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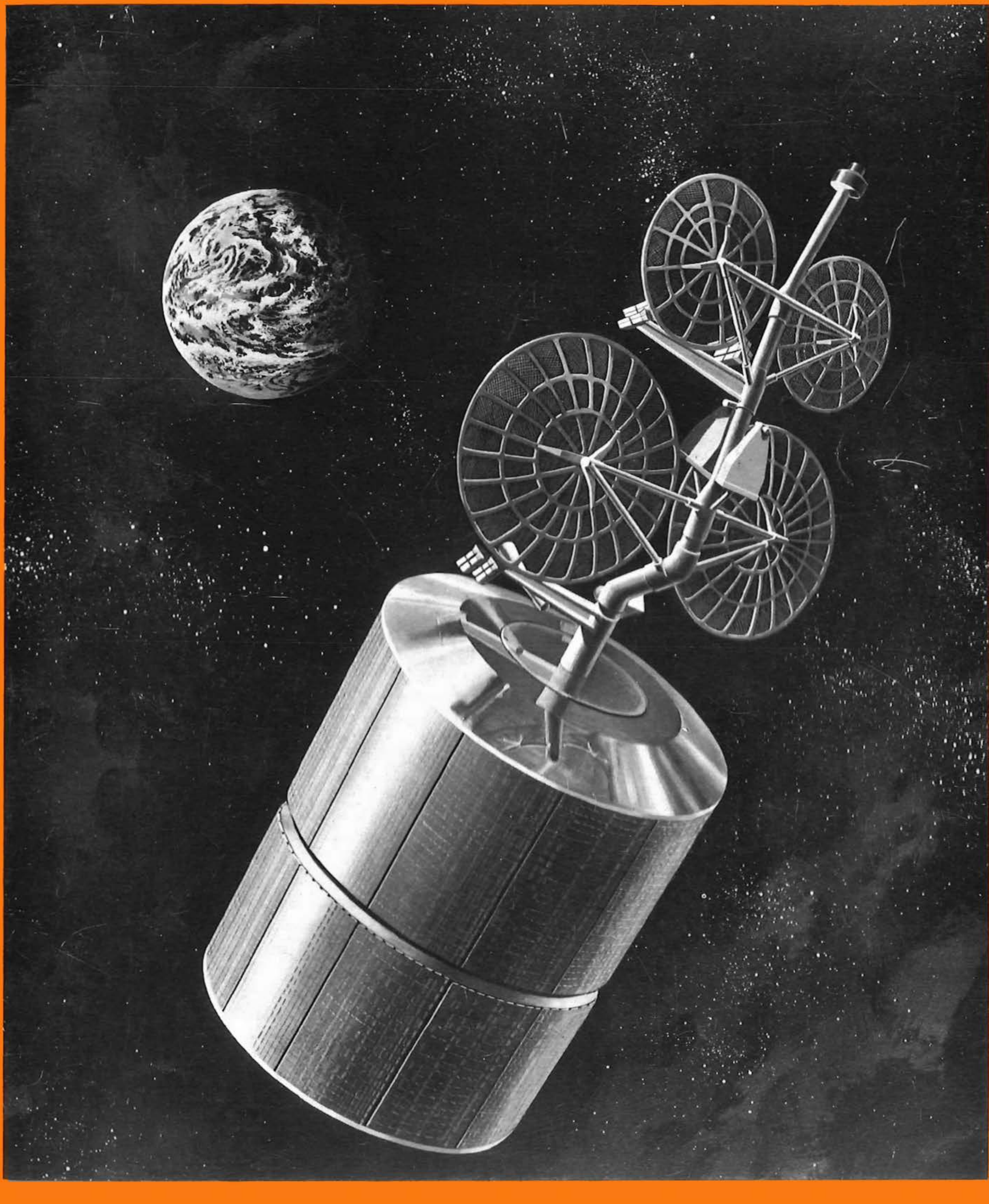

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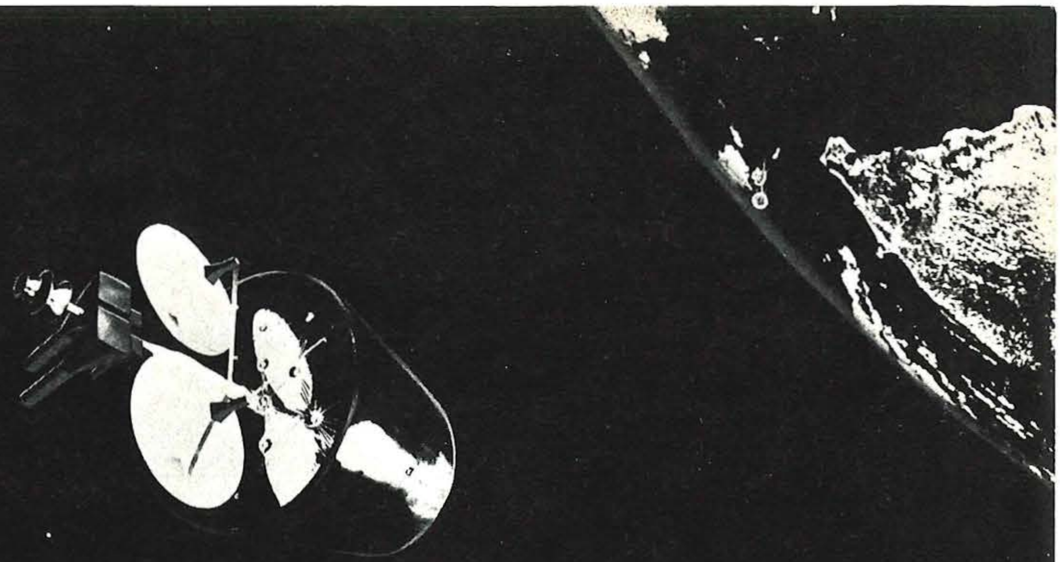

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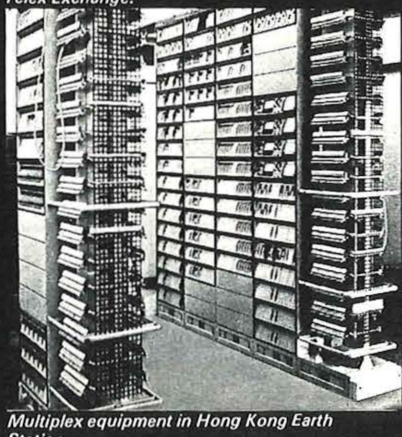

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Electronic exchanges on the move

Two recent events indicate the impact which electronic exchange equipment is making upon the expansion and modernisation of the telecommunications service. Britain's 400th TXE2 electronic exchange came into service at the end of June at Cholsey, Berkshire. At about the same time the Post Office took delivery of the first *mobile* version of the electronic exchange. It will initially go into service at Padgate, Lancashire.

Over the next 18 months 35 electronic "caravan-trailer" exchanges, believed to be the first of their type in the world, are to be delivered by Plessey Telecommunications. They will be moved around the country to provide telephone service quickly where it is most urgently needed. Each exchange will serve up to 1,000 customers, more than twice the capacity of a conventional mobile exchange. They are made up of two caravan units, one containing control equipment and the other line equipment. Next year an additional 10 caravans of line equipment will become available, and each can be used in association with a mobile exchange to double its capacity to 2,000 lines.

About £3 million is being spent on mobile electronic exchanges. In addition £5 million has been allocated for conventional mobile exchanges and the supply of portable exchange equipment which can be installed quickly in exchange buildings as ready-to-use units.

The programme for mobile and portable equipment, with its flexibility in meeting demand, is the short-term spearhead of the drive to reduce the waiting list.

With the opening of the 400th small local electronic exchange came an announcement that up to 180 more are to be brought into service over the next year at a cost of £16 million.

Mr Edward Fennessy, Managing Director of the Telecommunications Business, commented on the TXE2 programme when he visited the Cholsey exchange:

"Since the opening of the first electronic exchange in 1966 the Post Office has spent £35 million in providing electronic exchange systems giving a more reliable and efficient service to about 400,000 customers," he said. "In the next 12 months we will bring into service more electronic exchanges than we have ever installed in a single year. This is a clear and positive indication of the Post Office's determination to provide its customers with the best service modern technology can provide."

By the end of the year well over half-a-million customers will be linked to the telephone by electronic exchange systems. Meanwhile the Post Office's longer term plans for modernisation, which include the use of a large electronic exchange (TXE4) to complement the TXE2, have been approved by the Government and will make an increasing impact as the 'seventies progress.

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Cover: A new space communications satellite (Intelsat IV-A) will be launched in 1975. With the unique aerial system seen in the artist's impression it will nearly double the capacity of the present Intelsat IV satellite. See centre pages.

Doctor in a manhole

Getting down to work as Regional Medical Officer in the North Eastern Telecommunications Region, Dr Ann Hollingworth goes underground to inspect working conditions.

A business which employs nearly a quarter of a million people in such different fields as operating telephones, sailing ships, running factories and carrying out scientific research clearly faces a great challenge in maintaining a healthy working environment. Last year the Post Office Board decided to develop and expand the Corporation's Occupational Health Service, and in this article Dr Peter Gilbert, Principal Medical Officer for the Telecommunications Business, describes the objectives of the service and its plans for protecting and improving the health of telecommunications staff.

THE OLD CONCEPT of "industrial medicine", which was largely restricted to the control of industrial diseases among workers in factories, has been replaced in recent years by the practice of "occupational health". This is concerned with the health of people of every grade in all fields of employment, so that today the mental and physical well being of clerical workers and typists, scientists and managers, is just as important as the control of illness on the factory shop floor, which has more direct and obvious causes.

Occupational health is based on prevention rather than cure. Therefore while one of the responsibilities of a comprehensive Occupational Health Service (OHS) now being developed by the Post Office is to help to ensure that employees get efficient first aid and other initial treatment of illness or injury at work, its main aim will be to prevent such troubles and generally to improve the health of staff.

The service is designed to achieve these aims in a number of ways. Part of its task will be to identify and assess hazards to the health and well being of staff or the public. It will then be able to advise management on the medical aspects of controlling hazards arising from work methods and the working environment. The service will also be responsible for investigating the causes of sickness absence and suggesting means by which it might be reduced.

Another important objective of the Post Office's OHS will be to provide information on the effects of ill health on the working capacity of all staff, as well as helping to find suitable jobs for people with temporary or permanent disabilities. It will also advise on such subjects as premature retirement for medical reasons, and the medical aspects of catering and sanitary hygiene.

With all these responsibilities, the effective practice of an occupational health service in an organisation the size of the Post Office calls for careful planning. Within the overall framework of a Corporation service, therefore, organisation of the OHS is being divided largely between each business. For the Telecommunications Business, with 250,000 staff throughout the country, regional health teams are being set up, comprising full-time and part-time doctors and nurses. The Principal Medical Officer (Telecommunications) is responsible to the Chief Medical Officer of the Post Office for the development and monitoring of the health service in the business.

The source of immediate care for those injured or taken ill at work will, as in the past, be the large numbers of voluntary first aiders. Doctors and nurses in the new service will give professional support and guidance to the first aiders in their day-to-day problems, and by having these closely integrated teams it is hoped to provide a high quality service.

One important feature of the new system is the appointment of occupational health nurses. As part of the regional health teams they will act as advisers on health problems to local management and staff. By having ready access to a doctor to whom she can refer problems a trained and experienced nurse can undertake many more duties than a nurse working in isolation.

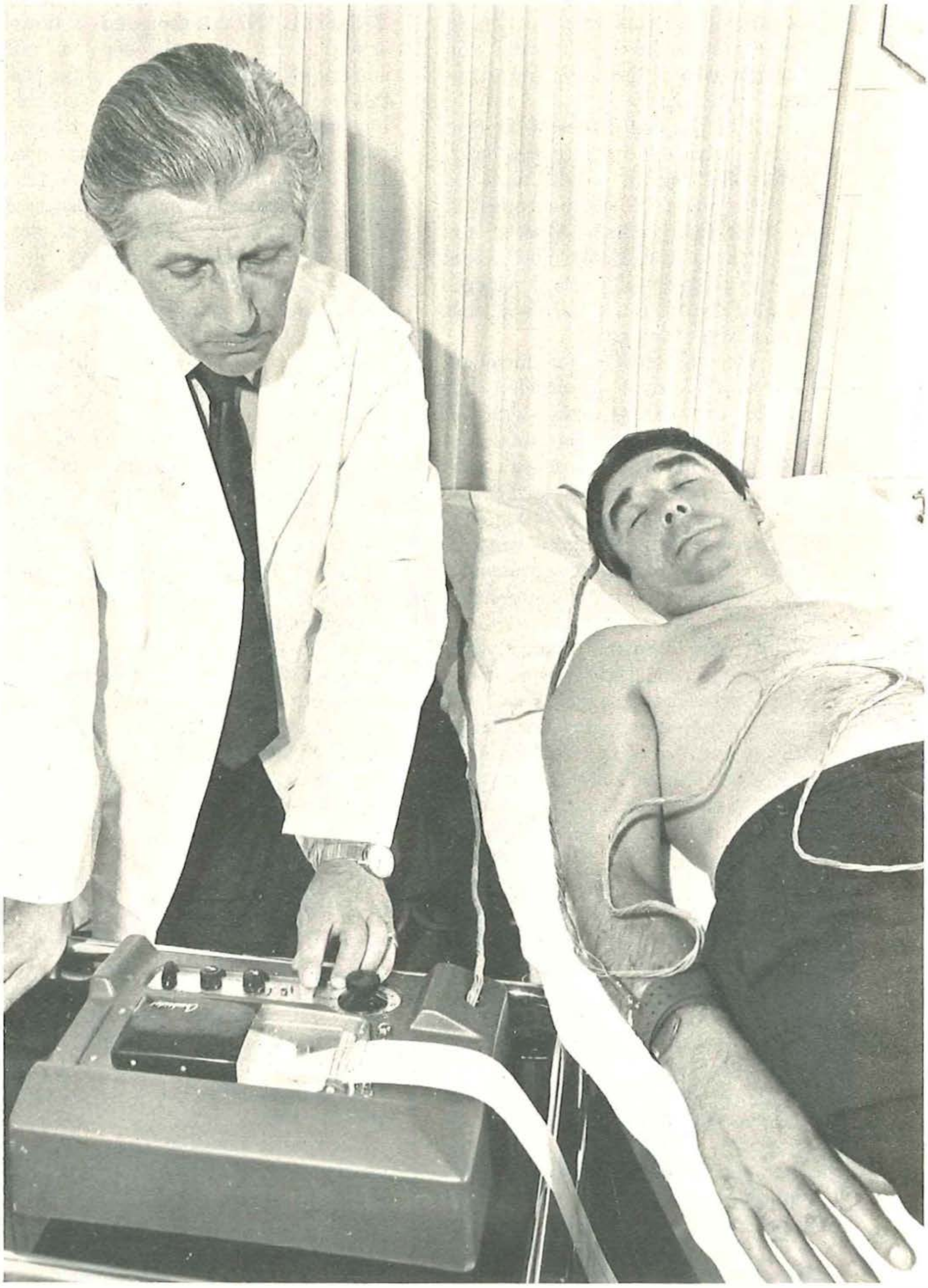
The Telecommunications Business is also likely to make more use of the comparatively new discipline "occupational hygiene". Already an Occupational Hygienist at Telecommunications Headquarters has measured environmental hazards to health such as dust, noise and toxic fumes. This should provide useful information in helping to create a safer and better working environment for workers exposed to this type of hazard.

Not only the size of the undertaking but the wide range of types of employments in the business presents a variety of tasks. Clearly, the bulk of the OHS efforts in telecommunications will be directed at the main body of the labour force – the manipulative grades. Factories represent what is almost certainly the only remaining field in the Post Office for what used to be called "industrial medicine". It is hoped under the new service to give more time to the study of health problems arising out of modern work practices at the factories in London, Birmingham and Cwmcarn.

The effect of working situations on telephonists and supervisors needs closer and more detailed study, particularly special aspects such as the use of cordless switchboards. Similarly, in the engineering field the use of new jointing techniques, increased use of mechanical aids, the impact of productivity agreements and smaller work gangs are all situations which could affect the physical and mental well being of the staff. Research Department, now in the midst of its move to the new site at Martlesham Heath, will ultimately be completely under the control of one Regional Medical Officer. He will pay particular attention to problems which may arise from the special techniques used to carry out investigations in this Department.

Although a great deal has already been done over the years to improve the health of Post Office cableship crews, the fitness of officers and men is of great importance and should be studied more closely. Staff employed at the isolated radio stations scattered around the country and supply depots using modern techniques of storage and handling are other examples of situations where the effect of work on health and health on work could be more closely studied to provide useful advice for management.

All this, of course, is a formidable task and cannot happen at once. The first job is to organise an efficient OHS structure. In London, the Midlands,



In his consulting room at Telecommunications Headquarters in London Dr Peter Gilbert, Principal Medical Officer for the business, checks the heart condition of a member of the staff. The patient is wired to electrocardiogram equipment which records the electrical waves generated at each heartbeat.

Doctor in a manhole

the North West and in Scotland the Telecommunications Business will have its own Regional Medical Officers, but other regions will share with the Postal Business. The exception, for the time being will be Northern Ireland which will be covered by part-time doctors under the Regional Medical Officer, North Western Postal Region. The appointment of part-time doctors in each region to the health teams will occur gradually as the needs and workloads become clear.

The Chief Nursing Officer of the Post Office is advising the business headquarters and regions on the need for and recruitment of suitably qualified and experienced nurses. One of the initial tasks of the doctors and nurses will be to explain to all levels of management how the OHS can be used and what sort of advice it can give.

It is clearly essential for members of the health teams to develop and maintain the closest links with all functions and levels of telecommunications staff, with unions and with professional organisations outside the Post Office. The full-time professional staff will develop and maintain effective working relationships with the personnel, welfare, safety and catering specialist disciplines.

Regular and frequent contact with other occupational health services and professional societies is vital for, as with all medical subjects, occupational health is developing fast with new ideas and techniques. This will help to keep the health service staff up-to-date with developments and enable them to present a good image of their OHS in attracting the best professional staff.

In a business which exists not only to give a service but also to make money, cost effectiveness is vitally important. All Regional Medical Officers will be responsible for producing a budget for their health teams on the lines of the normal business accounting procedure. The Principal Medical Officer for the Telecommunications Business will be responsible to the Chief Medical Officer and to the Managing Director, Telecommunications, for the consolidated budget.

It may be several years before the Occupational Health Service in the Post Office is fully developed. But the challenge it presents has been accepted and those responsible for its success are now getting on with the job in hand.

THE MONEY

A nationwide, on-line data network is being established with Post Office help by one of Britain's major banks to provide transmission links between all the bank's branches and its computer centres. The network will enable customers to obtain information about their accounts at any branch.

BANKS HANDLE thousands of transactions every day, involving a vast amount of accounting work. In the past this work was carried out almost entirely by manual methods, but growing demand for banking facilities presented increasing problems both in terms of the manpower and accommodation required to maintain an efficient banking service.

The development of computers provided an answer to the problem and created the opportunity for centralised systems of accounting in which data processing for a number of branches could be handled at one point. Initially these systems were off-line, and information had to be transported between branches and the computer centres. The availability of a widening range of Post Office data transmission systems has now made it possible to provide a faster and more efficient system in which information can be sent direct over telephone lines.

One of Britain's largest banks, the National Westminster, has until recently used both off-line and on-line systems based on eight computer centres as a result of mergers when it was formed four years ago. It is now setting up a national on-line network and concentrating data processing activities in two computer centres.

By the end of next year the bank plans to have its 3,500 branches throughout the country connected directly by Post Office private circuits to the two computer centres serving the network. Two data communication high-speed links are also being provided between the two computer centres so that the branches can interrogate records stored at each centre.

When the network becomes fully operational the computer centres – at Woolgate House, London, and Kegworth, Leicestershire – will each serve half the national total of accounts. Woolgate House will serve branches in London and others south of a line running roughly from Bristol to London, with Kegworth serving those branches to the north of the line. When the project was at the planning stage there was close consultation between the bank, the Data and Telegraph Commercial Projects Section of Post Office Telecommunications Headquarters and equipment manufacturers to decide on the network best suited to the bank's requirements.

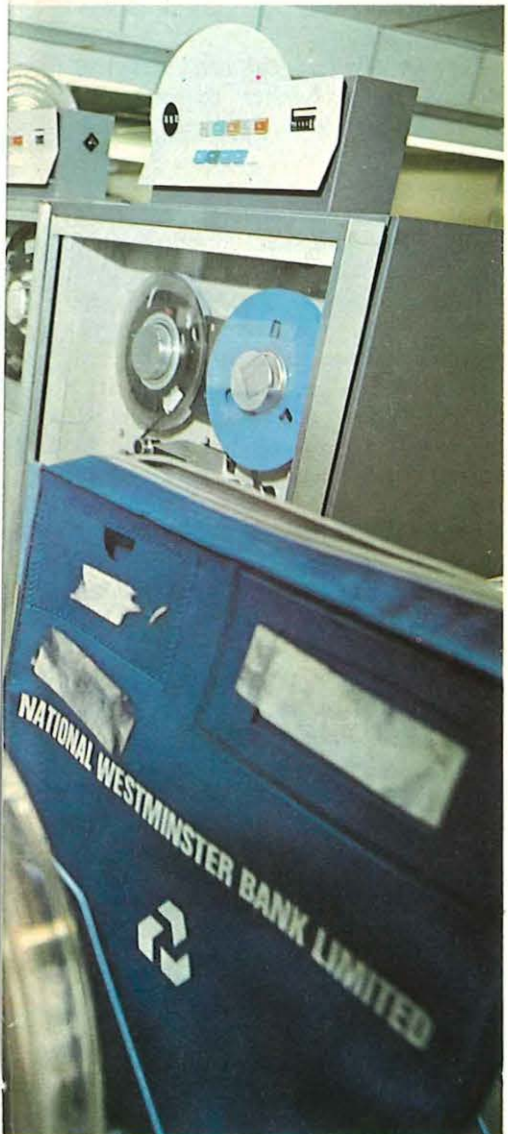
It was agreed to use a multipoint system of transmission. Basically a multipoint circuit consists of a main section leading from the computer centre to a branching point – a Group

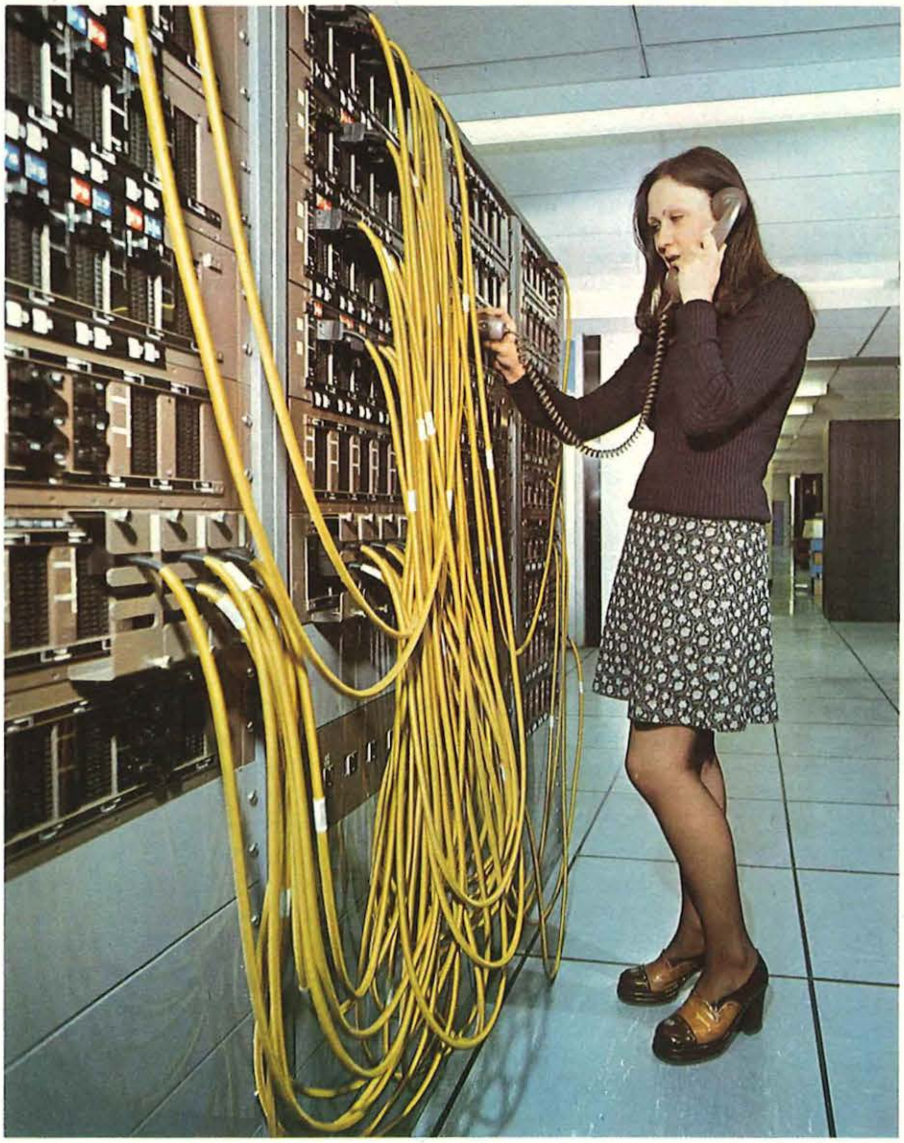
NETWORK

BM Jordan and EM Richardson

Below: Data signals from a branch are checked on a patching rack at the National Westminster Bank's Woolgate House computer centre.

Left: The magnetic tape room at the centre, equipped with units for "reading" computer tapes.





Switching Centre – from which a number of spur sections radiate to outstations (e.g., bank branches). These circuits provide interconnection between each outstation and the computer centre, but not between outstations.

As a number of closely grouped outstations can be served by one main line section, the multipoint circuit is economical both in the amount of Post Office line plant required and in the customer's line rental. There is also considerable saving in computer terminal equipment as there are fewer incoming circuits at the computer centre.

The main line section of a multipoint circuit is shared by all the outstations so a discipline has to be applied. This is done by the computer. The system is operated by the computer centre transmitting a message which is received by all the outstations but recognised by one only. (This operation is known as polling.) If the terminal at this outstation has information ready it is transmitted to the computer.

When the data transfer has been completed the procedure is repeated for every other outstation in turn, the whole process being carried out in a continuous cycle. If at any time the computer has information for a particular outstation it will interrupt the polling sequence, address that outstation and forward the data.

National Westminster's network provides data transmission at 1,200 bits per second (bit/s) over multipoint circuits between the computer centre

At the nerve centre of the network controlled from Woolgate House staff deal with transmission problems. Teleprinter-type terminals in the control room are used to "converse" with the computer.

and branches equipped with "intelligent" terminals. These terminals are capable of certain simple computing functions and are situated at branches mainly in the London area.

A two-speed system is used for other branches. It provides transmission at 1,200 bit/s over multipoint circuits to selected branches equipped with concentrators which are capable of onward transmission at 147 bit/s to surrounding offices. These branches are equipped with less "intelligent" terminals, but in both cases the branch equipment incorporates a fast teleprinter device.

The concentrator is a mini-computer and can collect information from and send data to a maximum of 16 terminals. It can also carry out certain computing functions such as editing and error checking.

One multipoint circuit can serve two concentrators. Allocation of branches to these circuits depends on forecast data traffic and the geographical concentration of branches. Another factor is the suitability of certain branches to accommodate the concentrators. The banks housing concentrators are, in general, those in large towns and may themselves have four or more terminals for their own use.

Data transmission across the network falls into three main categories. It is used to collect accounting data (banking transactions) and information (such as new accounts, changes of address) for amending files. This information is input by branch operators and is received in blocks by the computers.

Enquiries, of which there are 50 different types, can be sent from any terminal at any time during the day. These are either for interrogating the computer files or used in a message switching context between branches and other centralised locations.

Overnight reports by the computers are transmitted automatically to branches after customer files have been updated either at Woolgate House or Kegworth. The reports are printed by the unattended terminals in the branches.

The reliance of the National Westminster on its data transmission systems demands that any out of service time for any part of the system must be kept to a minimum. This has been ensured by providing duplicate equipment for use as reserves. The Post Office has played a large part in this effort by providing various reserve facilities.

Each multipoint circuit has a nominated reserve for its main section and spur sections using main line plant. These are normally in use as traffic circuits and can be substituted in the event of main line failures.

Outstations that are equipped with Post Office modems – equipment which converts data signals from terminals into a form suitable for transmission – can be connected to an exchange line. This enables the modem to be tested remotely from a Datel Test Centre and data to be transmitted over the public telephone network to the computer centre.

Some 64 exchange lines have been provided at Woolgate House for "standby" use in the event of private circuit failures. These are terminated on four data switchboards, each call being answered manually and switched through to its modem at the computer centre. Special diversion facilities have been provided whereby each exchange line can be answered by an Ansafone set to give out recorded messages, for example in the event of a system failure affecting data transmission.

The nerve centre of the network served from the Woolgate House computer centre is the "on-line control" room at the computer centre which houses the four data switchboards and four terminals. Branches report any difficulties on data transmission to this control room.

The four data terminals can be used to instruct the computer to poll any particular branch. If data transmission is still not possible "on-line control" staff carry out a diagnostic fault procedure to ascertain whether the fault lies in the computer terminal, outstation terminal or concentrator.

If the fault is discovered in the computer terminal or suspected to be in the computer centre modem, a reserve terminal or modem can be used. Where the Post Office line is suspected faulty, the branch concerned is instructed to transmit data on a standby exchange line, the private circuit fault being reported to the Post Office. Outstation terminal, concentrator or modem faults are reported to the manufacturer or the Post Office, as appropriate.

The Kegworth computer centre has an "on-line control" area similar to that at Woolgate House. It houses four data switchboards for terminating 80 standby exchange lines and four terminals, and will enable the 128 branches equipped with concentrators to contact Kegworth on a dial-up basis over the public telephone network in the event of failure on their main data links.

Initially the network was served by the Woolgate House computer centre. The National Westminster decided to introduce the second centre at Kegworth to provide room for the expanding volume of work to be handled.

The final plans will result in about 80 private circuits being connected to Kegworth and about 90 to Woolgate House. Although this rearrangement will mean a reduction in revenue for the Post Office, in the long term it will release a large number of circuits incoming to London where demand is very high. To enable data processing activities to be operated from the two centres the Post Office has successfully transferred 48 main circuits from Woolgate House to the Kegworth centre.

Inter-communication between the two computer centres is essential. For example, an account holder at a branch served by Kegworth may request his account balance at one served by Woolgate House. This is being provided by two Datel 48 kbit/s links between the two centres.

From the Post Office point of view, locating the second computer centre at Kegworth presented great problems. The town is about 18 miles from Leicester (its serving Group Switching Centre), 10 miles from Derby and 12 miles from Nottingham, the nearest Post Office centres of communication. Moreover, the local exchange at Kegworth – a 2,000 line TXE2 electronic type – has a limited capacity both in terms of the number of connections available and their traffic carrying capability.

Not nearly enough lines were available to provide the 80 private circuits and 80 standby exchange lines by normal means. The Midlands Telecommunications Region realised that the only way to meet the National Westminster's requirements by the date requested was to use a digital transmission system known as pulse code modulation (PCM) to provide direct links between the computer centre and one or more Group Switching Centres (GSCs), by-passing the local Kegworth exchange.

This is the first time the Post Office has used PCM to carry communications direct to a customer's premises. The system is normally used to obtain greater carrying capacity for speech or data on the telephone network between local exchanges.

Use of the PCM system enables the flow of data to and from the Kegworth computer centre to be carried on 14 pairs of wires, whereas without PCM more than 200 pairs would have been needed.

Of the three nearest GSCs to Kegworth, only Nottingham and Leicester had enough spare capacity to accept standby exchange lines. It was therefore decided that the private circuits would be evenly split between the two, with 60 standby exchange lines going to Leicester and the other 20 to Nottingham.

The National Westminster agreed to site the PCM terminal equipment in the computer centre room planned to contain the cable terminal equipment. Private Automatic Branch Exchange (PABX) and batteries. This room is under Post Office control, and because of the size of the installation the centre has been given a Post Office exchange code.

The PABX installed is one of the latest type of crossbar exchanges. All the administrative speech lines, some of which are used for branch enquiries on data transmission, are provided from the local Kegworth exchange which has been enlarged to cater for the additional traffic load.

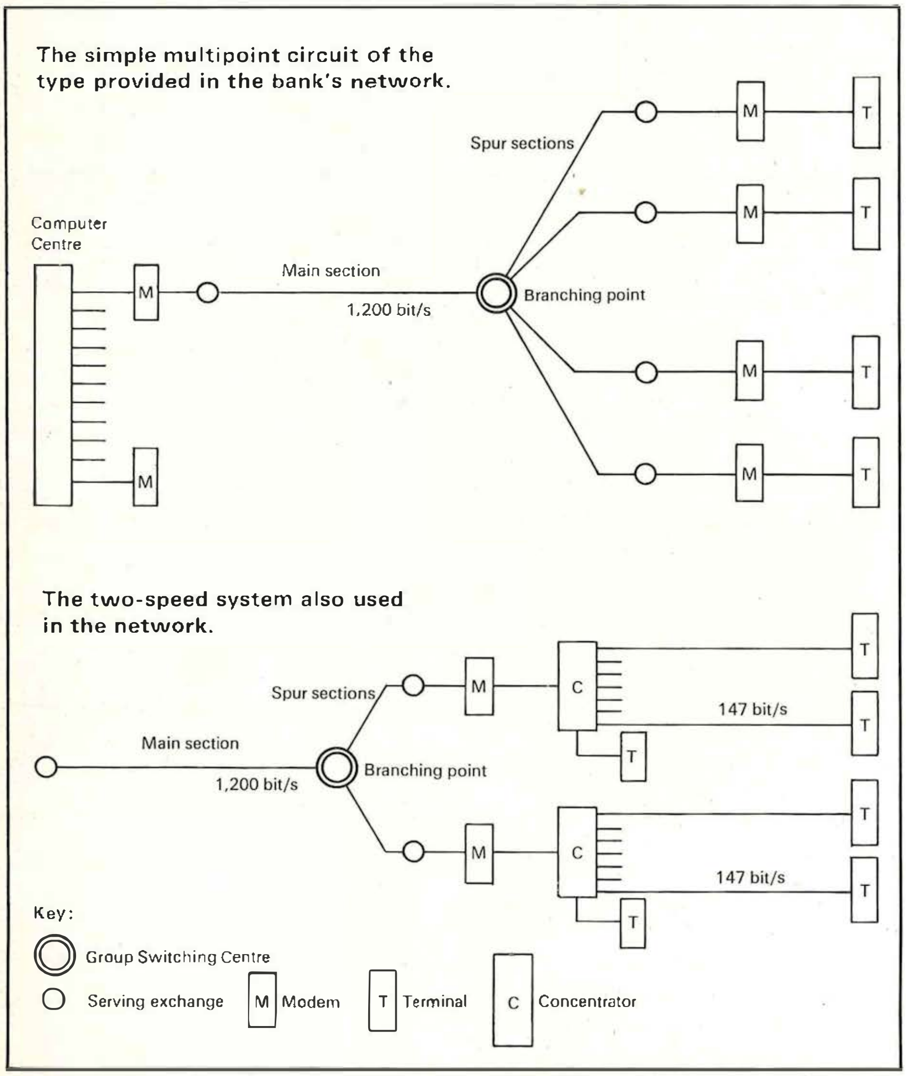
The bank's plans for the introduction of the Kegworth computer centre meant that the majority of private circuits intended for Kegworth were required by mid-1973. Most of these circuits had already been provided to Woolgate House and the bank was anxious that there should be negligible out-of-service time during the changeover. It also requested that the changeover of each circuit be effected at weekends since working circuits were involved.

This was considered impractical, and it was decided that each new circuit to Kegworth would be provided before the required changeover date, with the Woolgate House circuits remaining in service. The actual changeover would then be carried out by bank staff.

The method gave the bank the added advantage of access to either computer centre. If problems occurred with either a new circuit or the computer system at Kegworth, the branches could continue transmitting data to Woolgate House. The circuit to Woolgate House could be ceased when the bank was fully confident of the Kegworth system.

Installations of this size usually need a longer planning period than was available, and called for close co-ordination between the bank and THQ Departments, Regions and Telephone Area staff. The entire installation had to be completed and commissioned in six months to meet the required opening date.

Midlands Telecommunications Region took the initiative in setting up a monthly progress meeting for the project, and the efforts of Leicester Area staff enabled the installation to be completed by 1 September 1972. The bank then used the dual-access circuits to Woolgate House and Kegworth in a successful pilot scheme before requesting cessation of the circuits to Woolgate House computer centre.



Miss B. M. Jordan and **Mr E. M. Richardson** were members of the group in Network Planning Department at Telecommunications Headquarters responsible for the planning and progress of the National Westminster Bank's data network.

Made in Wales

New-style telephones currently on trial in three areas were assembled on a special production line designed, built and operated by Post Office Factories Division. A total of nearly 6,000 instruments, developed primarily for residential users, has been produced for the trial.

The assembly line was designed and built at Post Office Factory Headquarters in Birmingham. It consisted of a series of desk-type working positions equipped with all the jigs, tools, racks for components, and testers necessary for production.

Initial development and production problems were ironed out at Birmingham, and the first 100 instruments were assembled there during proving trials. The assembly line was then transferred to the Post Office factory at Cwmcarn, South Wales, for full-scale production of the trial models.

Staff at Cwmcarn have considerable experience in repairing existing telephone models, which have to be stripped, re-assembled and tested before being used again. However, it was the first time that a Post Office factory had assembled a large number of new instruments before their general production.

The field trials of the new-style phones – in Canterbury, Cardiff and Sheffield – are being used to assess the technical reliability and performance under working conditions. If they are successful and there is sufficient customer demand the new design may become the standard model for residential users. Plans would then be finalised for production by manufacturers.

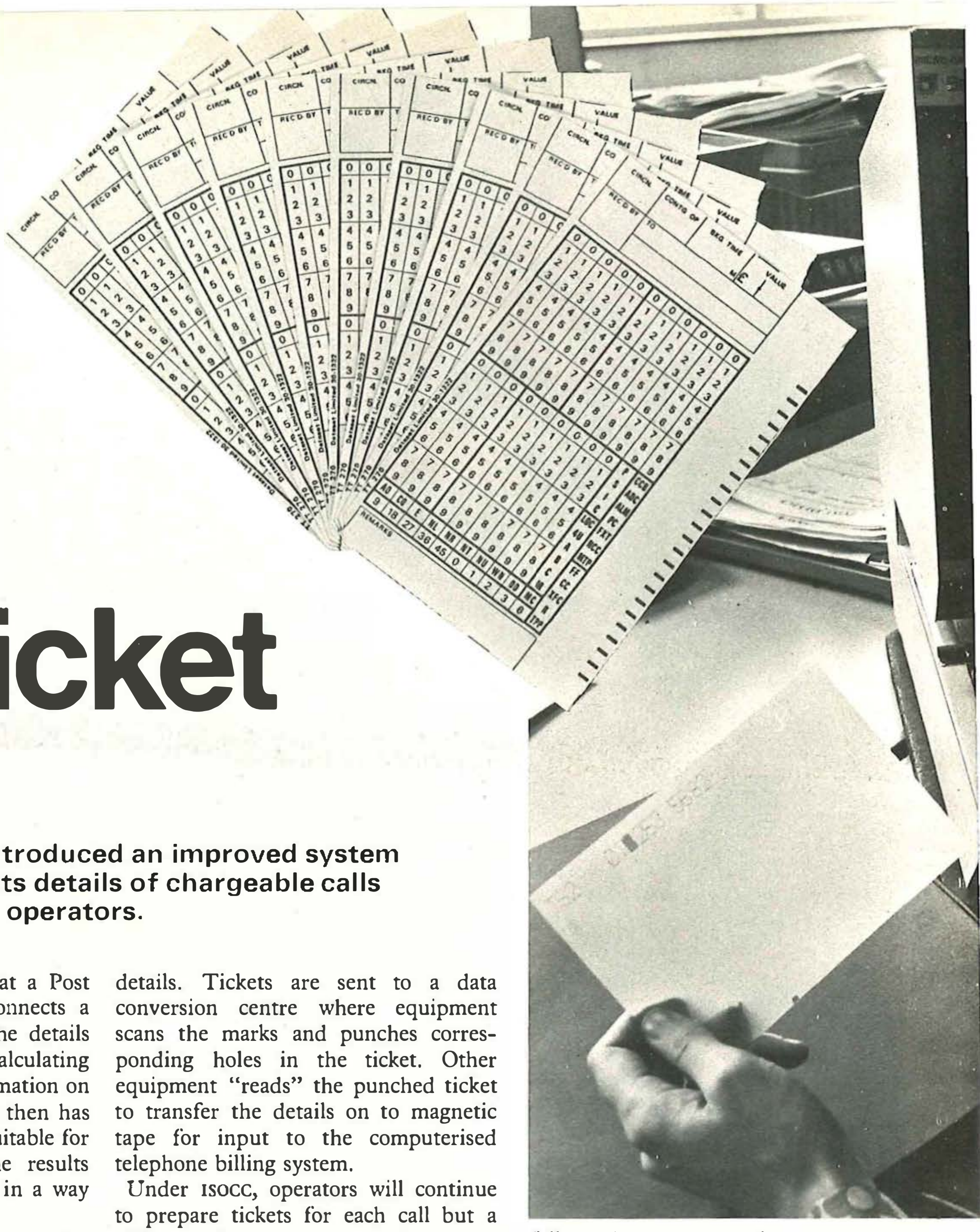
The new-style instrument is slimmer and lighter than the present standard model and features a separate bell unit. Its design, described in the Autumn 1972 issue of the Journal, makes extensive use of moulded plastic parts and snap-fit techniques.

Slim, light, attractive and economic to produce – the new-style telephone may become the standard model for residential users. It may also have some applications in businesses.

A bell unit takes shape from components arranged in trays for ease of assembly. The base of the unit is designed to snap fasten to the cover and can also be snap fastened to a wall mounting bracket. Leads to the bell can be arranged for sideways exit from the unit for a free standing telephone or downwards exit for wall mounting.

Above: Assembled instruments undergo transmission and acoustic tests. The send and receive levels and side tone (the amount of send tone that gets back into the receive tone) have to be closely controlled within certain limits to give satisfactory service. The bell is tested at both full and half current to make sure it works.

Left: The new telephones roll off the assembly line at the Post Office factory in Cwmcarn, South Wales. At peak production 1,000 instruments a week were assembled. The telephone has a separate bell unit and this, together with the extensive use of moulded parts and snap-fit techniques in its design, made assembly easier than for present models which are repaired at the factory.



It's just the ticket

F Faulks

The Post Office has introduced an improved system for recording on tickets details of chargeable calls handled by telephone operators.

EVERY TIME an operator at a Post Office telephone exchange connects a chargeable call she records the details on a separate ticket for use in calculating the customer's bill. The information on this manually prepared ticket then has to be converted into a form suitable for computer processing and the results presented on customers' bills in a way that can be easily understood.

The present method of converting data from about two million call tickets every day has remained virtually unchanged since its introduction some 12 years ago. It is fast becoming outdated and the data conversion equipment used is now reaching the end of its useful life.

A new system is therefore being introduced which will speed the production of data for billing, reduce current manual sorting and handling procedures and cater for future developments in switchboard operation. It will also provide easier access to records of calls for accounts staff in Telephone Areas. Called the Input System for Operator Controlled Calls (ISOCC), it will be phased in at exchanges throughout the country over a six-month period starting in November.

With the existing system operators make pencil marks in different sections of each ticket to indicate certain call details. Tickets are sent to a data conversion centre where equipment scans the marks and punches corresponding holes in the ticket. Other equipment "reads" the punched ticket to transfer the details on to magnetic tape for input to the computerised telephone billing system.

Under ISOCC, operators will continue to prepare tickets for each call but a different design is being adopted so that more machine readable information can be marked. Modern reading equipment will transfer call details from the tickets directly on to magnetic tape, doing the job of present mark scanning and reading machines in one operation and handling the tickets at a faster rate.

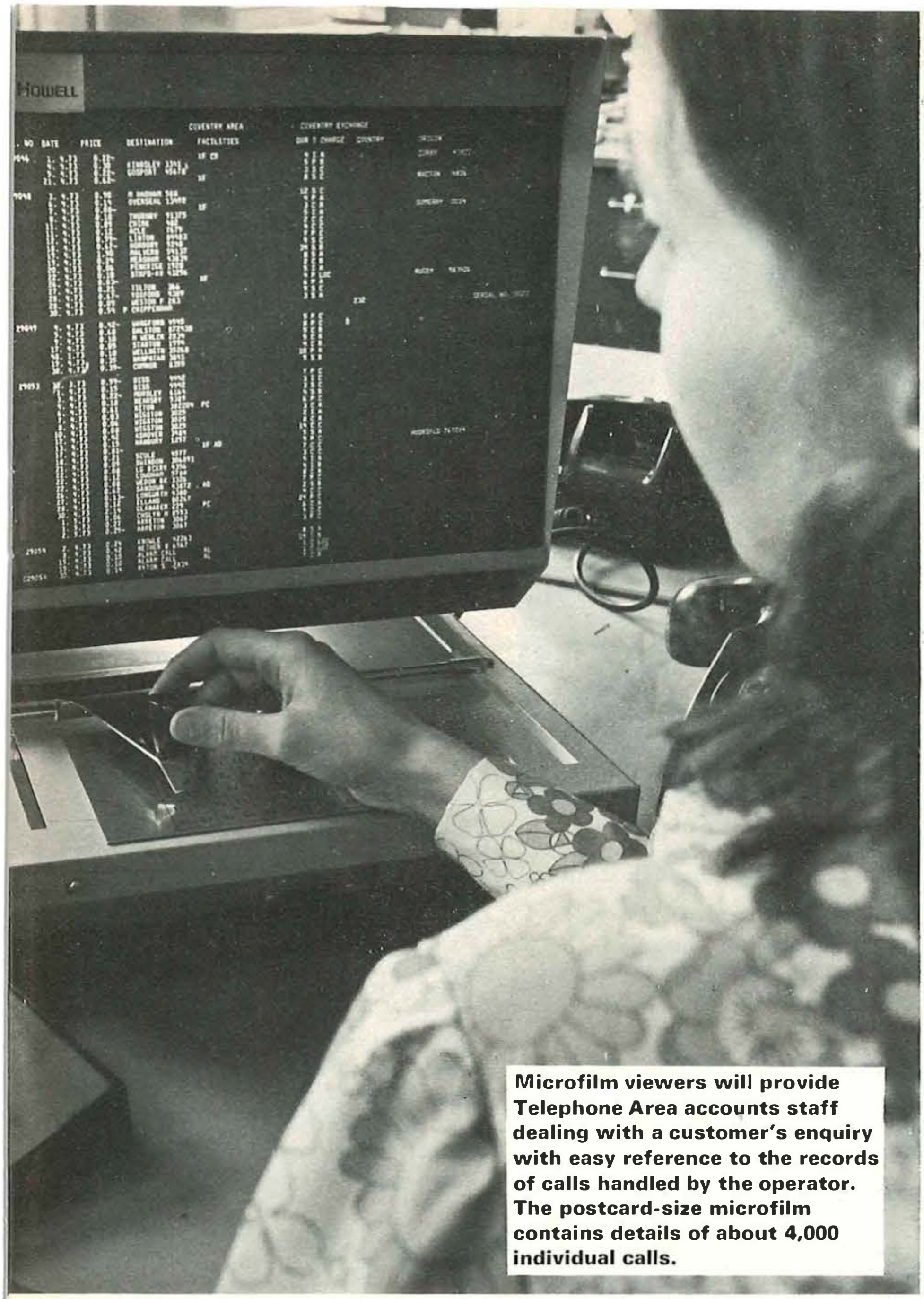
The new system will reduce delays by carrying out the data conversion work at two centres instead of the eight currently used. It will also produce microfilm records of each customer's calls, eliminating the need for storing millions of tickets in Telephone Area offices.

ISOCC will be capable of handling tickets for all types of calls, including inland, international, phonogram and ship calls. Inland calls comprise the largest section, and the system can best be described by following the processing of these tickets. Other types vary in design, but the procedure follows the same general ISOCC pattern.

The inland ticket is divided into "fields" for marking and subsequent machine reading, each one covering a specific category of information – such as called number, calling number and duration of call. Details of a call are recorded by the operator making horizontal pencil marks through the appropriate characters in these "fields".

One of the most significant changes in ticket design is that marking "fields" have been provided for both called and calling telephone numbers. At present the called number is written in manuscript and cannot be read by machine. It has to be punched in manually for customers who request detailed statements of account.

Another additional machine readable "field" provided by ISOCC indicates where a customer has met difficulty in dialling – for example, he may have been cut off, or received engaged or number



Microfilm viewers will provide Telephone Area accounts staff dealing with a customer's enquiry with easy reference to the records of calls handled by the operator. The postcard-size microfilm contains details of about 4,000 individual calls.

unobtainable tone. This will prove useful for statistical purposes and, for example, identifying trouble at a particular exchange.

To enable the called and calling numbers to be presented in machine readable form all telephone numbers will be marked in national number form – that is, Subscriber Trunk Dialling (STD) code followed by the customer's number. To achieve this it is necessary for exchanges which have not yet been allocated STD to be given hypothetical codes.

Operators will be provided with a list of codes for all exchanges under their control – the calling numbers. Visible index files – which give the operator routing and charging information for connecting calls – will include codes for all other exchanges. Where necessary the computer system will translate codes into exchange names so that telephone numbers can be presented on trunk call statements accompanying bills in a form that the customer can understand.

The present system calls for tedious sorting of tickets at exchanges. Calls from exchanges they control must be collated in order, with further sorting into other categories for statistical purposes and to aid processing at the data conversion centres. With the introduction of ISOCC most of this sorting will be eliminated.

In designing the new tickets consideration was given to colour for easy reading. During trials of the system in selected exchanges the opportunity was taken to find a generally acceptable combination of print and background colours, the print being limited to red or orange for machine reading purposes. The most popular combination was red on a pale blue background, and this is being used.

Chargeable tickets prepared in the telephone exchanges will be sent daily to a Ticket Reading Centre (TRC). One TRC at Derby will process tickets from exchanges in Scotland, Wales and the Marches, Northern Ireland and the North Eastern, North Western and Midland Telecommunications Regions. Another TRC, at Bristol, will serve exchanges in the other Regions.

All inland tickets except those related to Credit Card calls will be input direct to reading machines. Credit Card tickets, together with those for phonograms, ship and international calls, first have to be encoded with additional information. Encoding is carried out on manual, keyboard type machines. The operator keys in the required information, which appears as groups of characters on the right hand side of the ticket.

A few inland tickets will also need to be encoded, for example, in cases where additional details required for billing some calls or for statistical purposes have been recorded in manuscript by the operator. However, it is more convenient to pass these tickets through the readers first with the main stream and have them rejected than to keep them separate at all stages.

The ticket reader is a mini-computer which is capable of carrying out much of the data vetting required in the system. This has the advantage that many errors can be discovered early in the processing cycle, reducing delays in bringing calls to account. Some errors – such as tickets incorrectly prepared against numbers for lines which have not yet been allocated to a customer – will not be discovered until validation checks take place in the telephone billing system.

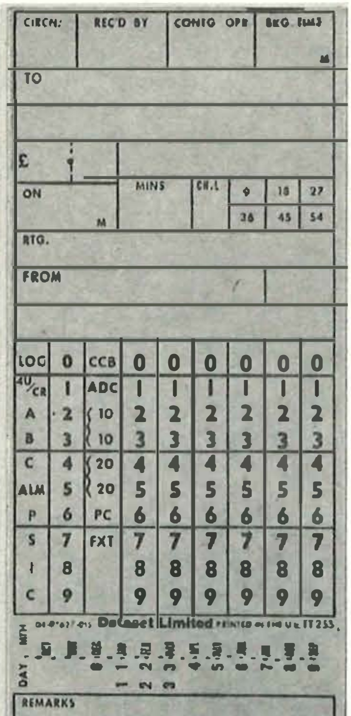
A report will be printed out for every ticket rejected by the reading equipment, and both rejected tickets and error reports will be individually examined by a Reject Analysis Unit. Some errors, such as those arising from encoding mistakes, will be corrected at the TRC and then re-input to the system. Tickets which cannot be corrected will be sent back to the originating exchange.

The reading equipment can process up to 1,200 tickets per minute, although under normal conditions the TRCs expect to process about 900 per minute. As tickets may have a combination of marks and encoded information, the machines have been designed for both Optical Mark Reading (OMR) and Optical Character Recognition (OCR). Both processes are carried out simultaneously, and the readers transfer data from accepted tickets on to magnetic tapes.

Once information has been transferred to the tapes the tickets have served their purpose. With the exception of Credit

Left: The control panel of an ISOCC ticket reading machine is checked before tickets, which contain details of operator-assisted calls, are inserted. The machine automatically transfers the details to magnetic tape for use in producing customers' bills and records for accounts staff.

Right: Call information is keyed on to an ISOCC ticket by an encoding machine which is used to print additional data on some tickets that cannot be marked by the exchange operator in machine-readable form. Data appears as groups of characters.



CIRCN: | REC'D BY | CONTG OPR | BKG. TIME M

TO

£

ON M | MINS | CH.L | 9 18 27 / 36 45 54

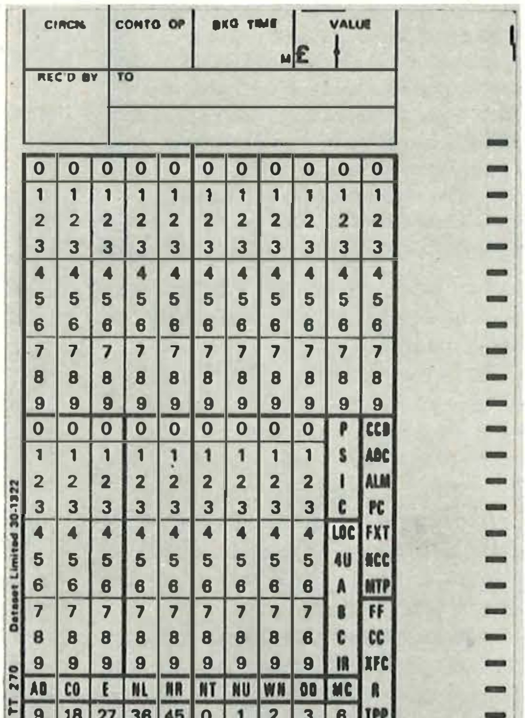
RTG.

FROM

LOC	0	CCB	0	0	0	0	0	0
4U/CR	1	ADC	1	1	1	1	1	1
A	2	10	2	2	2	2	2	2
B	3	10	3	3	3	3	3	3
C	4	20	4	4	4	4	4	4
ALM	5	20	5	5	5	5	5	5
P	6	PC	6	6	6	6	6	6
S	7	FXT	7	7	7	7	7	7
I	8		8	8	8	8	8	8
C	9		9	9	9	9	9	9

Dataset Limited

REMARKS



CIRCN. | CONTG OP | BKG TIME | VALUE M £

REC'D BY | TO

0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9
0	0	0	0	0	0	0	0	0	P	CCB
1	1	1	1	1	1	1	1	1	S	ADC
2	2	2	2	2	2	2	2	2	I	ALM
3	3	3	3	3	3	3	3	3	C	PC
4	4	4	4	4	4	4	4	4	LOC	FXT
5	5	5	5	5	5	5	5	5	4U	HCC
6	6	6	6	6	6	6	6	6	A	NTP
7	7	7	7	7	7	7	7	7	B	FF
8	8	8	8	8	8	8	8	6	C	CC
9	9	9	9	9	9	9	9	9	IR	XFC
AD	CO	E	NL	NR	NT	NU	WN	OO	MC	R
9	18	27	36	45	0	1	2	3	6	TPP

REMARKS

TT 270 Dataset Limited 30-1322

With the present call ticket prepared by exchange operators (left) only a limited amount of recorded information can be "read" by machine. On the new inland ticket (right) the two blocks of numbers are marked by the operator to indicate the number of the caller and the destination. The initials indicate various facilities, for example FXT for fixed time call and ADC for advice of duration and charge.

Card tickets they will be stored for seven days to allow for production of billing tapes before being destroyed. Initially, Credit Card tickets will be kept for seven months as an aid in fraud cases. Currently all tickets have to be returned to Telephone Areas and stored for record purposes.

Magnetic tapes produced by the ticket readers will be sent each day to the Post Office computer centre at Bristol. Here an ICL System 4-70 computer will price and sort the individual calls for daily output on a series of magnetic tapes for the telephone billing system.

Another output from the computer processing will be microfilm records of call information. These records will be produced each month and sent to Telephone Area accounts staff for use in dealing with customers' enquiries.

The records are produced on microfiche – a piece of postcard size microfilm – and contain details of all chargeable calls made through the operator, listed in telephone number order. A single microfiche consists of 69 separate images, each of which can contain details of up to 64 individual calls. Each microfiche will therefore replace about 4,000 tickets.

To enable accounts staff to read information on microfiche, reading equipment will be supplied which presents a single, magnified image on a screen. Apart from taking up far less storage space than tickets, the microfiche will provide much quicker retrieval of information for answering post-billing enquiries.

It is often necessary for records to be circulated outside accounts groups when further investigation of an enquiry is required. With the ISOCC system printers will be available in every Telephone Area for producing enlarged, printed copies of individual microfiche images. These copies can then be circulated while the original record of charges remains safely filed.

The main aim of ISOCC is to replace the older, outdated method of preparing data for telephone bills with a quicker, more efficient system. An important design aspect of the new system is that it will also cater for proposed developments in advanced cordless switchboards which can be operated remotely from exchanges. With this type of switchboard operators will be able to key call information directly on to magnetic tape for processing by computer.

Mr F. Faulks is a member of the operator services group in Service Department at Telecommunications Headquarters. He is responsible for co-ordinating the ISOCC project from the service point of view.

History in the Half Moon

PJ Povey

HAVE YOU EVER seen a Chinese telephone dial, an operator's bib, or a wooden bell-gong? All these things and many more can be seen at the Post Office Telecommunications Museum in Taunton. But the museum is not just a collection of curiosities, interesting as these are. When I started the museum my objective was to assemble a collection of exhibits which would illustrate the evolution of telecommunications in all its many facets. Today, 16 years and one thousand and one headaches later, the museum has grown into the largest of its kind in the provinces.

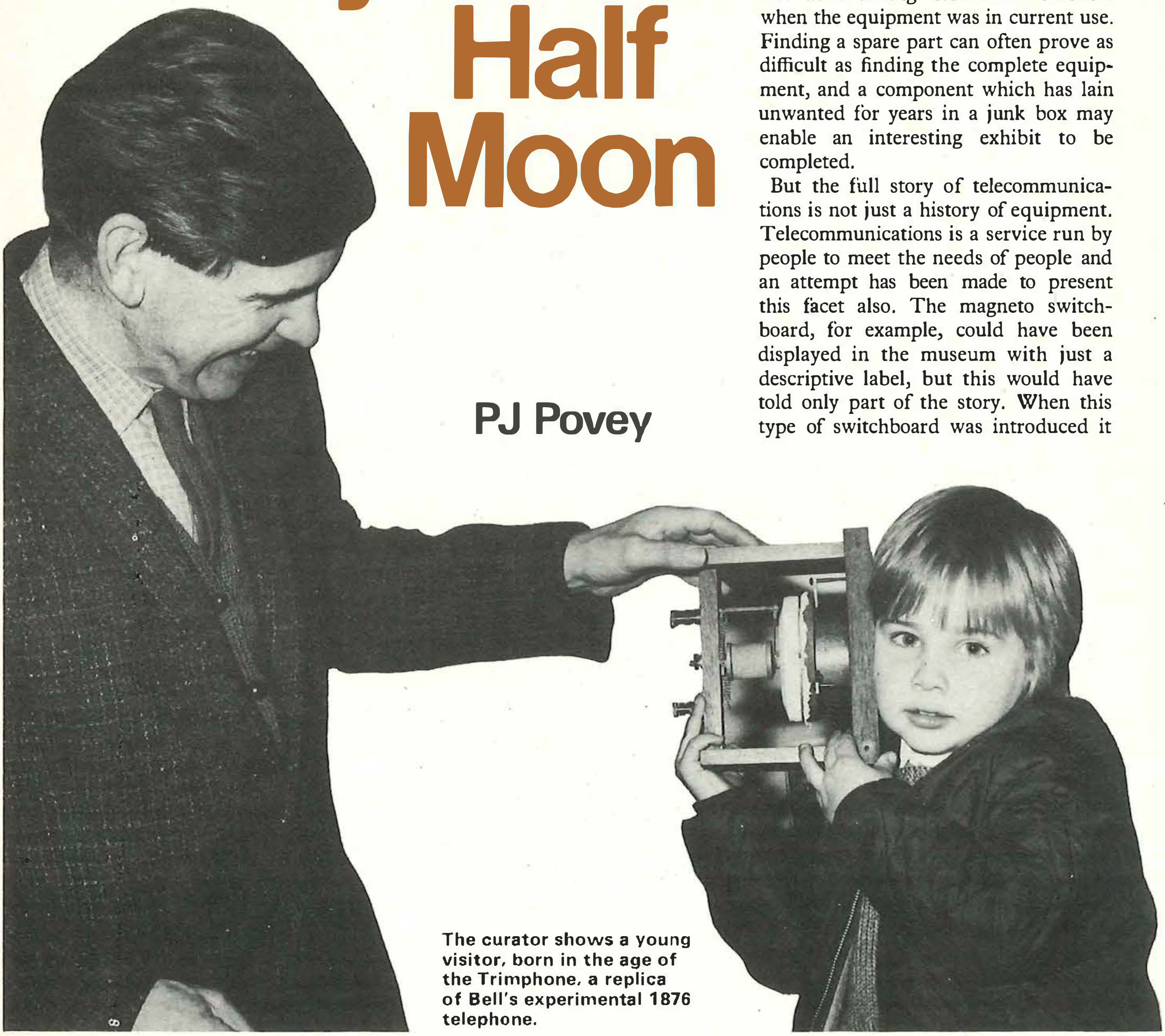
There is an original Bell telephone of 1877 and a replica of Bell's famous "gallows" receiver of 1876. Telegraph equipment dates from 1876 while in the submarine cable section a piece of the first transatlantic cable of 1858 rubs shoulders with a piece of the 1961 CANTAT I. Each of these cables represents a major breakthrough in cable design. Automatic switching is well represented with equipment dating back to Britain's first automatic exchange installed at Epsom in 1912. The section devoted to radio contains one of the giant water-cooled valves used for the first transatlantic telephone circuits of 1927. There is also a piece of the world's first television cable of 1937, and a line amplifier which was used with Britain's first coaxial cable laid between London and Birmingham in 1936.

But not all the exhibits are the first of their kind. A museum intended to show the evolution of telecommunications equipment must include some not so old items and even examples of comparatively modern equipment to help tell the story in full.

One point in favour of this equipment of intermediate age is that it can sometimes be displayed as a working exhibit. For instance, there is a complete working UAX5 telephone exchange originally installed in Zelah, Cornwall, in 1929. Two typical telephone installations of the same period have been wired to it and it is possible to observe the progress of a call through the exchange. There is also a working magneto switchboard of 1900, a teleprinter of 1929 and several smaller pieces of equipment.

Although we are anxious to display equipment which is actually working, the first priority is to retain authenticity. For example, modern parts are not fitted inside an old telephone. Renovation is limited to the type of work which was done during normal maintenance when the equipment was in current use. Finding a spare part can often prove as difficult as finding the complete equipment, and a component which has lain unwanted for years in a junk box may enable an interesting exhibit to be completed.

But the full story of telecommunications is not just a history of equipment. Telecommunications is a service run by people to meet the needs of people and an attempt has been made to present this facet also. The magneto switchboard, for example, could have been displayed in the museum with just a descriptive label, but this would have told only part of the story. When this type of switchboard was introduced it



The curator shows a young visitor, born in the age of the Trimphone, a replica of Bell's experimental 1876 telephone.

The "Chinese" telephone dial – it turned up in Yeovil.

Calls can be dialled to this UAX 5, a complete 25-line automatic exchange of 1929, from typical installations of the period seen on the right.

was often used in small towns and villages, installed in the living room or parlour of private houses. The switchboard was operated by the housewife or by one of the family. To help visitors to visualise this domestic setting the magneto switchboard is displayed in a reconstruction of one of these early exchanges. Visitors can peep in through a cottage doorway and see the switchboard with all its accessories, such as night bell switches, in Edwardian surroundings. On special occasions an operator in the costume of the period sits and chats to visitors through the doorway, and answers calls made by the visitors from telephones of the period in the museum. Photographs of old exchanges help to complete the picture. In the larger exchanges discipline was very strict. Operators were expected to dress in what was then considered to be a lady-like manner. This meant a black dress or a black skirt and a white blouse. No jewellery was permitted as this might rub against the operator's headset causing a noise which might annoy the subscribers. To prevent the metal of the headset from soiling their white blouses, operators were issued with a bib. They were responsible for laundering this, and the neckband of their headsets. One of these bibs is on display in the museum.

The museum is in a building which was originally part of a seventeenth century Inn called The Half Moon. It is open to the public most Saturday afternoons and at other times by appointment. The interest which is shown by the public in the museum has proved to be beyond all expectations. I think there are two reasons for this interest. People are becoming increasingly affected by telecommunications in their daily lives and want to know more about it; at the same time, stimulated by television programmes, there is a great upsurge of interest in the Victorian and Edwardian eras. The Telecommunications Museum satisfies both these needs. In addition many school children are doing projects on Post Office Telecommunications and the museum is often visited by school parties. This is a particularly valuable service for children who are too young to visit the telephone exchange.

The parent of one of these young visitors told me the children had been asked if they would like to visit a farm and see the animals, or the fire station. However, the children had their own ideas and wanted to visit the Telecommunications Museum. It appeared that an older class had visited the Museum previously and there had been so much talk in the playground about it that the younger children wanted to go too.

At the other end of the scale the serious student and the very knowledgeable visitor is also catered for. The exhibits are periodically changed, and when setting up new displays, items are selected from the considerable amount of equipment which is in storage to reflect current happenings in the world of telecommunications. For instance, the recent large-scale field trial of the Keyphone has focused attention on press-

A modern telephonist looks at the bib issued to protect the clothing of operators at the beginning of the century. She is holding a gas mask with a built-in headset issued to telephonists during World War Two.

Visitors can peep through this "doorway" to see a working magneto switchboard of 1900 in the setting of an Edwardian living room. These switchboards were often operated by housewives.

button dialling, and it seemed a good time to display an older form of this type of equipment. During 1929-30 a press-button unit was developed by a Mr Macadie of the Post Office Factory in Holloway, London. This unit came into general use in 1934, officially designated the Keysender No 5, but it became known as the "Macadie keysender." After some adjustments I was able to make one of these keysenders work, and connected to the UAX5 it is possible to compare the rate at which the buttons can be pressed with the response of the selector. The two-digit numbering scheme of the UAX5 does not give the Macadie keysender an opportunity to demonstrate its ability to store a large number of digits, so as an experiment I connected it to a line in Taunton exchange. It was most impressive to see its ability to cope with an STD call, particularly when it is remembered that the STD system was not even thought of when this equipment was invented.

The Macadie keysender illustrates the way in which the evolution of telecommunications equipment has sometimes taken an unexpected turn. The modern keyphone operates electronically and has in no way evolved from the Macadie's development which is a wholly mechanical device. But the work which went into the older equipment was by no means wasted. Lift the lid of a Macadie keysender and the mechanism, with its circle of sliding pins, will immediately appear familiar to anyone conversant with automatic exchange equipment, for it was from this that the impulse regenerator was later evolved.

The curator holds a CAT 10 water-cooled valve of the type used in the first transatlantic cable in 1927. These huge valves required 14 gallons of distilled water a minute for cooling purposes.

The Macadie keysender which came into general use in 1934.

It is especially pleasing to add items to the museum which have a West Country connection. There are several old local directories, the oldest issued in 1892 by the Western Counties and South Wales Telephone Company Limited, the forerunner of the National Telephone Company Limited. Much of the equipment shown spent its working life somewhere in the region. Even the Chinese telephone dial mentioned earlier can claim a tenuous connection with the West Country. It was originally manufactured in this country for export to either Singapore or Hong Kong, but was in fact fitted to a telephone which was included in a batch delivered to the Somerset town of Yeovil. As the label in the museum says: "This was an error as the people in Yeovil speak English."

Taunton is to have a new telephone exchange and space has been allocated in this building for the museum. The new museum accommodation will be designed for the purpose, and will be free from many of the limitations of the present building. One difficulty at the moment is that some of the larger exhibits cannot be brought into the building because of the size of the doorway. There is, for example, a Sullivan test desk complete with mirror galvanometer and precision test equipment which was recovered from Tavistock. Another exhibit is too big even for the new museum. This is a kiosk No 4, the largest type of kiosk ever used by the Post Office. As well as the normal telephone equipment it housed a post box and two stamp selling machines. Only fifty kiosks of this type were ever made, and the one which the museum now has was recovered from Newton Abbot in Devon where it was in use for forty years. It is proposed that this bulky exhibit should be erected in the forecourt of the new building.

A part of the museum which most visitors do not see is the collection of books and documents. Although hardly warranting the name "library" this collection is much appreciated by visitors wishing to delve more deeply into a particular aspect of telecommunications history. It is also invaluable to me for the identification of equipment, the preparation of captions, etc. Some of the more interesting documents in this section include correspondence about the cable laid by the Submarine Telegraph Company between Jersey and France, the earliest of which is dated 1870.

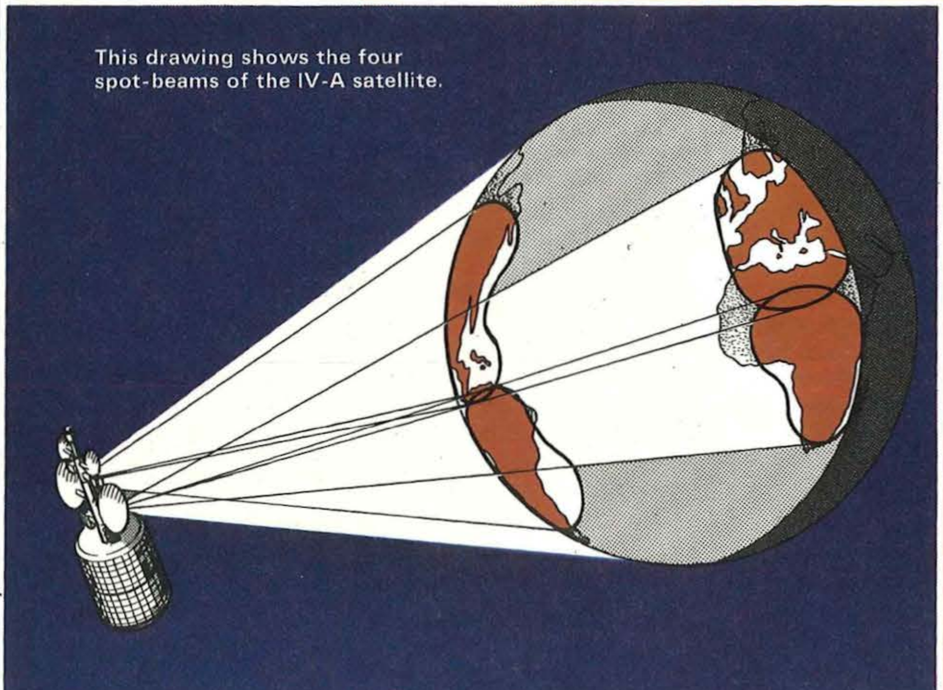
These books and documents help me to solve many mysteries, but not all. The museum was recently presented with a wooden bell-gong. It was found in a telephone and had been accurately turned in maple wood to exactly the size and shape of the gong fitted to the bell No 1A used by the Post Office. Searching through old rate-books and catalogues has so far failed to give me a lead, and I would be pleased to hear from anyone who can help.

Mr P. J. Povey is curator of the museum which he started in 1957. He is a Technical Officer in Taunton telephone area.

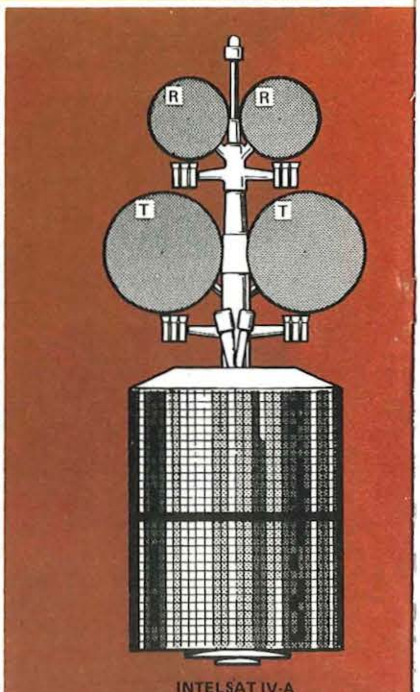
Taunton telephone museum is in Half Moon Lane next to the Head Post Office. Visitors to the West Country who would like to visit the museum can telephone Taunton 3391 for an appointment.

This telephone was designed by L. M. Ericsson in 1895. It set a new trend in design, being the first to have a handset.

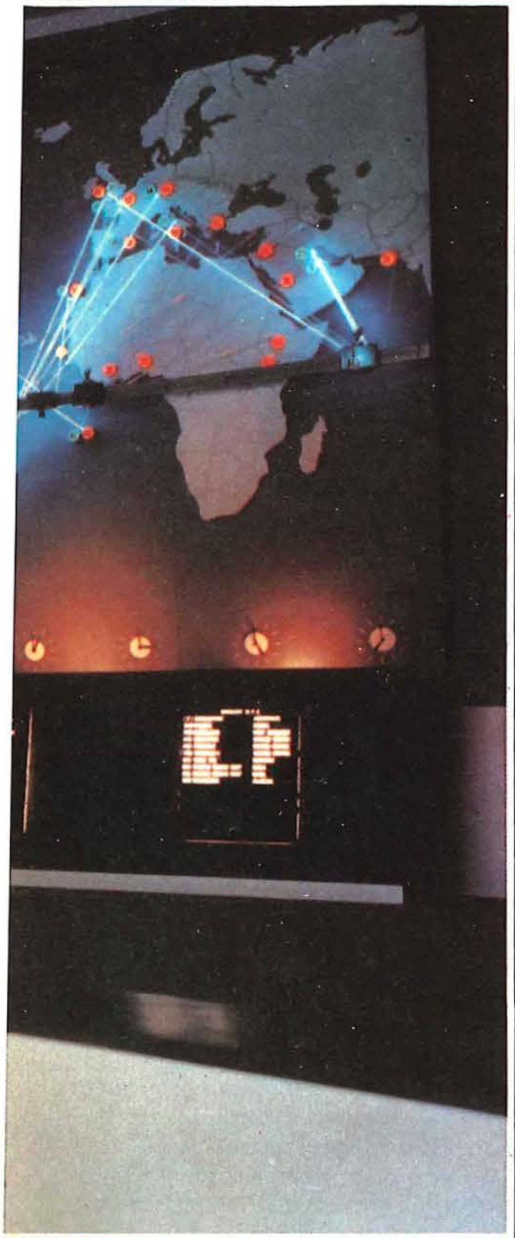
The operations centre in Washington, United States, where Intelsat earth station communication and satellite performance is monitored.



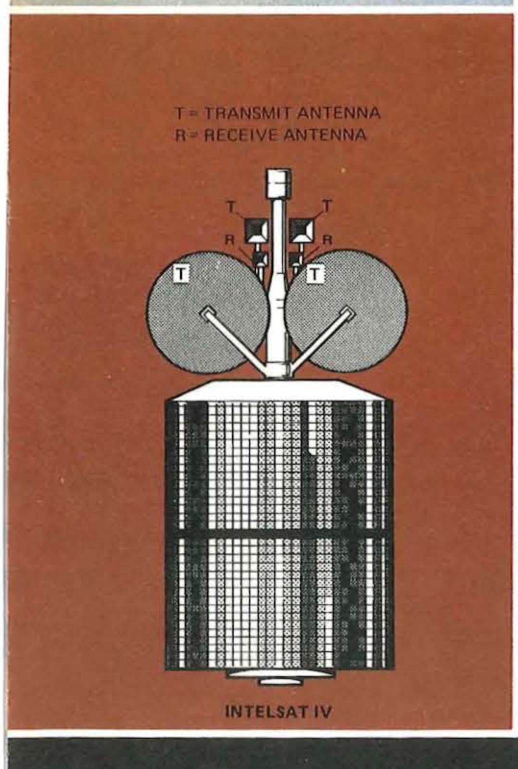
This drawing shows the four spot-beams of the IV-A satellite.



INTELSAT IV-A



A NEW MEMBER OF THE INTELSAT FAMILY



INTELSAT IV

A new communication satellite with a greatly increased capacity will be launched in 1975. It is a development of the present Intelsat IV satellite (and will be known as Intelsat IV-A) but design improvements have almost doubled the telephone circuits available at any one time. Intelsat IV-A will improve upon the spot-beam aerial system introduced by its "younger brother". These beams focus part of a satellite's capacity at selected areas of the world, rather like a stage spotlight. This provides a stronger signal, and thus more channel capacity, for those areas of the world with the heaviest telecommunications traffic.

There are two spot-beams on the Intelsat IV. The IV-A will be able to focus on four selected areas of the globe, with two beams from each of the two transmitting aerials which cover the eastern and western sectors of the globe.

The IV-A will also take advantage of the angular separation between the two transmitting aerials to allow greater use to be made of the limited number of radio frequencies allocated to a satellite. The new aerial and repeater system will make it possible for the same frequencies to be used for different signals sent simultaneously in both eastern and western directions. This double use of frequencies aimed at different parts of the globe is the main contributor to the increased capacity of the satellite.

The extension of effective frequency bandwidth can be achieved only by the addition of repeaters, and the number in IV-A has been increased to 20 (from 12 in IV) without exceeding the overall weight limits imposed on the satellite. This is the result of improvements in design and the use of lightweight materials.

Four of the repeaters will be used for the "global" coverage area of the satellite (about one third of the earth's surface) catering for the small number of earth stations not in the spot-beam areas, television transmission and other facilities. The remaining 16 repeaters will be used for spot-beam working, half operating to the land masses in the west and half to the east. For example, in the Atlantic region one group of repeaters can focus on North and South America and the other group on Europe and Africa. (See drawing.) A large measure of flexibility in the areas covered will be provided. Spot-beam repeaters in one group can be switched between the two different beams as traffic demands dictate.

The first Intelsat IV-A will be launched over the Atlantic in mid-1975 and will replace one of the present Intelsat IV satellites. A second will be launched a little later and, assuming all goes well with the first two, a third will act as a spare on the ground. The satellite will be nearly 21 ft long and 8 ft in diameter – only slightly larger than the present generation. The expected capacity of about 13,000 channels per satellite should cover the Atlantic traffic growth for about three years. It is planned that IV-A satellites will then be transferred to the Pacific region and replaced in the Atlantic by a completely new generation – the Intelsat V.

• The British Post Office is the second largest shareholder in the 83-nation International Telecommunications Satellite Organisation which owns the Intelsat global system.

Easing London's traffic jams

DM McIntyre

A large Post Office Telecommunications Centre is the main feature of an extensive development scheme in the City of London that will change the familiar waterfront of the River Thames. The multi-purpose Centre, highlighted in the artist's impression below, will help cater for the increasing flow of trunk telephone traffic into and out of central London. The building has been specially designed to avoid obstructing the view of St Paul's Cathedral. It will be flanked by a school and the new Mermaid Theatre.

THE HUGE number of trunk telephone calls to and from the London area are at present routed through 11 switching units located in central London. To provide relief for the units seven Sector Switching Centres (SSCs) are being established in the suburbs. These will route trunk calls, and some local traffic, to and from exchanges in their own sectors.

However, despite the progressive transfer of calls to the suburban SSCs, the volume of trunk traffic into and out of central London itself will still continue to increase. To cater in part for this growth a large multi-purpose Telecommunications Centre is being built in the City of London.

Most of the building will be occupied by trunk switching equipment. Five of the existing central trunk switching units handle outgoing traffic from London, and the other six deal with incoming calls. The new Centre will route traffic in both directions. It will also house a replacement exchange for London Toll "A" – a junction switching unit in the nearby Faraday telecommunications building which handles traffic from London 01- subscribers to Group Switching Centres in adjacent charge areas such as Dartford, Uxbridge and Watford.

A 10,000 line local automatic exchange in the Centre will provide relief for, and allow replacement of, older equipment at present located in Faraday building. Provision has also been made for the possible inclusion of a data switching exchange to handle computer-to-computer data transmission.

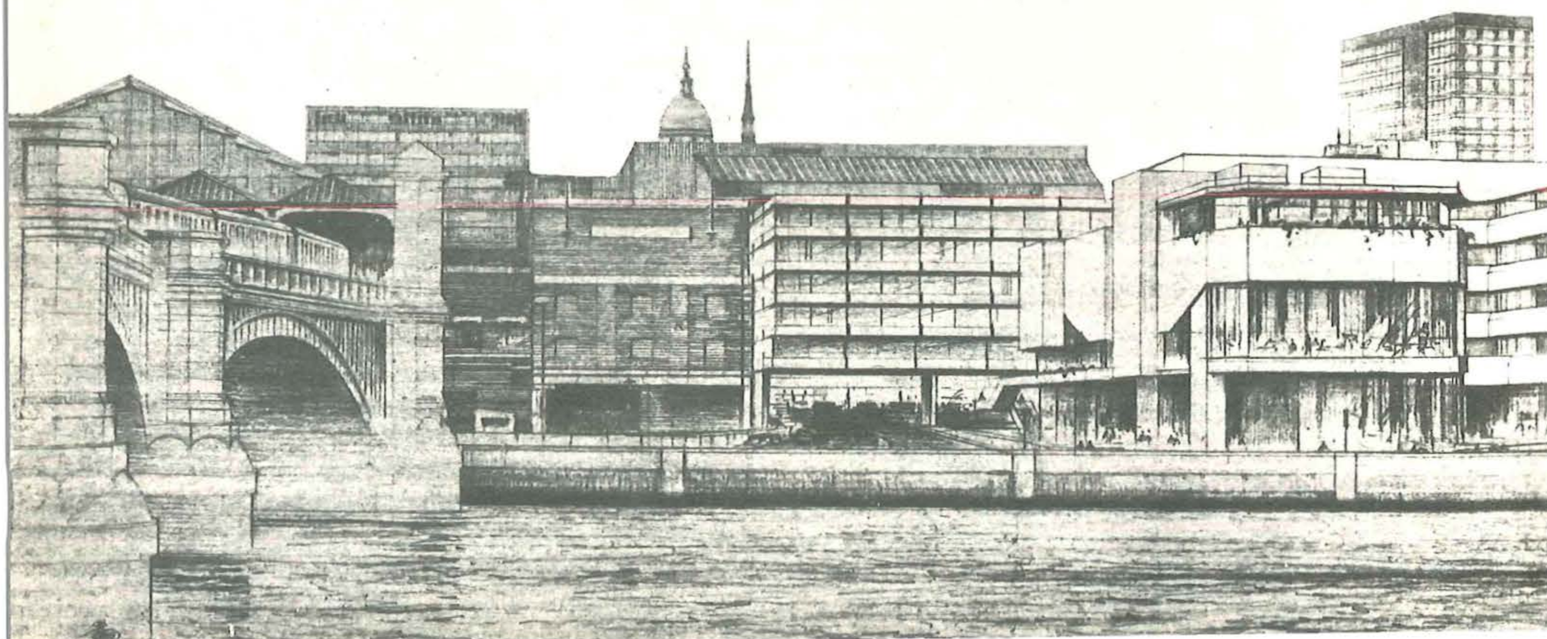
The Centre will have telephone switchrooms for operators to handle calls that customers are unable to dial for themselves and to give special services such as transfer charge and personal calls. These switchrooms are planned to be of a new cordless type, but in the longer term it might be economic to locate switchboards with remote working facilities away from central London. In this event the accommodation will be used for additional trunk switching equipment.

Among the reasons for decentralisation of trunk traffic from central London to the suburbs is the difficulty in obtaining suitable sites in the most congested part of the metropolis. In the square mile of the City of London itself the situation is at its worst.

In order to get a site near to the practical centre – the point at which external cabling costs can be kept to a minimum – it was necessary to accept a number of unusual conditions. This has called for great ingenuity by the architects in designing the building. Nevertheless the site is well placed and provides direct access, by means of a shaft from the building, to the extensive deep-level cable tunnel system which is an important feature of the London Telecommunications Region (LTR) cable network.

The site extends between the south side of the City's Queen Victoria Street (almost opposite the Faraday building) and the River Thames Embankment. Underneath the northern part of the Centre will be a City Corporation car park and the southern part will straddle a dual carriageway forming part of the City's Road Improvement Scheme.

A slip road from Queen Victoria Street will curve round the eastern and southern parts of the building. Further complicating the design, an elevated walkway will link the north side of Queen Victoria Street to a raised courtyard between two parts of the Centre's frontage and from there a subway through the building will connect with



a riverside walk being constructed along the Thames Embankment.

These complications were not of Post Office choosing but arose because the site forms part of a comprehensive development of the riverside for which the City of London had laid down overall planning requirements. The disadvantages and security problems created had to be accepted in order to obtain planning permission.

Another complication arose because St Paul's Cathedral lies just to the north of the site, and current planning regulations demand that its dome must be visible from the south side of the River Thames. Therefore a low profile building, stepped back from the river, had to be designed.

In a large telephone switching complex the apparatus generates considerable heat which must be removed from the building. The orthodox method for disposing of waste heat is by circulating water which is cooled in towers on the roof of the building. In this development the City Corporation refused to give permission for cooling towers to be sited on the roof, for environmental reasons, and also insisted that plumes of vapour from cooling towers must not obscure St Paul's Cathedral.

It will therefore be necessary to use water from the River Thames for cooling purposes. This will involve pumping water through a tunnel to cool the plant, then returning the heated water to the river. Bankside Power Station on the opposite side of the Thames is already disposing of waste heat in this way, and the Post Office scheme has involved a number of interested parties, including the Port of London Authority, the Central Electricity Generating Board and the Department of Trade and Industry. Tests have been carried out to ensure that the additional heat in the Thames will not cause thermal pollution and result in unwanted plant growth.

The whole building will be constructed for the Post Office by the Property Services Agency of the Department of the Environment, although the cost of the lower floors occupied by the public car park will be defrayed by the City of London. Having a public car park below the Centre has its own problems – fire prevention, security maintenance, and so forth – but certain Post Office services, such as the cable chamber and a standby power engine room, must also be on the lower floors.

A job as complicated as this development requires close liaison with other authorities and calls for strict planning of the whole construction programme. First, the part of the site breached by the dual carriageway has to be piled and concrete walls erected to form the sides of the road tunnels. The tunnel walls will be topped by a concrete "deck" to carry the Telecommunications Centre. This work is now in progress.

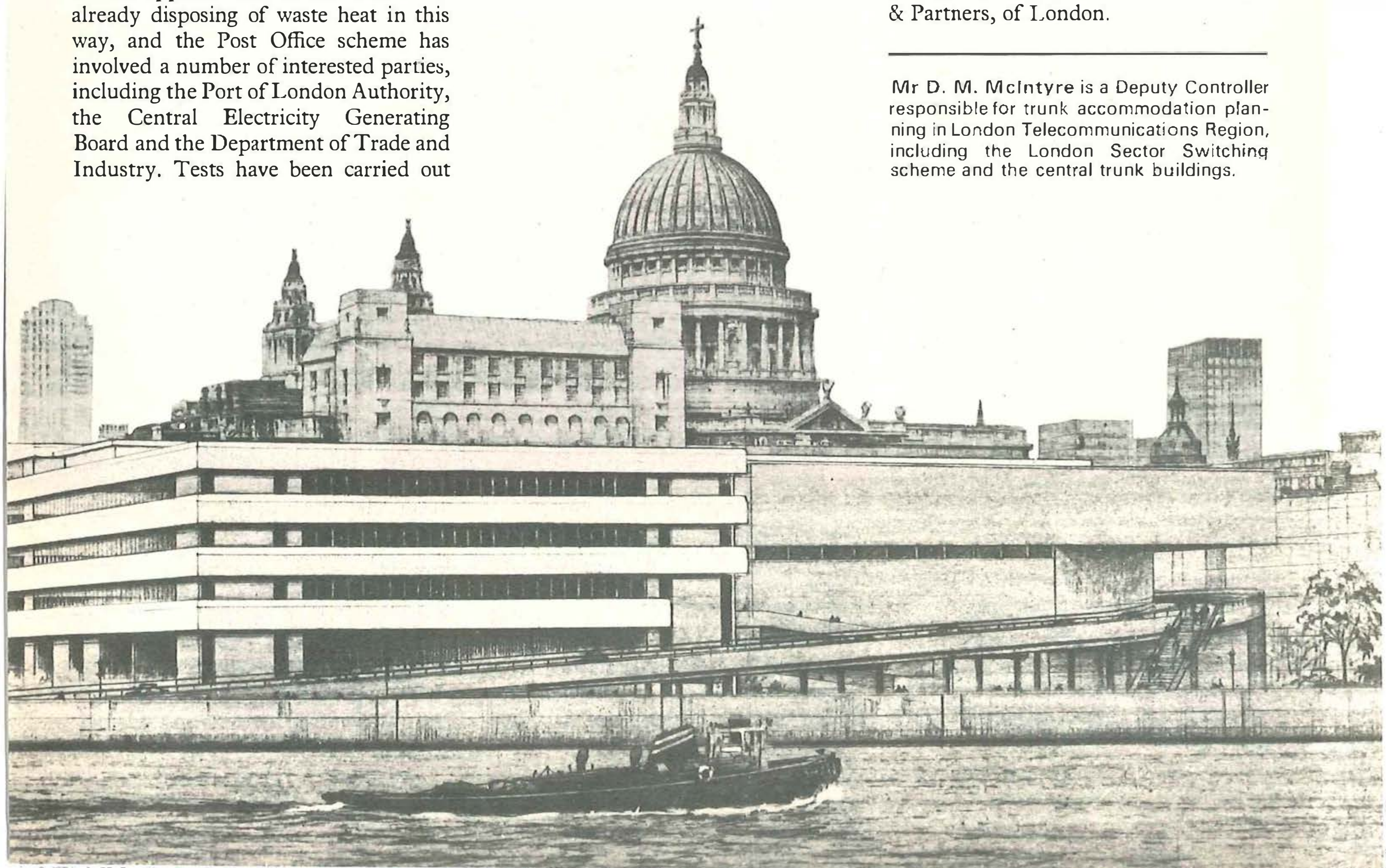
In March this year, following the completion of some work on the slip road round the east side of the building, Post Office contractors started to sink the shaft to connect with the LTR deep-level cable tunnel. City of London engineers and their contractors are working on the road system to the east of the site and the entire job is programmed to finish in March 1974, by which time the Post Office's contribution to the road tunnel system should be completed. Road traffic will then flow and construction of the building with an important highway running through the site will not be easy.

Meanwhile final planning of the building is in progress. It will provide a total of 54,000 square metres for the switching equipment, offices, stores and other facilities. The contract will be put out to tender with the object of starting the main building in March 1974 and forecast completion in the Autumn of 1977. As soon as the building is ready installation of equipment will begin. Since the building will be sitting on top of a public car park and a dual carriageway, air conditioning will be provided and windows will be sealed to keep out noise and fumes. Staff will have a particularly good view of the river from a restaurant sited on the roof top.

The new building is to be named Baynard House after a medieval castle which stood on the site in Tudor times. Henry I is said to have rebuilt part of the castle in 1487 and in so doing filled in the riverside dock with a great deal of material. Although then regarded as rubbish, this material has aroused the curiosity of archaeologists who have been researching on the site during the past year.

Design of the building is in the hands of the Property Services Agency of the Department of the Environment, Senior Architect P. W. Manning, and their nominated architects William Holford & Partners, of London.

Mr D. M. McIntyre is a Deputy Controller responsible for trunk accommodation planning in London Telecommunications Region, including the London Sector Switching scheme and the central trunk buildings.



Telecommunications in Japan

Continuing our series of articles on telecommunications abroad, the Japanese administration (NTT) describes the huge progress it has made in inland communication.

THE NIPPON Telegraph and Telephone Public Corporation (NTT) was incorporated in 1952 when it took over the operation of the telecommunication services in Japan which had been provided by the Japanese Government since 1869. It has a monopoly of domestic telecommunication services. Overseas services are operated by the Kokusai Denshin Denwa Company.

One of the purposes of the foundation of NTT was to establish a system for rational and efficient management of public telecommunications, and it was authorised to operate independently of government to a great extent. Its activities are supervised by the Minister of Posts and Telecommunications, however, and the annual budget, as well as the tariffs for its principal services, have to be approved by the Japanese Parliament, the Diet.

Starting in 1953, soon after its inauguration, NTT planned four successive Five-Year Expansion Programmes to attain two principal targets – eliminating the telephone waiting list and establishing a nation-wide STD system.

The first three of these programmes were successfully carried through and the number of subscriber lines almost doubled in each five-year period. At the end of the 1971 financial year the number of subscriber lines was more than 19 million, and nearly all subscribers had STD facilities.

NTT capital investment in 1971-72, at about 876,000 million yen (£1,090 million), put the Corporation at the head of the Japanese investment league table. Another 2.7 million subscriber lines and 114,000 junction and trunk telephone circuits were added during the year. Principal results of the expansion programme are shown in the table on these pages.

In spite of this rapid expansion, the demand for telephone services is still increasing and to cope with the problem NTT mapped out a Seven-Year Expansion Programme. (This included an expanded revision of the last two years of the fourth five-year Programme.)

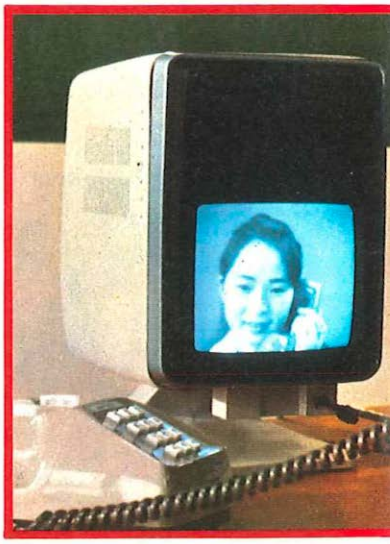
The fundamental aims of this programme are to abolish the waiting list for telephones by the end of the 1977 financial year and to promote further expansion and development of data processing networks and other new services.

Some 8,500,000 million yen (£10,600 million) will be spent to add 19.7 million subscriber lines, 3,500 automatic telephone offices, 740,000 trunk and junction telephone circuits and 210 data communications systems. At the end of the 1977 financial year there will

NTT EXPANSION PROGRAMME

(1971 Financial Year)

	Number added during the year (thousands)	Total at the end of the year (thousands)
Subscriber lines	2,690	19,093
Public telephones	54	504
Telephone sets	3,380	26,393
Trunk and junction telephone circuits	114	807
Telex subscriber lines	14	59
Leased circuits	24	227



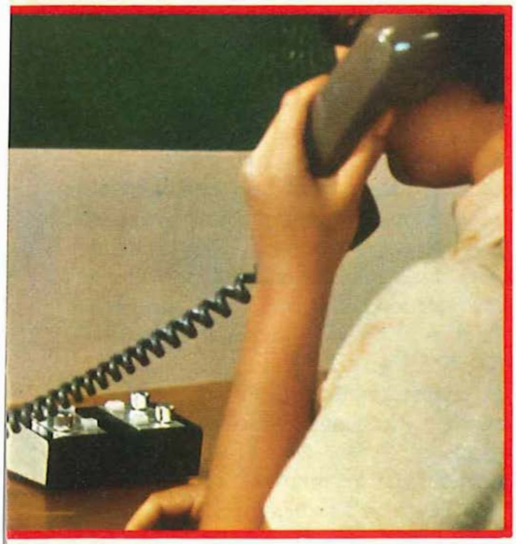
be about 34·8 million subscriber lines.

In 1971, the Diet passed an amendment to the Public Telecommunications Law which sets out the conditions, quality and principal charges of the various services provided by NTT. One important effect of the amendment is to simplify the system of telephone call charges into a single-rate structure.

Under the old system "local" calls were at a fixed rate (7 yen) and were untimed. The area covered by a local call varied considerably and could be as small as three kilometres across or as large as the Tokyo local service area, 30 km in diameter. Subscribers in the smaller areas had to pay trunk rates for what would have been untimed local

Public telephones of this type have been installed in front of shops, and inside department stores and hotels in increasing numbers. "Shop-front" telephones now account for more than 80 per cent of all public telephones in Japan.

A "Video Telephone" on trial at the NTT Headquarters where a large-capacity electronic exchange is installed.



calls in the larger areas. Under the new system the areas within which calls can be made for the minimum rate have generally been enlarged to an average of 30 km in diameter, and their number has been reduced from 5,000 to 562. Every call is now timed and the charge depends both on duration and distance.

Another major provision of the amended law is to establish data communication and processing as the Corporation's third service, following the telegraph and telephone services. It also authorises private use of the public telecommunications network by customers making use of the new service, either as a complete system or in conjunction with their own computer.

Research and development have contributed greatly to the remarkable growth of NTT. The introduction of a common control crossbar switching system has produced great improvements in STD switching performance, speech quality and reliability. More services can be offered and maintenance is easier. Almost all the trunk switching systems and about two-thirds of the local systems use crossbar switches. The rest of the local systems use step-by-step switches. Using the crossbar switching system, such diversified services as push-button telephones, variable abbreviated dialling and call queueing have been introduced.

NTT research on electronic switching systems was started in 1954 by the Electrical Communications Laboratory (ECL). After various trials and intensive investigation the DEX-2, a stored-program control system with miniaturised crossbar switches in the speech path, was developed in 1967.

The system was field-tested satisfactorily in Tokyo from 1967 to 1972. Based on experience of the DEX-2, a large-capacity standard commercial system (D-10) was brought into service at seven offices, including two trunk exchanges, in 1972. Two kinds of small capacity electronic switching systems are being developed, one using remote control techniques.

Electronic switching will play an important part in the total telecommunications network, which is expected to provide economically new telephone services, data communications and video transmission as well as conventional telephone services. Video telephones are now on trial at the NTT head office where a large-capacity D-10 electronic exchange has been installed.

In the transmission field, at present 12 MHz systems on 9.5mm coaxial cables and 4 GHz and 6 GHz microwave systems are used for long-distance trunk lines all over the country; 4 MHz systems using 4.4mm coaxial cables and 11 GHz microwave systems are widely used for spur routes.

For short-distance trunk lines, PCM-24-channel systems which can be used with existing trunk cables have been introduced since 1965. The systems are also applied to the local trunk lines in the big cities. At present, there are nearly 7,000 systems in use.

In 1970 field testing started of a 60 MHz, 10,800-channel system using 9.5mm coaxial cables. A large capacity coaxial cable system, which will have a capacity more than three times as big is under study. A 2,700-channel, single cable submarine coaxial carrier system was laid between the mainland and Shikoku Island in 1971.

A new digital multiplex transmission system for future video and data communication, using 9.5mm coaxial cable (bit rate: 100 Mbit/s; capacity: 1,440 telephone channels, nine 1 MHz TV channels or three 4 MHz TV channels) will have commercial tests this year.

Also on field test is a digital radio relay system, using the 20 GHz band (bit rate: 400 Mbit/s; capacity: 5,760 telephone channels or 36 1 MHz TV channels).

An experimental millimetric waveguide line, 20 km long, was recently installed and a system using the 40-80 GHz band (capacity: about 300,000 telephone channels or about 2,500 1 MHz TV channels) is now under intensive research. Commercial use is planned for about 1975.

Research and development work on a domestic satellite communication system is being carried out with the aim of having it in commercial use in the late 1970s.

Data communication is also developing rapidly. By March last year 15 NTT-developed data processing networks were in operation. (NTT supplied data processing networks for the Osaka Expo' 70 and the Sapporo Olympics.)

Access to seven of the 15 installed systems is through existing switching networks to computers. These seven give three different services: sales and inventory management, scientific and engineering calculation and telephone calculation. For the first two, standardised 100 bit/s and 200 bit/s data terminal equipments are used. For the telephone calculation system the push-button telephone is used.

Modems used for data communications circuits include 200 bit/s modems on 3,300 circuits; 1,200 bit/s modems on 3,200 circuits and 2,400 bit/s modems on 170 circuits. Under development are 4,800 bit/s and 9,600 bit/s modems used with voice channels.

Wideband data transmission systems, using 48 kbit/s and 240 kbit/s are also being developed.

This year a new large-scale computer system is to be tested commercially after six years of research by the Electrical Communications Laboratory.

Group switching goes crossbar

AL Perkins

Left: The old manual exchange at Brentwood. To meet growing demand for service the original building (on the left of the picture) was extended into the house alongside. Right: The new Group Switching Centre which has equipment designed to serve 18,500 lines.

BRITAIN'S LARGEST remaining manually operated telephone exchange – at Brentwood, Essex – closes down this summer. Its 14,500 customers' lines will be transferred to a new £3 million automatic exchange in the town, equipped with a modern crossbar switching system known as TXK1.

The new exchange is a Group Switching Centre (GSC) for Brentwood and 11 other local exchanges. It is one of about 350 GSCs serving Britain's 6,000 local telephone exchanges, their main task being to switch trunk calls between groups of these exchanges and the rest of the telephone network. They also switch calls between the local exchanges under their control and in many cases, as at Brentwood, function as a local exchange for customers in the immediate area.

Brentwood's TXK1 switching equipment was the first ordered under a programme, started in 1967, to modernise and expand the GSC network using the crossbar system. To date orders have been placed for 63 TXK1 GSCs and the first of these was opened at Dover earlier this year. Brentwood and others already ordered are being brought into service over the next three years.

Further TXK1 orders for GSCs are planned during the next four years. These will equip another 26 new GSCs – to be brought into service during the period 1976–1980 – and provide extensions at existing centres to meet requirements into the 1980s. TXK1 crossbar systems are also being used in some local exchanges and for seven Sector Switching Centres being established in the London area to reduce the flow of telephone traffic in and out of the heart of the capital.

Most of the TXK1 GSCs will provide automatic working and Subscriber Trunk Dialling (STD) facilities in areas that at present have to rely entirely on operator controlled switchboards. Others will replace Strowger automatic equipment where space is needed to expand the local exchange, and some will work alongside existing equipment of this type to meet increased demand for service.

Strowger and crossbar are both electromechanical switching systems, but crossbar offers a number of operational and maintenance advantages.

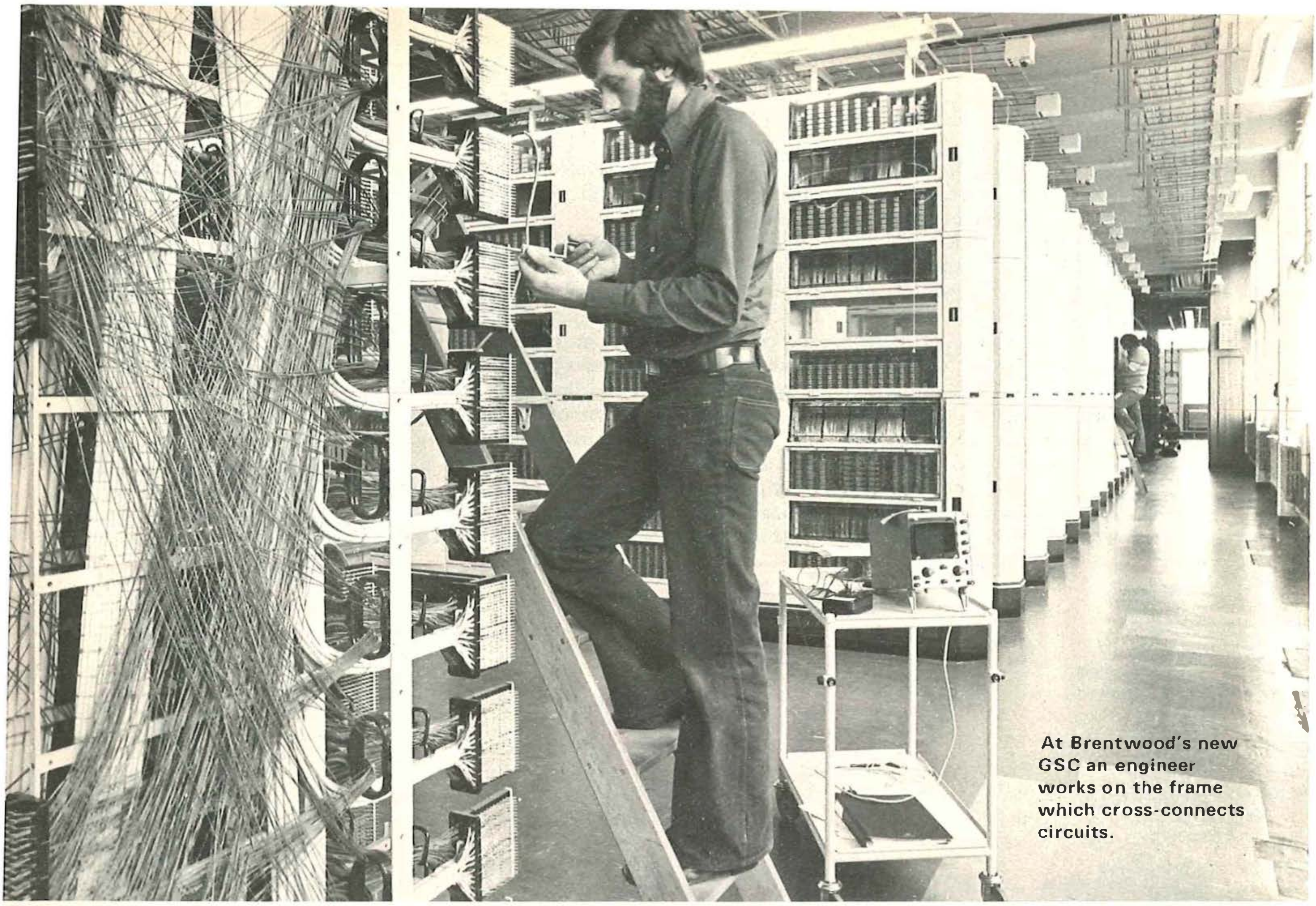
In a Strowger exchange a call is set up by a step-by-step system in which the switching equipment responds directly to impulses generated by each digit dialled by the caller. With this system all the exchange equipment is held for the duration of the call.

With a crossbar exchange a call is fed into common control equipment. This stores the dialled information until sufficient data has been received to process the call. If for any reason the call cannot be set up on the first chosen switching path through the exchange the equipment makes a second attempt through a different path without the caller needing to re-dial. As soon as a call is established the common control equipment is released and can be used for another call.

Crossbar switches are usually less prone to faults than Strowger types, and there is less wear and tear owing to their relative freedom from moving parts. Less maintenance effort is therefore needed on crossbar equipment, which is also much quieter in operation than Strowger.

A teleprinter unit is provided in each crossbar exchange which prints out details of faults. As a further aid to maintenance a computer program has been developed to analyse the information on this print out.

The crossbar system is also more compatible with developments in electronic control of switching. The seven TXK1 Sector Switching Centres being established in the London area, for example, will be controlled by a form of electronic Stored Program Control similar to that now being used to replace director equipment in some local



At Brentwood's new GSC an engineer works on the frame which cross-connects circuits.

exchanges (see "The Electronic Director", Spring 1973 issue).

The TXK1 crossbar equipment coming into use at Brentwood will solve long-standing problems faced in providing both local and GSC facilities. The exchange is in the centre of a fast growing locality of both industrial and residential development. Two out of every three homes have one or more telephones, and some 800 customers' lines are added to the local system each year. Since 1932 its telephone exchange has been successively extended to meet the growing demands, and today some 400 day and night staff are engaged in operating the local telephone service.

As early as 1964 it became clear that there would be difficulties in providing an automatic exchange to replace the manual system which was rapidly approaching exhaustion. Site negotiations had broken down and a fresh search for suitable land was meeting with little success. There was no alternative but to erect a two-storey prefabricated building on the existing site and install a relief manual exchange to serve a further 5,000 customers.

Meanwhile a transportable automatic exchange (MTX) became available and this provided the means for subscriber dialled calls to be switched between local automatic exchanges without operator assistance. The success of this arrangement can be measured by the volume of such traffic which has progressively increased since the MTX was installed in 1967 to a total of some 2,500 calls per hour.

Use of the MTX also created spare capacity in the Brentwood exchange which not only improved service to existing customers but provided service to others who would have had to join the waiting list.

As a GSC Brentwood also had the function of connecting trunk calls to and from subscribers on its own exchange and six other exchanges. By 1970 uncertainty arising from design problems with the new exchange and a rapidly rising volume of trunk traffic caused further concern.

A traffic study concluded that additional relief to the manual exchange was essential and spare capacity at the adjoining Chelmsford and Basildon GSCs was brought into use by providing special equipment and rearranging the trunk cables to by-pass Brentwood. This gave the six dependent exchanges direct access to the Chelmsford and Basildon GSCs, and provided STD for some 13,000 subscribers on these exchanges at a much earlier date than normal planning would have achieved.

Against this background of expedient relief measures a six-storey building for the new exchange had risen to dominate the skyline around Brentwood. Although built originally to house a traditional Strowger-type exchange the building was found to be satisfactory for the TXK1 crossbar system and a contract was placed in 1967.

The equipment installed is designed to serve 18,500 lines and has a capacity to switch up to 35,000 calls per hour. The exchange has its own electricity sub-station and power plant, and is also equipped with a standby generator.

Crossbar switching equipment, signalling relay racks and repeater station take up three of the building's six floors. The new switchroom of 46 cordless type switchboards and 12 Directory Enquiry positions is located immediately below the top floor which is devoted entirely to office and welfare requirements.

The exchange equipment consists basically of three sections – distributors, routers and common control equipment.

The main function of a distributor is to provide access between the exchange equipment and the customers' lines. It consists of an assembly of crossbar switches and can deal with calls to and from a block of up to 500 lines. A router is also an assembly of crossbar switches, whose purpose is primarily to provide interconnection between the distributors and other exchanges.

The common control equipment comprises register-senders, router controls, coders and markers. All calls are fed into this equipment, which has the ability to distinguish between various types, such as own-exchange and outgoing junction. When a caller has completed dialling the control equipment checks whether the called subscriber's line or outgoing junction is available before setting up the call.

When a subscriber picks up his telephone he is connected through a distributor and transmission relay group to a register-sender. Dialling tone is then received. As a number is dialled the information passes into the register-sender where it is stored. The register-sender calls in a router control to determine whether the call leaves the exchange.

With a call to a number on the same exchange the number is then tested via the marker to see whether the line is free, busy or faulty. If either of the last two conditions is met the engaged or number unobtainable tone is transmitted to the caller. Where the line is free a router control sets up the call through the exchange using router and distributor switches.

If the call is prevented from going through in its normal sequence – for example, owing to a faulty switch – another router control takes over, unknown to the caller, and attempts to set up the call through different switches. After successful switching the caller will hear ringing tone.

On a call to another exchange a coder tells the router control which route to take and which sender to use. The router control signals back to the register-sender to set up a path through the exchange. The sender then transmits to another exchange the signals necessary to establish the call.

Mr A. L. Perkins is head of the Operational Planning Division in Southend-on-Sea Telephone Area with responsibilities for the traffic design of the new Brentwood exchange.

EASTERN
Brentwood
Abingdon
Braintree
Saffron Walden
Attleborough
Banbury
Bletchley
Ware

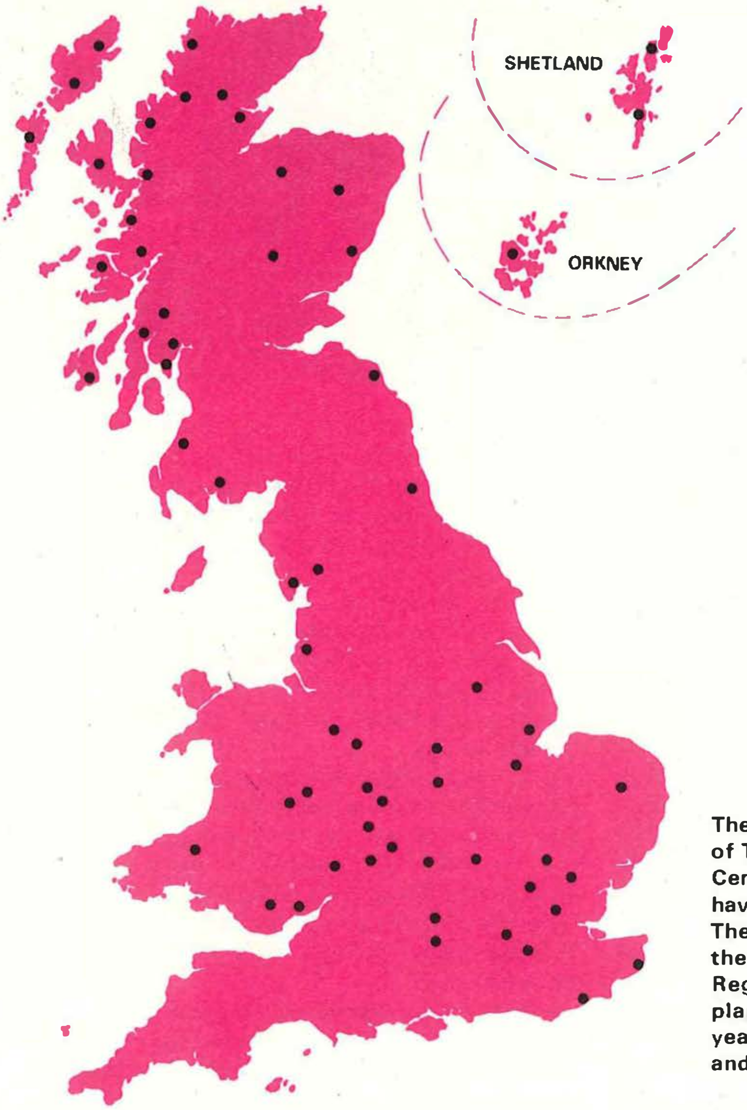
LONDON
Redhill
Staines

MIDLAND
Boston
Leicester
Spalding
Nottingham
Redditch
Crewe
Stafford
Stoke
Kidderminster
Wolverhampton
Worcester

NORTH EASTERN
Berwick on Tweed
Gainsborough
Newcastle

NORTH WESTERN
Barrow-in-Furness
Kendal
Southport

WALES & THE MARCHES
Newtown
Bryn Teifi
Welshpool
Newport
Hereford
Pontypridd



SCOTLAND
Kirkwall
Lochgilphead
Rothesay
Dunoon
Gairloch
Pitlochry
Montrose
Alford
Kyle
Newton Stewart
Port Ellen
Tobermory
Stornoway
Benbecula
Scourie
Strontian
Ullapool
Lerwick
Mid Yell
Lairg
Mallaig
Tain
Girvan
Harris
Grantown-on-Spey
Inverary
Portree

SOUTH EASTERN
Dover
Newbury
Hastings

The map shows the location of TXK1 Group Switching Centres for which orders have been placed to date. They are listed here under their Telecommunications Regions. Further orders planned during the next four years will equip 26 new GSCs and provide extensions.

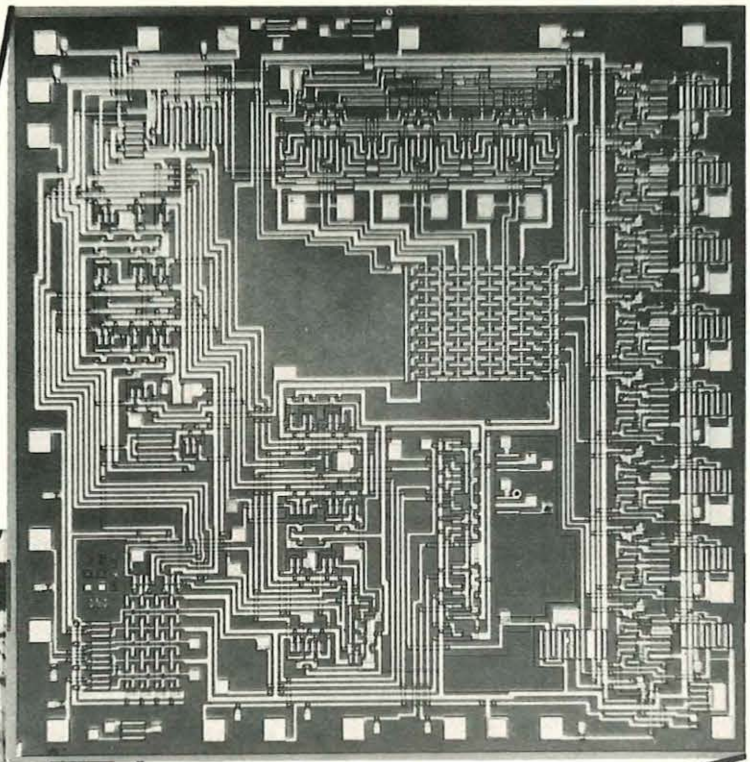
As part of its plans for modernising and expanding the telephone network the Post Office is making use of crossbar switching systems in local, trunk and international exchanges. Variations of one type – TXK1 – are being used for Group Switching Centres, medium-sized local exchanges and for Sector Switching Centres.

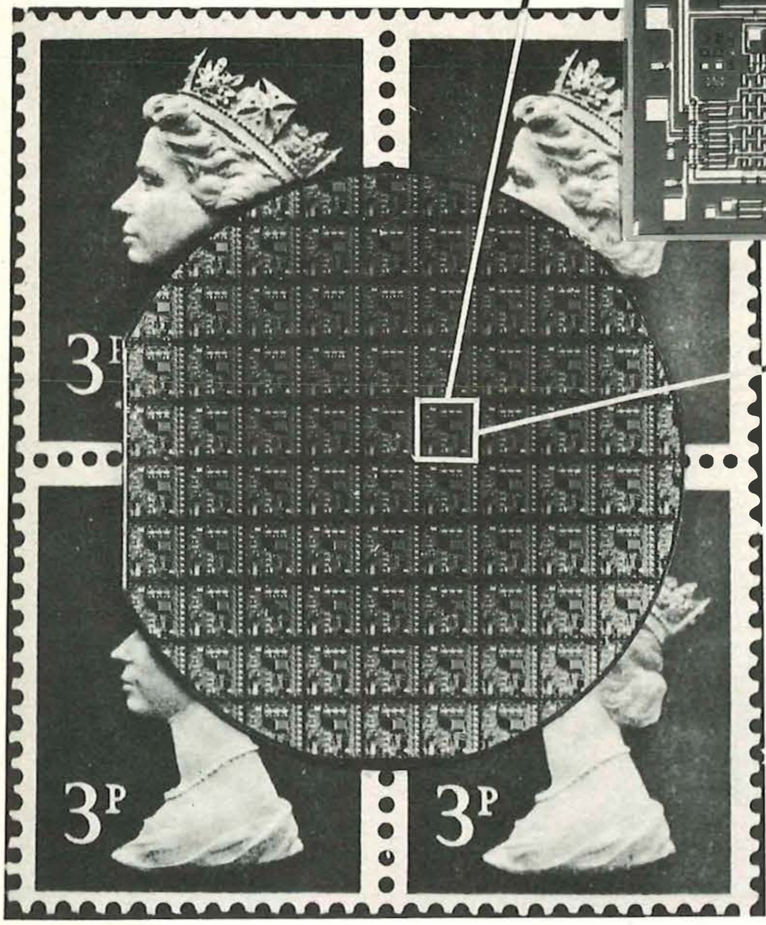
TXK2 equipment has been adopted for international switching centres, and TXK3 is generally for larger local exchanges and those which have very high calling rates. The TXK4 system is being used for Transit Switching Centres.

All the systems use crossbar switches, but their size, design and method of operation differs. This results largely from differences in control and trunking design and the varying facilities required by each type of exchange. For example, the TXK4 type is simpler than TXK2 where facilities have to be provided for charging some calls and for handling different signalling systems in the international services.

Another important difference between the systems is the number of wires used in transmission. The TXK1 and TXK3 exchanges use a two-wire method, the same pair of wires being used for both transmit and receive, whereas the other two systems employ separate pairs of wires to provide a satisfactory standard of transmission over long distances.

The magnification shows one of the tiny MOS "chips" which form the slice resting on the block of stamps. MOS technology currently allows up to 24,000 transistors to be packed into a "chip". The circuits shown with this article were designed and manufactured in the Post Office Research Department.





Electronic circuit techniques

JB Millar

AS THE TELEPHONE system has evolved it has become increasingly technology based. This has been dictated largely by economic considerations which reflect the steady rise in labour costs over the years. The communications industry shares with other industries, such as aerospace and computers, the need for cheaper and more reliable components and systems and, as a consequence, is able to benefit from developments in those fields as well as making its own contribution.

Continued research and development in the electronics field has made available to designers of electronic equipment a wide variety of circuit techniques. These range from the use of discrete components to the application of photographic and chemical diffusion processes to produce micro-miniaturised circuits.

The trend is towards smaller components and equipments. Apart from the obvious space and weight saving, small size offers greater reliability because smaller masses are less affected by shock and vibration forces and also because the large scale of integration that is possible greatly reduces the number of soldered or wrapped joints in an equipment. This results in an improved quality of service while at the same time reducing the demand for maintenance staff.

The following paragraphs outline the techniques available and where possible an indication has been given of the timescale of their adoption for general circuit applications. So far as established techniques are concerned availability of components, for example valves, for maintenance purposes has an important influence on the life of the technology.

Discrete components

Where possible miniature versions of relays and other components are employed. Some mechanical devices such as relays have electronic equivalents. The replacement of valves by transistors and the adoption of modern display devices, solid state memories and switching matrices all lead to improved reliability and smaller size. Computer-aided-design techniques can be applied to printed circuit board layouts and as a consequence modern equipments, using discrete components, can give a space saving of over 50 per cent compared with earlier conventional circuitry.

Bipolar integrated circuits

The transistor is a bipolar device, so called because its action depends on the characteristics of the junction between p- and n-type semiconductor materials. Integrated circuits are produced by forming on a common substrate of, say, p-type material a variety of circuit elements suitably interconnected by a metallization layer. Thus by a process of deposition, etching and diffusion circuits consisting of resistors, capacitors, diodes and transistors can be produced. The substrate and hence the finished monolithic "chip" are less than 0.5 cm square. The bipolar nature of the transistor requires that circuit elements usually have to be isolated from the substrate. As a consequence some 130 process steps are required and the number of elements that can be accommodated on a chip is limited to about 1,000.

In recent years a wide range of standard integrated circuits has been developed which can be classified according to the type of circuitry used to form the elemental gate circuit employed. These include resistor-transistor (RTL), diode transistor (DTL) and transistor-transistor (TTL) logic. In addition a range of linear integrated circuits is readily available which includes amplifiers, tone detectors and the like.

The use of bipolar integrated circuits is already well established and reliable noise-resistant equipment designs can be offered with confidence. In particular, low power TTL has distinct advantages, though at present the range of standard chips is restricted to standard logic gates, monostables and bistables.

MOS

MOS technology derives its name from the basic MOS transistor circuit which consists of a Metal gate, an Oxide insulating layer and a Semiconductor substrate arranged in sandwich form. A voltage applied to the gate influences the conductivity of an adjacent strip of substrate and this controls the flow of current from one part of the substrate (the source) to another part (the drain) which are held at different electrical potentials. The operation of the device is analogous to that of a conventional valve circuit and is classified as "unipolar". MOS transistors can be made in p-channel (PMOS) or n-channel (NMOS) form. Although somewhat larger, PMOS devices are more commonly used at present because NMOS manufacturing processes are still proving difficult to control.

The great advantage of MOS technology is that in integrated circuit form the individual elements are self-isolating by virtue of inherent reverse-biased junctions in the structure. This allows a much higher packing density (currently up to 24,000 transistors per chip) to be achieved, with consequent economies. The limit to the scale of integration is reached when the circuit complexity is such that the yield of usable chips from a production batch is below the economic level. The "dynamic-logic" mode of operation of MOS brings the further advantage of reduced power consumption and improved long-term stability.

All the usual circuit configurations are possible, although resistors are often replaced by transistors because they occupy less space.

There are two principal shortcomings with MOS. Firstly the upper limit of operating speed is about one million operations per second, though as component size, and hence parasitic capacitance, is reduced higher speeds will be possible. Secondly operating voltages are higher than for bipolar devices. This is partly because of the high threshold voltage necessary to operate a MOS transistor and also because in many logic configurations two threshold voltages appear in series. The search for a solution to the problem has resulted in the use of new gate dielectric materials and structures and to the development of "Complementary-MOS", a configuration

Below: Two pieces of equipment which do the same job. The larger version of SSAC9 signalling equipment is transistorised and uses discrete components. Now a miniaturised version has been developed with small-scale integrated circuits using TTL.
Top right: The thin-film circuit uses gold for its conductors and nickel-chromium for resistors. The whole device is an amplifier operating at 1.25 GHz in the waveguide research project.

in which PMOS and NMOS transistors complement each other in such a way that only one threshold voltage has to be overcome by the supply at any instant. At present CMOS suffers from slowness of operation and the fact that it requires more chip space than PMOS. Nevertheless the technology shows promise.

Large scale integrated circuits using MOS are already being offered to the Post Office by several manufacturers, and equipments are being developed for field trial in Post Office systems during 1973. Optimism prevails, but it is tempered with caution because of the obvious lack of information on its long-term reliability in the operational situation.

Film circuits

The applications of monolithic integrated circuitry can be considerably extended, particularly in terms of power output, by the use of hybrid circuits employing thick and thin film techniques. These hybrid circuits are essentially small printed circuit boards made of inorganic material on which are deposited interconnection tracks, resistors and capacitors and to which are added discrete or monolithic components. Thick films are provided by screen printing, using a conducting ink, on to an alumina substrate and subsequently firing. Thin films are produced by the evaporation on to a glass substrate of metals such as gold and nickel-chromium alloy.

Film circuits are receiving considerable attention and are proving to be reliable and easily reproducible within close tolerances. High operating speeds permit their use at microwave frequencies and adequate power handling capacities can generally be achieved.

Micro-processors

The circuits with the widest application are usually the simplest. Conversely the more complex circuits have narrower fields of application. As a consequence large-scale integration is sometimes not economically viable because the circuit quantities required are not sufficient to justify the initial design and tooling expenditure.

A possible way round this difficulty is to use a programmable logic circuit. This is essentially a small computer capable of a wide range of functions. The functions that it would perform in any particular situation would, however, be predetermined by a programme held in a read-only store. In this way a processor designed around a highly complex MOS chip could have a very wide application with consequent cost reduction.

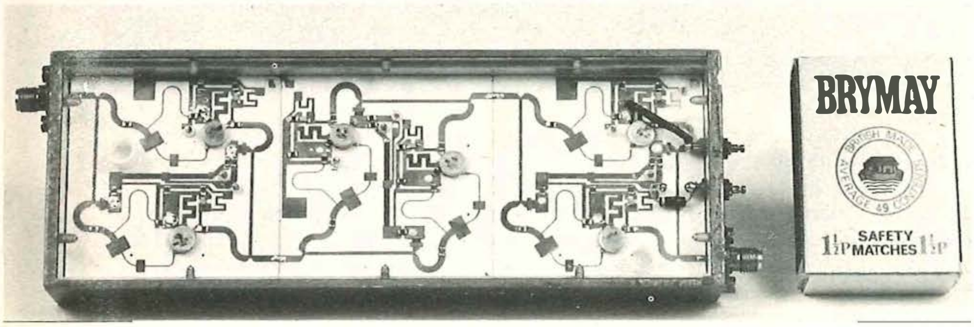
There are many types of relay set which would at first appear to justify replacement by micro-processors. However, in electronic form they would still be associated with electro-mechanical interface circuitry which would often constitute the bulk of the equipment. For this reason only those circuits performing the more complex functions – signalling relay sets, dialled digit receivers and the like – seem likely to receive attention in the near future.

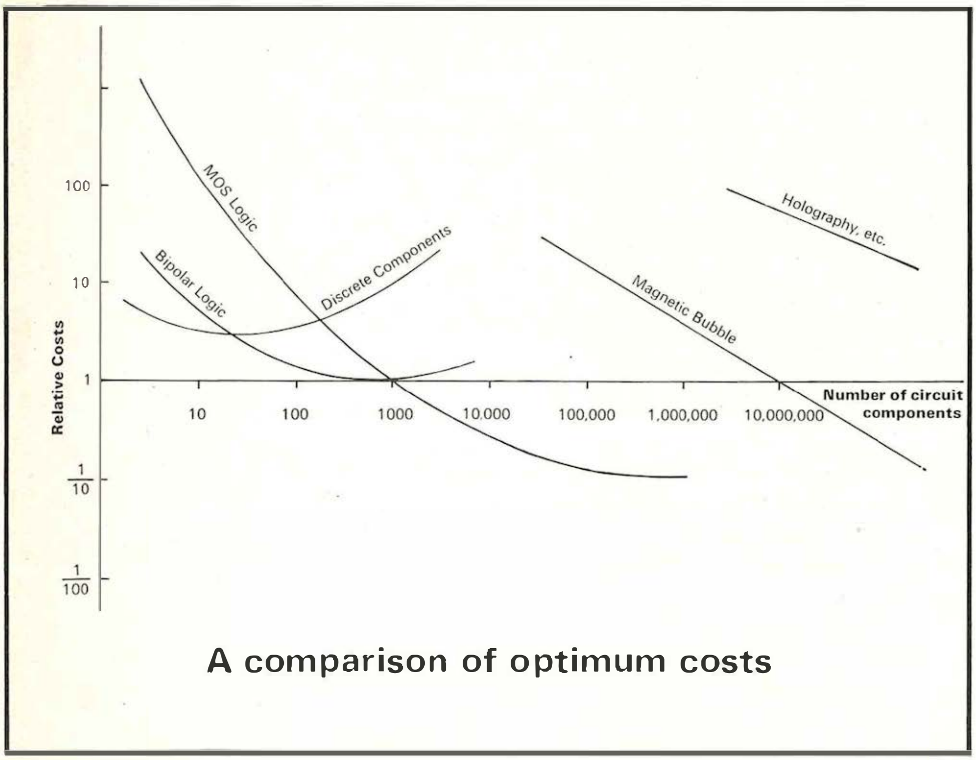
The future

Development is continuing in the areas already referred to and in addition several new techniques are showing promise. Among them is the magnetic bubble memory which relies for its operation on the movement of tiny magnetic domains in a predetermined manner in a substrate. Their manufacture calls for techniques similar to those used in existing microcircuitry. While primarily offering high density storage facilities, logic functions can also be performed. Present indications are that access speeds are not high enough for their use as computer stores, but quite adequate for such applications as directory information storage and recorded announcements using digital speech. It was reported in 1971 that a repertory key pad using a magnetic bubble memory had been successfully demonstrated by Bell. The Post Office Research Department is engaged in research into bubble technology and at least one contractor has started development work on a specific application.

Other storage media using holography and laser beam techniques are receiving attention but it is difficult at present to predict when economically viable systems will result.

It is clear that there will be a continuing need for cheaper, more reliable devices and systems capable of even higher operating speeds and requiring the minimum of maintenance effort. There is little doubt that the telecommunication industry will continue to make its contribution and exploit new technologies as they become available.





A comparison of optimum costs

Mr J. B. Millar is head of a section in Telecommunications Development Department concerned with switching systems and associated equipment.

Mechanical aids - a new pattern

SJ Little

The two units of heavy cabling equipment pictured in colour have been designed to install the largest telephone cables in underground ducts. The transporter (right) carries cable to one end of a duct route and uses a drawline – placed earlier in the duct by a rodding party – to pull a rope through the duct from the winch unit (above) at the other end. This rope is connected to cable on the transporter and the winch unit then draws the cable through the duct. Crews of the two units keep in touch by radio.

THE REASONS for mechanising manual tasks are basically the same in any field of employment. Mechanisation reduces human effort and, if carefully planned and applied, increases the efficiency with which a job can be carried out.

Over the years the Telecommunications Business of the Post Office has introduced a variety of mechanical aids for labour-intensive areas of work in providing and maintaining telephone service. They have helped to eliminate many of the difficult and dirty manual tasks facing external working parties, for example when laying underground telephone cables and erecting poles.

Development of mechanical aids for external staff has been generally directed towards producing individual items of plant and equipment for specific tasks. But it has become evident that, while these aids are of great benefit in carrying out the actual jobs in hand, considerable manual effort is required in setting up and handling the equipment on site.

Present policy in the design of mechanical aids is therefore being directed towards reducing the amount of physical handling required. To achieve this, equipment is being developed to meet the needs of specific areas of work rather than simply providing individual items for each job.

Many types of mechanical aids, with individual air compressors, electric generators and supplies of propane gas in cylinders, have to be unloaded from vehicles and set up on site. When the work has been completed these items must be cleared from the site and loaded back on the vehicle. All this takes time and calls for a lot of manhandling.

Now, where justified by the size and type of work, vehicles used to carry external working parties to the site are being purpose-built for certain tasks. Wherever possible the equipment required to carry out these tasks is integrated into the design so that work can be done direct from the vehicle. Power is derived from the vehicle's engine and converted to a form suitable for the operation involved by plant carried permanently on and integrated into the vehicle.

The recently introduced fleet of rodding and cabling vehicles for laying telephone cables is one example of these specially designed vehicles. An hydraulic pump driven by the vehicle's engine provides power for the rodding and cabling equipment, including a winch. The pump also powers air compressors for a road breaker, a submersible pneumatic pump and ductmotors. (A ductmotor is a device for passing a drawline through an underground duct prior to pulling in a cable.)

As the rodding machine is built into the vehicle, it requires only a minimum of setting up before it can be put to work. If a jointing chamber needs to be cleared of water before work can start, compressed air can easily be taken to the pneumatic pump by a flexible pipe which automatically rewinds on to a storage wheel in the vehicle when no longer required.

Application of these principles results in considerable savings both in time and manpower required for the work compared with earlier methods. It has also pointed the way for the development of other plant for specific purposes, for example, equipment to install the largest cables put into underground ducts, cable recovery equipment and a

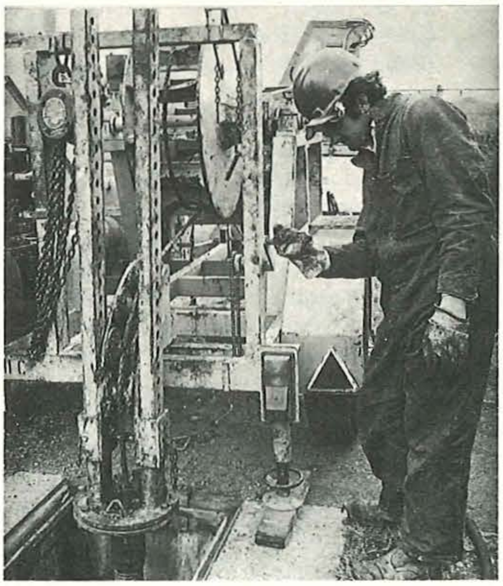
vehicle, fitted with a variety of plant, to assist external general-purpose parties to lay cables and erect poles.

It is not so easy to save time travelling to the site. Time taken for the journey from the depot or previous job is, of course, governed by the distance to be covered and traffic conditions. But even here careful planning of a day's operations helps to reduce ineffective time.

The introduction into field service of purpose-built equipment for specific activities should greatly improve productivity and provide better working conditions for external staff. At the same time, however, it calls for careful planning in use.

It is essential to keep the equipment fully employed on the work for which it is designed if it is to recoup the capital investment. Furthermore, as specific operations become more dependent upon relatively few vehicles, it is imperative that adequate reserves, spare equipment and maintenance support are available. These matters are an important aspect of present planning on the mechanisation of external activities.

Mr S. J. Little is head of the section in Operational Programming Department at Telecommunications Headquarters responsible for the development, introduction and utilisation of mechanical engineering equipment in the external field.



Cable recovery units have taken much of the physical effort out of removing old telephone cables from underground ducts. The unit in this picture has a mechanically driven capstan for pulling cable from the duct, and will be superseded by a more powerful and flexible unit which employs an hydraulic power transmission system.

The rodding and light cabling vehicle is a self-contained unit used for laying cable in underground ducts. A crew member is pictured here in wintry conditions preparing equipment for pumping water from a jointing chamber. The pneumatic pump is connected by flexible pipe to an air compressor in the vehicle.

1

AN EXCHANGE

A BLEAK outlook faced applicants for telephone service in the small South Wales town of Caldicot. The waiting list had reached 170 and was growing at a rate of 20 per month. Yet relief in the shape of a new electronic exchange for the town was still 18 months away.

Then engineers in the Cardiff Telephone Area came up with the bright idea of "importing" a complete exchange, almost intact, from the nearby town of Caerleon. Thanks to their ingenuity the waiting list was cleared virtually overnight.

The 800-line exchange used for this purpose was one of two at Caerleon which became redundant when a new crossbar exchange was opened in the town. It was housed in a timber building, the front of which faced directly on to the road. This made it possible to remove the equipment in one piece, transport it 16 miles by road and place it in the new exchange building at Caldicot, the whole operation being completed in one working day.

Schemes for providing used exchange equipment to ease waiting list problems are not new, of course, but normally the equipment has to be dismantled and rebuilt. By transporting the Caerleon exchange as a complete unit several hundred manhours of skilled engineering work were saved, and enabled the exchange to be brought into service more than three months earlier than could otherwise have been anticipated.

In the old UAX 13 exchange at Caerleon the equipment was arranged in three rows, separated by gangways about 2 ft wide. Cables between the racks were supported by runway and cable troughs, and this ironwork was removed to allow

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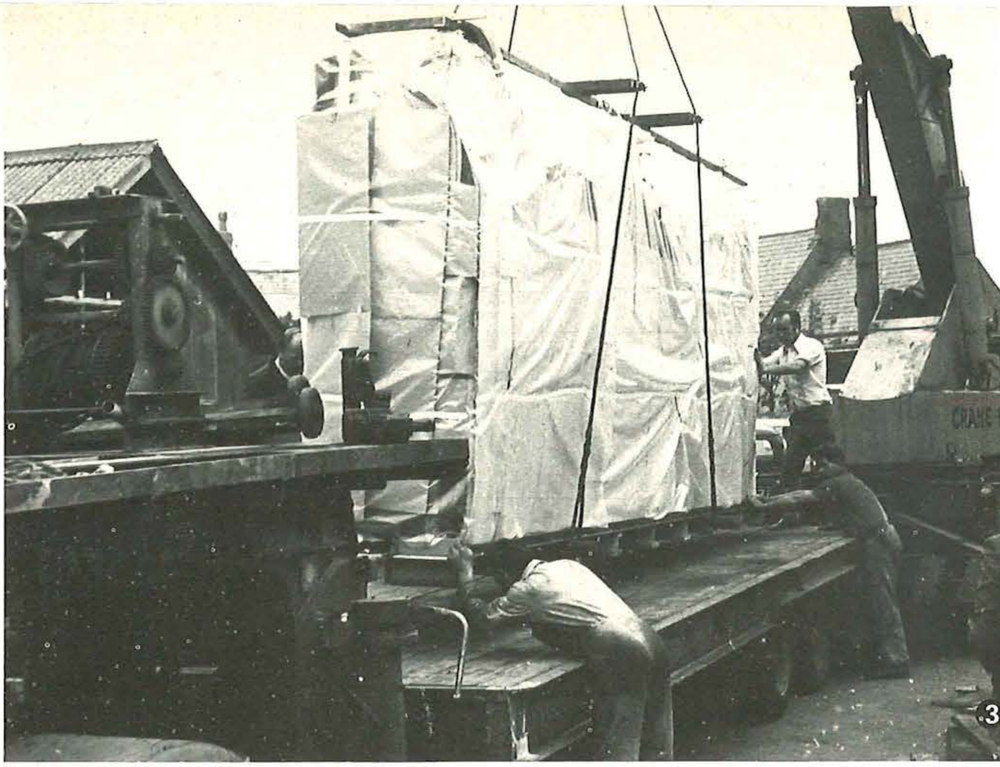

MOVES HOUSE

the equipment to be rearranged in two rows. These rows were then placed together and firmly secured face-to-face without disconnecting any internal cables.

The complete exchange, packaged into a unit measuring about 22 ft long, 3 ft wide and 8 ft high, was protected by cardboard and polythene sheet. Four robust metal frames, each fitted with industrial-type castors which could be jacked up, were placed underneath the "package".

To provide access from the Caerleon exchange to the road three end sections of the timber building were removed. The exchange equipment was then raised from the floor by using the jacking action of the castors and rolled out on to the road.

At this stage a firm of haulage contractors used a giant crane to lift the "package" on to a lorry for transporting to Caldicot. A window panel was removed from the new exchange building at Caldicot so that the exchange equipment could be moved into the apparatus room.

The overall cost of the project was less than that for dismantling, removing and rebuilding the equipment by conventional means, even taking into account the cost of the castors and frames to which they were attached. The speed with which extra exchange capacity was provided at Caldicot and the great saving in engineering work was even more important.

Footnote: For Post Office engineers who may be considering a similar move, photographs and a description covering every stage of the project are available from Mr. F. L. Howes, Area Engineer (Internal Construction) Cardiff, telephone Cardiff 45000.

1: The old timber building at Caerleon, which housed the 800-line exchange.
2: Protected by cardboard and polythene sheet, the exchange equipment is wheeled out of the exchange on specially built frames fitted with castors.
3: A giant crane loads the exchange on to a lorry trailer.
4: Relief is on the way. The equipment leaves Caerleon on its short journey to Caldicot.
5: After being lifted from the lorry, the crane manoeuvres the "package" into position outside the Caldicot exchange building.
6: Crane tackle is adjusted so that the equipment can be "slotted" into its new home.

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High-capacity pipeline

Vital trials in the search for future transmission systems

A FULL-SCALE field trial of a waveguide, a hollow tube capable of carrying up to 300,000 telephone conversations at a time, is due to start in 1975. The trial section of waveguide, little thicker than a car's exhaust pipe, will run from the new Post Office Research Station at Martlesham Heath, near Ipswich, to the Suffolk town of Wickham Market about ten miles away.

The trial follows successful tests on waveguide systems by Research Station staff at Martlesham. In conjunction with British industry the Post Office has developed prototypes of repeater and terminal equipment and a new design of lightweight waveguide.

The system is capable of transmitting signals of very short wavelength (equivalent to frequencies from 32 to 110 GHz) and so accommodates a high number of telephone, television and data channels.

The inner surface of the waveguide tube is about 2 in diameter, and is formed from a close-wound helix of superfine, enamelled copper wire. This is covered by layers of resin-impregnated glass fibres which provide structural strength and absorb energy leakage. An aluminium foil barrier gives protection against water and oxygen and this is in turn covered with an outer jacket for protection against mechanical damage.

An order to supply waveguide for the trial has been placed with British Insulated Callenders Cables (BICC). They will first develop, design and construct machinery to make the waveguide in three-metre lengths.

Work is already advanced on the manufacture of repeaters and terminal equipment by GEC-Marconi Electronics Ltd. This includes band-branching units which divide the total operational frequency spectrum into five bands.

Transmitter and receiver equipment will provide several complete channels, each of 500 Mbit/s capacity and operating below 50 GHz, to carry either simulated or genuine pulse code modulation communication traffic. In addition band-branching units will enable the characteristics of the circular waveguide path to be examined up to frequencies of at least 110 GHz, and also facilitate the subsequent introduction of transmitter and receiver equipment for use above 50 GHz.

A circuit length of 30 km (nearly 20 miles) will be obtained in the trial by using Martlesham as a terminal station and Wickham Market as a repeater. Signals will be sent along the waveguide in one frequency band to Wickham Market where repeaters will return them to Martlesham in another frequency band. Longer circuits can be simulated by multiple looping – sending the signals to Wickham Market and back several times in succession on different channels.

A tubular steel duct which will house the waveguide is being laid about four feet deep over the route of the trial. Here a surveyor checks the line of the trench while preparations are made to lower the four-inch diameter duct which has to be constructed with fine precision.

High-speed trunk calls

ANOTHER STEP forward has been taken in the development of a high-speed, digital transmission system for the telephone trunk network. Contracts have been placed with three manufacturers to develop systems enabling pulse code modulation – already widely employed to increase circuit capacity in local networks – to be used over long distances. Trials are to be held between Guildford, Portsmouth and Southampton in 1975.

At present Britain's trunk network is based on analogue transmission – sending an electrical signal which represents speech patterns. These signals are kept separate by sending them at different frequencies – the technique of frequency-division multiplexing (FDM).

With a digital PCM system the messages are first converted to a stream of many thousands of on-off electrical pulses a second. Signals transmitted over the same bearer circuit are kept separate by time-division multiplexing (TDM) – slotting the pulses from one source into the intervals between the pulses of others.

Digital systems can provide the same quality of performance as the present analogue systems, and may in future provide this at greatly reduced cost. They allow much simpler signalling systems to be used for routeing calls through the network, simplify the multiplexing of different signals and, for complicated signals – those for TV and Viewphone for example – permit greater exploitation of the transmission medium. In addition they pave the way for the introduction of cheaper, quicker, switching systems using computer-like methods operating directly on the digital information under stored program control.

The decision to develop a digital system for the UK trunk network stems from the results of feasibility studies carried out for the Post Office by GEC and Plessey in 1970–71. (See Telecommunications Journal, Autumn, 1971.) These studies confirmed that it is technically possible to introduce a digital system using the standard 1.2/4.4 mm coaxial cable pairs now in use for multichannel FDM transmission.

Under the development contracts, STC, GEC and Plessey have been commissioned to design, develop, manufacture and install systems, transmitting information at a rate of 120 Mbit/s and compatible with the Post Office's existing 12 MHz analogue system for 1.2/4.4 mm cables, using the same repeater spacing, housing and power feed arrangements. For this purpose the Post Office has set aside spare coaxial pairs in its trunk cables between Guildford, Portsmouth and Southampton. STC is to provide the system for the Guildford-Portsmouth link; GEC and Plessey are collaborating on the Portsmouth-Southampton link. Each system will be capable of transmitting up to 1,680 telephone conversations simultaneously by PCM/TDM.

MISCELLANY

Across the Atlantic

The Post Office, the French Ministry of Posts and Telecommunications and the American Telephone and Telegraph Company are to pool resources to develop the world's largest undersea telephone cable system. It will be capable of carrying 4,000 telephone conversations simultaneously – more than twice as many calls as any submarine cable now in service.

The first cable using the new system will be a transatlantic link between the USA and France, coming into service in 1976. The 2,500 nautical-mile cable, called TAT6, will run from Rhode Island, USA, to St Hilaire, France. Its manufacture, installation and maintenance will be financed by a consortium of 20 nations, including Britain, and four American telecommunication companies.

Britain's telecommunication service is to have the use of more than 750 circuits in the new cable. These will be extended by overland routes from St Hilaire to Northern France, and then by undersea cable to Britain.

TAT6 will provide the Post Office with a fourth major link for its main transatlantic services. The others are two satellites and the CANTAT 2 cable between the UK and Canada the major sections of which are currently being laid.

Britain's role in developing the new system will be in the field of cable production, cable-laying and maintenance, fault location and testing. The Post Office's Research Department is to carry out this work in close collaboration with Standard Telephones and Cables.

France will develop terminal equipment for the shore ends and America is to work on the repeaters – amplifiers placed in the cable at regular intervals.

Experimental lengths of cable, developed by Post Office engineers and produced at STC's Southampton factory, are already being used in sea trials by the Post Office cableship *Alert*.

. . . and the Channel

Two new undersea telephone cables will double the number of circuits between Britain and France. Due to come into service early in 1976 and 1978, they will each have a far greater call-carrying capability than any other cable to Europe now in service.

The first new cable will be able to carry up to 2,580 calls simultaneously. It is a 25 MHz system of 43 supergroups and will be manufactured by the French firm, Les Cables de Lyons. The second, carrying at least 3,600 calls at once, is expected to be a 40 MHz system with 60 supergroups, and will be made in Britain by Standard Telephones and Cables.

At present most communications with France are carried on a 30-mile microwave radio "hop" across the Channel near Dover. As well as carrying communications between the UK and France this link also carries many international calls routed through France.

The new cables will also be used as cross-Channel feeder routes for communications from the Continent through Britain to Canada in the CANTAT 2 cable and through Britain to the USA in the TAT6 cable.

A new undersea link between Broadstairs in Kent and Domburg on the Dutch coast will expand communications between Britain and The Netherlands and Germany. To be in service by May 1975, the 14 MHz cable will carry up to 1,380 telephone calls at once. An earlier project for four high-capacity cables linking Britain directly with Germany, Belgium, The Netherlands and Denmark is now nearing completion.

A second direct undersea telephone cable between Britain and Spain will also come into service in 1975, and will have a capacity similar to that of the new Britain-Netherlands link. The first direct link to Spain, capable of carrying 480 calls simultaneously, was completed in 1971.

ISD for Leeds

Telephone users in Leeds and district can now dial their own calls to many places in Western Europe and to North America following a further extension of International Subscriber Dialling. The service is already available in London, Liverpool, Manchester, Birmingham, Edinburgh, Glasgow and Cardiff.

Another Board

A new Board with some members from outside the Post Office has been set up in Manchester to run the North-West's telecommunications business.

It is the seventh to be set up under Post Office plans for regional boards throughout the United Kingdom to run day-to-day services. These Boards provide a more flexible system permitting local managers, working within national guidelines, to consider local needs.

Chairman of the North-West Telecommunications Board is Mr J. V. Greenlaw, formerly the Regional Director. The Board has eight members, four senior Post Office executives and four members appointed from outside.

Protection squad

The "dial before you dig" campaign, launched in 1968 to safeguard vital underground telephone cables and equipment, is being stepped-up. Plant Protection Officers – specially trained Post Office Staff – are preparing to go into action from centres throughout Britain.

By dialling the operator and asking for Freefone One-Double-One, public works and building contractors, local councils and other authorities can have a Post Office engineer promptly on site. He can then mark the route of underground

A Plant Protection Officer uses cable locating equipment to find the route of an underground telephone cable. See the item "Protection squad".

telephone cables before digging, tunnelling or blasting begins.

This is an essential back-up for the Post Office's consultative service which provides information about underground plant during the planning stage of building and roadworks.

A nationwide team of nearly 300 men is now completing special training. They will be on call at 68 centres, known as External Plant Maintenance Controls. The Plant Protection Officers will also advise on the treatment of excavations near Post Office plant and supervise movement and protection of equipment.

Gas-powered vans

Field trials of gas-powered vehicles are to be extended by the Post Office Telecommunications fleet.

Six light vans used on telephone installation work are to be converted from petrol to liquid-petroleum-gas (LPG) operation and compared closely with six petrol-driven vehicles working in similar conditions. The vehicles join four gas-powered, 15-cwt utility vans already on trial and will operate in London and the Home Counties.

The decision to extend the trials follows encouraging results from tests over the past two years with the four vehicles converted to LPG operation. These have shown that toxic exhaust emissions of carbon monoxide, and other oxides associated with petrol, are virtually eliminated; engines are cleaner, showing less wear and tear; and need for oil changes is drastically reduced. One of the four vans under test completed 15,000 miles without an oil change.

Post Office tests so far show little change in acceleration, speed and hill-climbing performance of gas-powered vehicles compared with their petrol-driven counterparts.

Fuel consumption, however, varied considerably. Each of the vans was fitted with a different carburettor and although the best of these gave almost as many miles to the gallon as petrol vehicles, the others used more fuel.

Although LPG is cheaper than petrol, costing about 22p a gallon, the conversion cost of about £100 a van adds considerably to initial financial outlay in a fleet of the size operated by the telecommunication service – it has 44,000 vehicles (28,000 petrol-driven).

Senior appointments

Mr Southerton

Mr Rees

The responsibilities of the former Senior Director, Finance and Personnel, in Telecommunications Headquarters were divided earlier this year and now two new appointments have been announced.

Mr Thomas Southerton, former Director of the Management Services Department, is the new Senior Director, Telecommunications Personnel. He succeeds Mr Eric Shepherd who has retired. **Mr William Kember** has transferred from Post Office Central Headquarters to become Senior Director, Finance and Management Services.

Mr Southerton, who joined the Post Office in 1934, played a key role in the introduction of flow-line repair techniques at Post Office factories. He was appointed Controller of the Factories Division in 1964.

After planning the establishment of a management services department for the telecommunications service, he became its first director in 1968. One of its first tasks under his direction was to carry out the reorganisation of the management structure of Telecommunications Headquarters into its present form.

Mr Kember is a chartered accountant, who formerly worked with Shell and British Oxygen.

In 1970, as a member of the consulting staff of Cooper Brothers and Co., he was seconded to the Post Office to help with the alterations required to its financial organisation following the change from government department to public corporation. In January last year he was appointed to a new post as Senior Director, Central Finance.

Mr Jim Rees, Deputy Director of Telecommunications Service Department, has been appointed Director of Management Services in succession to Mr Southerton.

Mr Ralph Quartano succeeds Mr Kember as Senior Director, Central Finance, at Post Office Central Headquarters. He was formerly Director of Central Financial Planning.

Mr G. H. G. Tilling, Director of the Eastern Postal Region, has been appointed Secretary of the Post Office in succession to Mr Alan Wolstencroft, CB, who has retired from the Post Office.

Chinese credit

British businessmen and travellers in the People's Republic of China are now able to make telephone calls to Britain with Post Office credit cards.

Users simply quote their credit-card numbers and the cost is billed to their UK telephone numbers. Alternatively collect (transferred) charge calls can be made from China to Britain, and China has also agreed to accept transfer-charge calls from the UK.

Automatic telex

British telex users can now make their own calls on automatic service to every state in the USA following the opening of a new link with Alaska. The new service replaces an operator-controlled link.

Calls on automatic service will cost £1 a minute with a one-minute minimum charge, compared with a minimum of £3 for calls placed through the operator.

Automatic telex links with mainland USA were first introduced in 1964, with all US inland networks taking automatic service from Britain by 1971. Last year an auto link was established with Hawaii, and the start of the new service with Alaska puts all parts of the USA directly at the fingertips of Britain's 40,000 telex users.

Britain now has automatic telex service to 56 places abroad, and 97 per cent of the 34 million international telex calls from Britain each year are automatic.

New Datel service

Many new possibilities for data transmission are offered by the Datel 400 service which recently came into operation.

The service provides a one-way system for information recorded at outstations to be sent over the public telephone network to a central control. During trials it has already been used to send heart-beat readings from a small hospital to a large one a mile away, and information on river pollution to a Government laboratory. A research laboratory is now developing equipment for sending information on motorway hazards and weather conditions to a central monitoring point.

The signal transmitted can be in binary digits – a stream of rapid on-off electrical pulses – at rates up to 600 bit/s, or an analogue waveform such as the brainwave signals produced by an electroencephalograph.

There is a robust, weatherproof version of the outstation equipment for use out of doors – for example, on a river bank where water level and flow may be measured.

Because of the new opportunities opened up by the service the Post Office's Data Communications Division has invited firms making telemetry or data-collection equipment to consider developing future terminal equipment with Datel 400 in mind.

To use Datel 400 the customer's terminal equipment is connected to the telephone line through a modulator, which converts its signal into a form suitable for transmission.

There need be no telephone at the outstation since the line from the exchange ends in the modulator, which is then equipped for automatic answering. This installation is particularly suitable for use at remote outstations.

A telephone may be provided if required and incoming interrogation calls can then be accepted on it and switched manually to the modulator as an alternative to automatic answering. A modulator can be added to an existing line and telephone and when it is not being used for data transfer the telephone can be used for ordinary calls.

Real costs fall

The cost of a three-minute telephone call between London and Glasgow has been reduced over the past 60 years almost to one-tenth, in terms of present-day values. And a similar call from London to New York has been reduced in cost, since the service began 36 years ago, almost to one-fiftieth, again at today's values.

These and other reductions benefiting the customer have been made possible by the Post Office's constant development of new methods and materials, said Professor J. H. H. Merriman, Post Office Board Member for Technology, when he delivered the annual Kelvin lecture to the Royal Philosophical Society of Glasgow.

Professor Merriman (who this year was awarded the Society's Kelvin Prize) showed how the Post Office had achieved a progressive reduction in the real cost to the customer of telephone service. In 1910, a three-minute telephone call between London and Glasgow cost 4s 6d – at 1972 values £1.80. Today the same call made during the day would cost 22p, or as little as 5p at the cheap rate. In 1927, a three-minute call from London to New York cost £15 – at today's values, this would be £69.75. On ISD now, a three-minute London-New York call costs only £1.50.

For the future, Professor Merriman foresaw that world-wide research and development into cheaper and more effective switching systems would result in some plant cost reduction. But, he warned, these would not possibly have the same anti-inflationary effect on long-distance charges that earlier developments had brought in past decades. "There is a limit somewhere to the pips that can be squeezed from this particular orange," he declared.

●Sir John Eden, Minister of Posts and Telecommunications, has announced the re-appointment of Professor Merriman for a further period of three years as member of the Post Office Board with special responsibilities for technology.

Calling yachtsmen

In a new radio service for yachtsmen the Post Office's 11 coast radio stations will broadcast urgent business or personal messages immediately following the morning and evening weather forecasts.

The scheme is aimed at providing an avenue of communication from the shore for the many hundreds of yachts and other small craft equipped with radio receivers, but not with two-way radio. At present they have no means of keeping in touch with the shore.

The service will be on trial for six months and is available from all telephones without coinboxes. Charges will be included in the quarterly bill.

Messages are telephoned to the coast radio station nearest the vessel. If the vessels' location is not known, the Post Office can arrange to have the message broadcast from other coast radio stations at an extra charge.

The receipt of one-way messages cannot be guaranteed: yachts may have the radio switched off, be out of radio range, or be in a radio "blind spot".

The Post Office's radio stations will broadcast each message twice.

Essay winners

An essay on Telecommunications in the Netherlands won a £14 first prize for Technical Officer Mr J. V. Buckley in the annual essay competition run by the Institution of Post Office Electrical Engineers. Mr Buckley works in the North Central Area of London Telecommunications Region.

Other prizes were £9 – Mr C. Kelley, Technician 2A Rotherham (Development of communications satellites); Miss A. J. Owen, Senior Drawing Office Assistant Northampton (Today's juniors-tomorrow's seniors). £4 – Mr D. E. G. Coles, TO Birmingham (Critical path analysis); Mr J. Searby, T2A Liverpool (Historical sketch of telecommunications in UK).

Power from line

The development of simple, low-speed data transmission devices is expected to receive impetus from a Post Office decision to permit privately provided attachments to the telephone to be operated by the power flow from the telephone line.

Until now all telephone attachments have had to have an independent power supply. From June next year attachments will be able to draw power from the telephone line – but as the power available can be very low it is expected to be adequate only for the operation of solid-state devices.

They will be able to draw power from the line while a call is in progress. However, power cannot be used off-line – for example, to recharge a power cell in a data terminal.

All attachments will need to meet Post Office technical requirements and to be supplied to users on a rental basis rather than sold. Technical specifications will be published in September by Telecommunications Service Department.

Network grows

More than a million orders for exchange line connection to the telephone network were met by the Post Office in the six months ended March 31.

Of a total of 1,047,000 orders met during this period, 760,000 were for new exchange lines and 287,000 for the take-over of existing exchange line equipment by new customers.

This is an increase of 6.5 per cent on the corresponding period in 1971-72 when orders met for exchange line connection totalled 982,000.

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

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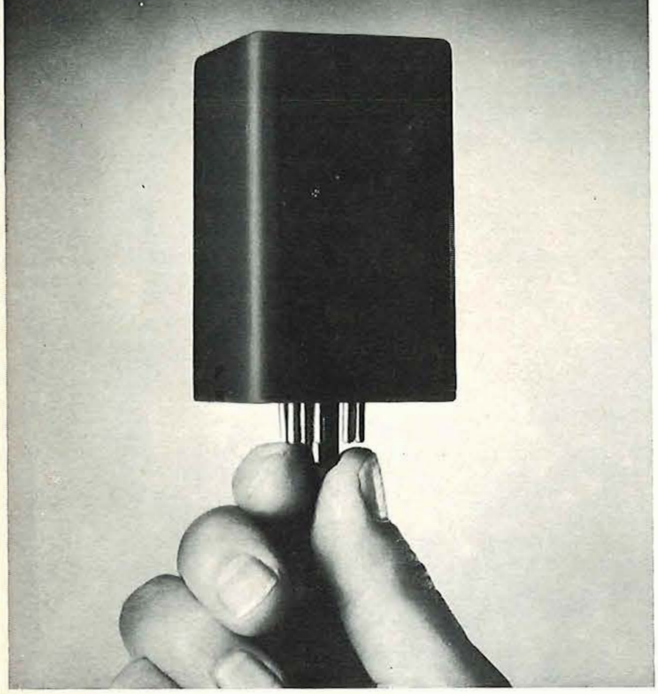

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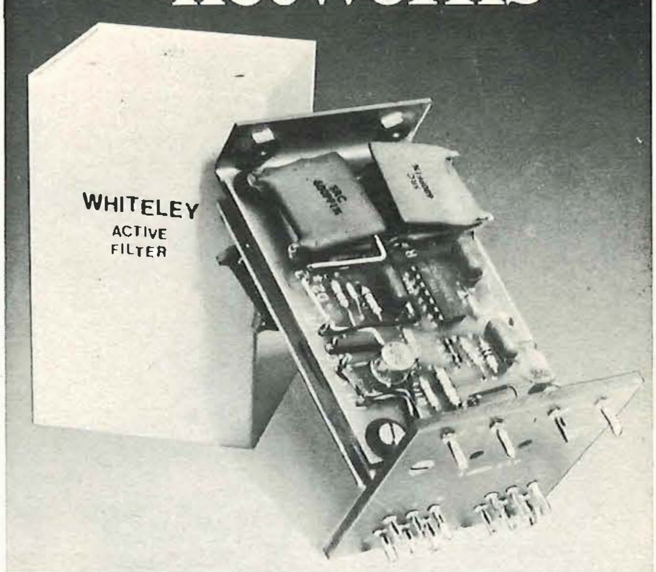
New active filter takes over from passive networks



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