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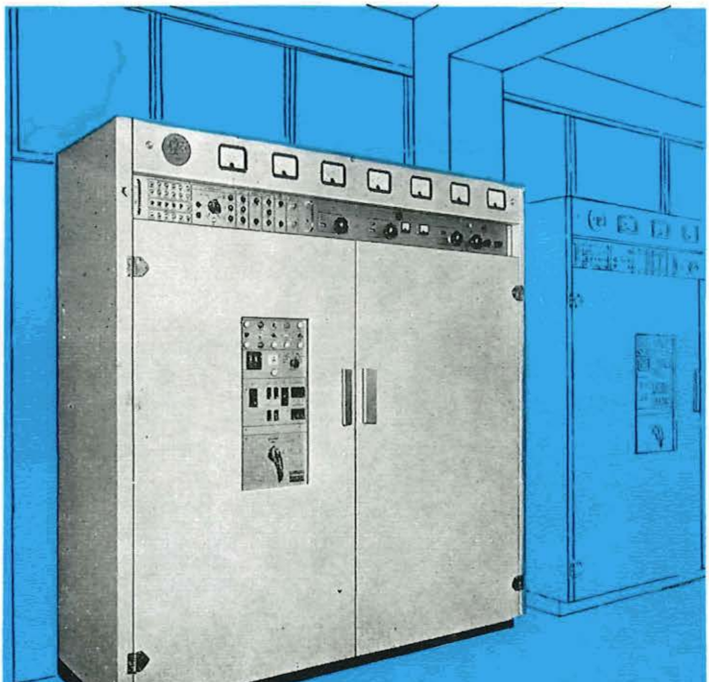
SPRING 1967

STC Telecommunications Review

MARCH, [illegible]



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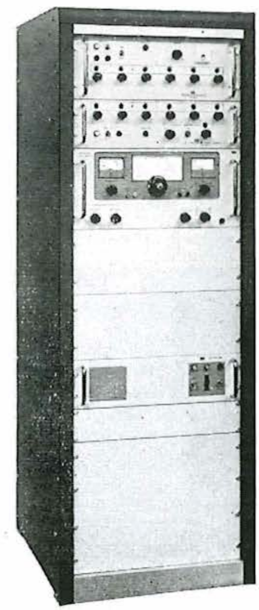

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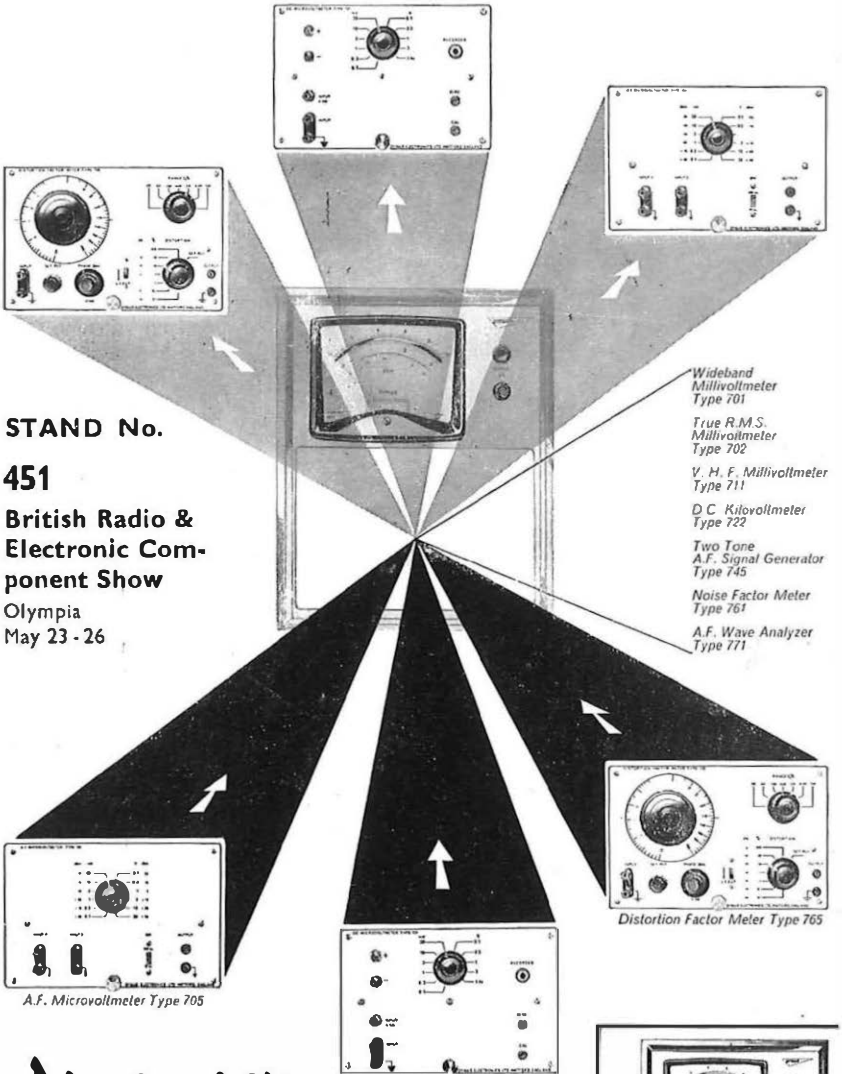

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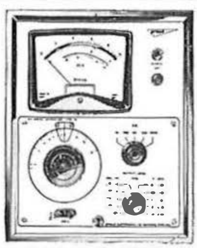

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Post Office Telecommunications Journal

Published by the Post Office of the United Kingdom to promote and extend knowledge of the operation and management of telecommunications

CONTENTS

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Vol. 19 Spring 1967 No. 1

CRITICISM & CONGRATULATION

THE telecommunications services emerge with considerable credit from the investigation by the Select Committee on Nationalised Industries whose report was published as the *Journal* went to press.

The report recognises and sympathises with the Post Office's peculiar problems and makes it plain that the Post Office does a much better job than it is usually given credit for.

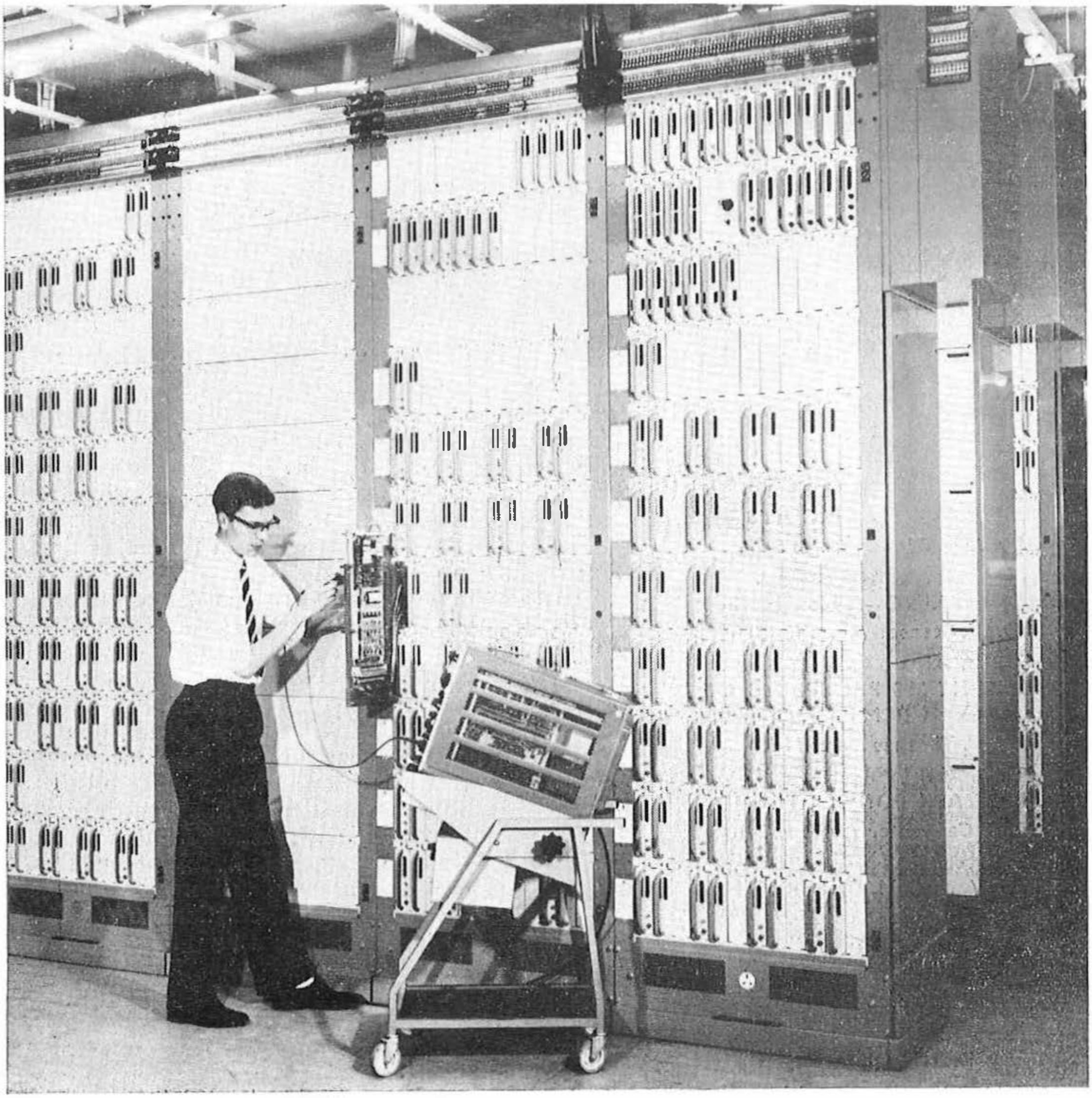
The Committee criticises some weaknesses which arise from lack of capital in the past and inaccurate forecasting of the rate at which the telephone service was expected to grow and comments on the fact that the Post Office has to provide a number of unprofitable "social" services. On the other hand the Committee congratulates the Post Office on the way it is equipping itself to provide a broader range of services which take into account the varied needs of the community for the rapid transfer of information and "applauds the readiness to think in such terms and to prepare to pioneer new means of telecommunications."

The report also welcomes the action the Post Office is taking to improve forecasting techniques and speed the flow of exchange equipment and endorses the priority the Post Office is now giving in its investment programme to improving the telephone service for existing subscribers rather than to extending service to new subscribers.

Finally, the report congratulates both management and staff on the significant gains (between 4 and 6 per cent a year since 1960-61) from increased productivity, particularly in the engineering field.

The need for even greater increases in productivity was stressed by the Postmaster General when he spoke at a Press Conference on the White Paper on *Post Office Prospects, 1967-68,* which was published shortly after the Select Committee Report. "We have to do everything we can to improve our efficiency," he said. "This is not just a pious hope. We have already begun a fundamental examination of our managerial structure and are applying new practices and methods of work, better management techniques and intensifying productivity in full consultation with the staff associations. And we aim to do all this without debasing the standards of our services."

** Full reports on the Select Committee's Report and the White Paper* Post Office Prospects, 1967-68 *will be given in the Summer issue of the* Journal.



Ambergate–First in the World

"THIS exchange heralds a new era in telecommunications," said the Postmaster General, the Rt. Hon. Edward Short. "It is a significant step forward in the Post Office programme for modernising the telephone system to meet the needs of today and of the future."

The Postmaster General was opening the new electronic exchange at Ambergate, Derbyshire, the first production electronic exchange in Europe and the first small-to-medium size electronic exchange in the world.

Orders for about 30 exchanges of the same type—known as the Post Office TXE 2—have already been placed and another ten are expected to be ordered by the end of March, 1967. Thereafter, another 80 to 90 TXE 2 exchanges will be ordered each year. "This means that for the first time anywhere in the world electronic equipment for small-to-medium ex-

A new age in telecommunications was opened when the world's first small-to-medium electronic exchange was brought into service at the Derbyshire village of Ambergate. It took ten years to perfect

Final tests being carried out on the new TXE 2 electronic exchange at Ambergate. In normal operation the system is self-proving and any fault is automatically detected.

changes is in production," said the Postmaster General.

The new TXE 2 exchanges are now the standard Post Office installations for all small-to-medium new and replacement exchanges up to 2,000 lines capacity and have for some time been ordered for all new exchanges of appropriate size.

"But," warned Mr. Short, "this is not a revolution which will change the telephone service overnight. We do expect that about one fifth of our annual requirements for new equipment will be met by electronics by 1970-71. This does not mean that the whole system will be electronic by that time because exchange equipment has an economic life of about 30 years and the newest electro-mechanical exchanges would not normally be replaced until about the turn of the century. The fact remains, however, that we in this country are at the beginning of a new era comparable in some ways with that about 50 years ago when automatic switching was being introduced. The decision to go all out for electronic exchanges of the small-to-medium size is one in which Britain leads the world."

The new exchange at Ambergate (technical details of which were published in the article *Breakthrough for Britain* in the Spring, 1966, issue of the *Journal*) is the result of ten years collaboration between the Post Office and the telecommunications industry.

The key component of the TXE 2, as in other British electronic systems at present being developed, is the miniature dry reed relay which is used for speech path switching and certain control functions. Each switching crosspoint consists of four reeds, enclosed in an operating coil. The contacts, which are gold-plated and protected in an inert atmosphere by an hermetically-sealed glass envelope, are closed by the generation of a magnetic field in the coil. This means that the reed relays are subjected

Technician 11A Mr. H Radford blocks off the manual switchboard at Ambergate before the new electronic exchange is brought into use.

to virtually no wear and are, in fact, expected to withstand several million operations without failing or becoming noisy.

In addition, the components do not require mechanical adjustment, which means that there is much less need for maintenance, running costs are lower and the exchanges are more reliable. Compared with electro-mechanical exchanges, the TXE 2 is much smaller and installation and extensions are much easier to carry out. Since they are more compact they require smaller buildings to house them—a very

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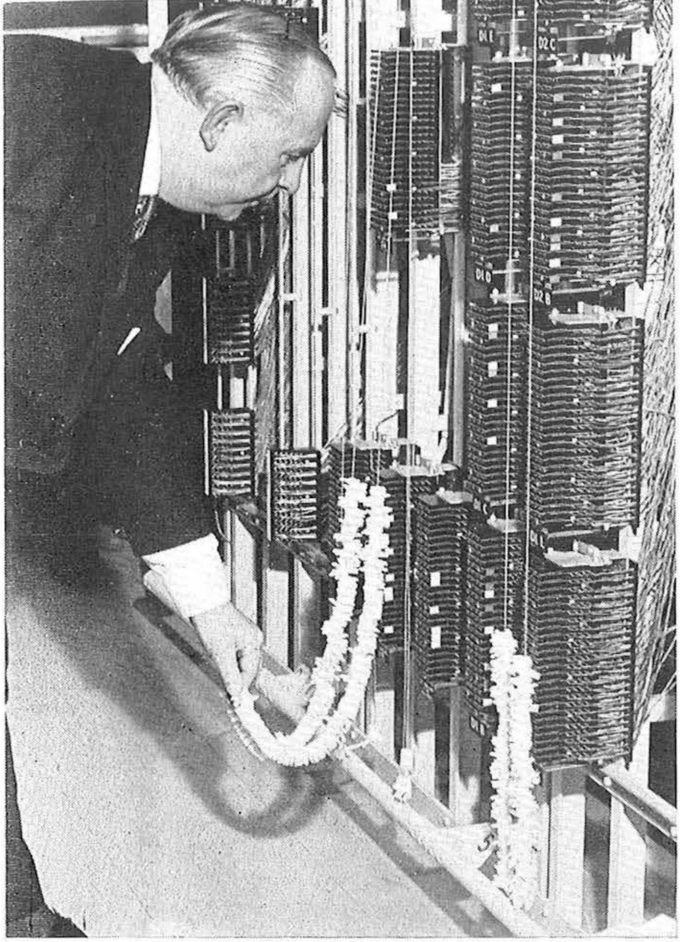
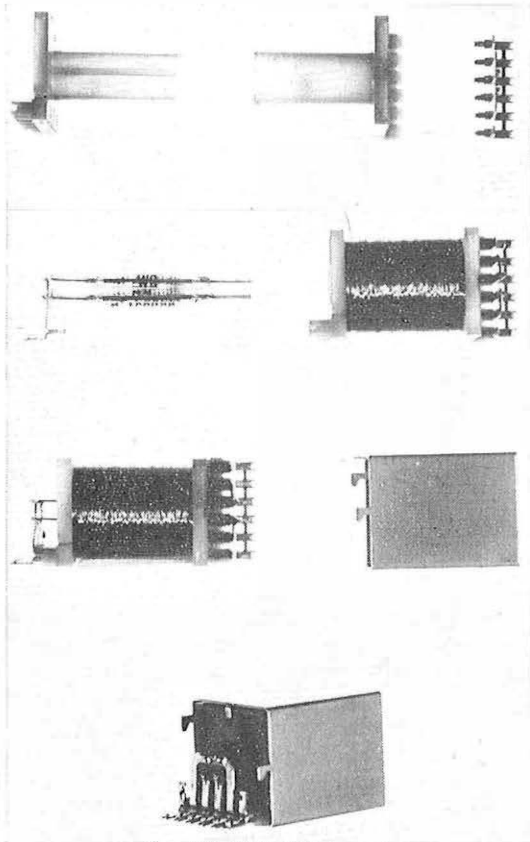
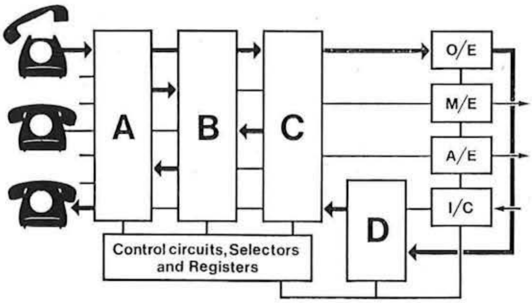


Left : Mr. E. G. Hucker, Director Midland Region, pulls out the wedges to bring the new TXE 2 exchange into action. Below : Exploded view of a reed-relay, the gold-plated contacts of which are sealed in an inert atmosphere to prevent contamination and ensure a long, fault-free life.

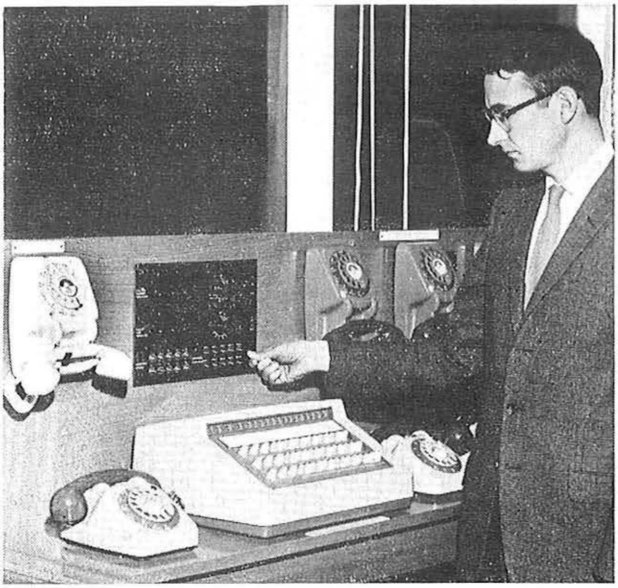




This diagram shows a typical connection between two subscribers on the same TXE 2 exchange. A,B,C and D are groups of crosspoint switches; O/E is own-exchange supervisory relay set: M/E the main exchange (outgoing) supervisory relay set; A/E the adjacent exchange (outgoing) supervisory relay set and I/C the incoming-junction supervisory relay set.

considerable advantage at a time when there is great pressure on space for sites. For example, the TXE 2 at Ambergate, at present serving some 600 subscribers, houses 3,500 lines with electronic equipment compared with only 1,800 lines of existing electro-mechanical equipment.

The TXE 2 offers many advantages for subscribers, too. Perhaps the most important derives from the speed at which it can "think" and act. Electronic circuits operate many times faster than electro-mechanical circuits so that operations controlling the setting up of a call can be carried out much more rapidly. This



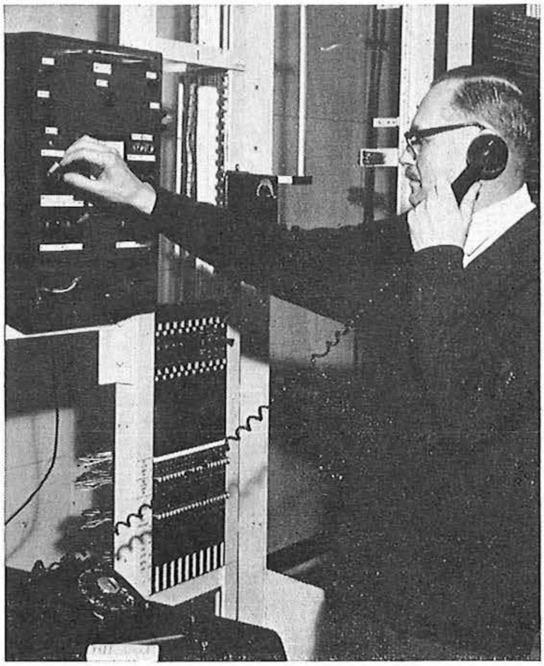
Mr. J. A. Carlisle, a senior engineer of the Plessey Telecommunications Group, operating a display panel at the new Ambergate Exchange. The panel indicates numbers being called.

enables facilities to be provided for a second attempt to set up a call automatically, without any additional action by the caller, and without his knowledge, if the first attempt is made over a path which is unsatisfactory because of a random fault in the exchange. Hence, in most instances, many fewer calls should fail, even if there are component faults in the exchange. In addition, the likelihood of background noise in the telephone receiver is substantially less than with conventional equipment.

There are other advantages as well. For example, if a subscriber rents more than one connection these do not have to be arranged consecutively on the equipment in the exchange. Spare numbers do not have to be reserved for expected growth and unexpected growth will not involve, as it often does with the conventional exchange system, a change in the subscriber's published number. One new facility which is being provided at Ambergate at a small extra charge is the ability to transfer incoming calls to another designated number or numbers under the control of the subscriber himself.

Further facilities are likely to become available in the near future. One is the *Keyphone* which, using ten press buttons or keys in place of the dial, enables callers to key their numbers much more quickly than they could dial. This will exploit the fast switching capability of the electronic equipment, although the fullest advantage to subscribers will not be realised until all the exchanges they call are also electronic and faster signalling between exchanges —another further development—is available. Another is abbreviated dialling, a system by which subscribers will be able to dial a special short code instead of the full number, leaving the equipment to do the rest. This facility will save the caller time and effort in obtaining regularly-dialled numbers, especially those—such as STD and international numbers—which require extra digits to be dialled.

Three more TXE 2 exchanges will come into service towards the end of 1967. These will be at Odiham, in Hampshire, at Brampton, in Cumberland, and at Bishopton (Renfrewshire). By the end of 1968 some 40 TXE's are expected to be in service.



Mr. K. Slater, Clerk of Works on the Ambergate project, tests the new lines after the change-over to the new electronic equipment.

FROM TRANSISTORS TO INTEGRATED CIRCUITS

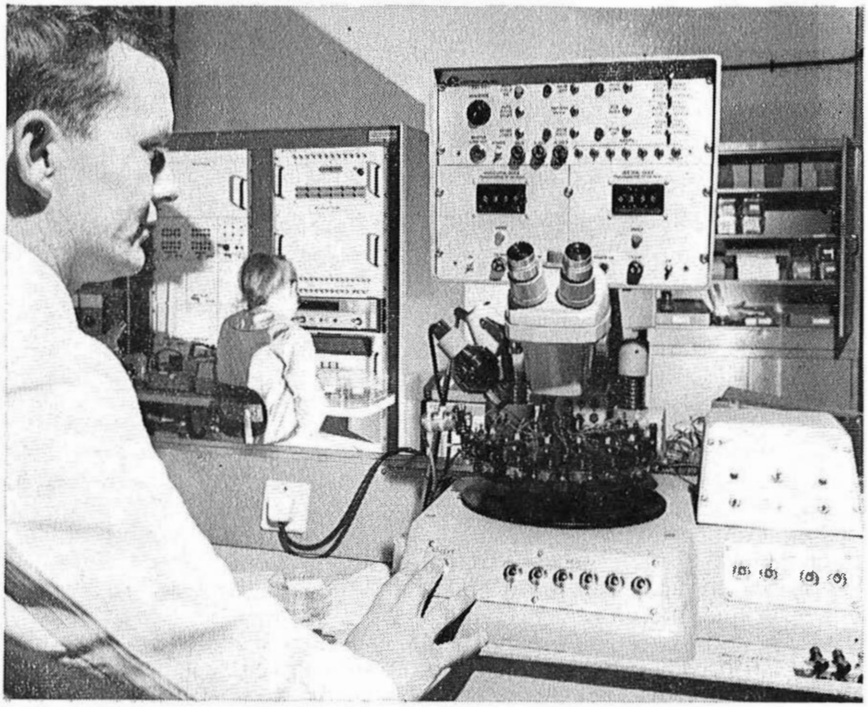
By Dr. J. R. TILLMAN, D.Sc., F.Inst.P., FIEE.

THE development of integrated circuits is the most important which has yet taken place in microelectronics. It has sprung not from any new scientific discoveries, but from the extension of techniques developed for silicon transistors. Powerful incentives from military, space and computer electronics speeded it along because all three fields required a form of microminiaturisation which would combine a large reduction of size of equipments, greater reliability and lower overall costs.

Electronic circuits today consist mainly of resistors, capacitors, transistors and diodes, which are usually mounted on a board and interconnected by a metallic pattern printed on the board. Strenuous efforts have been made to reduce the size of these circuits by making each component part smaller and by clever methods of assembly and interconnection.

But this approach to microminiaturisation has been overtaken by the new development which can put the equivalent of 50 or more of these components on to a thin chip of silicon less than one-tenth of an inch square—though the overall size after encapsulation, with leads, is several times larger.

Mass production of many ranges of silicon integrated circuits has already begun, particularly of circuits suitable for digital computers, and these circuits will soon be in use in telecommunications. Although the space saving thus made possible might never have been of overwhelming importance to the Post Office, the combination of weight saving, improved reliability and reduced costs, which the new circuits offer, will be irresistible. Considerable scope for them can be foreseen, for example,



Integrated circuits are subjected to automatic programmed tests while at the slice stage. Inspection and testing must be very thorough.—Picture: Courtesy Elliott-Automation Micro-Electronics Ltd.

Micro-electronics has taken a big leap forward with the development of silicon integrated circuits which have already found many uses in military and space projects. Integrated circuits have many potential purposes in telecommunications, particularly in telephone switching, pulse code modulation and data processing and transmission. New facilities for subscribers will also become practical and there will be major savings in space, power, first costs and in maintenance

in future generations of electronic telephone exchanges and in both the terminal and line equipment of pulse code modulation systems.

The Research Branch of the Engineering Department is itself developing a small experimental exchange which will use many integrated circuits. The exchange will handle conversations in pulse-code-modulated form. Incoming junctions will carry up to 24 conversations, which will be switched out to other junctions, also capable of carrying pcm signals, according to dialling information, without having to convert from pcm to audio before switching and audio to pcm after switching.

The integrated circuit was developed indirectly from the germanium transistor which inaugurated the era of the solid state device. Having no need of a heater or filament the germanium transistor made possible a greatly increased packing density of components, thereby giving a stimulus to microelectronics. In addition, germanium paved the way for silicon, its rival as a semiconductor suitable for transistors. Silicon technology took some years to be brought under adequate control but, when it was, the expected advantages of the ability of silicon devices to work in higher ambient temperatures, to withstand higher voltages and to have very low failure rates were soon demonstrated.

Then, in the late 1950s, the silicon planar technology was developed. Processes of oxide masking, photolithography and solid state diffusion were used to convert a slice of homogeneous silicon into an array of potential transistors. The areas of the emitter and base regions could be very accurately defined by the photolithography. After a further sequence of processes combining more photolithography with the deposition of a metallic film and its etching away in all but a few selected areas, the

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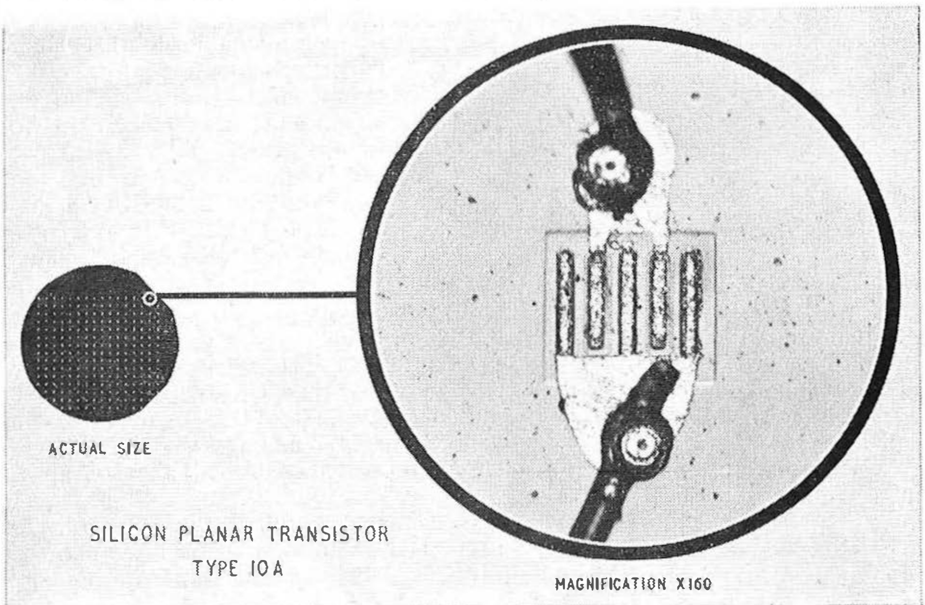
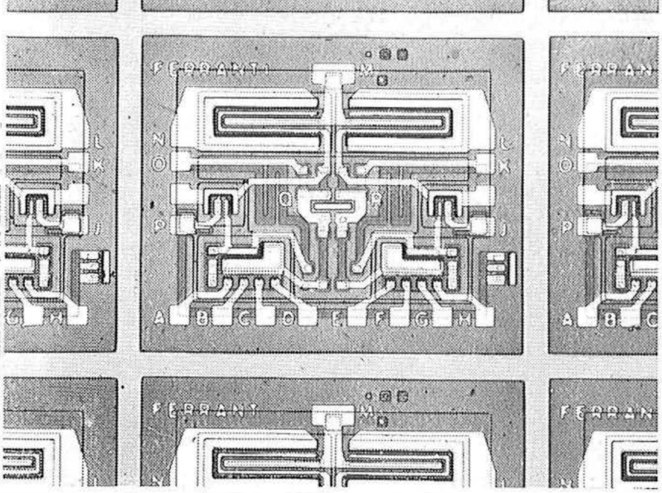
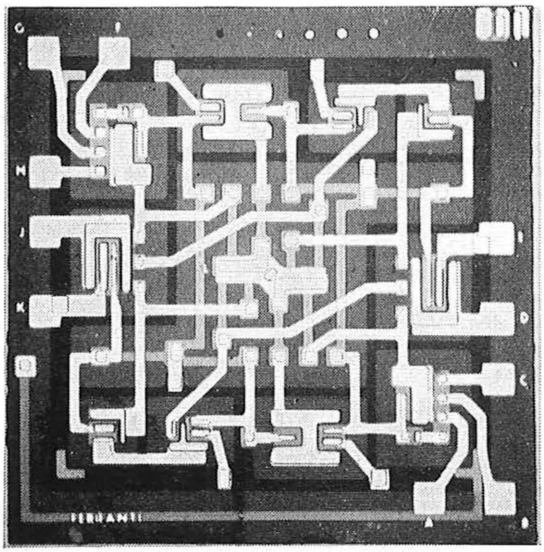


A magnified image of a planar transistor is shown here alongside the slice of silicon on which it and 200 other similar transistors were made.



Above: A slice of silicon can be converted into many integrated circuits. Here (magnified 40 times) is part of a slice which will be divided into many chips, each containing one circuit. Below: This integrated circuit chip (magnified 80 times) contains ten transistors, 16 diodes, 14 resistors and two capacitors. Connections for external use have yet to be added.



slice can be cut into many hundreds of chips, each containing one transistor ready to be mounted on a header, to have lead wires attached to the small remaining metallised areas and to be encapsulated.

The planar process needs careful control at many stages and the sets of masks used in the photolithography must be very accurate and capable of alignment to better than one-twentieth of one thousandth of an inch. This process is used by the Post Office for making transistors for the repeaters of future high capacity underwater cable schemes.

Once the process had been mastered, the steps to simple integrated circuits were quickly taken. Clearly, a processed slice need not be reduced to chips, each carrying only one transistor. Larger chips could carry several transistors and a simple addition to the processing ensures effective electrical isolation between transistors on a common chip. By extending the pattern of evaporated aluminium, the collector of one transistor on the larger chip could, for example, be connected to the base of another and the two emitters connected together.

Small diodes, capable of passing adequately large currents when biased in one direction and negligible current in the other, are easily made by the planar process, side by side on a slice with transistors, by arranging for the oxide masking to be removed only for the diffusion processes essential to them. They are required in large numbers in some switching and computing circuits. Such diodes, when reverse-biased, behave electrically as capacitors—though of strictly limited capacitances. More area of the slice must be devoted to each diode if large values are required. But capacitors are formed as simply by a sandwich of silicon, silicon dioxide and metallic film without adding new processes or new materials to the planar technology.

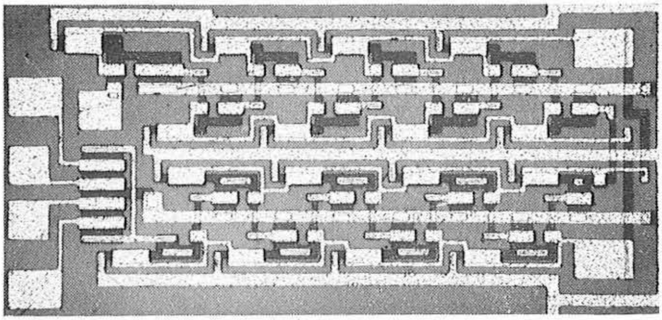
The passive component required in largest numbers in most circuits, whether designed to handle digital or analogue signals, is the resistor, hitherto made of fine wire, a carbon rod or a thin film of carbon or metal. But a thin diffused layer of silicon such that is easily produced by the planar technology and isolated from the underlying substrate, can be given a wide range of conductivity, by control of diffusant and of the time and temperature of the diffusion process. Control is not yet good enough to produce the close tolerances of some conventional resistors, but many circuits can be made to depend more on ratios of resistances (which can be better controlled) than on absolute values.

One component required in some conventional circuits, is the inductor. This cannot be usefully fabricated by the planar technology but its properties can be simulated with moderate success by circuits containing transistors, resistors and capacitors. Improvements are needed to satisfy the more stringent requirements of some telecommunications circuits.

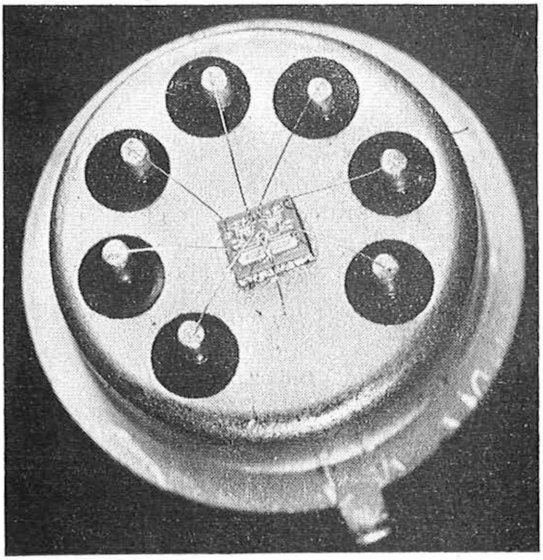
At first, the integrated circuits, consisting of no more than ten built-in components, were fairly simple. Popular among these were logic circuits aimed at the computer market. They had three or four input terminals, one output terminal and two terminals for supplying power to drive the circuit. They were designed to operate in one of several ways. In one design, the output showed a response only when all the inputs were energised; in another when at least one input was energised. Elaboration of these circuits soon appeared, incorporating 20 to 50 integrated components and capable of more complicated signal processing. The chips were a little larger and the overall number of external connections rose.

Linear or analogue circuits were also developed, some of them able to amplify signals of very wide bandwidth. Although their performance fell short of that of the best discrete-component circuits, they demonstrated their potential for many fields of application. There are markets for hundreds of thousands of each of a series of logic circuits but none seems imminent for any particular linear circuits. The properties of linear circuits specified by different users differ too much at the moment to allow concentration on only a few circuits and small runs of highly individual circuits are costly. Fortunately the experience gained in mass producing the logic circuits is relevant in many ways to linear circuits so that progress is being made with the latter despite the absence as yet of big markets.

During the development of silicon integrated circuits a new solid state device had been developed. It exploits a physical effect different from that which made the conventional junction transistor possible, but is called a Metal-Oxide-Semiconductor Tranistor (MOST). It is best made by a simple adaptation of the planar technology, though requiring fewer processes than does the planar tranisistor. It can be made in two distinct types, electrically mirror images of each other. When one of each is suitably interconnected, a storage element is produced which responds quickly and consumes very little power except during "writing" or "reading" operations. Very large arrays of these units have been made.



Above: An integrated circuit employing MOS transistors (magnified 56 times). Below: A circuit (magnified eight times) mounted on a header, with fine wire connections to stout external leads. A cap is added to seal the unit hermetically.



Fourteen lead wires suffice for most logic and linear circuits made so far but even this number is too many to be easily accommodated in the encapsulations used for low power transistors. Consequently, new designs of enclosure have been proposed. Two at least are produced in quantity. One, the flat pack, can be connected to a printed wiring board by welding or microsoldering its narrow strip connections. Packing densities can be very high. The other,

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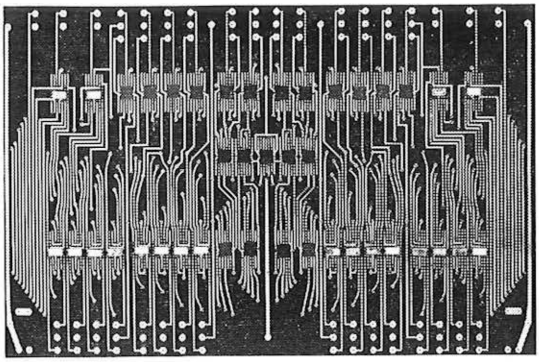


A column card of a switch proposed for use in a PCM exchange using integrated circuits. The card contains 14 double crosspoint gates and associated logic. Twelve cards make up the whole array.

the "dual in-line", has leads bent so that they can be pushed through 14 suitably-spaced holes in the printed board and dip soldered.

The most severe problem which manufacturers of integrated circuits have had to face is that of low yield. This is attributable to many causes, including defects or lack of uniformity in the initial silicon, inaccuracies in masks or their alignment, lack of reproducible behaviour of some of the materials used in photolithography and small uncertainties or fluctuation in furnace temperatures affecting diffusion. Only those chips which satisfy thorough tests go on to be mounted, to have their leads connected and to be encapsulated, when further losses are encountered. Very low yields were obtained when circuits integrating large numbers of components were first attempted. Indeed, some manufacturers sought a solution by making a range of very simple chips with a high yield and so designed that many complicated circuits could be made by mounting and interconnecting several chips within one encapsulation.

Other approaches to producing more complicated circuits without experiencing large losses due to defective elementary components have been suggested. Extra components can be included in each group which is to become a circuit, the interconnection of the components being determined only after extensive testing. Other suggestions involve completely new techniques for these connections, using an electron beam instead of photographic masks to define them. The beam would write a pattern under the control of a computer to which has been fed the information about the positions of satisfactory components and the particular circuit configurations required.

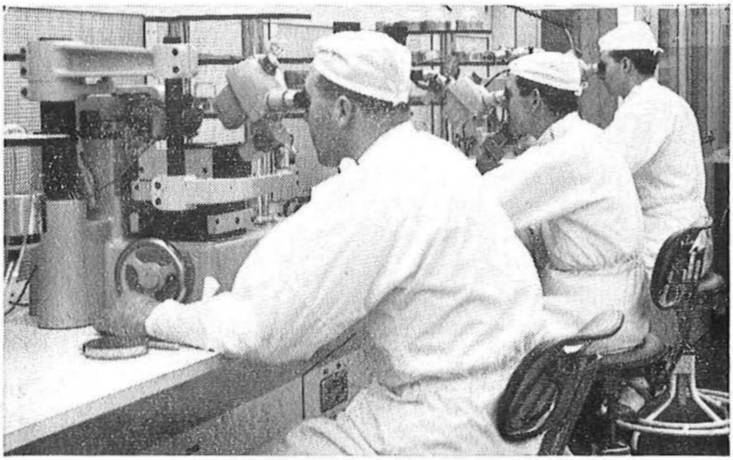
As the yields of circuits have improved, however, designers have set their targets of circuit complexity higher. Large scale integration aimed at building circuits with hundreds or thousands of components is currently occupying much attention. The technological problems it poses are severe and complex. Their solutions require simultaneous attention to many individual processes combining several scientific disciplines and calling for a large team of workers with a wide range of skills. The large number—50 or more—of external leads which a practical circuit containing a thousand components may require sets a particularly severe problem. A full scale test of such a circuit would require extensive test gear of high quality and some hundreds of separate tests.

The reduction in size and weight afforded by the integrated circuits made by the planar technology has never been in doubt. The savings in power consumption are less impressive, particularly in circuits designed to respond very rapidly, but can be important in some applications. The information on reliability, though not complete, is very promising and the costs of manufacture and the prices to the user are steadily falling.

Two other important advantages of integrated circuits are emerging. Systems can be designed around them more rapidly than they could with individual components—since so much is already done in the circuits themselves—and systems can be much more quickly produced.

The drawbacks of using integrated circuits must not be overlooked, however, even if some are steadily diminishing. Circuits designed to work satisfactorily over a wide range of temperature cost considerably more than those suitable for a strictly limited range. Most circuits are designed to handle and generate comparatively weak signals. If they are used in electrically noisy conditions, such as a Strowger exchange might produce, the unwanted signals picked up may give false operation of digital circuits and spoil an otherwise adequate signal/noise ratio in analogue circuits.

The circuits need protection against power



The silicon planar technology produces devices so small that the system demands considerable use of microscopes, both for inspection and assembly.

surges, even of very short duration, rather more so than do conventional transistor circuits. Practical difficulties of mounting on, and possible removal from, miniature printed boards may yet come to light. No integrated circuits produced so far can match the performance required in a submerged repeater or a wideband intermediate-frequency amplifier for a microwave relay system.

The coming of integrated circuits must inevitably change the roles played by many electronic engineers and the education best suited to their profession. The separate functions of component makers and equipment and systems manufacturers may largely disappear, mixing together technologists and engineers as never before.

Telecommunications cannot fail to benefit greatly from these developments of integrated circuits and the many more to come. Subscribers' equipment may well be the site of many integrated circuits for processing information, given by the subscriber via a dial or set of push buttons, for immediate or future use. Speech recognition may be much facilitated by the availability of integrated circuits and the newer electronic postal plant will be made ripe for conversion, particularly if machines for reading typescript or handwriting are included. There could be scope in a computer network and in electronic teleprinters. Integration is also being studied in microwave circuits.

Now that the circuits are becoming available and prices are falling, the engineer is presented with a challenge to find ways of using them to provide new services cheaply. He will undoubtedly accept the challenge and produce facilities which have hitherto been entirely ruled out on grounds of cost and physical size.

The shortening of the time scale of equipment design and system development and production could present major problems in the field for the Post Office. The temptation hurriedly to put large quantities of equipment mainly composed of integrated circuits into conventional buildings, with only a comparatively small staff needed to attend to the rare faults, may have to be guarded against initially lest unforeseen difficulties occur due to inaccessibility, errors in maintenance and the possibility that full compatibility with the existing network has not been achieved.

That slight warning note should not, however, be read as implying the need for any serious brake on the introduction of integrated circuits into telecommunications. The potential they offer in reduced costs, greater reliability, new facilities and a speedier route to systems capable of a better service for the subscriber is enormous.

THE AUTHOR

DR. J. R. TILLMAN, *Deputy Director of Research, Post Office Research Station, Dollis Hill, joined the Post Office in 1936, having previously carried out research in atomic and nuclear physics at Imperial College.*

During his varied career in the Research Branch, Dr. Tillman has been very much concerned with solid state electronics since the discovery of the transistor and in speeding the introduction of solid state devices in the Post Office.

Duct Sealing—A New Method

Post Office engineers have now perfected a new way of sealing ducts which cuts costs and can be used on all types of PVC cable designs

By D. W. STENSON

A NEW method of sealing ducts—known as the PVC Duct Seal—which also simplifies the work of protecting buildings and does so at reduced cost, has been developed by the Post Office Engineering Department and is now being used in all new telephone buildings.

The new method uses the principle of caulking, or packing, between the cable and the inside of the duct mouth. It can be applied to almost any cable, irrespective of sheath material and without fundamental changes to the duct seal design. It also effectively insures against water and inflammable gases entering the building and possibly causing flooding or an explosion.

In small installations where only one or two ducts enter a building it is usual to fill the space between the cables and the inside of the duct with a non-setting compound. In larger installations, duct seals bonded to the cable sheath are used. With lead-sheathed cables a sheet of lead is mounted in a steel frame and bolted over the duct entry. Holes are cut in the sheet for the cables to come through and the cables are then plumbed to the sheet.

The introduction of plastic-sheathed cables made it no longer possible to plumb the cables to the sheet. This problem has now been overcome by passing the cable through a short length of lead plumbed to the sheet and packing mastic compound between the cable and the lead tube. This method will continue to be used with all existing lead duct seals. Since the sealing process requires the services of a plumber, however, this is an expensive method to apply to plastic sheathed cables, particularly as they are now so extensively used.

Reduction in the price of plastic permitted the general introduction of plastic ducts. At first these were used to improve the duct track between a building and its adjacent manhole and this led in due course to the complete re-design of the duct seal.

A jointer plumbing a new cable into an old-style duct seal. Note the lead tubes.

The plastic duct seal produced its own problems, the biggest being how to seal the cable into the mouth of the plastic duct. This was solved by using a packing compound between the cables and the duct.

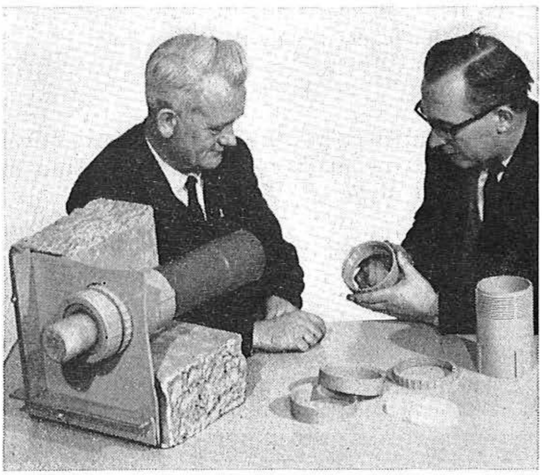
Another problem is that when buildings are constructed, an opening or "window" is left in the basement wall into which the ducts are subsequently concreted. Concrete tends to shrink during setting and leave a leakage path around the "window". Plastic ducts do not bond to their concrete surround so that gas or water could percolate along the outside of individual ducts and so into the building. This difficulty has been overcome by covering the duct entry with a plastic sheet and sealing the individual ducts into this sheet. This new sheet seal is of a rigid polyvinylchloride (PVC) material, the same as used for the ducts.

Since the duct track can contain almost any number of ducts and enter the building at a fairly wide range of angles, each seal has to be tailored for the particular job. The conditions under which much of the work is done do not allow precise design before installation and since the use of welding or adhesives to bond individual ducts into the sheet is not practical, a special end-piece or gland has had to be designed to join the duct and the sheet.

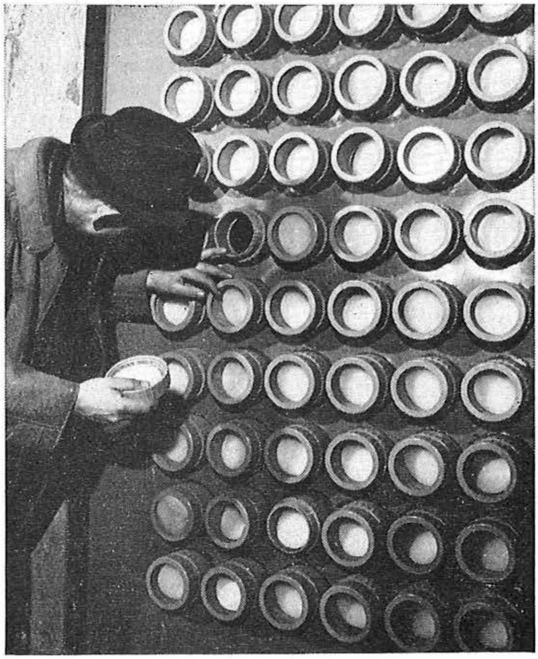
The gland is designed to allow for constructional inaccuracies and to accept ducts approaching the building at any angle up to 15 degrees—the normally accepted maximum angle for ease of cabling. A well-defined packing or caulking space is also provided and loose polythene discs are used not only to restrict the caulking compound which, because of its non-setting properties can flow in time, but also to prevent accidental disturbance of the seal.

A cap-nut is also provided to prevent extrusion of the compound due to the long-term effects of water pressure in the duct behind the seal.

The new duct seal, apart from being cheaper, will meet the needs of the future and cater for all forseeable cable designs.



The author (right) and a colleague examine a sectionised model of the new duct seal. Mr. Stenson is holding a seal gland.



A works supervisor examines a recently completed 60-way PVC duct seal at Houndsditch.

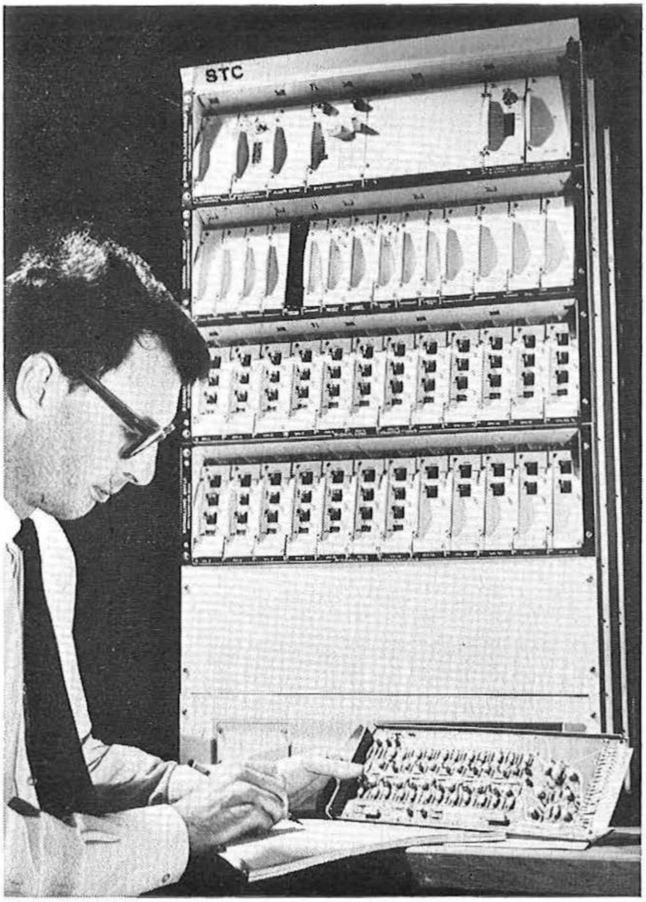
Experience with the London Radiophone Service, which was introduced in July, 1965, has shown a need to simplify the operation of the mobile equipment and to provide better supervisory indications to the switchboard operator.

For these reasons, plans are in hand to introduce as soon as possible a new service in which the mobile equipment, when switched on, will automatically search for a free channel and repeat the process if that channel becomes engaged. Each mobile equipment will be given a unique code and have a decoder set to respond to that code. When called, the equipment will automatically transmit an acknowledgement signal, even if the customer is not available to answer the call.

Under the new scheme, 30 radio channels will be available and a mobile equipment will have access to all of them. Since the channels will be individually allocated to a number of radio stations in each service area—in London there will be three—the equipment will be designed to differentiate between free channels, engaged channels and those not allocated.

★

The Post Office has decided to amend its engineering terminology by adopting a new term and a new abbreviation. In future the term "hertz" will be used in place of "cycles per second" as the unit for frequency and the symbol dB, instead of db, as the approved abbreviation for decibel. These changes will bring the British Post Office into line with the terminology used in most other counties.



THE EXCITING PROSPECTS OF PCM

By J. F. P. THOMAS, BSc., MIEE

This article discusses ways in which Pulse Code Modulation techniques are being used and may in future be used in the Post Office communications network. Recent developments suggest a number of exciting possibilities

A research engineer examines and tests a 24-circuit terminal equipment. The complete equipment is only three feet high.

PULSE Code Modulation (PCM) is now a fashionable talking point in telecommunications. Publications and discussion reflect a range of reactions varying from the belief that the day of instant circuits is with us to the fear that PCM is an invention of the devil which no God-fearing planner would use as an alternative to a multiplicity of good copper wires.

The truth is somewhere between these two extremes and now that the Post Office has placed the first large United Kingdom orders for PCM, its present and future status can be assessed in the Post Office network.

Briefly, PCM uses terminal equipment which converts electrical signals generated by the telephone into trains of data like pulses. The trains of pulses from several telephones are then interleaved so that they can all be transmitted in one pair of wires. At the other end of the circuit the interleaved pulses are split into separate trains and then re-converted to the conventional electrical equivalents of speech signals. (A more detailed description of the technique was published in the Autumn, 1964, issue of the *Journal*.)

The systems at present commercially available in Britain provide 24 telephone circuits on two pairs of wires (one pair for each direction of transmission). The pairs in existing types of audio cable are suitable for this purpose. Boosters, called regenerative repeaters, are mounted in sealed boxes and sited in manholes

Girls at STC's Basildon factory assemble units for PCM terminals. The Post Office has already decided to order £6 m. worth of PCM transmission equipment.

every 2,000 yards along the circuit to compensate for the losses experienced by the pulses.

The multiplex equipment at terminals which undertakes the conversion into, and from, the interleaved 'data' signals is complex, but small. Further terminal equipment is required to send power to the regenerative repeaters and to perform the various signalling tasks. A complete 24-circuit terminal occupies about three feet on a standard bayside and the equipment is powered from exchange batteries.

PCM cannot provide instant circuits since this involves external work to the cable systems and internal work at the terminals. It does, however, in many circumstances, provide cheaper circuits than "good copper wires". Orders have already been placed with two contractors for about 140 of their individual designs of 24-circuit systems which are scheduled to be working by the end of 1967. Since the contracts were arranged the specification of a standard Post Office system has been completed and substantial orders to new specifications are now being placed.

The Post Office buys transmission equipment on a competitive basis and a number of manufacturers have developed, or have indicated their intention to develop, PCM systems for Post Office use. A balance had to be struck between the desire to give manufacturers the maximum design freedom and the need to standardise so that all makes of PCM equipment could be interconnected and present the Post Office with a reasonable maintenance proposition.

Experience of three trial systems, consultations with telephone organisations in Europe and America, and calculations and experiments by Post Office Research Branch and manufacturers enabled the basic technical parameters of a Post Office system to be agreed. Post Office requirements for standardisation have been met by the introduction of certain digital interfaces and between these interfaces the equipments conform to a standard specification for physical dimensions, external connections and power supplies. The designers, however, have complete freedom in the way they meet the performance requirements, subject to the Post Office being satisfied about the reliability and ease of maintenance of the equipment. An agreed fault-locating technique permits standard fault-locating equipment to be used on any make of system.

Initially, the PCM systems will be used to meet growth on existing audio junction cable routes

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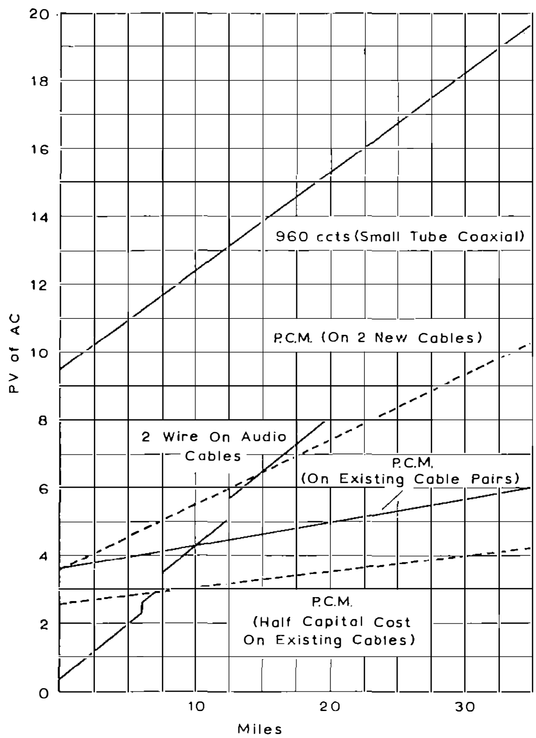

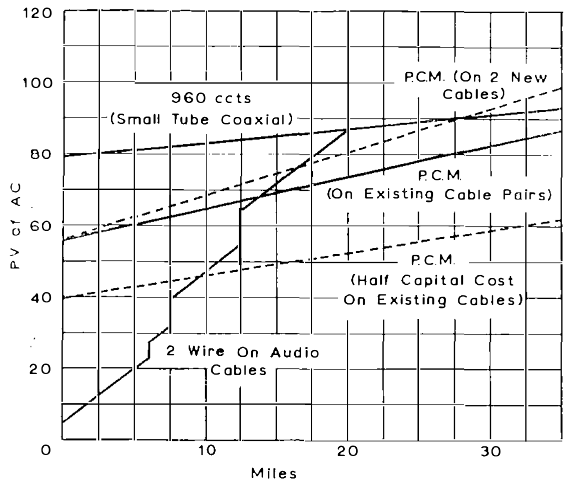

These two diagrams illustrate the comparative costs of providing a number of circuits by ordinary audio cable and PCM for (left) a low growth rate and (right) a high growth rate.

as an alternative to the laying of new audio cables and the planning of such systems has been made a Regional responsibility. The PCM equipments will be ordered as stores items in the same way as audio transmission equipment. Bulk annual requirements will be forwarded to the Engineering Department and the equipment will be made available to the Regions through the Supplies Department.

Regions will install the equipment by direct labour. Preliminary planning information is now available so that the Regions can determine the economic advantages of PCM or audio provision in particular circumstances, and assess the technical suitability of routes for PCM. These preliminary planning rules are, as yet, only a conservative estimate of the PCM potential of various types of audio cable but more accurate and, it is hoped, more liberal rules will be drawn up when a large programme of cable measurements at the frequencies involved in PCM working has been completed.

To assist Regions during the development stage, the Engineering Department has arranged courses for Regional Planning Engineers at Headquarters. The training of staff for installation, commissioning and internal and external maintenance duties will be undertaken by Training Branch.

From the provisioning and maintenance points of view PCM should not be allowed to grow on a random point-to-point basis. Simple point-to-point provision would result in unnecessarily frequent cable works where different routes have common cable sections and result in unnecessary hazards to circuit security. It would also mean that maintenance control would be ill-defined and difficult to operate efficiently. Schemes are being planned, therefore, with standard digital interfaces at all spur points to minimise disturbance to cables in the field and allow section-by-section maintenance control. The extra equipments needed to provide the standard digital interfaces are not expensive and the cost is off-set by the saving in the number of spare links required for circuit restoration and fault location.

New techniques such as PCM are not introduced because they are new or ingenious. PCM, in fact, is one of the best examples of the control which economics places on the introduction of a new technique. The original idea was formu-

An operator at STC's Basildon factory examines a completed 24-circuit, two-way repeater unit. These units, placed at intervals in a telephone circuit, accept the PCM pulse signals and instead of merely amplifying them, completely regenerate a new replica of incoming pulses. At each repeater unit the signals start off again as new and arrive at the distant junction end noise-free and unimpaired in quality.

lated in 1938, but it had to wait 20 years for suitable electronic components to be developed before it could be exploited economically.

The introduction of audio amplifiers, carrier systems on paired cable, coaxial systems, microwave radio and now PCM has occurred only as these techniques have proved to have the best overall economics to meet the requirements of some part of the transmission network. The pattern of progress in communications has, indeed, been a triumph of brain over brawn. Over the years, systems employing more advanced technology have gradually justified their use in an increasing part of the network.

Many factors, such as growth rates, influence the relative economics of the various forms of provision. The cost comparisons take into account 24 circuit PCM systems on existing audio cables, conventional 960 circuit systems (FDM) on small tube coaxial cables and audio provision by the most economic audio techniques at present available (10 lb cable with negative impedance repeaters and DC 2 signalling as necessary) over the range 0 to 40 miles. In cost comparison, PCM is in strong competition with audio cables in the 10 to 20-mile range and also with small tube coaxial systems at the higher circuit growth rates in the 20 to 50-mile range. This competition is maintained over part of the mileage range even if it is necessary to lay new cables to accommodate the PCM systems. Local factors can introduce significant deviations from the mean when costs are compared.

A planner who stakes his reputation on PCM prices dropping more rapidly in the long term than other forms of provision could even be bold or foolhardy. But he would be less bold and foolhardy to suggest this will be the pattern over the next few years. Curves have been included on the effect of halving the capital cost of PCM and, as expected, this extends the mileage range over which PCM is attractive. If this should be the price trend and PCM systems prove completely satisfactory in the field the demand could well rise above 1,000 systems a year.

Looking ahead, communication engineers can reasonably say that it is possible with known techniques for every house to be connected for vision 'phone, piped colour television, newspapers by facsimile, shopping by data 'phone, remote meter reading and a host of commercial applications for data transfer and telemetering and control.

Possibility becomes reality when the price at which a service is offered equals the price the consumer is able and chooses to pay for it. These forecasts of things to come are not for the short-term planner but when they do come, as they will, it may well be an all-digital network that provides it. In the more immediate future (say the next 15 years) digital techniques will have to justify themselves on the economics of carrying speech circuits. While the demand for data and allied services will undoubtedly in-

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crease during this period, the suitability of PCM for these services can be only a bonus and not the main reason for its choice as a medium.

As the development of microwave radio and coaxial cables has been encouraged equally over the last decade, irrespective of transistory advantages of one technique over the other, so should the development of digital and analogue techniques be encouraged equally over the next decade and the results of both be exploited.

It is too early yet to write off existing techniques or to assume that the old and the new will not live successfully side by side. It could be a costly mistake to start thinking of analogue techniques as moribund. The immediate requirement in the development of PCM is to agree a hierarchy of digital transmission systems that will best meet the various needs of the entire network and then decide at which level it is possible and most profitable to develop next.

THE AUTHOR

MR. J. F. P. THOMAS *is a Staff Engineer in Main Lines Planning and Provision Branch of the Engineering Department, concerned with the planning, provision and utilisation of the Trunk Network. He joined the Post Office in 1937 as a Youth-in-Training.*

ANOTHER FIRST FOR BRITAIN

THE Post Office is shortly to begin work on installing the world's first Pulse Code Modulation tandem exchange. It will be set up at London's Empress Exchange and when it becomes operational, at the end of 1967, selected traffic from the Acorn, Ealing and Shepherds Bush exchanges will be directed through it to test the combination of PCM switching and transmission systems.

If, during the feasibility trials, the switching experiment proves successful, it will encourage a much greater use of the new transmission system and hence reduce the need for many new cables and road works.

Pulse Code Modulation—pioneered by an Englishman, Mr. A. H. Reeves, in the late 1930s—had to await the development of the transistor before it became a practical and economic proposition. The transmission systems have been largely developed by industry to basic requirements determined by engineers at the Post Office Research Station at Dollis Hill. Post Office engineers have also developed the technique for switching traffic in digital form and ensured that the transmission and switching systems are compatible.

When junction pairs are used for PCM, the loading coils are replaced by specially-designed regenerative pulse repeaters which makes it possible for two pairs to carry 24 conversations. The speech from 24 individual sources is sampled and coded, then interleaved to form a sequential pulse train which is passed over the repeatered junction.

Intermediate digital exchanges, similar to the one to be installed at Empress Exchange, can be used to interconnect the coded traffic which emerges at the remote end of the junction as good in quality as when first coded, no matter how far the distance it has travelled or how many switching centres it has passed through. The digital signals have to be reconverted into audio form before being transmitted to the subscriber.

The introduction of PCM on a wide scale could provide up to 12 times the capacity of that part of the telephone system which at present is provided on an audio basis.

The use of PCM techniques also enables the physical size of tandem exchanges to be greatly reduced. The work of some 300 relays, for example, can be performed by a card only about eight inches square on which silicon solid state components are mounted.

The Post Office has already decided to place orders for £6 million worth of PCM transmission equipment. Some was recently ordered from Standard Telephones and Cables Ltd. and the General Electric Company and the remainder has been put out to tender.

Similar systems for switching and transmission systems are undergoing trial in a number of European countries and in the United States and Japan.

Kinlochbervie, in the north-west of Scotland, one of the wildest and most beautiful parts of Britain and one of the most difficult in which to establish and maintain communications links.

A BIG TASK FOR SCOTLAND

By T. C. CARPENTER

The Post Office in Scotland has embarked on a £6½ million scheme to expand and improve its telecommunications services, building a chain of radio links, installing automatic switching centres and extending STD

SCOTLAND is a land of infinite contrast and variety, from the rich farmlands and the tweed mills of the Borders to the teeming central belt with its two great cities of Glasgow and Edinburgh; across the new road bridges to Fife and the rival cities of Dundee and Aberdeen and north and west to the Highlands and Islands where the ancient Gaelic language still lives.

The task of providing Scotland with essential communications was never easy and in recent years it has presented new problems and new challenges.

For the past three years in common with the rest of Britain, the Post Office in Scotland has been coping with a phenomenal increase in demand for telephone service. In 1962 demand was 32,000 new telephones. Last year over 72,000 were fitted—an increase of 125 per cent in three years! In 1965 demand for new telephones in the Glasgow area alone equalled the total demand three years earlier for the whole of Scotland.

In 1946 there were about 226,000 telephone lines in Scotland. There are now more than 600,000. In the next five years the total is expected to exceed one million. In other words, we have to plan for a greater expansion in the next five years than was achieved in the last 20.

And the end is nowhere in sight. Demand in Scotland in the June quarter of 1966 was up by

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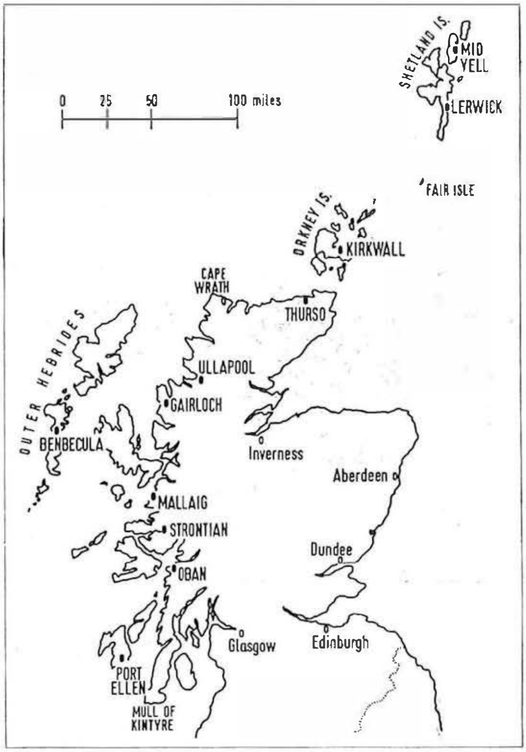

Left: Scotland, land of infinite variety—and telecommunications problems. Below: The duct route for the main small-bore coaxial cables to the Highlands leaves Inverness.

nearly 30 per cent over the corresponding period of 1965 and it was confidently forecast that the total demand for 1966 would not be far short of 100,000 new telephones. This was not, in fact, achieved because the economic freeze and the decision to require new and removing customers to pay a year's rental in advance damped down demand for a time. But the potential is still there and plans must be made to meet it.

Nor is this all. People are now using the telephone more and more for both local and trunk calls. Last year about 600 million local telephone calls were made in Scotland. In five years time this figure is expected to rise to over 1,000 million calls. Last year about 75 million trunk calls originated in Scotland. In five years time this figure is expected to have doubled.

This story could be repeated for every other Post Office Region. In the next five years all Regions are faced with a many-sided task. All have to try to meet the demand for new telephones; all have to expand the network of trunk and local lines and the associated equipment to cater for the massive increase in the number of calls. All have to press ahead with the programme for converting manual exchanges to automatic and extending the scope of subscriber trunk dialling for both inland and international calls. All have to take steps to ensure that the quality of service to subscribers does not fall below an acceptable minimum standard. And all have to do these things while taking advantage of new techniques and new methods designed to keep costs to a minimum.

Scotland, however, has one unique problem. The distance as the crow flies from the Mull of Kintyre north to Cape Wrath is about 200 miles. But the coastline covers many times that distance. And in the whole of the vast territory north and west of Glasgow there are just a few small towns—not one with a population of as much as 10,000—and a multitude of villages and crofting communities.

Above: Distances are so great and the countryside so remote and wild that personnel carriers have to be used. Right: An engineer carries out tests on a mountain top to pin-point the site for a new radio station in the Western Isles.

Across the Pentland Firth lie the islands of Orkney and, beyond, far out in the northern seas, are the bleak Shetlands. To the west are the romantic Hebrides: Skye and Iona, Coll and Tiree, Islay and Mull, Eigg and Rhum and the Outer Isles: Lewis and Harris, the Uists and Benbecula. All told there are 700 islands of which 150 are inhabited, and where there are people there is need for communication which the Post Office alone can provide.

In recent years it has been a major concern of successive Governments to stem the migration which was threatening to depopulate this remote region. Old industries such as the manufacture of tweed in Harris and Lewis, and of knitwear in the Shetlands are thriving. Distilleries are working at top pressure and new ones are being built to supply the world with whisky. The Forestry Commission are planting vast new timber forests throughout the Highlands. New industries such as the great pulp mill at Fort William are giving the region a shot in the arm. Most important of all, new roads and car ferries are opening up the Highlands and Islands to thousands of summer tourists.

All these developments, and more promised for the future, are conspiring to strain the telephone resources in the area which, inevitably, have fallen back in the race for modernity. When capital and equipment were scarce the first priority naturally had to be given to the bigger towns and cities of Scotland, and the telephone service in the remoter areas is, by modern standards, relatively primitive. There are a good many small automatic exchanges in the Islands but throughout the area a high proportion of local calls and all trunk calls are connected manually. Some of the main trunk routes in the far north-west of Scotland are still provided by open wires—for example, the route on the road to the Isles, from Fort William to Mallaig. Moreover, the whole network has grown in a haphazard fashion.

The Post Office in Scotland is now planning a sensible pattern of service for the area as a whole. A scheme has been worked out which will give the telephone service in the Highlands and Islands a completely new look and bring automatic service and STD to all subscribers in that part of Scotland except, for the time being, those on Fair Isle, midway between the Orkney and Shetland groups, and telephone call office users on the tiny islands of Foula, Soay and Stroma

The main problem in working out this plan in detail was how to link the many small exchanges to one another and to the main trunk

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Typical of the wild Scottish countryside is the road south of Lochinver. The only reassurance that it will ultimately lead somewhere is the row of telegraph poles.

The duct route for the main small-bore coaxial cables to the Highlands passes under the railway line at Beauly on its way to Ullapool.

system. Between the islands an extensive system of submarine cables would have been very costly to install and very difficult to maintain, while even on the mainland the terrain over which the cables would have to travel is wild, rocky, mountainous and often barred by broad stretches of water.

The solution is a complex system of multi-channel radio links and during the next few years more than 40 new radio stations will be erected throughout the area. On the building side alone this is a gargantuan task. It means finding 40 or more sites, often in remote and very inaccessible spots, making sure that the radio stations can operate from them and then negotiating the sales from perhaps not very willing owners. In many of these places arable land is at a premium and a great part of the non-arable land is rocky, marshy or otherwise unsuitable for building.

It means, too, finding building contractors with the will and the resources to erect the buildings in these out of the way places. Some of the sites are so inaccessible that more than a mile of road will have to be made before work on the building can even be started. But with

A telecommunication engineer's nightmare: a sea patterned with islands and skerries off Badcall Bay south of Scourie.

the help of the Scottish Division of the Ministry of Public Building and Works progress has already been made and there is no doubt that the job can be done.

When the buildings are complete there is the installation job to be done, much of it in places so remote that the installation teams will have to be provisioned almost as for a polar exploration.

The pattern of the new network will be simple. First, a number of new automatic switching centres will be established, each of them serving a large area from which calls will be transmitted to the switching centre by land line or radio. For example, a new automatic switching centre is planned to be built in Benbecula to provide the link with the mainland for all calls originating in North and South Uist, Benbecula and Barra, that is, the whole of the southern half of the Outer Hebrides. The new building on Benbecula is likely to be by far the largest building on the island.

In the Shetland Islands there will be two switching centres, one in Lerwick and another near Mid Yell. There will be other centres in Kirkwall, Thurso, Ullapool, Gairloch, Mallaig, Oban, Strontian and Port Ellen. Each of these

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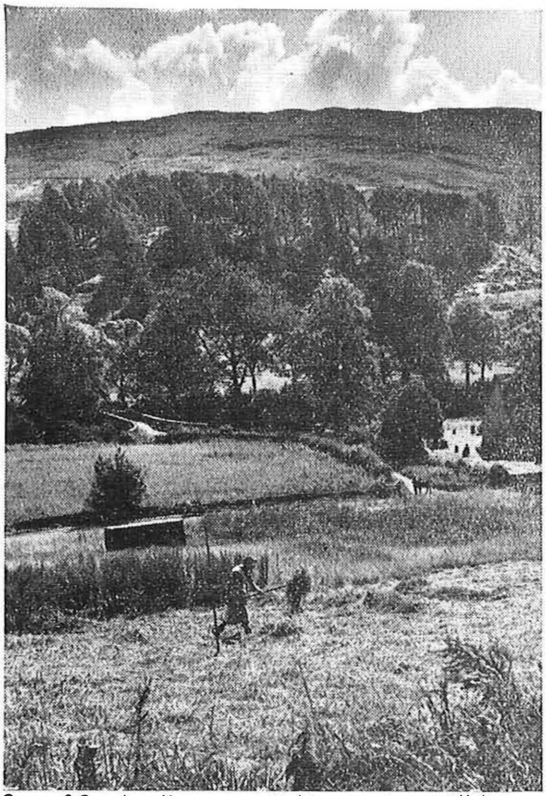
The severe winter weather doesn't help much, either. This picture shows a cable gang using a moleplough to install new cables in Caithness.



One of Scotland's new switching centres will be set up at Strontian, on Lock Sunart. Each centre will feed into the main trunk network.

On the road between Inverness and Ullapool between which a new coaxial cable system will be laid to replace the existing open wire route.

switching centres will feed back into the main trunk network of the country and the routes back to the nearest large group centres will be strengthened. Duct for a new coaxial cable is already being laid between Inverness and Ullapool to replace the open wire route which at present links the whole of the north west of Scotland with the south.

The scheme is expected to cost £6½ million, of which £4 million will be spent on the trunk system and £2½ million on new automatic exchanges and the extension of STD throughout the area. Remoteness, isolation and terrain combine to make the plan more difficult to achieve than it was to formulate. Many people are involved—the Regional experts, Engineering Department radio specialists, Ministry of Works estate surveyors and architects, and so on. One senior Ministry official, acting on behalf of the Royal Fine Art Commission for Scotland, recently flew in a helicopter over the sites proposed for the new radio stations to ensure that the towers would not mar the beauty of the surrounding countryside.

Co-ordinating the task is also proving a unique exercise for the Scottish Network Analysis Team. But despite all the difficulties the job will be done and done quickly so that at the latest by the early 1970's all those who work or play in the Highlands and Islands will have a first class modern telephone service.

THE AUTHOR

MR. T. C. CARPENTER *is Deputy Regional Director in Scotland. He joined the Post Office in 1936 and spent 28 years at Headquarters, mostly in the Personnel Department and the Overseas Mails Branch and latterly as Private Secretary to the Postmaster General. He was appointed to his present post in August, 1964.*

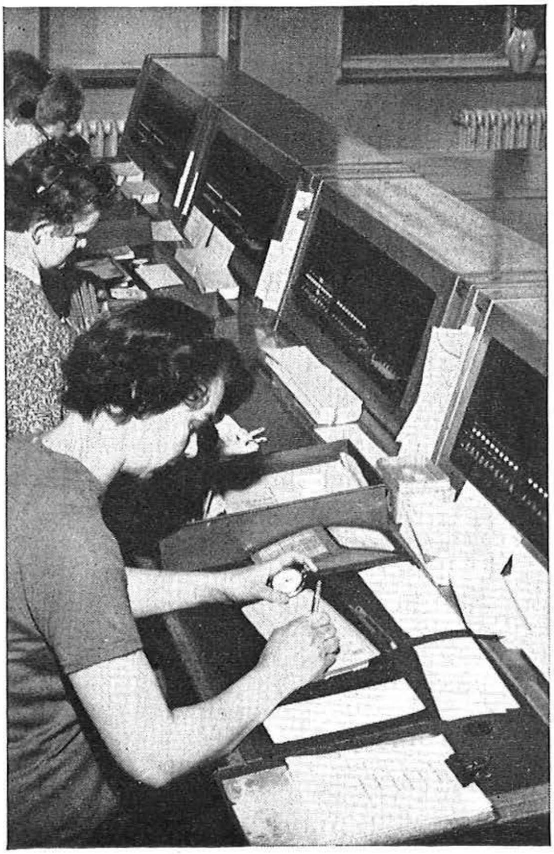
Successful trials have been carried out in Liverpool with a new system for collecting and recording comprehensive details of telephone traffic. This article describes how the system works and its advantages

THE LIVERPOOL EXPERIMENT

By J. P. HARRIS, BSc

A NOVEL approach to the problem of producing a comprehensive analysis of traffic originating in a Director Area has been tried out with considerable success in the Liverpool Telephone Area.

Here, customers on 35 Director exchanges can dial about 60 exchanges or services in the local fee area—a total of about 2,100 theoretical routings. Only a small number of these connections are made over direct routes; the great majority are set up over one or two tandem links. The conventional traffic record gives no indication of the various destinations of the traffic leaving the director exchange by way of the tandem route and, until the recent development of the Route Calls Recorder, the only method of breaking down the tandem traffic was both time consuming and tedious.



The new technique used in Liverpool was devised to obtain comprehensive information with the minimum of effort and expense and to an acceptable order of accuracy. Basically, it involves a machine analysis of Centralised Service Observation (CSO) punched cards, the information so obtained being applied to results given by normal traffic records.

The monthly CSO statistics are produced from information recorded in punched card form by service observation supervisors, one card being prepared for each call observed. For each local exchange, details of over 200 calls, selected at random by automatic equipment, are recorded in this way each month. The information is processed by the LEAPS computer unit and then published in the form of CSO statistics which relate mainly to the quality of service at each exchange.

In the trials just completed at Liverpool, 13 months' observations—about 100,000 punched cards, or 3,000 for each exchange—were analysed with the aid of equipment hired from International Computers and Tabulators (ICT) Limited which had extensive computing facilities available in the same buiding as the Telephone Manager's Office.

The punched cards were presented to the machine—an 80-column card sorter—in 35 batches, each of which consisted of cards for one originating exchange. In three passes through the machine, the cards were arranged with the digits dialled in numerical order. After

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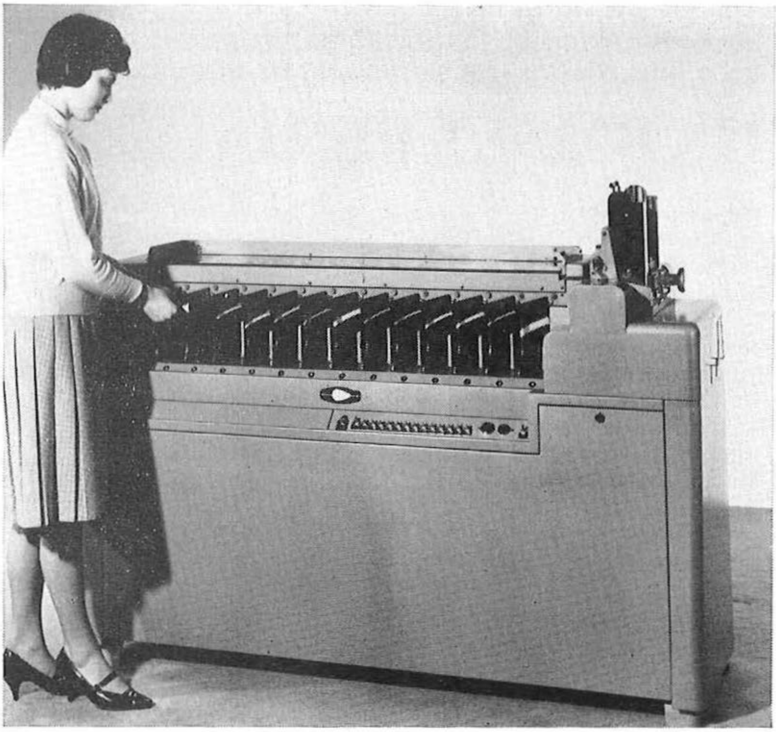
At the Centralised Service Observation Bureau, details of the progress of STD calls—shown on illuminated panels—are recorded on punched cards which are later analysed by computer.



The punched cards pass through a high-speed sorter which arranges them in destination order.

passing through the sorter they were fed into a tabulator which counted and printed out the number of calls to each destination. Sorting was carried out at an overall rate of 200 cards a minute (three passes at 600 a minute) and the rate of tabulation was also 200 cards a minute. All the information required was obtained in a few hours of machine time at a reasonable cost without passing any work on to the exchanges involved.

These distribution results were applied to the total originating busy hour traffic levels derived from normal exchange traffic records projected forward six months. In this way, a comprehensive picture of the erlang distribution of local traffic in the Director Area was built up.

Local call observations, on which the major part of the Liverpool study was based, are in practice taken throughout the period of the normal working day, most between 9 a.m. and 12 noon, and 2 p.m. and 4.30 p.m. It is assumed that although in any one exchange local traffic *levels* vary throughout the day, the percentage *distribution* of this traffic is not substantially different from the morning busy hour distribution. This assumption is, of course, necessary to justify applying observation results to a quantity measured only during the busy hour. Since the CSO results, which relate to effective and ineffective *calls*, are applied to traffic levels measured in *erlangs*, a further assumption is also necessary: that the duration and outcome of a call is independent of its destination, providing the sample size is large enough.

The accuracy of the end product depends mainly on the validity of these assumptions. Although appearing quite reasonable, they were not rigorously investigated at the time the study was undertaken at Liverpool. A simple test of accuracy is, however, quite readily available in that most of the larger quantities of traffic are actually carried on direct routes and in these instances a direct comparison can be made with quantities measured on the normal six-monthly traffic record. From this comparison it was determined that nearly 90 per cent of the figures which could be verified were in very good agreement with known results and the re-

The cards are analysed in this tabulator which counts them and prints out the number of calls to each destination at 200 cards a minute.

mainder were in any case satisfactory. Agreement seemed to be better with business than with residential exchanges.

In using the results, is has to be remembered that the method is indirect. The distribution of traffic, in *calls*, derived from the computer printout is factual, but the way it has been applied in this particular instance involves certain assumptions which need to be borne in mind in any application. On the other hand, the indirect nature of the method eliminates the hazards and pitfalls of the "unrepresentative day"—the inexplicable dips or peaks in traffic which can disrupt the best of records—since all traffic levels are uniformly projected forward to a common date.

The Liverpool study was undertaken primarily to see if the large amount of latent information stored on CSO punched cards could be extracted quickly and cheaply and used to justify direct routes to relieve congested tandem exchanges. It has also proved valuable in the preparation of traffic data and the study of changes in traffic patterns with the introduction of all-figure numbering and sectorisation. Long-term planning studies and any other feasability exercises required in connection with the routing of local traffic will also be helped forward by the extensive information made available.

THE AUTHOR

MR. J. P. HARRIS *is an Executive Engineer in the Liverpool Area, where he is concerned with auto exchange planning.*

A NEW £100,000 TV SWITCHING CENTRE

A NEW television network switching centre linking studios and transmitters in the north of England, Scotland and Northern Ireland with those in other parts of the country has been opened by the Post Office at Salford in Lancashire.

The new centre—in Dial House—replaces an existing switching centre which has been in service there since 1956 and forms part of the Post Office's national network of television links and switching centres.

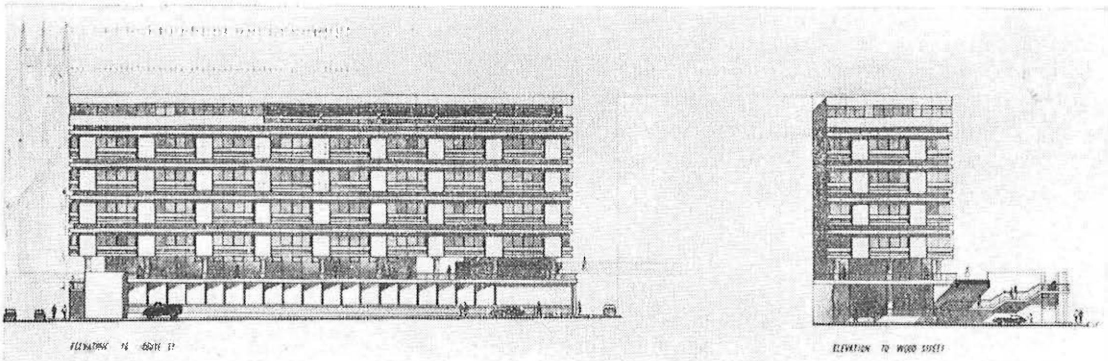
Costing £100,00 the new centre is second only to that at the Post Office Tower in London in the number of switching operations handled. It includes a repeater station and represents an important advance on its predecessor.

The design of the control room follows the national pattern and the provision of the latest and most modern equipment and the best possible working conditions will greatly assist the staff in their task of routing programmes, maintaining equipment and testing picture quality.

For the television viewer, the opening of the new centre means that in the event of a breakdown on the Post Office network, normal service will be resumed with even less delay than before. Previously, engineering staff had to move test apparatus around the equipment, making a number of plugging-in operations to locate the fault. Now, fault detection is carried out by push button from three test consoles.

There are 20 miles of television cable in the centre and equipment for colour television is being installed. There are 17 main links to other parts of the country and 38 studio links to the broadcasting authorities' premises.

DAVID NORBURY.



An architect's drawing of what the new centre will look like when completed—Reproduced by courtesy of the Chief Architect's Division of the Ministry of Public Building and Works.

A World Centre at Wood Street

By V. H. TUERENA

One of the biggest and most important telecommunications centres in the world is taking shape in the heart of London. When it becomes operational in 1969 it will house the most modern equipment

A NEW six-storey building now in the first stages of construction on London Wall, in the heart of the City of London, will house a comprehensive International Telephone Services Centre—the first to be planned as such from the outset.

The north block of Faraday Building in London is at present the main centre of all the international telephone services in Britain. But the accommodation there is limited and already the growth of traffic has made it necessary to provide both Continental and Inter-Continental manual switch-rooms in other buildings—at Wren House, Monarch Telephone Exchange and Kelvin House. Switchroom space has also been vacated in Faraday House north block to enable additional automatic switching equipment for the overseas services to be installed.

The new International Telephone Services Centre is being built on an extension of the site of the existing Wood Street Telephone Exchange and will provide about 80,000 square feet of floor space—sufficient adequately to meet the needs of the international telephone service up to about 1975. It is estimated that the maximum circuit capacity will be 3,450 overseas circuits and 3,700 inland circuits—enough, it is thought, to cater for the needs ten years hence.

The new building will house an engine room, cable chambers and car park in the basement; a battery room, electric light and power room and another car park on the lower ground level; a main distribution frame and repeater station on the ground floor; and a fan room, offices and reception centre on the podium floor. The International Maintenance Centre and switching equipment will be accommodated on the second floor, while the third floor will house the International accounting equipment and switching equipment; the fourth floor more switching equipment and offices; the fifth floor a switchroom; and the sixth floor a staff canteen, locker rooms and recreational centre. The Repeater station, International Maintenance Centre and rooms containing switching equipment will all be air-conditioned.

The switchroom will contain 114 positions which initially will deal only with outgoing, on demand and assistance traffic to the rest of Europe, although this could possibly be changed later as conditions alter. It had been hoped to install cordless switchboards but, because of the special needs of the international services, development work could not be carried out in time to meet the ready-for-service date and sleeve-control boards will be provided. The switchroom will operate exclusively to the Switching Centre in the same building.

The International Maintenance Centre will form the transmission fault reporting, circuit control and maintenance centre for the technical services which terminate in the new building and the initial access point for the corresponding overseas technical services for any engineering matters of an operational or maintenance nature. Automatic aids will be used wherever possible. These will include automatic routine transmission testing and automatic test access from the testing officers' positions to any traffic circuit. Call progress indicators will also enable testing officers to monitor signalling while a call is being set up.

The test positions are of an entirely new concept. They will be completely cordless, use high-precision transmission measurement and be completely self-contained. A full range of test equipment will be installed on each of the 14 planned positions. This will include frequency counters with digital in-line readouts; digital decibel meters; variable and fixed oscillators; psophometers; call progress indicators for all types of signalling; and standard facilities for direct current testing. Additional positions will be provided for investigating special faults, including those peculiar to VF telegraph and high-speed data circuits.

It is also intended to set up in the new building an International Reference Centre to aid the maintenance of the international telephone service by analysing fault reports and other engineering information from various sources—for example, from the inland reference centres and other international maintenance centres in both Britain and overseas countries.

The new centre will contain the only international transit switching centre in Europe. It will be able to switch calls through London between other European countries and from provincial and local exchanges in the London Director Area to subscribers in all parts of the world.

The switching centre will be of the cross-bar pattern and a large amount of design and development work is necessary on the peripheral equipment to give the exchange its various functions.

The Post Office has been considering the use of the cross-bar exchange for some time to fill the gap caused by the very large planned expansion of the inland network and the inability of the manufacturers to produce sufficient

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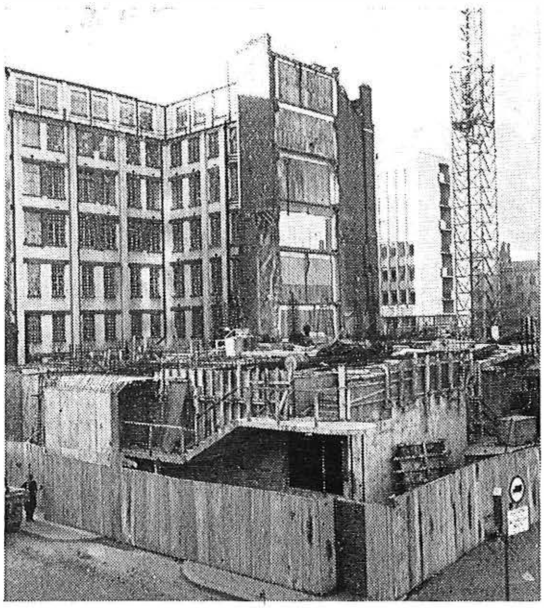
The new centre was orginally planned to be ready for service in 1965 or 1966, but, because of unavoidable delays in obtaining planning permission and site acquisition, it will not be completed until November, 1967. It is expected to become operational in mid-1969.

The detailed engineering planning of the apparatus to be installed was carried out by a planning committee under ETE chairmanship and composed of representatives of ETE, the Engineering Department, the London Telecommunications Region Headquarters and City Area. A number of working parties were set up to deal with specific apparatus and installation problems, to handle staff and maintenance aspects and to produce transmission standards and inter-connection arrangements.

As the *Journal* went to press the contractors were about to begin work on the first-floor.



The new centre rises at London Wall. In the background is the existing Wood Street Exchange.

An engineer examines and tests part of a 5005 crossbar exchange, similar to that which will be installed at the new Wood Street Centre.

Strowger-type equipment to meet the increasing needs.

The cross-bar type of exchange has some advantages, particularly in the international field, since it is easily adapted to four-wire operation. Its speed of operation confers benefits on both the subscriber and the Post Office in that it makes more efficient use of line plant. Since all the contacts are of the relay type, as opposed to the wiping contacts of rotary switches, precious metal contacts can be used which give an improved transmission performance and a longer life. In addition, the further setting up of calls if the first attempt fails is initiated through a common control which reroutes the call through the exchange until a satisfactory connection is made. The various VF signalling systems used on inland and international routes will need to be adapted into the system and this is now being carried out.

When complete, the international centre will contain the first large cross-bar exchange in Britain. A joint design team from the Post Office and the manufacturers has been set up and excellent progress is being made.

The international repeater station will be the terminal point for all national and international services entering the building and provide the equipment for deriving circuits from wideband systems, supergroups and groups from overseas submarine cables, microwave radio and satellite systems and inland cables. The equipment will be designed to the requirements for international circuits and include special facilities such as dual group reference pilot and group section pilot injection and extraction, supergroup automatic gain control and testing arrangements not normally provided on transmission equipment for inland use.

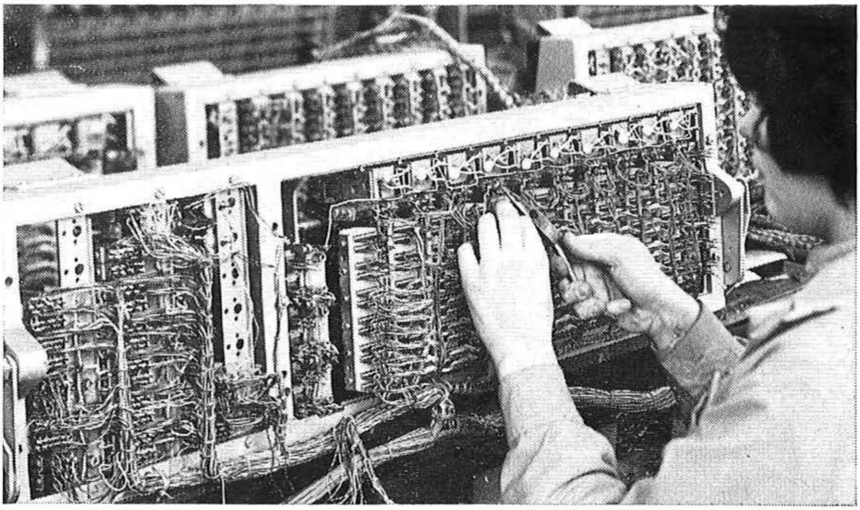
All the transmission equipment is expected to be of the "62"-type with transistorised plug-in cards and units and maintenance procedures will be based on replacement by spare cards. A repair service centre will be set up in the Repeater Station for the clearance of faults.

All the test equipment—audio and high frequency—will be situated on test consoles in a separate maintenance area. The normal mains and battery power supplies and engine generators for standby mains supply will be available and, in addition, steps will be taken to reduce the normal multiplicity of fuses in the power distribution arrangements to the transmission equipment so as to reduce the effects of power faults.

Techniques will be devised to meet the need for special maintenance procedures required on the international services and computers may be used to handle the considerable amount of data processing work which will be involved.

The opportunity will also be taken to specify the transmission losses in the United Kingdom network when connected to international circuits according to the CCITT world transmission plan. Routing diagrams showing transmission losses for all classes of traffic have been produced and rules have been formulated which will enable transmission objectives to be attained.

Losses through switching equipment have been studied and methods devised to ensure that they are acceptable. In addition, transmission characteristic limits have been set for the switching equipment covering loss, linearity, An intricate wiring operation on a section of a four-wire crossbar exchange recently installed at Sydney, Australia. The crossbar exchange at Wood Street will be the biggest of its kind in Britain.



crosstalk, group-delay distortion, impedance, balance-to-earth and impulsive-noise, taking into account the possible future use of the network for data as well as telephony.

The building for the new centre has been designed to high standards appropriate to its position as one of the largest and most important telecommunications centres in the world and to the very considerable numbers of overseas visitors it will attract. It will contain a great deal of equipment of a completely new design and higher performance standards than have hitherto been adopted elsewhere and play a very big part in meeting the rapidly increasing demand for international telecommunication services.

THE AUTHOR

MR. V. H. TUERENA, *joined the Post Office in 1948 after service with the Royal Air Force and worked as technicion in the Long Distance Area of LTR on repeater station duties. He was transferred in 1955, to LTR Headquarters and later worked on Regional Telegraph, dealing with equipment and maintenance. In 1959 he was promoted to Assistant Executive Engineer, ETE Engineering Branch Planning.*

Nine Authors wrote this Book

THERE are many books which deal with one technique for solving problems and give examples of the various problems to which the technique can be applied.

A new book—*Field Analysis: Experimental and Computional Methods* edited by D. Vitkovitch (*D. van Norstrand Co. Ltd., £5*)—is unusual in that it deals with one problem—that of the analysis of fields—and the techniques that can be used. Electromagnetic field theory is familiar, as a name at least, in telecommunications, since it lies behind many engineering techniques, but field theory has many other applications: gravitation, fluid-dynamics, mechanical stress-strain, heat conduction and diffusion.

Two chapters deal with paper-and-pencil methods—graphical field plotting—and those methods which replace the differential equations by approximate difference equations, leading to sets of simultaneous linear equations. The relaxation method of solving these equations is basically paper-and-pencil but this method, and other methods, can also be used with electronic digital computers. Three chapters deal with analogue systems—the conductive sheet and the electrolytic tank—both of which preserve the continuity of the variables and impedance networks which, once again, replace differential by difference equations.

These chapters are preceded by two dealing with basic concepts and mathematical theory and followed by four going into more detail for dielectric fields, magnetic fields, thermal fields, torsion of shafts and bending of beams and fluid-dynamic fields.

The book is the product of nine authors—one also acting as editor—from universities, technological institutes and industry. This leads to a certain amount of repetition, but is no bad thing since users are likely to consult particular chapters rather than read the book as a whole. For those with problems to solve this book would be an excellent starting point; most likely it would provide enough information to see the problem through but, if not, the many references should lead to a solution.

W. E. THOMSON.

The Making of Managers

By N. GANDON, C. Eng., MIEE

An essential part of management training in the Post Office is carried out at the Management Training Centre at Eastbourne where students study the art and practice of management and so achieve a better understanding of common aims and inter-relationships

A syndicate in session. Left to right: Messrs A. C. Holmes (LTR), P. H. Toy (North Area, LTR), J. Loughlin (Aberdeen), A. Hancock (Nottingham, chairman), F. de Courcy (Glasgow) and E. Locke (Manchester).

MANAGEMENT training—the subject of a considerable amount of literature and of conflicting opinions as to its value and application—can best be described as a career-long process in which development on the job, self-education and formal courses all play a vital part.

In the Post Office telecommunications sphere management training has two aspects—training in specialised responsibilities and training in general management. The former is provided for engineering, executive, sales and traffic staffs at the appropriate operational training centres and the latter is given by the Management Training Centre at Eastbourne. To say that these two aspects of training are complementary is almost an understatement since the function of the Management Training Centre is to promote from the foundation of specialist training, a greater knowledge and appreciation of the wider problems of the telecommunications services.

Management Training, as an aim rather than an afterthought, emerged in Post Office history in the late 1930's, when training programmes for the first Telephone Managers to be appointed under Regionalisation were being arranged. The training envisaged was appropriate to an era of direction from the top, of hard and fast rules and of fairly easy recruitment. It was designed for an organisation which was first and foremost a Government Department and secondly, a commercial undertaking.

World War Two and the early post war period produced both a pause in general management training in the Post Office and the development of an increasing number of new ideas and methods in management and in training in the business world. Within the various hierarchies in the Post Office, however, and in the training establishments and schemes run by the Operational Departments one began to hear of such things as Training within Industry, Organisation and Supervision, Switchroom Management and so on. The development of these activities in the present Engineering, Executive, Sales and Traffic Schools into Management Training courses indicates the extent to which knowledge of the techniques of management is being recognised as complementary to technical and professional ability.

In 1952, as a result of a report by an informal working party set up in 1949, general Management Training courses were started at an hotel in Clacton for both the Postal and Telecommunications sides of the Post Office, the earlier courses being attended by Head Postmasters of the larger offices and by Telephone Managers. The two-fold aim was to provide a clear understanding of Post Office objectives and policies and the part which Managers play in their fulfilment; and to give an insight into the principles and specialised techniques which underlie successful management practice.

Subsequent courses catered for Head Postmasters in the smaller offices and Heads of Divisions in Telephone Areas, with a small sprinkling of people of equivalent ranks from Headquarters Departments and Regional Headquarters. Courses lasted four weeks and included lectures from the MTC staff and talks from visiting speakers from inside and outside the Post Office. The main feature of the course was syndicate discussion of wide-ranging subjects—organisation, finance, productivity, staff management—leading to the preparation of lengthy reports presented in plenary session.

In general, the accent in the early years of the MTC was on a critical examination of Post Office policies and procedures rather than on the job of management itself. In 1960, however, a radical change was made, when the syllabus was re-shaped and re-orientated with the aim of examining the objectives and attitudes in the various fields of management responsibility. Syndicate discussions of wide-ranging subjects gave way to guided discussions on appraisement, budgetary control, forward planning and so on in which the instructor played a more positive and more demanding role. Report writing practically disappeared. Students were still drawn in the main from Heads of Division, with a sprinkling of people of higher rank, and from equivalent grades in Regional offices.

The Post Office also makes use of courses provided by external organisations. Selected officers are sent to the Administrative Staff College at Henley, to the new business schools at London and Manchester and to other institutions active in management education.

This form of training provides an opportunity for members of the telecommunications service to rub shoulders and exchange ideas and experience with their counterparts in the world of commerce and industry and will assume increasing significance as the Post Office prepares to become a public corporation.

In 1963 the first moves were made in a series of changes which have ultimately produced the present pattern of courses. The underlying philosophy from which these changes have stemmed can be summarised as:—

1. Formal management training is not a once-for-all process but needs to be repeated and developed as a man progresses up the management ladder.
2. The earlier that formal, general as opposed to specialist management training can start the better.
3. Even when a man has reached the limit of the career possibilities open to him, he can still benefit from periodical refresher training.

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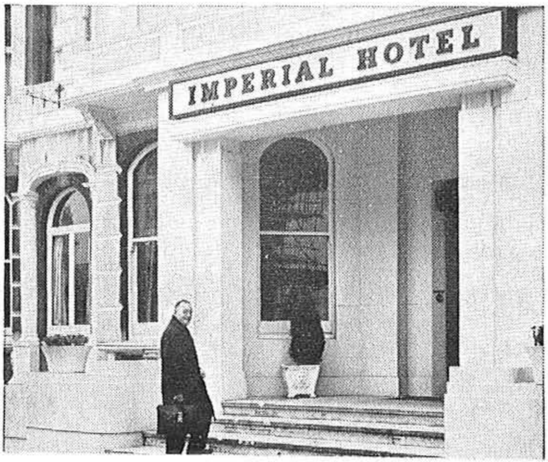


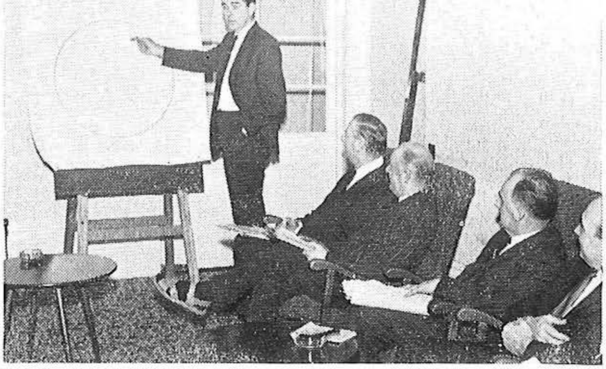
The Commandant, Mr. R. B. Bailey, Assistant Secretary in the Training Branch, Personnel Department, arrives at the MTC Headquarters.

4. Management is much more than the detailed study of its impact and responsibilities in the various fields of work with which it is concerned.

In keeping with this philosophy, the MTC is evolving a pattern of courses designed to provide a graduated and progressive pattern throughout a manager's career. The syllabus is no longer primarily concerned with the functional details of the job but with the way in which management needs to operate both to achieve the objectives of the organisation and to get results through people. The broad objectives remain as in 1952 but specifically all the MTC courses aim to bring students to realise that:—

1. the purpose of managers is to help to achieve the objectives of the undertaking which employs them;
2. no undertaking can be more effective than its managers;
3. effectiveness (doing the right things) is more than efficiency (doing things right);
4. effectiveness demands achievement, that is, results;
5. managers are the people who must obtain results and to do this they have to harness the full endeavour of the whole of their supporting team (on this whole theme we have been expounding the philosophy of "management by objectives"—also known as "target-setting"—for the past two years); and
6. managers must judge themselves, and expect to be judged, by results.

The ground covered is broadly similar in all courses. although the accent and approach naturally varies. Management's job in any organisation, the external environment in which management has to operate, the management processes of decision making, delegation, communication and control, and the manager's responsibility for his staff and for himself are dealt with in discussion and in syndicate exercises. Visiting speakers from ITD, PD, ED and COSD and from the staff sides deal with current problems, activities and developments. The whole course aims at providing a sound basis for self-development in the art and practice of management. and at promoting a better understanding of the common aims and objects of all Divisions and their inter-relationships and interdependence.



Mr. J. Judd, of the Computer Development and Office Services Department, reveals the shape of some of the things to come during a lecture on the use of computers in telecommunications.

The three courses now provided cater for the three levels of Area management from the Telephone Manager/Deputy Telephone Manager down and their Regional Office equivalents. At the TM/DTM level, the MTC has recently participated in a conscious exercise in management development by inviting to senior seminars recently-appointed DTMs and their Regional equivalents and officers placed on the TM/DTM promotion panel who have not attended the MTC during the previous four years. It is hoped to continue and extend this development as opportunity permits.

Course time tables leave little room for relaxation at Eastbourne. Apart from the fact that most people away from home prefer to be occupied than to be idle, the intensive nature of the courses deliberately simulates the conditions of pressure under which most managers work to-day. The "short sharp bite" is likely to produce, in our view, a more lasting result than a longer, slower process would achieve.

Management generally is widely becoming recognised as a profession in its own right which can be studied in the same way as longer-established and universally-accepted disciplines. The extent to which such study can be efficiently carried is still the subject of much debate, though on questions of detail rather than of principle. What is quite certain is that successful managers can no longer rely—if, indeed, they ever did—on hunch, inspiration and guesswork. The MTC cannot afford to ignore these developments.

Post Office management faces two formidable problems in the immediate future: the change in the Post Office status and the introduction of computers. The former represents the greatest challenge and stimulus to management in the

300-year-long history of the Post Office and its success will depend on the response which management makes—for no organisation can be more successful than its management. The development of computers is something in which many managers are already actively engaged and in which all managers will be involved before long. As development proceeds, it will accelerate changes in management processes and thought of a fundamental nature. Both these major developments will naturally find a considerable place in the work of the MTC.

Management training does not, however, end there. Self-development, recognised as essential nearly 30 years ago, is every bit as important to-day. Precept and example play their part and senior managers have a duty to perform in the active development of their juniors. Although MTC courses are focussed on the Telecommunications Service, there is a vast amount of literature available on the general subject. Reading widely and taking an intelligent interest in developments in the field of management in the world at large are a vital part of the process of self-development.

To-morrow's manager will need to apply the skills of mathematics and science which he has employed with precision in his specialist field, to the uncertainties of life in the management field, thereby reducing to a minimum the associated risks and providing a keen edge to the decisions he is called on to make. Any undertaking is only as good as its managers and if the Telecommunications Service is to be, in the words of the Postmaster General's statement in Parliament last summer, " a forward looking, go-ahead, bustling and developing industry" then its managers will themselves need to develop these attributes. The MTC will strive to continue to play its part in this process.

THE AUTHOR

MR. N. GANDON, *a Telecommunications Controller, is at present Director of Studies (Telecomms), Post Office Management Training Centre, Eastbourne. He joined the Post Office in 1938 and his varied career has included service in Area and Regional offices Cardiff, Area Engineer, Cardiff, and Telephone Manager, Coventry.*

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Management Training in LTR

By C. FAWKES

For the past three years LTR has been holding its own series of training conferences designed to develop a common approach to service problems and to fit middle management for its many and varied tasks now and in future

THE London Telecommunications Region, in common with other Regions, avails itself of the training courses provided by the Post Office General Management Training Centre at Eastbourne and the Engineering Management Training College at Bexhill-on-Sea.

Understandably, neither establishment can operate exclusively against the background of the management problems peculiar to any one Region. Nor can their resources be devoted exclusively to one Region at a time. This imposes some limit on both the number of managers trained and the penetration into the various levels of management.

Those seeking to support with fact the view that London is different could point to the size of the staff in London in relation to the size of

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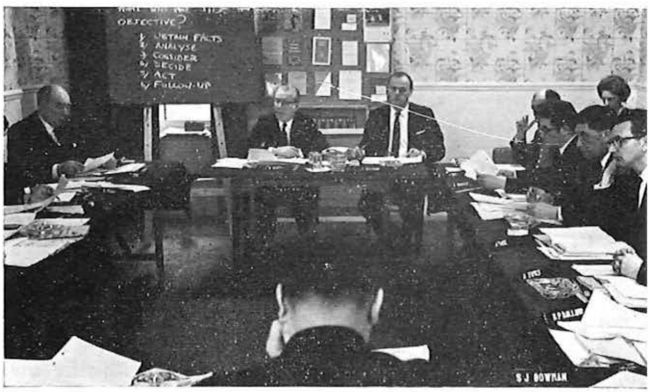

A work simplification conference in session under the chairmanship of the group leaders, Mr. C. S. Coleman and Mr. J. R. White (top table).

The Conference hostess, Mrs. J. Van-Stratten, welcomes delegates to a Haddon Hall conference.

the staffs in other Regions. This reflects the high proportion of the total system centred on London and indicates indirectly that the commitment of staff to the supervisory and management functions is, in total, higher than in any other Region.

With such a high concentration of staff effort, basically fragmented by functional grouping as a feature of organisation, there is a danger that further fragmentation could result from varying degrees of specialisation. One counter measure is the reorganisation of the London Areas (see the Autumn, 1966, issue of the *Journal*). Another counter measure, initiated in London just over two years ago, is to bring into conference individuals in the organisation who would not normally be brought together in a conventional type of training course.

Whenever a group of Post Office people get together off duty they will inevitably for much of the time be talking shop. Bring a group of Post Office people with particular responsibilities together officially and again they will talk shop. This is commonly called a conference. Provide conference facilities in an atmosphere which recognises the status of the individuals and the importance of what is to be discussed, remove the pressures of daily travel and day-to-day management tasks and you have a residential conference where people will talk shop, possibly far into the night. Direct the discussions by skilled group leading, introduce specialists to inject new thoughts and information, expose representatives of top management to the opinions and criticisms of those engaged nearer the front line and you have a pattern for Residential Management Training Conferences.

In 1963 it became apparent that a need existed for bringing together London's Service Superintendents—the men and women of the Traffic Division, many of them quite young, responsible for day-to-day service to the customer—to supplement what was being done at the Headquarters Traffic Training School and to concentrate on London's problems. It became possible to use the Management Training Centre's Eastbourne hotel accommodation in the weeks between their courses and so, early in 1964, the first LTR Service Superintendents' one-week Conference was launched there.

The guiding philosophy of the LTR's early endeavours in this field, and one that has remained a cardinal principle since, is to bring together either those people in the organisation with a common interest in a particular field—for example, Service Superintendents—or those with specialist contributions to make in a field of common responsibility. At all times emphasis has been focussed on the London Telephone Service, its problems and opportunities and the way in which those involved can marshall the resources available, and develop their own skills in the best interests of the customer to whom the service is a unity.

Broadly, the aims of the first and subsequent conferences were to stimulate awareness of customer need (often emphasised by visiting speakers from the Institute of Office Management Communication Managers' Division) and an acceptance of the fact that the Post Office is in business; to clarify objectives; to examine critically the tools of management and their uses; to consider ways in which individuals can best use their time and resources—both in their own particular field of activity and in response to the needs of others—and to give delegates a unique opportunity to exchange views with Regional Board members and other representatives of senior management.

By a judicious mixture of syndicate discussion, films, case studies and short formal talks, groups are encouraged to speak freely about their problems, to hear of the problems of others and to find comfort or challenge in all that is said. Early on, the Director of Home

Mr. E. Mitchell (left) and Mr. R. Ewing examine a home-made model used in a work simplification exercise on space utilisation.

Counties Region (as it was then) was asked if he would like to send a few representatives. He responded readily and the contributions made by his staff have been much appreciated and often quite refreshing. If some of London's problems seem insoluble it is stimulating to find that close neighbours have similar problems and sometimes have the answers as well!

By the spring of 1965 most LTR and many HCR Service Superintendents had attended conferences at Eastbourne. Reports from Areas were encouraging and it was decided to continue the conferences and also to widen their scope to embrace other staff in Regional Headquarters and Areas on telephone and telegraph work who could gain from them. It was clear that since both Engineering and Traffic staffs have separate and also collective responsibilities for the telephone service, there would be advantages in having delegates from both divisions conferring round the same table. So the first of a series of joint Service conferences was born at which Executive Engineers and Senior Telecommunications Superintendents in roughly equal numbers, range over a syllabus containing items of common interest such as computer developments, customer co-operation, the grade and quality of service, the telephone service of the future and service management. These joint conferences were very successful and in turn led to joint conferences at Head-of-Division level.

The LTR Conferences in Eastbourne soon became well established and, to meet the need for expansion, extra hotel accommodation was found at Haddon Hall hotel. Additional conferences for Assistant Executive Engineers and Telecommunications Traffic Superintendents on service/maintenance duties were arranged on the same pattern as those for EE/STS and later further experience was added by the inclusion of Higher Clerical Officers from Area Accounts Groups. Two conferences have been held exclusively for women—the Travelling Supervisors who do so much to carry the Post Office image to its customers and keep the administration informed on the customers' point of view.

The next field of endeavour was provision of service. With the accent on speedy completion of the customer's order, conferences were arranged for Senior Sales Superintendents and Executive Engineers, followed later by conferences for Assistant Executive Engineers, Inspectors and Sales Superintendents and also of the appropriate Heads of Divisions.

In examining ways and means of doing things, odd and cumbrous practices which should be looked at with a critical eye are often encountered. In 1965, the Department of Scientific and Industrial Research were offering training in the field of "Work Simplification" and the LTR was sending delegates to its Roffey Park Courses. The Department of Scientific and Industrial Research (now the Ministry of Technology) was invited to run a joint conference at Eastbourne for Sales and Traffic staff. Following this initial course the LTR instructors took over, concentrating more on Post Office problems and widening the scope of the courses so that other grades would benefit by attendance. Thus, LTR embarked on yet another series best described as work study appreciation courses.

Work simplification training fosters a discipline of ordered critical thinking and, as in the other conferences, considerable use is made of case studies. The syllabus covers the applications of charting techniques, string diagrams and

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Time off for a cup of tea. Left to right: Mr. R. F. Isted, Mr. J. Yates, Mr. J. Tate, Mr. S. Bowman, Mr. J. E. Little, Mr. K. P. Ballard, Mr. D. Mckay, Mr. W. Graham, Mr. J. M. Moffatt and Mr. G. Vaughan.

so on to such everyday practical problems as the installation of a Keymaster system, the circulation of written complaints, the utilisation of accommodation in a training school and the organisation of Advice Note procedure.

Clearly, in a week, it is neither the aim nor the claim that delegates will develop any expertise, but considerable interest is aroused in the methods available and—perhaps more important—a critical attitude is developed among staff in all grades to the need and opportunities for increased productivity. Quite apart from what can subsequently be done by individuals, a climate is produced in which new processes and procedures developed by experts can be more readily understood and adapted in the field.

At present, under the aegis of LTR's Recruitment and Training Branch, a full range of conferences is being held at Eastbourne, including follow-up conferences for Service Superintendents who have attended earlier ones. Higher Clerical Officers and Executive Officers are joining with their Engineering, Sales and Traffic colleagues in every type of conference except those run solely for Service Superintendents. The representation on a typical Work Simplification conference was four Engineers, two Clerical/Executives, five Sales and three Traffic Officers.

Is it worth it? The Group Leaders whose long hours of dedication to the task bring reward in the form of keenly interested and well integrated discussion groups have no doubt that it is; nor have those who have attended the conferences and nor have the Managers of the units which provide the students. Managers have to decide whether service and individual interests are going to be furthered by releasing delegates to attend, often at difficult times. There has been no falling off in demand for seats and Areas are always willing to send visiting speakers to the conferences.

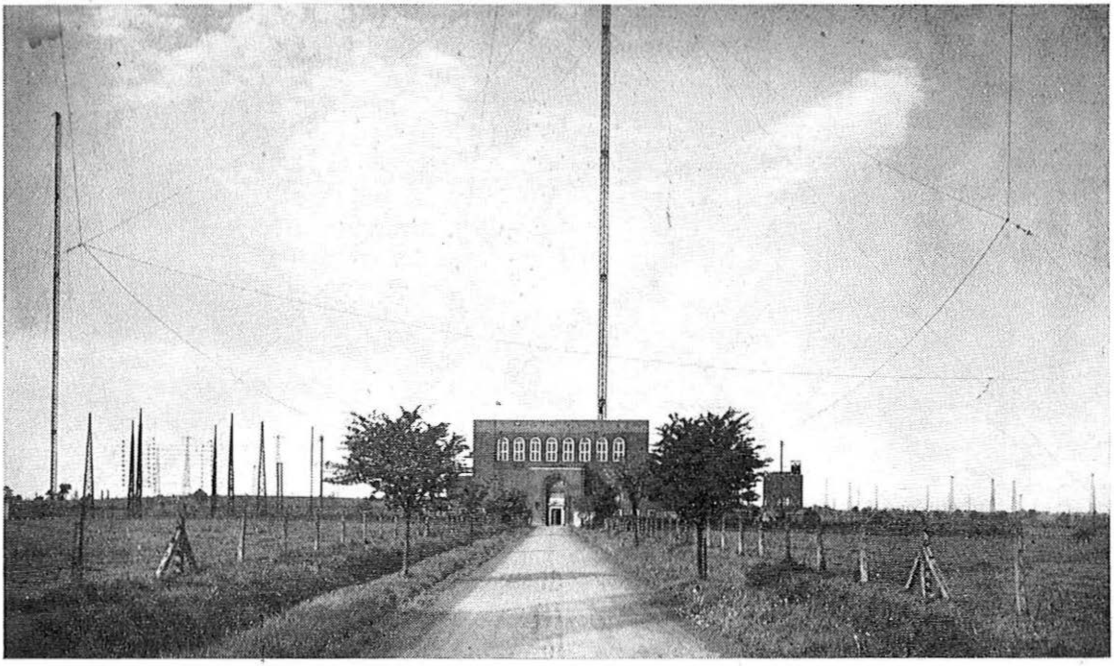
Should these conferences be residential? The stimulating *ad hoc* discussion groups which form outside the formal hours of conference provide an affirmative answer. Groups work well together. There are no disturbing influences in evidence and no rush to finish discussions because people have trains to catch. There is time, comfort, good company, good food and plenty to talk about.

To attend an LTR Conference at Eastbourne is to seize an opportunity to reflect, to reappraise, to challenge and be challenged and, particularly on the mixed conferences, to be reminded that for service, customers look to the Post Office as a whole. The LTR is on the march to meet the challenge of the '70s and this imaginative step in Management Development Training aimed at developing a common approach to service problems has much to commend it in fitting middle managerial grades for the many and varied activities that need to be approached as common tasks.

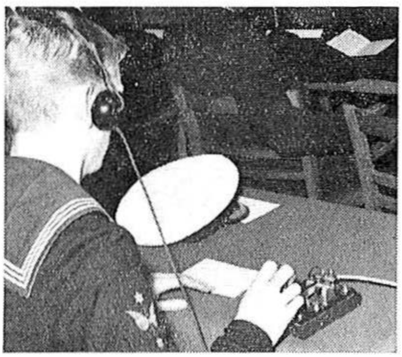
THE AUTHOR

MR. C. FAWKES. *Deputy Telecommunications Controller (Service) at LTR Headquarters, had a provincial engineering background, mainly in North Wales, before joining the Engineering Department Training School, Cambridge. He transfered to the Traffic side in 1947 and in 1952 joined the HQ Traffic Training School as an instructor in various aspects of traffic work and tutor for extramural operational telecommunications courses. From 1959 he served at Home Counties Regional Headquarters where he was responsible for Subscribers' Accounting and Provision of Service matters until his promotion to LTR in 1964. He played a leading part in planning and setting up the conferences described in this article.*

"GBR" IS BACK ON THE AIR



Front view of Rugby Radio Station, one of the most powerful in the world. Its aerial system has remained almost completely unchanged since the Station was first brought into service in 1926.



A naval rating keys the call sign "GBR" for the first time for a year. The new transmitter was opened by the Director of Naval Signals, Captain G. B. H. Wake-Walker, RN.

THE VLF transmitter at the Post Office's Rugby Radio Station is back in service and the famous call sign "GBR"—which for 40 years, in peace and war, provided a vital link with British ships throughout the world—is on the air again. So, too, are the Greenwich time signals, accurate to within one ten-thousandth of a second, which the Station sends out four time a day.

The transmitter, designed and built by Post Office engineers in the early 1920s and first brought into service in January, 1926, went off the air at the end of 1965 so that modifications could be made to increase its radiated power by at least 50 per cent and to improve its operating capabilities. These modifications are now complete and the new transmitter is one of the most powerful in the world.

The most striking changes are in the amplifier units and the modulator while a new con-

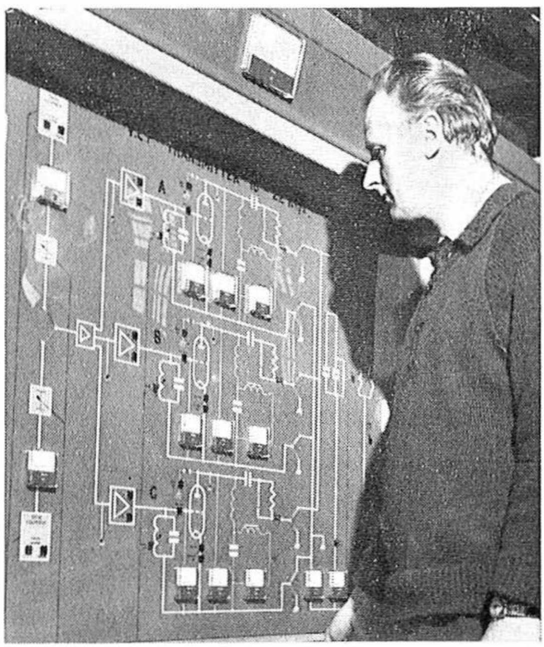
OVER

Technical Officer Mr. R. Hope, operates the new transmitter which is much more powerful than before.

trol centre has been installed which will also serve the other two low-frequency transmitters housed at the Station.

The amplifier section of the new transmitter consists of three identical units in separate compartments, with an end compartment containing equipment to convert telegraph signals from line into signals to drive the amplifiers at the correct radio frequency and with appropriate keying modulation. Each amplifier unit contains a 5 kW, air-cooled driver stage which feeds into a steam-cooled valve giving a radio frequency output of some 170 kW. The power supplies for each unit are derived from silicon rectifiers, with the exception of the high-power valve which is fed from a mercury-arc rectifier. Normally, the outputs of the three units are connected in parallel to give full power, but if a unit become faulty it can be disconnected and the other units arranged to operate together or singly with a consequent reduction in power output.

Below : The mimic panel from which the transmitter is controlled. All the switching points are outlined from behind by lamps.



Above (left): A Technical Officer checks the connections to one of the three final stage, vapour-cooled valves. Right: Technical Officer Mr. A. E. Christopher adjusts a tapping switch on the aerial tuning inductance coils.

The low-power drive units, in duplicate, give a choice of carrier "on-off" or frequency modulation and either the morse code or teleprinter keying can be used. They are specially designed to control the frequency and phase of the emissions very precisely and the transmitter can now operate at a much higher modulation rate than formerly.

The transmitter is controlled from a mimic panel on which switching points are outlined from behind by lamps so that the condition of the transmitter can be seen at a glance. Associated with the mimic panel are the basic controls for choosing the drive to the amplifiers and remotely controlling the variometers which tune the anode and aerial circuits.

The aerial circuit has also been improved, notably by the introduction of variometers for tuning between the fixed points available from the main coil taps and for automatically adjusting the tune of the aerial circuit to compensate for varying weather conditions. Additional variometers have also been included in the common anode circuit for tuning and adjusting the coupling between the anode and the aerial circuits. In addition, all the variometers and the three aerial tuning coils are double-wound with insulated wire to increase their current carrying capacity.

The new transmitter is also equipped with all the most modern safety devices designed to make it impossible for anyone to approach dangerous voltage areas without first isolating them.

LTR technicians jointing cables in one of the seven-ft diameter tunnels beneath Oxford Circus. Each tunnel is about 300 yards long. All tunnel shafts and manholes are electrically lit and ventilated.

Underground at Oxford Circus

By W. H. LAMB

ONE of the most unusual and complex tasks which the London Telecommunications Region has been involved in for many years—the re-siting and re-construction of the network of ducts and cables which carry telecommunications services under Oxford Circus—is nearing completion.

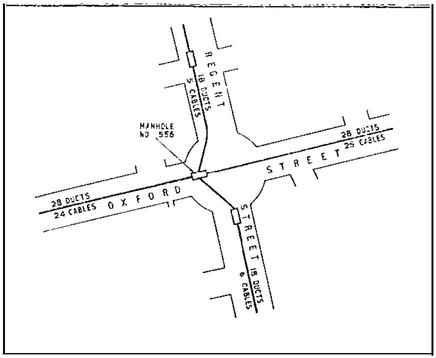
Reconstructing the cat's cradle of pipes, cables, ducts, sewers, drains and subways under the Circus became necessary when it was decided in the early 1960s to rebuild Oxford Circus Underground Station, the inter-change station for the Central and Bakerloo lines and soon to become the inter-change station for the new Victoria line as well.

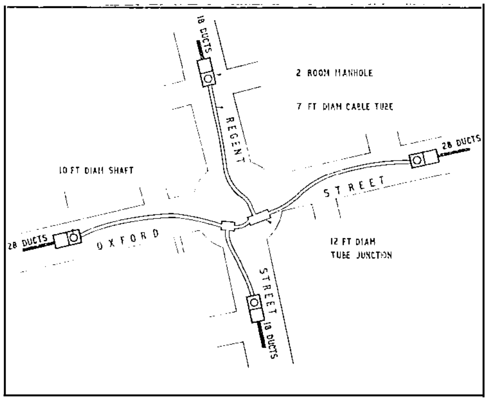
The pattern of Post Office ducts and cables below the Circus was similar to that under many road junctions in London. But moving the network presented some difficult and unusual problems since there are no practical alternative routes around the junction and the structural features of the booking hall of the new station, which occupies all the space under Oxford Circus, do not allow pipes to be laid over, under or around it.

After a detailed study of several possible alternatives, however, LTR decided to install the cables in special Post Office cable tunnels dug underneath the new booking hall and threaded between the new escalator shafts and other station tunnels.

Work on the Post Office task began early in 1965 when four large, two-room manholes were built—two under Regent Street and two under Oxford Street. The existing ducts and cables were passed into the first room in each of these manholes. New cables were joined on and led

Right: Diagram showing the plant system as it was and (far right) as it is now.





down 40-ft deep, 10-ft diameter vertical shafts from the second room. The bottoms of the shafts were then linked by seven-ft-diameter tunnels—each about 300 yards long and all manually dug—through which the new cables now run.

Entry to the manholes is obtained through normal manhole covers at ground level and to the tunnels by ladders and platforms built into the shafts. To prevent gas and water entering the tunnels, the two rooms in each manhole are isolated by gas-tight doors and the cables pass from room to room through pipes fitted with gas-tight glands. The tunnels, shafts and manholes are drained, ventilated and electrically-lit and the cables and joints are supported on steel cable bearers bolted on to the cast-iron tunnel linings.

The tunnels, shafts and manholes, drainage and ventilation systems were designed by Sir W. Halcrow and Partners, consulting engineers to the Post Office, in co-operation with the Engineering Branch of London Telecommunications Region, and constructed by London Transport. The electrical installation was carried out by the LTR Power Section and all cabling and jointing work was done by staff of the Centre Area Telephone Manager.

Among other advantages which the completion of this long and difficult task will bring is that the Post Office should never again need to dig up the road at Oxford Circus to put in new cables and ducts or to carry out repairs to the existing network.

THE AUTHOR

MR. W. H. LAMB *joined the Post Office as a Youth-in-Training in the old London Engineering District and is now a Senior Executive Engineer in the Engineering Branch of the LTR. Before World War Two he was seconded to the Colonial Office to install automatic exchanges in East Africa. In World War Two he served with the Royal Signals in the Middle East, attaining the rank of Lieutenant Colonel.*

★

A MANCHESTER MILESTONE

A milestone in the development of the Manchester director system was reached at the end of February when the last manual exchange in the director area was converted to automatic.

With the opening of a new £160,000 exchange at Marple, Cheshire, automatic service was given to all the 400,000 telephones served by the 48 exchanges in the director area.

The Manchester director system is one of six serving Britain's principal cities; others are in London, Birmingham, Liverpool, Edinburgh and Glasgow.

The first three exchanges in the Manchester director system, ARDwick, COLlyhurst and MOSs Side, were opened in 1930. The system developed throughout the Greater Manchester area and now includes 235,000 exchange lines in South Lancashire and North Cheshire.

Telephone users in the Manchester director area make nearly 25 million calls each month. Subscribers on a typical exchange in the director area can dial 100 local exchanges, 3,000 exchanges in this country on STD and many exchanges on the Continent by way of the International subscriber dialling system.

TELSTA SPEEDS AERIAL CABLING

By B. L. NUTTALL, BA

A new machine which, operated by only two men, can erect aerial cables four times as fast as the normal four-to-five-man gang, is undergoing extensive field trials in the Shrewsbury Telephone Area.

It is the American-manufactured *Telsta T* 36—more prosaically called the Aerial Cabling Unit in Britain—and is being used in rural areas to put up the aerial cables which are rapidly replacing the familiar telephone wires. It can erect aerial cables at the rate of between four to six miles a week, the machine paying out the cable in mid-air from the end of its electrically-operated boom as it is driven along at walking pace.

The Aerial Cabling Unit consists of a turret-like base and a main boom fitted with an extending inner section. The working platform, in the form of a metal basket, is supported on steel arms at the end of the telescopic boom which has a horizontal reach of 25 ft. 11 ins. and a vertical reach of 36 ft. The complete assembly is mounted on a Dodge vehicle chassis with a two-speed rear axle and a new type of differential lock consisting of two rollers which can be made to bear against the rear wheels to prevent wheel spin in mud or snow.

The boom is easily and rapidly raised, lowered or rotated by means of a hand-operated joystick, power being obtained from a propane-driven electric generating set, with an electric self-starter, mounted at the rear of the chassis. The generator drives a number of electric motors which move the boom through a series of chains and chain wheels. If a chain breaks, the working platform can be manually rotated and safely lowered to the ground.

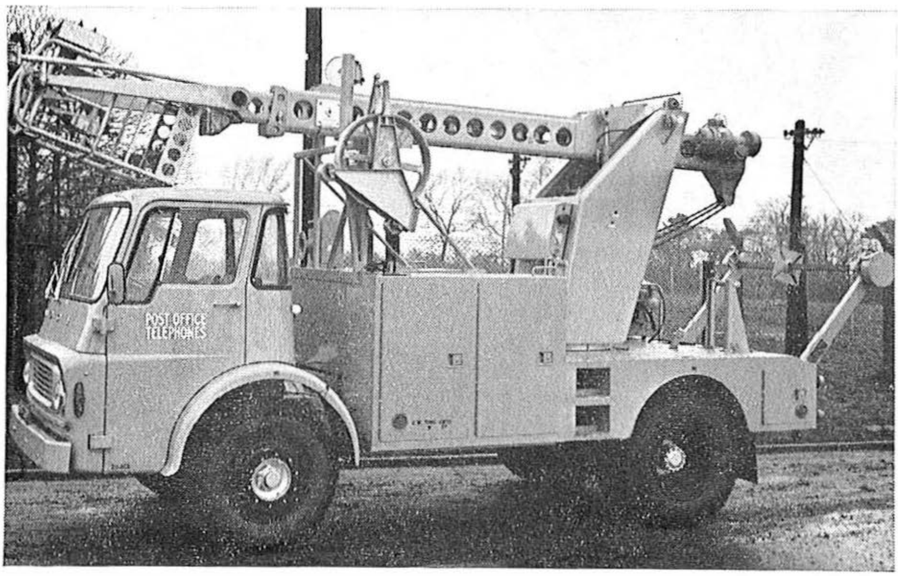
Telsta's *telescopic boom reaches 36 feet high. In the metal basket is AEE Mr. G. V. Hunt.*

The new unit can carry more than 30 cwt. of cable on two arms at the rear of the chassis so that additional cable-carrying transport is unnecessary. The arms can be hydraulically raised and lowered for loading and unloading cable drums. The payload of the basket is five cwt. and in addition nearly a ton of suspension wire can be carried in the well of the vehicle.

As the machine moves along its route between poles, the aerial cable can be paid out under tension obtained by electrically-operated drum brakes mounted on the cable drum spindles and controlled by the driver in his cab. The machine stops only briefly at each pole, the operator boring a hole through it with a quick-change combined electrical drill and torque wrench, passing through a bolt and tightening the clamp with the wrench. This operation takes only a few minutes.

The machine also has a small but powerful three-speed winch so that at no stage does cable

Telsta *at work in the Shrewsbury Telephone Area, lashing a second cable on to an existing route. The unit can erect aerial cables at the rate of up to six miles a week.*



Telsta *in the travelling position, its metal basket and boom neatly stored. It can carry more than 35 cwt. of cable.*

have to be manhandled. This winch—called the electric towline—is used by the Americans to carry out a number of specialised tasks, including passing cable behind poles.

Shortly after the machine arrived in Britain from the United States, Mr. J. S. Kennedy, factory manager of the Telsta Corporation, was flown over to supervise the training of Post Office teams in its use and maintenance.

First reports indicate that the trials will be successful and that use of the new Aerial Cabling Unit will not only increase productivity but also take much of the hard work out of aerial cabling.

THE AUTHOR

Mr. B. L. NUTTALL *joined the Post Office as a Student Apprentice in 1961 and is now an Executive Engineer in the External Plant Development Section of the Engineering Departments External Plant and Protection Branch.*

Telecommunications Statistics

	Quarter ended 30 Sept., 1966	Quarter ended 30 June, 1966	Quarter ended 30 Sept., 1965
Telegraph Service			
Inland telegrams (including Press, Railway Pass, Service and Irish Republic)	**2,847,000**	2,594,000	3,009,000
Greetings telegrams	**727,000**	603,000	732,000
Overseas telegrams:			
Originating U.K. messages	**1,907,000**	1,816,000	1,885,000
Terminating U.K. messages	**1,918,000**	1,803,000	1,900,000
Transit messages	**1,473,000**	1,451,000	1,483,000
Telephone Service			
Inland			
Net demand	**165,000**	228,000	193,000
Connections supplied	**188,000**	200,000	185,000
Total orders in hand	**232,000**	255,000	184,000
Total working connections	**6,744,000**	6,658,000	6,244,000
Shared service connections (Bus./Res.) ..	**1,338,000**	1,324,000	1,219,000
Effective inland trunk calls	**233,823,000**	227,196,000	209,819,000
Effective cheap rate trunk calls	**55,573,000**	51,636,000	49,679,000
Overseas			
European: Outward	***2,153,000**	2,050,000	1,739,000
Inward	†not available	not available	not available
Transit	***7,000**	7,000	14,000
Extra European: Outward	***199,000**	190,000	154,000
Inward	†not available	not available	not available
Transit	†not available	not available	not available
Telex Service			
Inland			
Total working lines	**18,000**	18,000	16,000
Metered units (including Service and Irish Republic)	**46,117,000**	53,093,000	42,153,000
Manual calls Assistance and Multelex	**29,000**	24,000	17,000
Overseas			
Originating (U.K. and Irish Republic)	***3,090,000**	3,000,000	2,703,000

Figures rounded to nearest thousand.
*Estimated figures.

† Extra European Inward and Transit—Full details not available.
† European Inward—not available.

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

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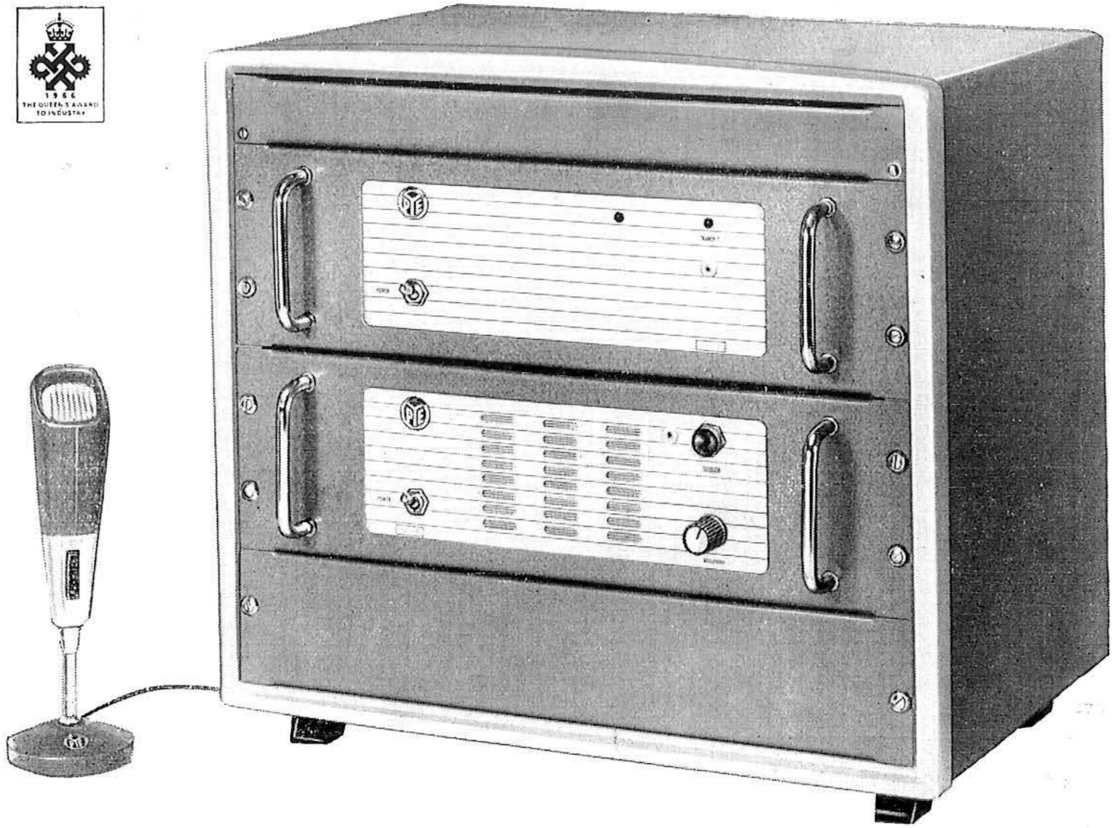

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