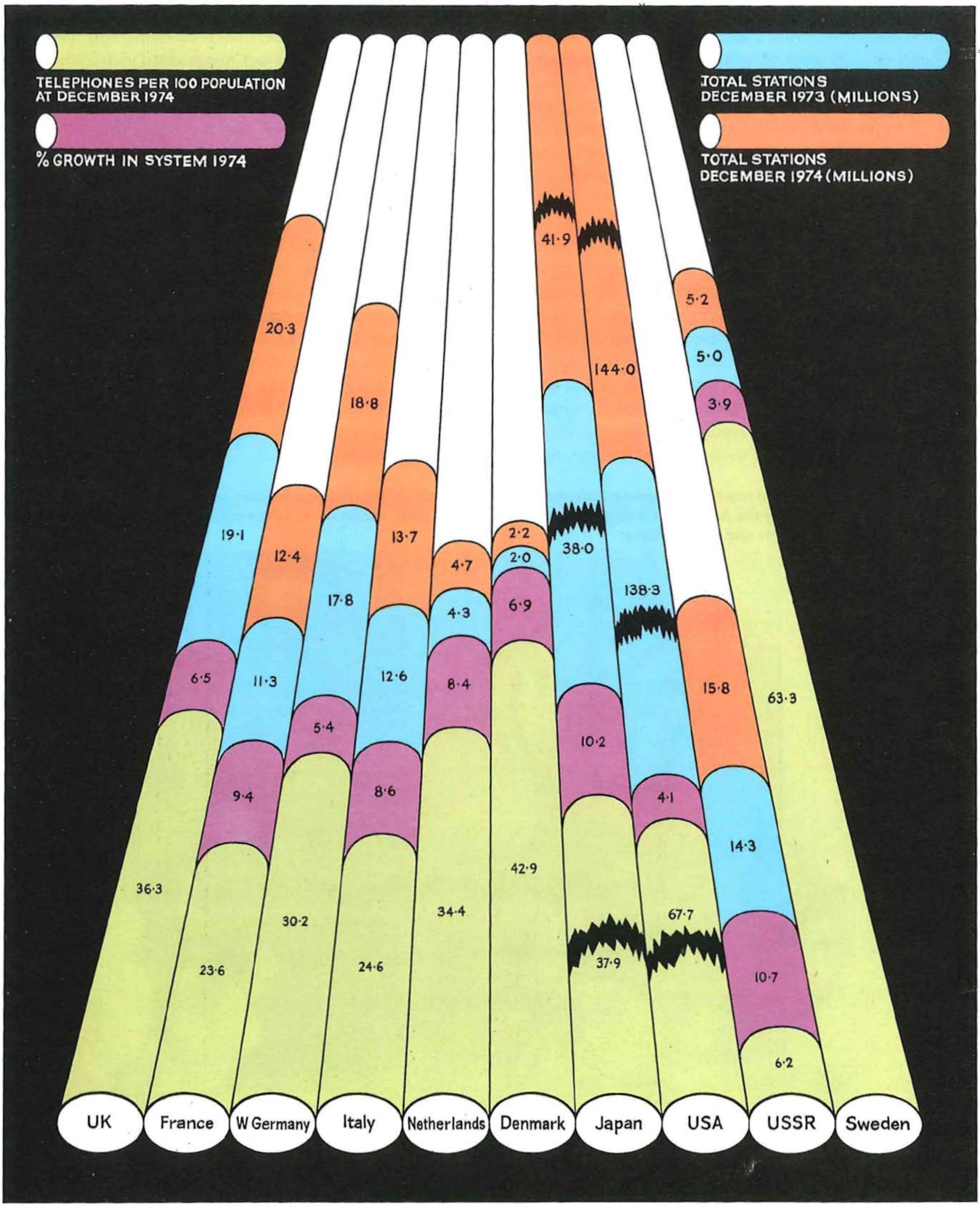
Underlying all this may be, so far as society is concerned, the widening gap between the apparent utter simplicity of the range of services offered and the complexity of the hidden, unobserved, taken-for-granted infrastructure needed to create and sustain those services. Those concerned therefore in their development, design and management will face added problems of education and communication as society seeks to order priorities of its needs – a society which would seem, increasingly, to have to depend upon electronic transmission of words, print and pictures rather than physical transmission of people and papers.

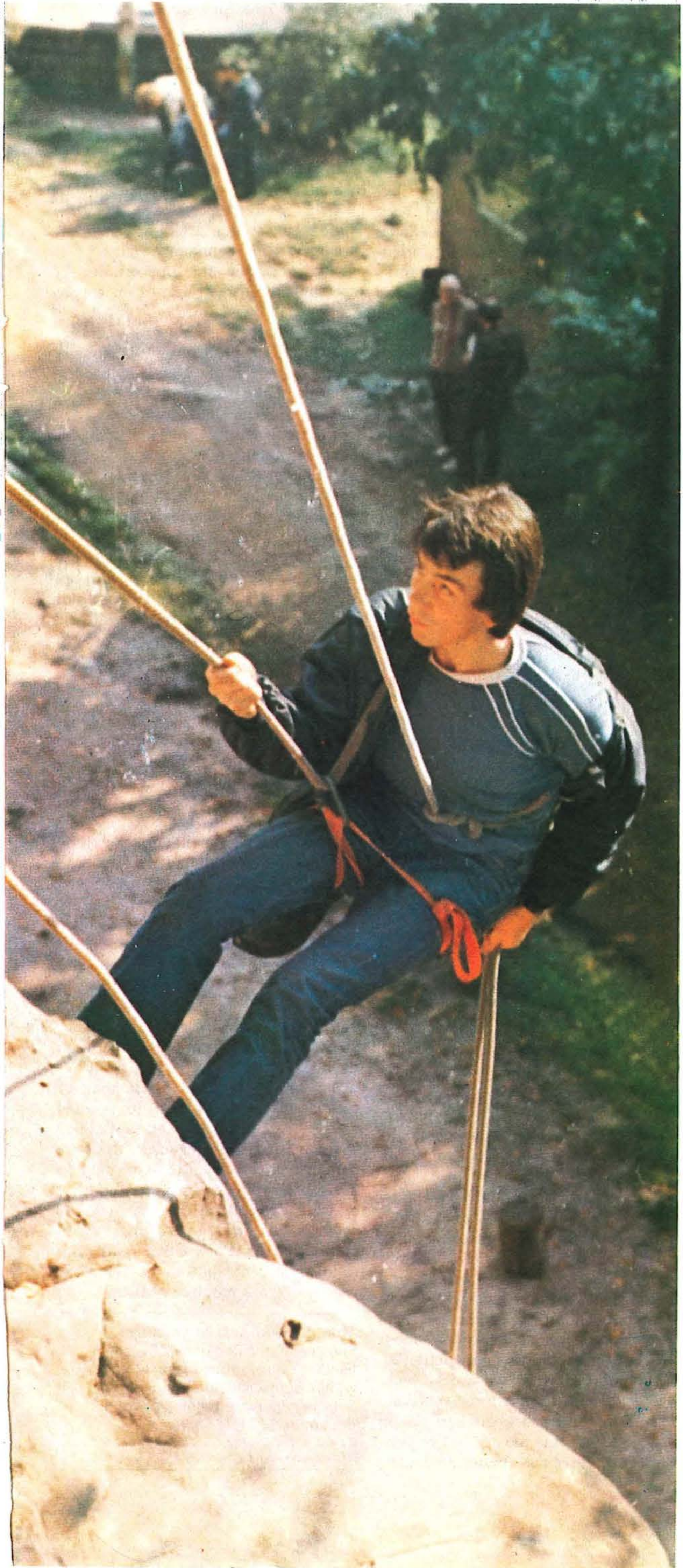
The world's first commercial maritime telecommunications satellite, Marisat, launched earlier this year into synchronous orbit over the Atlantic. It is designed to provide voice, telex, facsimile and data communications for merchant marine vessels and the US Navy.



Telephones around the world

Here are our annual international comparison of telecommunications statistics. They show countries with the highest number of telephones, and include figures to indicate the percentage growth in their systems over the previous year. The source of the figures is the American Telephone and Telegraph Company.





On course for success

ST Windsor

"I REALISE now that the Post Office really does care about the happiness and welfare of its staff. . . they must or this course would never have been organised. I believe courses like this should be a standard part of training for all young people coming into the Post Office."

The words are those of a young Technician in London Telecommunications Region (LTR) and they were written soon after he had returned from one of two specially devised development training courses at the Bowles Outdoor Pursuits Centre near Eridge on the Kent and Sussex borders. Colleagues, both male and female and ranging from typists to clerical officers, who also attended the week-long courses were unanimous in their reports that the activities had enabled them not only to develop confidence but, for the first time, to see their own jobs in the context of the Post Office as a whole.

So, how, then, did the courses come about? And what was the magic formula? Since 1972 the Post Office has increasingly encouraged the attendance of its young people on courses and leisure activities designed to help them develop into mature and stable adults who are reliable, thoughtful and co-operative members of staff.

Following trial courses run by the Welfare, Health and Safety Division at Central Headquarters, it was decided the approach to Post Office Development Courses should be broadened to include elements of Post Office orientated training as well as the outdoor, leisure and social activities which had formed the basis of outside courses. Responsibility for running them was devolved to those Regions who wished to do so.

The first step in the LTR was to nominate four young women and eight young men to attend a course at Fallbarrow Hall in the Lake District in November 1974. The course was run by Mr R. C. Bevis, the Post Office ▶

David Blackman, a young Technician from City Telephone Area, on the rocks during an exercise at a development training course organised by the London Telecommunications Region.

National Youth Adviser. There were a variety of outdoor activities together with special Post Office sessions. Despite atrocious weather 80 young people from all over the country, including Northern Ireland, had a worthwhile time.

At a report-back meeting the LTR Deputy Director met the 12 representatives and they convinced him that similar courses could and should be run in the Region. Thus on a trial basis, two courses with 40 students on each were authorised for 1975.

Factors considered in devising suitable courses, including the likely needs of young people, the general needs of the Post Office and the inclusion of material complementary to the training students might already be receiving. At the same time it was important

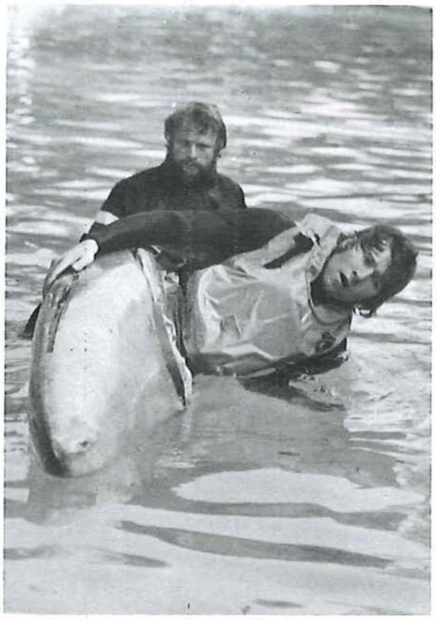
Trainee Technician Philip Davis takes to the ski-slope, watched by colleagues at a development training course.

to make the whole programme stimulating and challenging enough to attract applicants and spark on the process of personal development taking into account the varying levels of maturity and intellectual ability.

When the course programme was finally drawn up its main objectives were towards the development of self-confidence, verbal ability, self awareness, understanding of other people, tolerance of other points of view and the ability to work effectively with a group. Other qualities looked for were ability to lead and control a group, ability to think logically and effectively together with general resourcefulness and initiative.

All this, of course, had to be achieved against a background of maintaining a balance between physical, emotional and mental challenge and sporting, cultural and other activities. The Bowles Outdoor Pursuits Centre was found to be ideal for putting into practice the ideas which had been formulated. It had facilities for canoeing, rock-climbing, ski-ing and orienteering – which involves cross-country walks and map reading. Staff had the necessary expertise, and all the domestic needs existed for a mixed course of 40 young people together with resident Post Office staff of three – a leader and two syndicate advisers.

The first session on the first evening gave students a chance to meet in an informal atmosphere and an opportunity to get to know one another as well as discussing their lives both inside and outside the Post Office. Later



Keith Guyford, Trainee Technician from North West Telephone Area, about to get a ducking during a work-out on the canoe lake.

full details of the many leisure activities available within the London Area were given together with information about the many activities which can be followed through the Duke of Edinburgh Award scheme.

A session on Health and Hygiene by Dr D. J. W. Taylor and Mrs M. Coulson of the Post Office's Occupational Health Service dealt with questions about drinking, drugs, smoking and male/female relationships while at a second session some senior Regional managers answered questions about the Post Office and its many activities.

Communication in its widest sense was dealt with by means of syndicate discussions and practical examples in which the students took an active part. They were given a chance to understand how to apply good communication to the work situation and decide for themselves the most effective means of communication. The session which caused most apprehension but which, in retrospect, was the one which the students claimed had increased their confidence most, was giving everyone the opportunity of speaking for three minutes on a subject of their own choice.

It was the responsibility of the Post Office staff to get to know personally every member of the course and to encourage them to talk of their enthusiasms, problems and ambitions. They needed to identify the slow and encourage them to greater endeavour, to notice the brash and forceful and, without dampening their enthusiasm, encourage their co-operation for the good of the whole course.

Throughout it was imperative for the leader and the advisers to mix with the students and gain their confidence, not as omnipotent instructors with all the answers, but as friendly people able to interpret aspects of life and discuss problems and topics of interest.

Working in syndicates of 10, the students learned about rock-climbing, canoeing, lightweight camping, dry slope ski-ing and orienteering. A new leader was appointed each day so everyone had a chance of testing his organising talents.

There is no doubt that each activity tried on the course had a place, and the week-long get together reinforced the idea that everyone is an individual with something special and unique to contribute. Co-operation is undoubtedly the password to progress and although imaginative leadership can spur that progress to worthwhile objectives all can be lost without constant communication between members of the group.

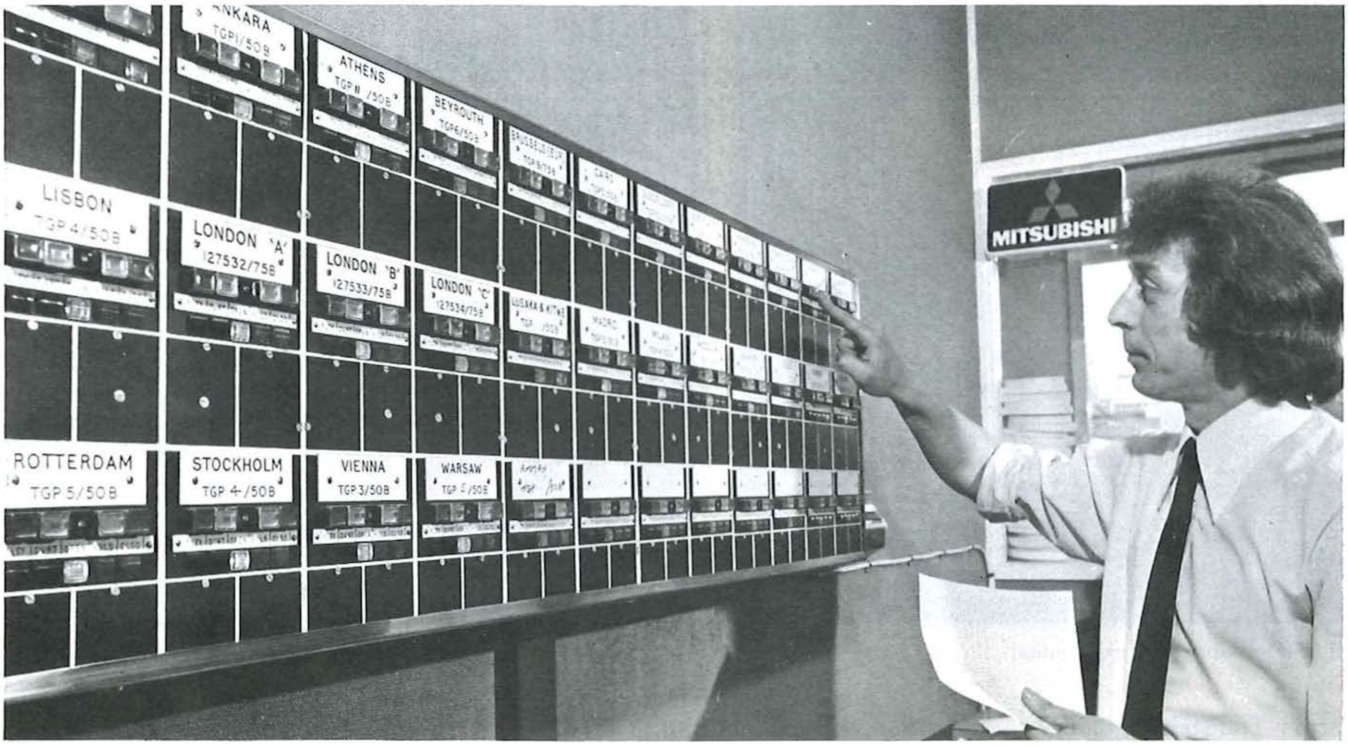
The present economic climate, of course, makes it difficult to provide courses such as these on a regular basis. It is obvious, however, from experience so far that they can help to develop in younger staff the qualities of care, consideration and co-operation which will go a long way to providing the Post Office with the right calibre of staff to do the wide variety of work required of them.

Mr S. T. Windsor is an Executive Engineer in the Personnel Division of London Telecommunications Region with responsibility for Engineering Sub-management training policy and the Youth Advisory Service.

How big business gets the message

An international message switching service offered by the Post Office provides facilities for the effective control of large privately operated leased telegraph networks. The largest system provided to date by the service is now in operation for the Mitsubishi Corporation of Japan.

P Allen



The supervisor at Mitsubishi's communications centre in London updates the Status Board which shows the situation of all leased channels to which the Post Office message switching centre is connected.

EFFICIENT communications are vital to the day-to-day operation of any industrial or commerical organisation, and perhaps none more so than those with world-wide interests. In major international companies thousands of messages pass daily between their centres in different countries, and many concerns operate their own networks of private leased telegraph circuits to provide the necessary links.

While these world-wide networks are privately operated for both economic and service quality reasons, it has been found that as the networks expand difficulties begin to arise with their effective control and utilisation. The problems tend to fall into two categories. First there is the cost of providing suitable accommodation for existing and future terminal equipment and, second, there are often difficulties associated with staffing these systems to provide a satisfactory service.

To help solve these problems many organisations use tape relay systems, but the more communications conscious concerns look for methods of automating the switching function. Line switching systems can help, but these generally give poor exploitation of circuit capacity. One method of maximising the use of costly international line plant is to store a message when the required line is engaged and release it as soon as the line becomes free. Unlike telephone connections it is rarely necessary for both the originator and the recipient to be available on line at the same time and, in any case, world time differences tend to limit the opportunity for direct discussion.

It is evident, therefore, that computers offer an ideal method of providing a store and forward message switching system. The flexibility inherent in the software means that in addition to providing the basic message switching function, many desirable facilities can be offered, such as priority working which offers five different categories of urgency and multi-delivery which allows the same message to be sent to several different addresses on one transmission.

To meet the changing requirements of Post Office customers of international leased circuits, the External Telecommunications Executive (ETE) began an International Leased Telegraph Message Switching (ILTMS) service in 1971. Basically the facility provides interconnecting international circuits for transmitting messages between all terminals in the customer's network. Initially the service could handle only small networks of up to a dozen or so connections at circuit speeds of 50 bauds – approximately 67 words per minute. However, as customers' networks have increased in both size and complexity, the Post Office has provided more sophisticated hardware and software, and the service now has a total of more than 30 customers.

By far the largest and most sophisticated system provided by the ILTMS service to date came into operation last year for the Mitsubishi Corporation of Japan. Mitsubishi is a trading firm of huge size and scope, which employs about 20,000 people in a global network of nearly 250 branches and liaison offices. It handles thousands of products and services ranging from raw materials to consumer products, and its activities also include shipping, ▶

Two new uncomplicated teleprinters from Transtel

B305S ASR telex/private wire terminal

B305STL low-cost telex special

New from Transtel: the model B305S automatic send/receive teleprinter for telex and private wire use, and the B305STL low-cost telex special. Each is a quiet, reliable, typewriter-styled teleprinter designed to fit unobtrusively into any office environment.

Both the B305S and the B305STL come with 100 percent solid state internal memories for storage of received messages as well as high-speed preparation of error-free copy with direct transmission from memory to line. Other features include telex control unit; automatic dialing, message numbering, and paging; full monitor mode, 3 switchable line speeds, remote control of memory, polar or neutral interface, full- or half-duplex operation, and simultaneous line and local operation with automatic switching of available devices. All feature selection, answerback, and automatic dial numbers can be programmed from the keyboard. Off-line speed for both machines exceeds 200 bauds, and each machine automatically switches to correct line speeds of up to 200 bauds as required by the exchange.

Modular design permits custom configuration of the model B305S for specific applications. For example, the model B305S can be field modified to include a plug-in paper tape punch-reader with remote control and low paper tape alarm. While the B305STL is designed for desktop use, the B305S is intended for pedestal mounting.

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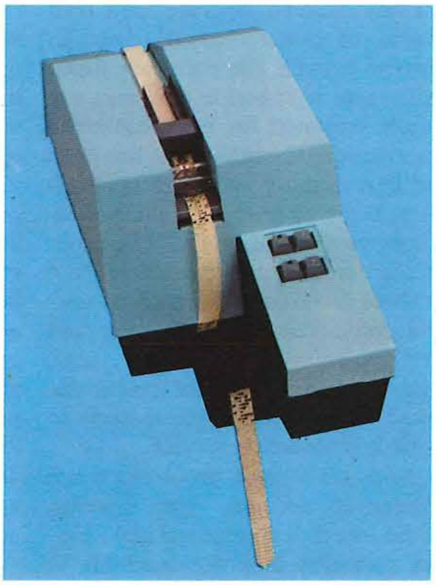

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transport, insurance and banking.

The ILTMS service provides more than 40 teleprinter circuits linking Mitsubishi's offices throughout the world and enables its City of London branch to communicate world-wide directly over the network. The London centre is, in fact, a "clearing house" for about 19,000 messages flowing daily between offices in the network.

Previously operations in London were limited to providing transit private leased circuits from other European countries to the Mitsubishi centre in New York, together with direct private leased circuits between London and New York. London and other European traffic was switched to New York. With the introduction of the ILTMS system all leased circuits are now terminated on stored program-controlled switching equipment in a Post Office building in London.

The service has several interesting features, in particular a facility for the customer to retrieve copies of messages and to retrieve messages which may have been corrupted during transmission. A typical response for a message retrieval request is 45 seconds.

When Mitsubishi first approached the Post Office it already had a message switching network using computers in Osaka, Tokyo and New York. The Post Office therefore had to ensure that its own message switching system, which would handle all traffic in the European, Middle East and African areas, was fully compatible with the existing network. Staff from the ETE spent more than two years planning and installing the network, and throughout worked closely with Mitsubishi's communications experts and trained their operators.

The ETE Customer Services Group controlled overall provision using computerised critical path analysis techniques to give regular indications of progress and to enable problem areas to be rapidly identified. In designing the network a detailed study was made of Mitsubishi's operational requirements, including traffic patterns, to ensure that optimum use was made of the private circuit network.

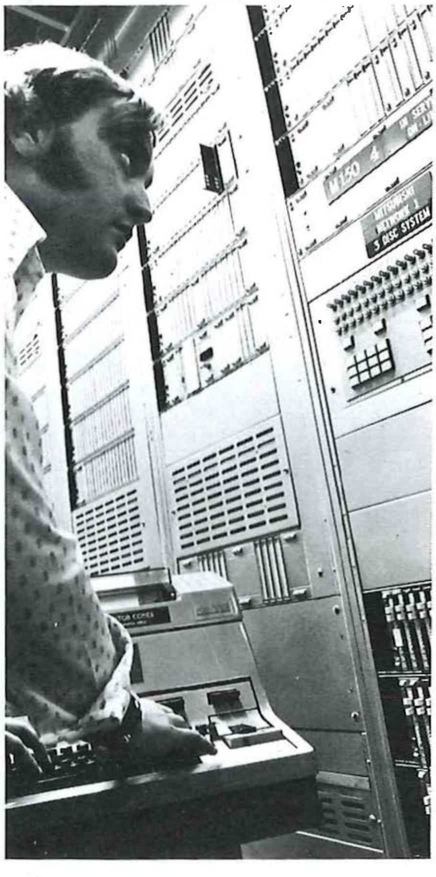
The Mitsubishi contract was, in fact, won by the Post Office in the face of strong competition from the United States of America and Germany. The ILTMS service was chosen because of its flexibility, maintenance facilities and competitive cost, and early indications are that the customer is not disappointed. Indeed, the flow of messages since the new system went live has shown a sharp increase.

The manager of Mitsubishi's London communications centre discusses a telex message from Tokyo with his supervisor.

In addition to being a major triumph for the Post Office ILTMS service, the Mitsubishi contract was also an important step towards ensuring that London remains the hub of the international business world. As a trading nation the United Kingdom has a vested interest in the capital retaining its pre-eminent telecommunications position, but this has been threatened by the advent of the Common Market with its headquarters in Brussels.

Despite rapidly increasing competition from other countries, particularly in France and Belguim, the Post Office is already gaining an international reputation for its message switching services. There is little doubt that existing ILTMS customers are satisfied, and this is also reflected in the high demand for service. Undoubtedly, one of the main attractions is the high standard of Post Office maintenance arrangements which cover the full 24 hours a day, thus resulting in quick attention to any difficulties which may arise.

At the Post Office's computer controlled message switching centre a Technician checks the Mitsubishi program.



To help cater for present and future requirements of customers, a purpose-built message switching exchange has been built in part of the old radio telephone terminal at Brent, North London. Conversion work began early last year and the new centre should be completed within the next few months. While the present capacity of the ILTMS service is about 500 line connections, the Brent exchange is planned to have a capacity of nearly three times this figure.

In addition, developments are now taking place with a view to providing facilities for low-speed data transmission over customers' ILTMS systems, thus providing an integrated telegraph and data system. Consideration is also being given to interconnection with the public service Telegram Retransmission Centre (see Telecommunications Journal, Autumn 1975) and also the SWIFT interbank network which enables banks in Europe and North America to make speedy transactions with each other.

Mr P. Allen is a Telecommunications Superintendent in the International Customer Division of the External Telecommunications Executive in charge of the group dealing with the ILTMS.

Time to choose

WE Mason

AN OFF-PEAK visit to the hairdresser or a weekday round of golf normally means Post Office staff having to take annual leave. But, in experiments involving more than 5,000 people now taking place throughout the Telecommunications Business, the one activity is fairly easily fitted into the working day while the other can occasionally be enjoyed without using leave.

The reason, of course, is flexible working hours. During the last couple of years, following close consultation with the Civil and Public Services Association (CPSA) and the Society of Civil Servants (SCS), selected offices throughout the country have been taking part in trials.

Basically, flexible working hours is a system under which daily attendance is broken into "core" time, when staff are due to be at work, and "flexible" time when staff are free to attend as they choose. The main conditions are that staff within the scheme must not work more than $9\frac{1}{2}$ hours in any one day and overall conditioned hours must be completed over a set number of weeks.

Supporters of the flexible working hours system, which was pioneered nearly 10 years ago in West Germany, claim that it creates less tension and strain for staff, reduces labour shortages, boosts morale, cuts absenteeism and bad time-keeping and generally leads to greater efficiency. On the other hand its opponents point to the additional administrative work involved and the fact that increased output based on concentrated effort could lead eventually to unemployment.

Staff in London's North Telephone Area at one of the units where, using their own plastic keys, they sign in for work under the flexible hours scheme.

By the late 1960s a few companies in Britain – mainly in the insurance world – had taken up the idea of flexible working hours and by 1972 the shortfall of labour gave impetus to the scheme as it attracted back to work young married women who could adjust their hours of work to suit their domestic commitments.

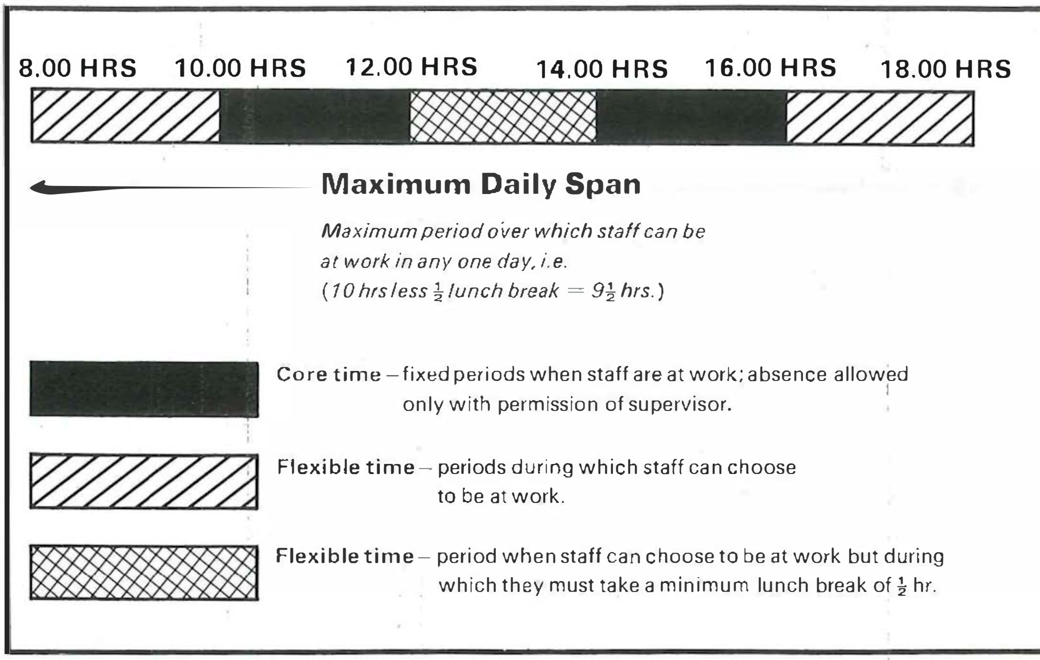
The Post Office became involved in 1973 when agreement was reached to launch experiments at offices in the Telecommunications and Data Processing Businesses where the majority of staff represented by CPSA are employed. At least one office in each Telecommunications Region and one computer centre were selected for a twelve-month trial.

As far as was practicable, and subject to local agreement, all the staff represented by CPSA and SCS at the experimental offices were to be included in the trial. At some locations attendance was to be recorded manually, while at others time recording machines were to be used. Individual participation in the experiments was made optional but, once an employee had chosen to take part, he was not allowed subsequently to withdraw.

Participation did not involve any obligation to alter existing attendance patterns, which could be maintained unaltered within the scheme. Problems were foreseen with supervisors, represented by other Unions, who controlled CPSA represented staff, and the Council of Post Office Unions (COPOU) were advised of the experiments and were furnished with copies of the guide lines jointly agreed by CPSA, SCS and the Post Office.

Ultimately, 15 offices were selected for experiments: 12 Telephone Area offices, the Temple Avenue component of P&SD Contracts Division, part of the External Telecommunications Executive (ETE) and Derby Computer Centre. Subsequently the experiment in ETE and one Telephone Area did not go ahead but the Regional office of North Western Telecommunications Board (NWTB) was added.

Thus the experiments not only embraced offices throughout England, Scotland and Wales but also the three organisational levels of Telecommuni-



An example of a working day under the Flexible Working Hours Scheme.

cations. The number of staff involved ranged from about 200 in the smaller offices to about 700 in the larger ones. In all over 10 per cent of the total clerical and executive staff in Telecommunications were involved.

The detail of implementation of each experiment was settled locally using normal consultative procedures. In advance of these local negotiations, however, a team of two from Telecommunications Pay and Grading Department (TPGD) which had been appointed to co-ordinate, monitor and evaluate the scheme, together with two national officials of the Unions visited each selected office during the last quarter of 1974 and early in the following year. The purpose was to explain to both local management and unions the details of the flexible working hours scheme as agreed in central negotiations and to ensure that not only were the principles of the scheme known but also to point to possible difficulties and ways of avoiding them.

It was emphasised at all stages of negotiation and in explanatory material that the aim should be to devise a scheme which satisfied the normal function of the office but at the same time allowed the staff as much flexibility as possible in their attendance at work.

In Telephone Area offices the standard of service to the public had to be maintained while, at the computer centre, time critical processes were not to be jeopardised.

Flexibility was restricted, by agreement, to the extent that a carrying forward from one accounting period to the next of a maximum credit of eight hours or a maximum deficit of five hours was permitted within the guide lines. Permission to be absent in "core" time had to be authorised and hence the working day was split into a morning and afternoon "core" time so that lunch could be taken without having to seek permission beforehand.

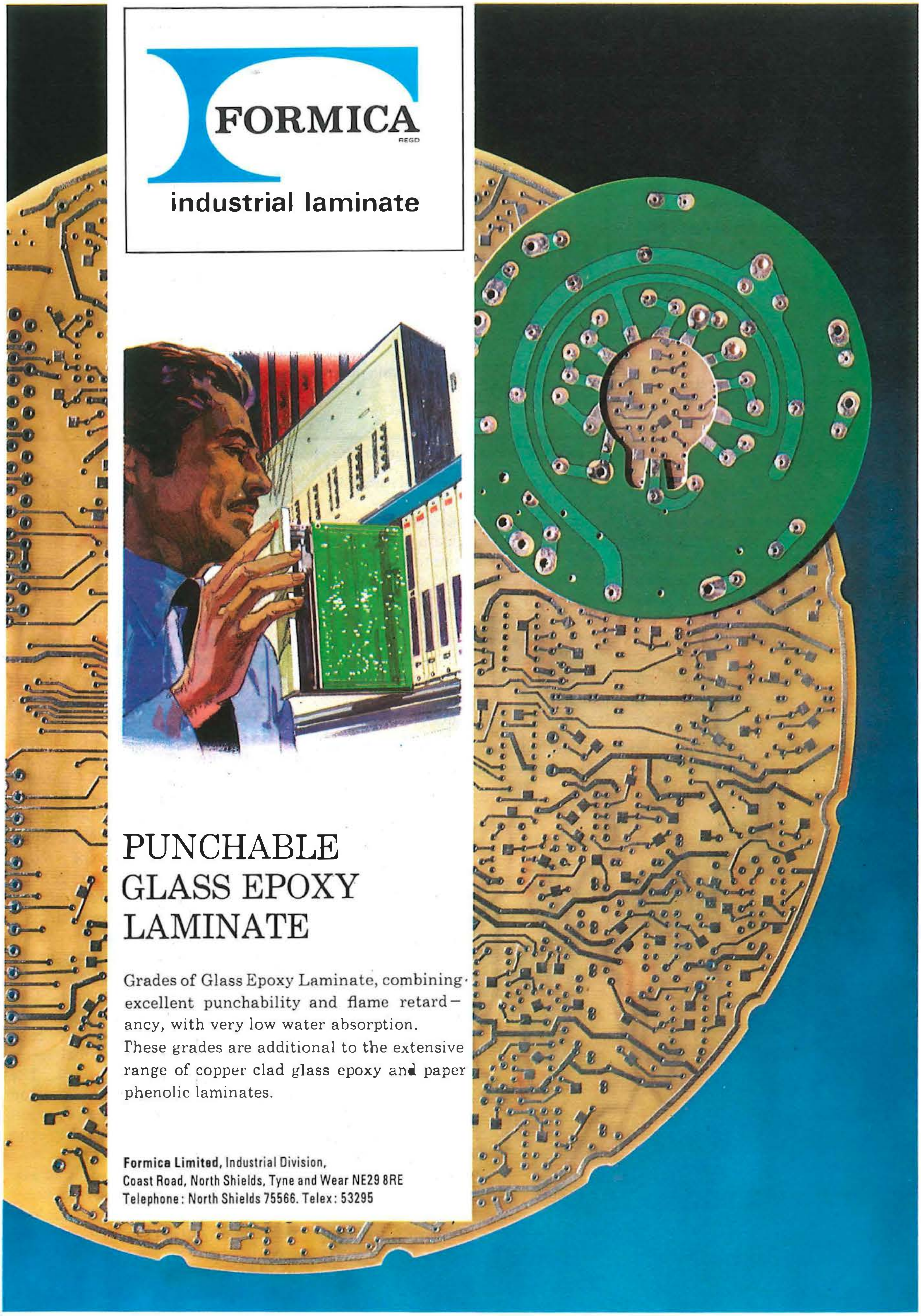
Connected to the key entry unit is a master unit which contains a memory bank and can print out daily, or on demand, the cumulative hours worked by each key holder.

The maximum length of the lunch break was the time between the two "core" times but the minimum was set at half an hour. Absence to the extent of two half days (not in the same week) or one full day within each accounting period on account of accumulated credit hours was allowed. Overtime working was kept totally separate from the flexible working hours scheme.

Some of the offices where attendances were to be recorded manually – Bedford, Chester and Plymouth Telephone Areas and part of Contracts Division for instance – made an early start with the experiment, either late in 1974 or early in 1975 – while, Aberdeen Telephone Area and NWTB Regional office began later in the year.

In the meantime, following a brief survey of time recording machines available, and taking account of experience of other users, mainly in the Civil Service, it was decided to use equipment offered by three firms. Two of these equipments are essentially time elapsed recorders with each employee having an individual meter located near his place of work. The total hours worked are displayed on the meter, which is activated by insertion or removal of a personal key or in some cases, card.

The other equipment consists of key entry units at which employees, using their own individual coded plastic key, "key" in or out. A separate, but connected, master unit contains the memory bank and has the facility to print out daily, or on demand, the total cumulative hours worked by each ▶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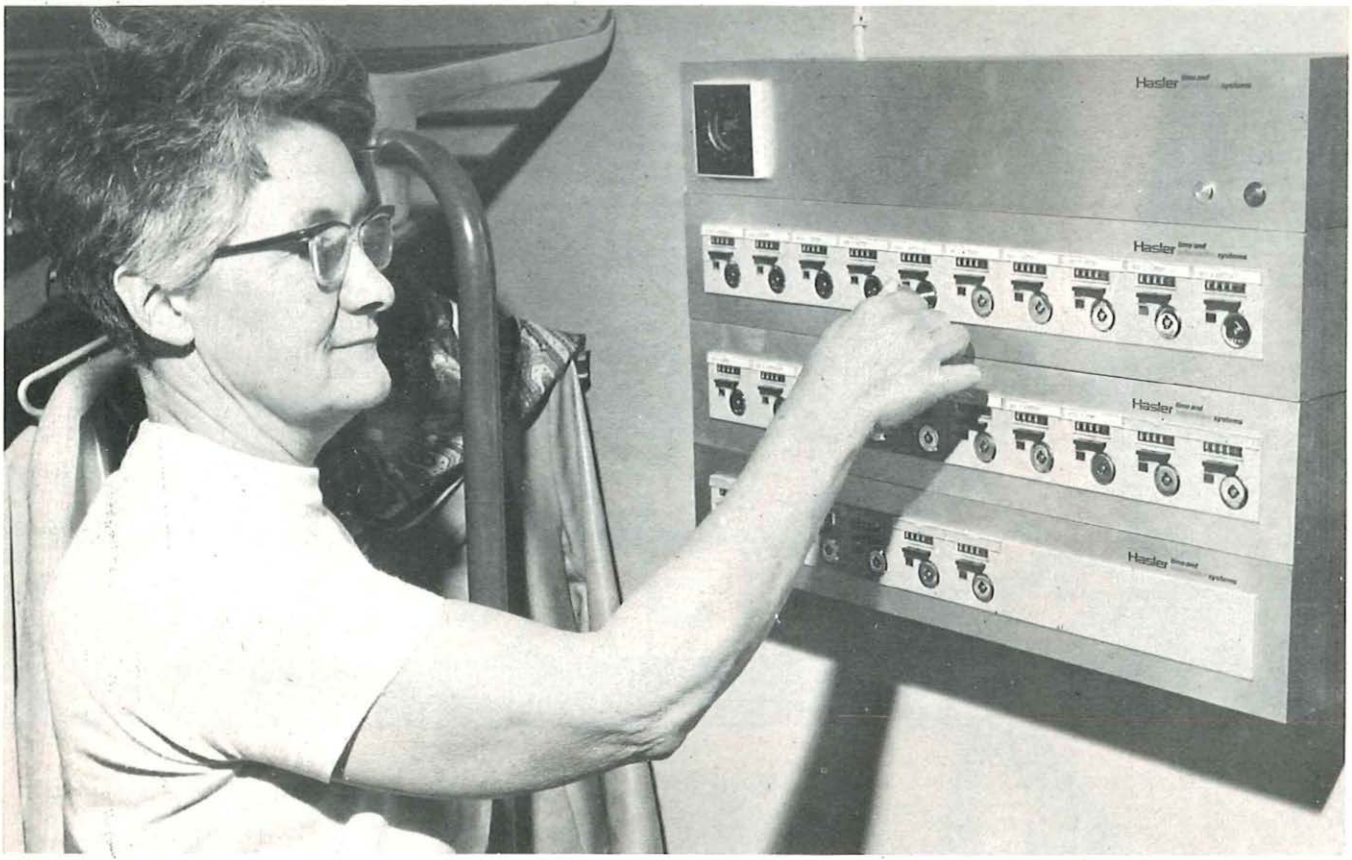


Another type of automatic equipment is used in Canterbury Telephone Area where staff key in at their own designated entry point.

key holder together with his credit or debit in relation to standard hours.

With the latter equipment it is a simple matter to feed into it details of debit and credit hours allowed by supervisors as they occur, and thereby to maintain an accurate running record. On the individual meter, which can be reset only to a zero reading, such adjustments have to be recorded manually on paper and are taken into account when the meter is read at the end of the accounting period to arrive at a "corrected" total.

Some local managers had made the use of machine recording a pre-requisite to their running the experiment because they, in general, held the view that better control would be available with machines. In the end it was decided to install machines at eight offices, the types being determined largely by local preference but also having regard for an equitable spread of the various machines.

The first office to begin a machine experiment, in June last year, was Canterbury Telephone Area, followed by Bournemouth, Liverpool, Newcastle, West Midland, Edinburgh, and North Telephone Area in London and Derby Computer Centre.

The machine costs of the experiment are being borne on the budget of Telecommunications Headquarters. These costs have drawn attention to the fact that the more precise recording of attendances, their summation and comparison with standard hours, grant of debits and credits and general administration of the flexible working hours scheme, involves the expenditure of additional staff time and is expensive. The amount of staff time involved is being assessed, but Civil Service experience points to about three to four hours per employee a year. It remains to be seen whether a system involving machines is more or less costly than a manual scheme.

Psychological Services Division is conducting a survey of staff opinion about flexible working using a selection of experimental offices and some "control" offices. Their report is not likely to be available until late this year at the earliest, but the Unions hope that evaluation of the experiments will have progressed sufficiently for them to be able to make firm recommendations to their 1976 annual conferences. Statistical evaluation criteria have been agreed with the unions but to achieve the target they are aiming at it will be necessary to make evaluations based, in some instances, on less than six months' experience.

To the extent that the experiments have been launched without much difficulty, the scheme can be regarded as being successful. The appointment of a liaison point in each Region and the frequent issue to them of guidance memoranda by TPGD has made a significant contribution.

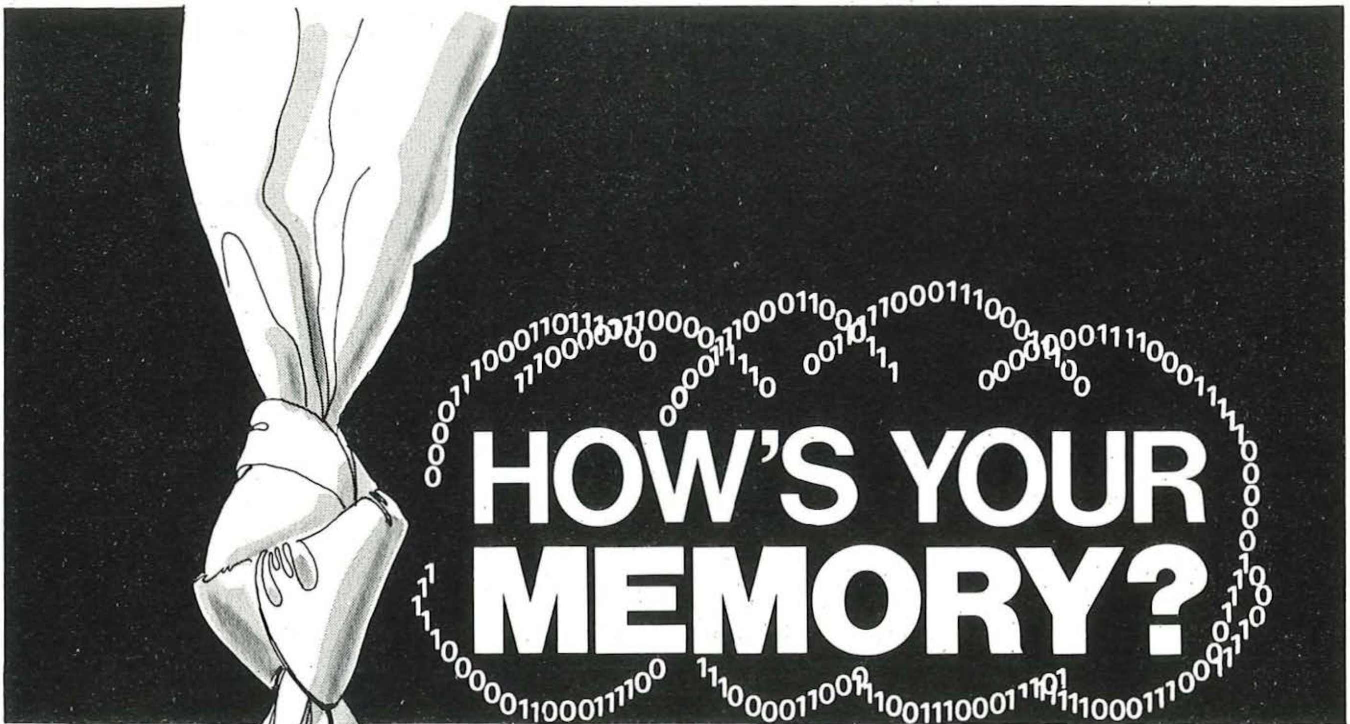
Negotiations centrally with unions have been conducted amicably. The CPSA, who have in mind introduction of flexible working for all their members in the Post Office, claim that the obvious advantages of the system to the staff also extend to the Post Office in that late attendance is virtually eliminated, overtime working is reduced, attendance is aligned closer to the flow of work, casual absences are fewer, output is higher and staff morale is improved considerably.

Many of these claimed advantages are not assessable in money terms but they will be tested and evaluated in due course. There can be little doubt that some form of flexible attendance will at sometime in the future be more generally introduced for clerical workers. Indeed it is unlikely that those offices now experimenting will wish to return to fixed daily hours.

However any permanent adoption of flexible working hours in the Post Office must await evaluation of the current experiments.

Mr W. E. Mason is head of section in Telecommunications Pay and Grading Department with responsibility for general conditions of service.

PO Telecommunications Journal, Spring 1976



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TXE4 goes live

The first production TXE4 electronic telephone exchange has been successfully brought into operation in Birmingham. The exchange, known as Rectory, is serving 3,000 customers previously connected to Sutton Coldfield.

The move is a step forward in a scheme to improve the quality of Britain's automatic service. By March 1980 the Post Office expects on present plans to spend about £330 million on electronic exchanges at current price levels.

The development of TXE4 into a working system has been carried out by STC under a contract from the Post Office, and the first orders for production exchanges were placed with this company. However, GEC and Plessey are also now well advanced in building up production capacity for the system, and a total of 84 TXE4s are now on the order books.

Network grows again

Britain's telephone network grew by nearly 600,000 exchange lines during 1975. At the end of the year, 13,093,000 lines were in service, 594,000 more than at the end of 1974 – an increase of 4.8 per cent during the year.

A breakdown of the figures shows that domestic connections rose by 566,000 to reach a new peak of 9,898,000. Business connections rose by 28,000 to a total of 3,195,000.

World's biggest

The world's biggest communications satellite, an Intelsat IVA stationed above the Atlantic, is now carrying communications between Europe, America, Africa and the Middle East. Britain is working to the satellite through the Post Office's satellite earth station at Goonhilly Downs.

Switching the satellite to an operational role followed the successful launch early this year of a second Intelsat IVA satellite to act as a back-up. To ensure a high degree of reliability the first satellite was not made operational until the standby had been placed in orbit.

The bringing into service of the new Atlantic region satellite represents the first phase of a programme to replace the existing satellites which provide communication on a global scale.

In the past five years the Post Office has increased the number of satellite telephone circuits from about 400 to 1,300 through its earth station at Goonhilly Downs.

Automatic telex

The programme to provide automatic telex service from Britain to the Middle East Arabian countries has been further extended. The latest link is to Sharjah, Ras Al Khaimah and Umm Al Quwain, four of the United Arab Emirate States.

British firms have been making about 1,200 operator connected calls a month to the four Sheikdoms. Major users include the oil industry and companies involved in "invisible" exports.

Other countries for which automatic telex links have been provided recently are Cyprus, Iran and Tunisia. Altogether Britain's international telex service now provides automatic links to 89 countries, and 98 per cent of all international telex calls are made direct by customers.

Coastal contact

Two new radio stations have been opened in Wales, specially designed to meet the needs of shipping near the coast. They are Severn Radio at Wenallt near Cardiff, and Celtic Radio at St Ann's Head, Dyfed.

The two VHF stations provide full national and international telephone and telegram services for shipping in the Celtic Sea and Bristol Channel. They will also broadcast traffic lists, weather forecasts and gale warnings simultaneously with Ilfracombe radio, the radio station in North Devon from which the new stations are remotely controlled.

So far 13 VHF stations remotely controlled from the manned coast radio stations are planned by the Post Office to improve maritime communications around Britain's coastline. The first of these – Bacton Radio, controlled by Humber Radio – started working on the Norfolk Coast in 1972. Similar stations now in service are on Shetland (controlled from Wick), Clyde (controlled from Portpatrick) and Thames (controlled from North Foreland).

Under the rest of the programme – due to be completed by the end of 1979 – other VHF stations will be provided at Islay and Skye (controlled from Oban), at Caithness and South Ronaldsay (both controlled from Wick, whose own VHF service will then be closed down), North Berwick and Tees (Cullercoats), Beachy Head (North Foreland) and Start Point (Land's End).

Research awards

Nine research workers at the Post Office's Martlesham Research Centre near Ipswich have received 1975 Scientific and Craftsmanship Premiums of the Gordon Radley Fund (Christopher Columbus Prize).

Awarded annually for work of outstanding quality, they were presented this year by Professor James Merriman, Post Office Board Member for Technology, and Senior Director, Development, Telecommunications Headquarters.

Scientific Premiums are awarded to young scientists and engineers for research work described in papers published in scientific or technical journals or in a comparable way. This year, Scientific Premiums were awarded to: Dr John Grierson (27), for work on high-power microelectronic devices – known as IMPATT diodes – which are being studied for use in future microwave radio and waveguide systems, Dr Ian Garrett (31), for studies of crystals and their production, published in a book of which he is co-author, and Mr Michael Reeve (25), for work on optical fibres. In addition, Mr Michael Maddison (26), was highly commended for a study of a computer-like processing system capable of being used to control future telephone exchanges.

There were four Craftsmanship Premiums presented to technical staff for precision engineering work displaying particularly high skill in design and production. Recipients were Mr Harry Crisp and Mr Roger Bates for a large injection moulding tool used for producing small precision insulators in plastics; Mr Peter North for a printing machine used in automatic letter sorting equipment; Mr John Williams for making a special holder for a piece of gauze to enable its resistance to air flow to be measured accurately; and Mr Arthur Wright and Mr Robin Hooper-Greenhill for designing and making electronic equipment used in association with a computer for timing and counting.

In addition, Mr Graham Cosier was highly commended for a device to hold a telephone microphone so that its acoustic performance could be tested.

Contract

Marconi Communication Systems Ltd. – More than £3 million to supply 3,000 Datel modems. This order brings the total quantity to be supplied by the company to the Post Office to 6,200. Special manufacturing arrangements are being made to meet the Post Office's delivery requirements. The modems are used to provide the Datel 2400 service to customers such as banks, insurance companies, industry, commercial enterprises, government departments and computer bureaux.

Loan for Scotland

A £17.3 million loan to help improve and extend the telephone service in Scotland has been signed by the Post Office and the European Investment Bank, the EEC's long term finance institution. The loan will be used to help pay for 226 new telephone exchanges, 589 extensions to existing exchanges and other improvements to services. It is the second loan made by the European Investment Bank to the Post Office and will be repaid over a period of ten years.

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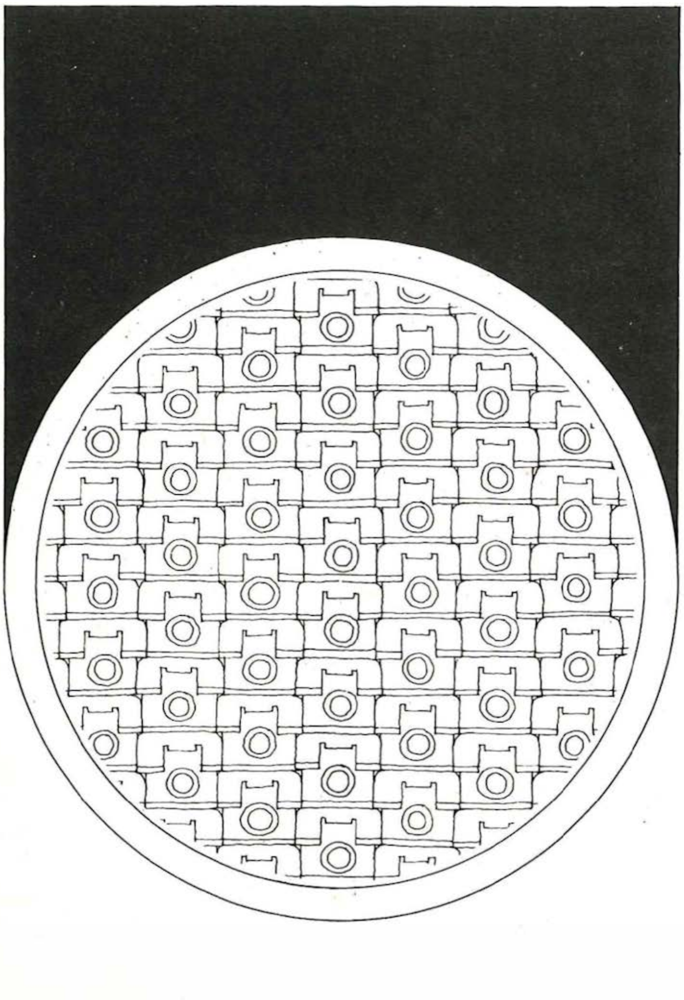

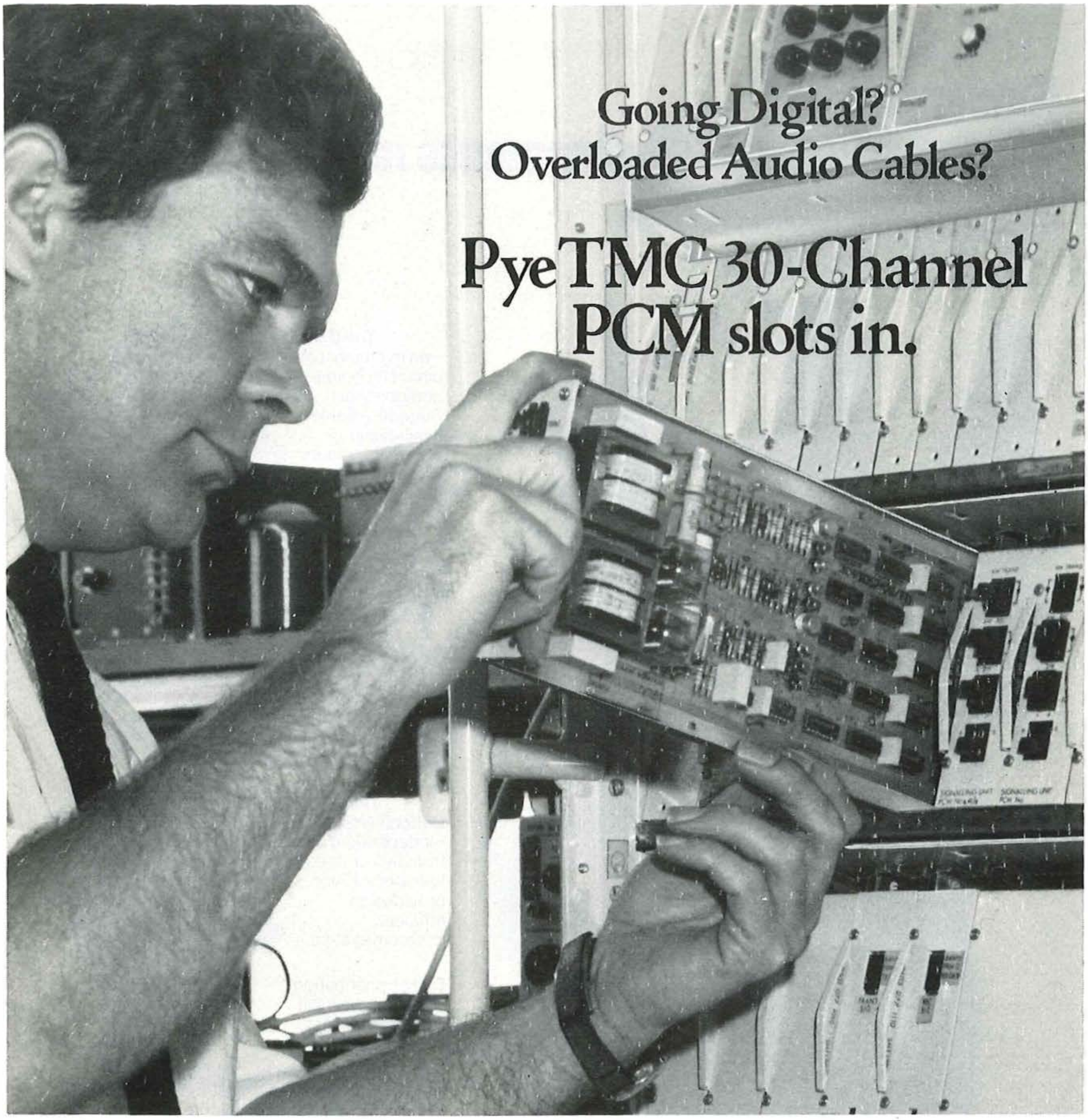

Typical
line regenerator
casing

Pye TMC 30-Channel PCM systems will increase the capacity of existing cables and will also interwork directly with most types of exchange.

The line system is suitable for use on cables as small as 0·63 mm diameter and will tolerate losses of up to 42 dB.

The equipment transmits at 2·048 Mbit/s and is designed in accordance with BPO, CEPT and CCITT specifications/recommendations. As such it forms the first stage of the digital hierarchy proposed by the BPO and CCITT.

The audio interface is two or four wire and the twelve types of signalling unit available allow for in-band, E & M or loop disconnect types of signalling, with options for metering, manual hold and trunk offer facilities. The range of signalling interfaces is being extended to provide even greater flexibility of application.

For full technical information contact:

Pye TMC Limited

Commercial Division, Martell Road, West Dulwich,
London England. SE21 8EF. Telephone: 01-670 2211.
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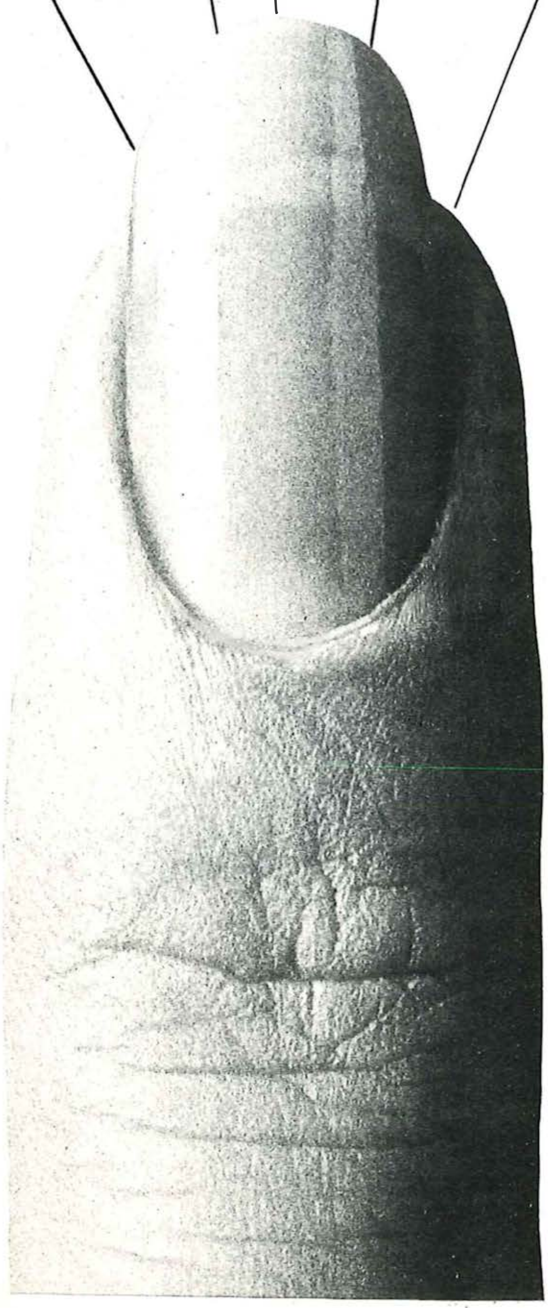
At your fingertip. Two or three telephones on one exchange line and an intercom system all in one.



The versatile GEC 740 switching telephone.

There's more to the GEC 740 switching telephone than meets the eye....

On one hand it provides independent access to a single exchange line from two telephones (1/2 system) or three telephones (1/3 system).

On the other, it is a separate intercom system–keeping exchange calls secret from internal calls. And it's all in one basic instrument–controlled by push-button switches in front of the hand-set on each 'phone. Neat, simple to use–but extremely versatile.

Dial or pushbutton versions available for all telephones.

GEC manufacture telephones for world markets: table and wall-mounting models in a number of attractive colours, loudspeaking telephones, pushbutton telephones and switching telephone systems....

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