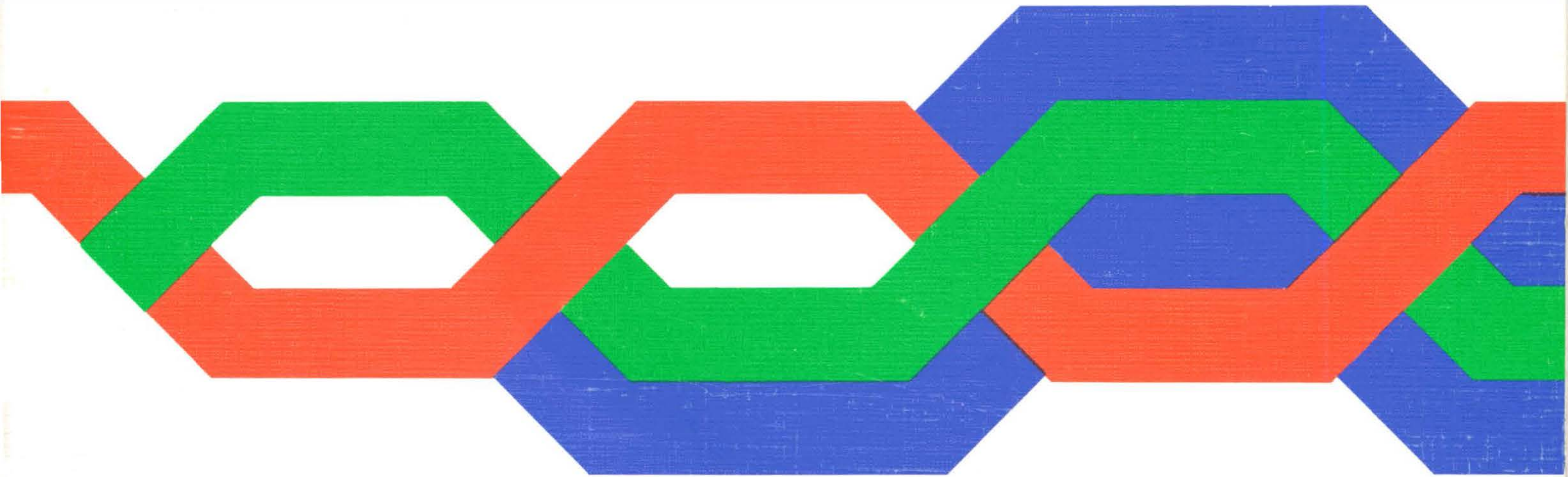
Post Office
Telecommunications

Maintenance News 3

Autumn/Winter 1973



Contents

Produced for SvD by THQ Internal Communication Unit

Editorial

I started getting your letters long before begging for them in the editorial of issue two and now there has been quite a flood. Thank you, one and all. Correspondents will, I hope, appreciate that only a fraction can be published. Please don't let the feeling that the odds are against your letter appearing in print deter you from sending it. All letters are acknowledged directly as soon as possible after receipt and those that need a longer reply get one in due course. The aim of *Maintenance News* is to establish two-way communication, even though only the tip of the iceberg can show in our correspondence columns. By the way, may I apologise to those who thought the spurious letter in issue one was written in meaningful Latin.

I had several comments, not all favourable, about the cartoons in the earlier issues which were largely the work of Ken Howse of Sv6.5.5. We need a sprinkling of cartoons to help express points and would welcome your contributions. They have to have certain restrictions of line and form placed on them to make them reproducible, for example, black ink, line drawings, but with some help from the Internal Communication Unit your personal styles should still show up and will be acknowledged.*

Readers may be interested to know the composition of the Editorial Board of *Maintenance News*: it consists of invited Deputy Controllers — usually plant maintenance men — from three RHQ's, the two Staff Engineers of the Maintenance Division (Sv5 and Sv6) and myself as Editor.

The Deputy Controllers will make way for others after three or four issues to give an opportunity for ideas to come forward from all quarters of the country. But by no means all the useful ideas come from the Editorial Board, and this is where I repeat the offer to you of space.

The Editor

PS: You will be sorry to hear that the Editor, Dave Manning, whose hard work saw the first two issues into print and who had done the ground work for this issue, has been incapacitated for eight weeks by illness but is mending well. We all hope that by the time you read this he will be fully recovered.

Meantime the Editorial Chair is occupied by N J (Tom) Paine.

**(See TI s B Marketing Commercial 6 Publicity C0001 for description of the functions of ICU, and C0005 for policy on House Journals.)*

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(01-432 1380)

Letters

Cover Design

Congratulations on producing such an eye-catching booklet, but did the second edition have to be identical? I was about to put it in my locker after a quick revision of items dealt with, and only then realised it was a different issue.

— R E Allen, Exeter

We are using the colour of the inside cover to distinguish successive issues, but will think about varying the outside as well.

— Editor

Favourite Target — TIs

I have yet to meet anyone who could see the reason for changing from EIs other than to give jobs for the boys.

— C J Beasley, Bexleyheath

I sit fifteen feet from a type 3 file and since its arrival have heard nothing but "Where's the b...... index?"

— P Clifton, Reading

You suggest that weeding out is permissible, something that was definitely taboo in the days of EIs. If a weed-out is performed, only to find in a year or two that the 'never likely' has nevertheless happened, what machinery exists to recover the TIs now necessary?

— C P Booker, Goonhilly

Three extracts from letters, mostly complaining about indexes. People will complain about indexes for evermore, especially as it is impracticable to up-date them more often than once a year or so. But there is no excuse for not being able to find them. E Division indexes, in the A0001 series, have been available for over a year. If you are on exchange maintenance, for instance, your index is E6 A0001. If you want TIs on general matters, the general index for maintenance people is E1 A0001. Now this TI certainly was inadequate at the time I got your letters, because when it was compiled many general TIs had not yet been distributed to maintenance files. By the time you get this Maintenance News *it should have been updated. Do remember that you only get indexes appropriate to your basic duty.*

Changing from EIs was meant to place responsibility for instructions where it belonged in the re-organised Telecomms Business; it will be some time yet before things settle down. TIs belong in a business organised on functional lines whereas EIs belonged to the days when we were organised in hierarchies. Those days have gone. It is no use hankering after them. If you've been hanging on to EIs, you might just as well tear them up: they will never be updated again. Both THQ and the field just have to make the new system work.

As for the conversion from EIs to TIs, this certainly did make jobs for the boys, all of them hard-pressed with other tasks. Our lot managed to convert 40% of the TIs in the Business. On time as well!

One letter complained about there being no section files for exchanges. Section files are on the way – see TI E1 A0006.

We are sorry if they are taking so long. Don't be surprised if they contain fewer TIs than you asked for: they should contain only those adjustment and testing TIs needed while actually doing the work.

About tearing up TIs. A manageable basic duty system simply cannot possibly be selective enough for every local situation. You are almost bound to get some TIs you don't want and if you don't want to file them I see no objection to you tearing them up. But have a care: if you tear up a TI and later find you need it, you can always requisition it; there will be no questions asked since it will be appropriate to your basic duty; as things are at the moment, however, P&SD may take a long time sending it.

Finally the big problem — type I files. I am convinced we distributed far too many TIs to type I files when we did the EI/TI conversion. They should now be weeded to the absolutely essential instructions. Some Regions think the same. And if THQ does the weeding, sooner or later you are likely to have to tear up a lot of TIs because you won't get updated ones even if you ask for them. Some of you may even enjoy a good tear-up. Remember, you will still have the Type 2 file back at your headquarters.

— Editor and E Div TI Adviser

Careless Wiring

About 35 years ago we had a fault on a certain 1st selector, which was occasionally failing to release; and as it was the 24th choice the fault occurred only in the busy period and, of course, was common to a whole section of the exchange. It took us a week or two to track it down to a little piece of scrap wire wedged in an unequipped uniselector bank causing contact between two adjacent P-wires.

Recently, in the same exchange, a technician was allowing pieces of scrap wire and solder to fall on working terminal tags. He did not know that a few racks away a TO was investigating an over-metering complaint. Three months previously the technician had dropped solder across the M-wires of two customers, one a very busy one . . .

— A Bagnall, Prestwick

These are only two examples quoted by Mr Bagnall from long experience. He considers the real culprits are PO construction staff and contract installers. So say all of us, but are our maintenance noses all that clean?

— Editor

Echometers

My colleagues and I find it difficult to understand how the LTR can claim such good results when testing from MDF to sub with echometers TO 3/2 and TO 3/3. I can only conclude that the distances involved are short and the types of cable such that it is only necessary to give a faultsman an approximate location. In most Areas the situation is somewhat different, with cabinets up to 4000m from the exchange. With the advent of buried polythene cables and few joint-boxes, the main use of echometers is out on site, testing over short distances from, say, joint-box to sub.

For disconnections, HRs, split pairs and short circuits the set is extremely good, but I fail to see how a battery or earth fault can be measured. On paper-core, of course, an earth fault would normally be S/C but on poly an earth or battery often affects only one leg and cannot in my experience be seen on the set as a fault. I cannot really see the economics of issuing £1000 test-sets to every faultsman when we have fully trained and equipped Precision Test Officers in the Areas. And how is it proposed to power the sets? Faultsmen do not carry 24V battery/generator sets!

— C R Mynott, Guildford

Provincial trials so far confirm Mr Mynott's point and a much lower success rate has been achieved than in LTR. The LTR trial has been extended for another nine months and further assessments of the technique are to be made by THQ staff, using the equipment from flexibility points. If the technique proves successful and economically viable the sets, like the majority in present use, will be both mains and battery operated with internal rechargeable cells.

It is impracticable for PTOs to deal with all faults requiring use of echometers. In Mr Mynott's own Area there were 46 local underground faults reported each day, on average, in 1972.

Sv5.1.1 (01-432 1378)

Network Co-ordination Centres

Your contributor who wrote about the Service Protection Network said that management of the network is vested in the national NCC. Although this is true at THQ level, it would be truer to say that overall it is managed by the NCC organisation as a whole. This is no mere quibble over words. Although each Regional NCC is within its own Regional organisation, and national NCC is within the THQ organisation, in day to day operation the organisation works as an inter-Regional team with all NCC's of equal status and able to make joint decisions.

The thing that makes this possible is the instant inter-communication between all NCCs provided by an omnibus loud-speaker network — no dialling; we just pick up the phone and call for whoever we want, and everybody can hear what's going on and can join in if necessary.

Apart from this conference facility the omnibus speaker is of great value in keeping all Regions informed of major service failures anywhere in the country. If, for instance, a coaxial link failure is announced by one NCC, the other NCCs are immediately aware of the fact and can assess how the event affects circuits from their own Regions and this knowledge can be used to reduce unnecessary effort in places remote from the fault. Also, of course, if anyone wants to know something about the current state of the network his NCC should be able to tell him.

— T S Farres NP 145, National NCC

PCM Problems

First introduced in this country over five years ago, 24-channel pulse code modulation (PCM) transmission systems were seen as an economic method of providing short trunk and junction circuits. Today there are more than 2000 working systems serving approximately 300 exchanges and the number is growing daily.

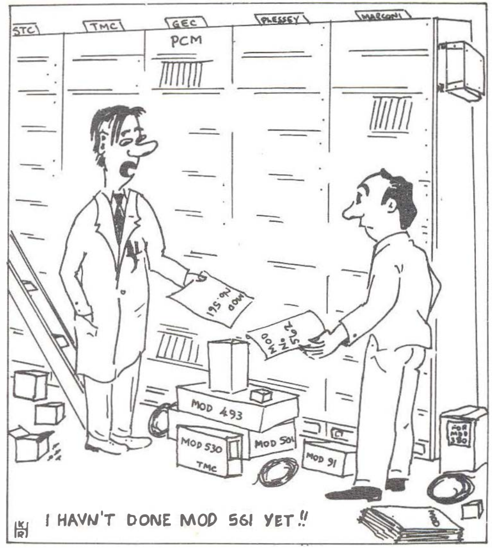
The equipment is constructed in 62 type practice and is manufactured to PO 'black box' specifications by five manufacturers: STC, GEC, Plessey, Marconi and TMC. The black box specification allows the contractors considerable freedom in detailed design with the result that the multiplex equipment is produced in a variety of assemblies.

The ability to achieve a rapid restoration of service is most important on many traffic routes served by PCM systems. The 24 circuits provided by each system can represent a large proportion of the total number of circuits on each route and therefore system failures in these circumstances would seriously affect service.

The maintenance policy for these systems is to provide, at terminal stations, a spare multiplex card for each different type in use. In addition, at least one spare digital section is provided between adjacent section terminals on each route. System failures can then be dealt with quickly by replacing the faulty plant.

The majority of faults which occur affect individual circuits only. These are usually due to failure of the signalling unit at either the outgoing or the incoming end. Many of these faults, however, are of an intermittent nature and it is in these cases that it is difficult to know which signalling unit has failed. It is expected that these types of faults will diminish significantly when all reed inserts have been changed to the gold diffused type.

Faults on individual circuit cards do not necessarily busy out the circuit but complete system failures automatically busy all the circuits affected. When a system fails it may not always be obvious which terminal equipment has failed, or even whether or not the digital link itself has failed. The supervisories are normally self explanatory but for some types of faults an alarm indication is given at both



terminals. When this occurs the problem of fault localisation is overcome by looping the transmit and receive directions of transmission at each multiplex. The multiplex still displaying an alarm indicates the faulty equipment. If neither equipment displays an alarm then the digital link between the terminals is faulty.

Another PCM problem which is causing some concern at the present time is due to interference from high voltage surges generated by the exchange switching equipment. This causes momentary loss of synchronisation between the PCM terminal equipments. When this occurs there is a break in transmission lasting from about 30 milliseconds. These breaks normally only produce an audible click in speech channels although they could, if of sufficient duration, produce signalling failures and premature release of circuits. However, it is known that they can affect Datel services and THQ are carrying out investigations to determine the mechanism of these failures and so find a satisfactory cure for the problem. It has been found during tests in the laboratory that every manufacturers' equipment suffers to some extent, but some have greater immunity from interference than others. The failure is more likely to occur during high traffic periods.

As with most new types of system, PCM equipment has not been without its full share of teething troubles. There have been a number of design weaknesses, which is perhaps understandable for such a radically different type of transmission system, where manufacturers and the PO had little field experience prior to the installation of equipment. Equipment has therefore had to be modified to overcome these deficiencies, many of which involved large numbers of units. There have been some 150 changes to date.

It is hoped that most of the major problems have now been resolved fairly satisfactorily but not all have been fully implemented. Early evidence suggests that when all these modifications have been completed a significant improvement in the fault rate will follow.

Certain types of early digital test equipment proved very unreliable, being susceptible to spurious interference problems. This placed serious restrictions on carrying out a long term monitor or when routining the systems.

The planned growth for 24-channel PCM is such that the number of systems in service will have doubled by 1974 and possibly trebled by 1976. In addition a new European standard 30-channel system is planned to be introduced in 1976 which will form the basic block for feeding higher order digital systems in the main network as well as succeeding the 24-channel systems in the junction network.

Considerable credit is due to PCM maintenance staff for their interest and enthusiasm in tackling the new problems which have arisen with the introduction of digital transmission systems.

Sv6.2.1 (01-432 1371)

Lightning protection on broadcast video links

Lightning is one of nature's more spectacular phenomena that we all witness from time to time. Little was known about it, apart from its capacity to cause damage, until research was carried out in recent years. This showed that the spectrum of energy in a lightning discharge is almost completely contained within the video transmission band.

Although damage to valve operated equipment occasionally occurred, the introduction of transistor amplifiers and associated equipment brought with it a far more serious problem because a transistor can be destroyed by a very short duration energy pulse. The protection of the new equipment presented a very difficult problem because of the need for any protective device to be very fast acting.

Standard protection arrangements

Protection is applied in two stages. The first of these consists of two low voltage (90V) gas discharge tubes connected, respectively, between the inner conductor of the coaxial pair and the cable sheath, and between the outer conductor of the coaxial pair and the cable sheath. These tubes are fitted at both ends of a cable section on the sealing ends. The second stage is a fast acting low slope resistance limiter in the form of a diode bridge fitted across the amplifier input. The limiter takes advantage of the high forward resistance of diodes at low voltages such as signal voltages, and their low resistance at higher voltages. The turn-on time is less than 10ns and the terminal voltage drop during a 1 microsecond pulse of 8A is 12 to 14V. Between the two stages of protection is a coaxial choke, the impedance of which delays longitudinal surges sufficiently to allow the slower acting discharge tubes to conduct and dissipate the main energy to earth. The limiter protects the amplifier from residual voltages and the lead cable sheath provides the direct path back to the station earth. A schematic diagram is shown on page eight.

The relative incidence of damage to correctly protected equipment is small. A study has shown that at some stations the gas discharge tubes operate momentarily many times during a storm without recorded loss of programme or damage to equipment.

Investigations into lightning damage

Investigations carried out by Sv6.3.3 into lightning damage on video links has revealed that, in nearly every case the damage and/or loss of service could have been prevented or reduced if the installation had been correctly installed and maintained. It is felt that it would be useful to maintenance staff to list the most important factors which affect the efficiency of the protection equipment.

The coaxial cable lead sheath, which acts as the discharge path, should be connected to the cable entry duct seal and from there to the station earth. *No other earth paths should be provided to the lightning gas discharge tubes.*

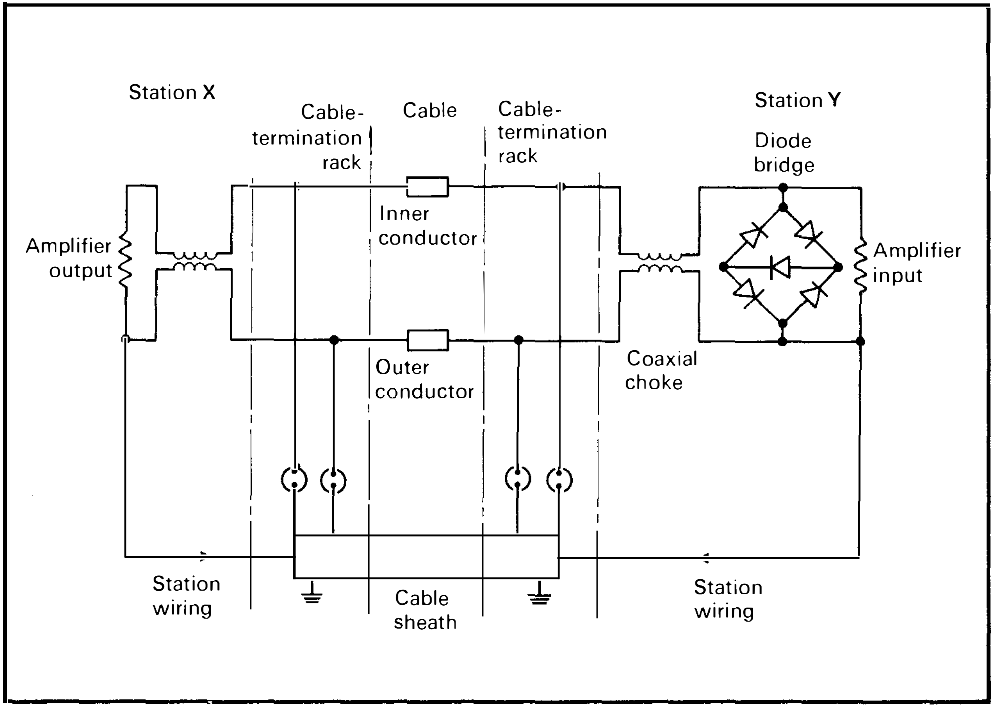
Lightning discharges tend to travel in straight lines; therefore sharp bends in earth wiring, used in the discharge path, should be avoided or minimised wherever possible.

The most common faults which were found during inspections were as follows:

1 Cable sheath not earthed to station earth. In particular polythene covered lead sheathed cables had not been bonded to the duct seal.

2 Gas discharge tube mounting brackets loose on the cable termination mounting. The protectors no 2A and 6A rely on the sealing end locknut to obtain the connexion to the lead cable sheath.

3 Station earth resistance too high.



4 Corroded earth cables.

5 Non-standard earthing arrangements including instation earth loops on equipment racks.

Routine checks

Pending issue of a TI on the subject of lightning protection on PO broadcast video links, maintenance staff are reminded of the following mainenance checks on the protection equipment.

1 To overcome the problem of the tubes losing efficiency after being subjected to lightning strikes, gas discharge tubes (protectors no 9A) should be changed at the periodicity shown.

All stations in high risk areas	— Four yearly
All other stations	— Six yearly

2 A yearly check should be made of the protectors to see that they are undamaged and that the locknut securing the mounting plate to the cable sheath is making good contact.

It is recommended that an updated diagram of earthing runs be kept at every station and that the station earth resistance be checked regularly in accordance with the relevant TI.

Additional lightning protection

Recently PO equipment at some transmitting stations was damaged by lightning currents flowing to the equipment from the customer's installation. Additional protection, in the form of coaxial chokes (inductor coil no 166B) and gas discharge tubes, is being installed between PO and customer's equipment. This work is due for completion by January 1974.

Problems being investigated

The use of polythene sheathed cables and pvc duct seals for new installations has taken up with NPD and TDD. SvD are await the answer to these problems and will advise maintenance staff of the outcome.

There is now a further problem which will have to be solved: the new generation of external cables will have no lead sheath, only a moisture barrier.

In conclusion

Constant vigilance is necessary if protection is to remain effective. We have statistics to disprove the old saying that lightning never strikes in the same place twice!

Sv6.3.3 (01-432 1437)

Lightning strike on a West Country transmitter

Regenerator No. 5A

Ask a Strowger maintenance man to name the most fault-prone item of equipment in his exchange and the chances are that he will say without hesitation 'Regen 1s' — unless perhaps he is lucky enough not to have any installed on his patch! That regenerators no 1, the standard PO dial-pulse regenerator, should enjoy such a dubious reputation is not altogether surprising since they are very complex electro-mechanisms.

Originally developed in the late '30s to permit two or more junction links to be used in tandem without introducing dial pulse distortion, the number of circuit applications of regenerator no 1 has steadily increased; loop-disconnect auto-auto relay sets at first, then later as a pulse storage device in 2000-type satellite discriminators, SSDC1 and AC1 outgoing relay sets, and more recently for a similar purpose in UAX STD relay sets. A survey made in 1972 showed that some quarter million regenerators no 1 were in use at the time — quite a large maintenance commitment with each unit needing around 40 minutes attention every year.

Recent developments in the field of electronics, and particularly the large scale integration of components by MOST (metal oxide silicon transistor) technology, have made feasible a 'solid state' equivalent to the electro-mechanical regenerator with the promise of benefits in maintenance costs and reliability. In 1968 the British telephone manufacturing industry was invited to tender designs for such a device to serve as a direct replacement for regenerator no 1. Pye/TMC, who had been exploring the possibilities of MOST technology for a number of years, offered a design that met the specification laid down by the PO and were awarded a contract to supply 10 000 of the devices. These subsequently became known as regenerator no 5A Mk 1.

For those who have not seen inside the casing of the Mk 1 electronic regenerator, of the components mounted on the two printed circuit boards two are dual-in-line integrated circuits. Between them, these two ICs contain some 1600 components. Each of the two 'chips' occupies an area no greater than four square millimetres. A mercury-wetted reed relay provides the necessary dry-loop pulsing-out element. By using the same connexion plug and keeping the size within the dimensions of the regenerator no 1, the electronic and electro-mechanical versions are interchangeable.

The 10 000 Mk 1 electronic regenerators were placed in exchanges all over the country to confirm the performance and reliability of production samples under everyday service conditions in the 35 or so varieties of relay-set employing regenerators. Several lessons were learned from these trials, including the need for minor modifications to maintenance testing equipment and to some types of relay set to ensure full compatibility.

Meanwhile, Pye/TMC development engineers were refining the design of their regenerator, culminating in a Mk 2 version containing only half the components used in the Mk 1. The design uses a single IC containing some 1000 components encapsulated in a transistor-type can. A contract was placed for the supply of 37 500 Mk 2 regenerators and to date some 30 000 of these have been delivered. Like its predecessor, the new version has to undergo a controlled service approval trial to ensure compatibility with all relay sets and to confirm serviceability. To this end the first 6500 placed in service are being closely monitored by THQ and the manufacturer,.

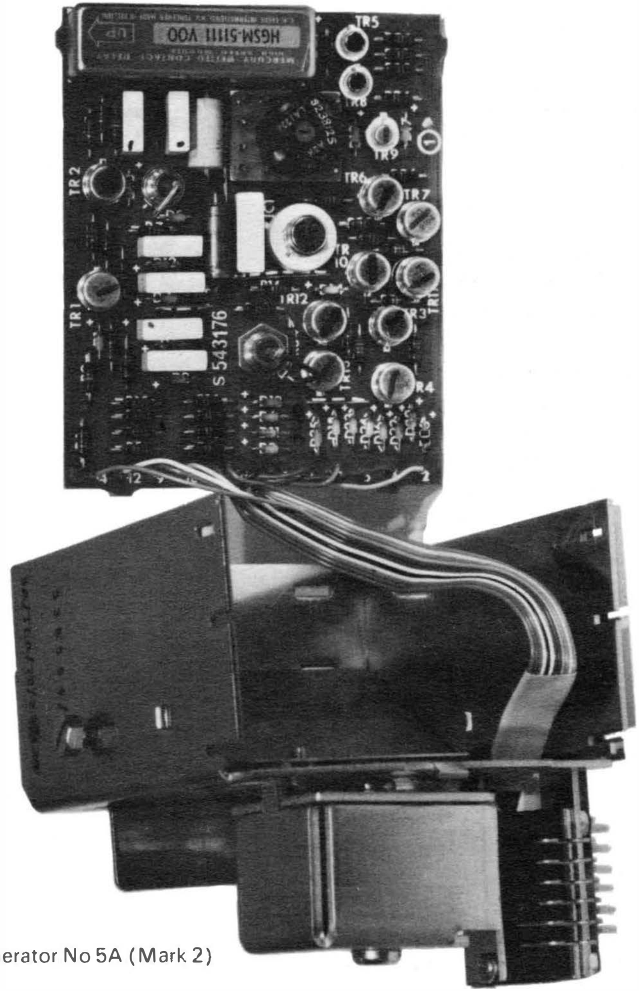
The rest are being distributed to Regions as and where local management consider their maximum impact will be felt.

A contract has also been placed with GEC for 12 500 regenerators no 5A of their own design. These Mk 3 versions are awaited with interest as the design is different from the Pye/TMC products in many respects.

As no device can be 100 per cent reliable regional replacement depots have been set up to provide a maintenance exchange service; TI E6 H0055 explains the procedures to be used. This TI also contains information on the periodicity at which the regenerators and relay sets should be routine tested.

The future for the regenerator no 5A? This very much depends upon the results of the service trials. If failure rates prove to be as low as early results of the Mk 2 trial seem to indicate, then electronic regenerators should be an economic proposition for use in relay sets ordered to meet network growth. Whether replacement of all existing regenerators no 1 by 5As can be justified is a more difficult question to answer, particularly in view of the decision to introduce TXE and TXK exchanges which have no need for such devices.

Sv6.5.5 (01-432 1354)



Regenerator No 5A (Mark 2)

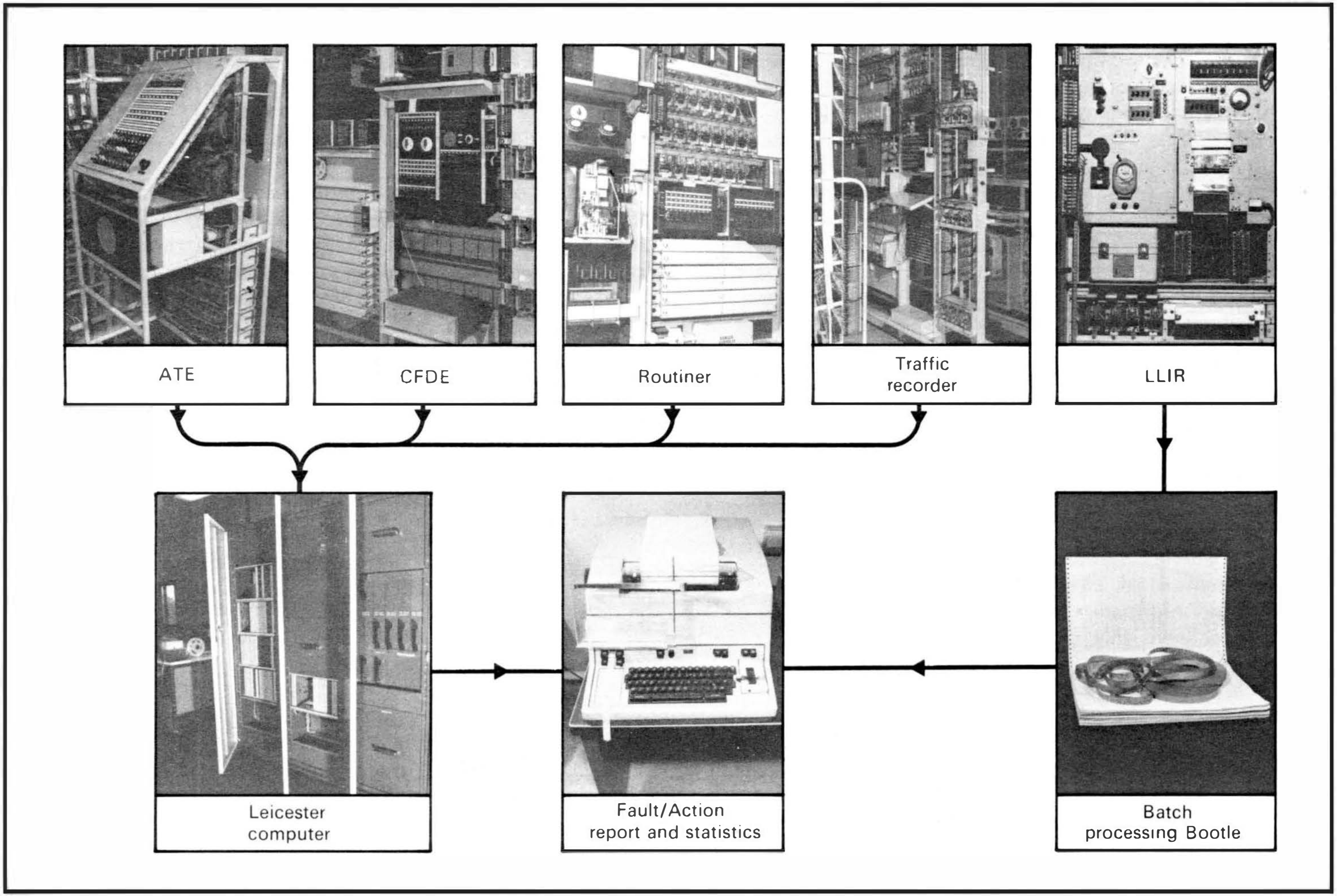
Computer Aided Maintenance Project

A field trial is being carried out in the Leicester Telephone Area to assess one of the latest aids to telephone exchange maintenance — the computer. A Ferranti Argus 500 machine, situated at West Wigston telephone exchange, gathers information round the clock from 22 Strowger exchanges and processes it under a variety of tasks to assist in both maintenance and traffic recording.

There are two tasks which have been developed specifically for exchange equipment maintenance. The first, network surveillance, has been running successfully since the beginning of this year. Call failure information is input directly to the computer as failures are detected. In computer jargon this is 'on-line' working. The sources of call failure information are customer reports, call failure detection equipment (CFDE) located at exchanges, and artificial traffic equipment (ATE) located at a fault reference centre (FRC). The computer processes the failure information immediately it is received and a response indicating what fault action is required is output within a few seconds (real-time processing). Processing involves first the comparison and then the grouping of failures having common routings, or originating points. When the number of failures in a group reaches a prescribed number, termed the action parameter, a course of action is automatically indicated. This varies according to the diagnosed location of the fault in the network. If the use of an ATE is indicated the necessary routing instructions are output adjacent to the ATE. The mode of operation of both CFDEs and ATEs is such that they hold a failed call until real-time processing of the failure information indicates whether action is required, and if so whether the device should be held for fault tracing purposes. If not, a reset signal is generated by the computer. If action does appear necessary the computer prints out on the appropriate exchange teleprinters a history of the call failures involved and an indication of any call held. The network surveillance task forms part of the FRC system.

The other exchange maintenance task is the analysis of the output of automatic routiners and the establishment of records of equipment faults. The first part of this task, routiner output analysis, will soon become operational. This is based upon the current maintenance technique of overnight routining. Reports from automatic routiners in exchanges are passed on-line to the computer during the night and weekend routine cycle periods. The result of each period of routining is output on the exchange teleprinter on the morning following the period concerned. The output is sorted into routiner order and includes the following types of report: fault symptom, busy, start, stop, routine finished, routiner fault and error reports. These are sorted into a suitable form for morning testing removing the need for manual sorting.

The second part of the task will be introduced early in 1974 and involves the use of the computer to maintain records of equipment faults and to provide equipment performance statistics. Existing fault dockets will be replaced at the 22 exchanges involved, by two new dockets.


ATE
CFDE
Routiner
Traffic recorder
LLIR
Leicester computer
Fault/Action report and statistics
Batch processing Bootle

These will be used, after completion in the exchanges, as documents for on-line input of the 'clear information' into the computer. A visual display unit (VDU) located at West Wigston exchange will be used to do this. Fault clear information input in this way will be stored by the computer and a twice weekly update of the record file will take place. As records of faults are added to the file a check will be made to see if recurrent faults have occurred on the particular items of equipment involved. When recurrence of faults is detected a report is output by the computer for distribution to the appropriate exchange management. This report will contain a history of all faults which have occurred on the item of equipment over the past year.

At present there is no rapid, comprehensive and sustained method for obtaining detailed analysis of equipment performance. The information collected and stored to achieve this computer aided analysis procedure will be used to provide a comprehensive range of performance figures.

Computer aided traffic recording is a task, already operational, involving the on-line collection of data from automatic traffic recorders and the control of these by the computer. The data is processed to determine the volume of traffic carried by individual circuit groups to produce locally a traffic summary (form A 854) and a traffic balance for each exchange. In addition to removing the start and meter reading functions from the maintenance staff duties there are other maintenance advantages from this task. Print-out on exchange teleprinters at the end of each recording period indicates which selectors have been continuously busy so that faults causing this condition can be found. In addition, weekly print-out is available showing those selectors which have been unused or which have carried traffic when shown spare. It is hoped that extension of the task to include more detailed grading analysis for traffic balancing will also permit a more extensive location of faulty equipment.

Another task which is also operational is the traffic pattern analysis of 'good call' output from CFDEs. The results from this analysis give the pattern of calls from each exchange and help with exchange design.

Computer analysis of local line insulation routiner output is a task which is included in the CAMP project although processing is carried out at the Bootle computer centre. The analysis is carried out on a weekly batch basis and provides a continuously changing picture of the state of the local line plant network in four Telephone Areas including Leicester. Deterioration of insulation standards are pin-pointed so that preventive maintenance can be carried out and service affecting faults avoided.

The computer at Leicester is serving as an invaluable 'test-bed' to explore the ways in which computers can help in the maintenance of the Strowger network. The results are now being assessed for their operational usefulness and economic benefits and will, where appropriate, be incorporated in proposals now being developed such as the Measurement and Analysis Centre scheme.

Sv6.5.2 (01-739 3464 x 7703)

Any crossbar exchanges in your area?

Have you any idea why we have introduced crossbar systems into the national network?

In the mid 1960s the PO had to solve the problem of quickly meeting an increasing demand for telephone service at a time when the contractors' maximum manufacturing capacity for Strowger equipment was insufficient for our needs. This meant we were faced with the difficulty of meeting one of our prime business objectives — giving service to customers. What alternatives were there to Strowger exchanges? The design and manufacture of electronic exchanges had not then reached the level required to meet our needs but both Plessey (PTL) and STC offered designs of common control crossbar exchanges suitable to meet PO needs. The introduction of a new system into our national network might amongst other things incur cost and space penalties. These in all probability would be offset by reduced maintenance costs and increased reliability when compared with Strowger exchanges and this is in fact proving to be the case. Whilst crossbar systems inherently have a number of very good features it should be appreciated that the main reason for using them was to meet a demand for service which otherwise could not have been met.

What types are we buying?

The crossbar switching systems at present in use in the PO exchange network can be divided into three fundamental types — those based on the Plessey 5005 crossbar switch, those based on the Pentaconta multiselector of French origin, (known as the BXB system), and more recently that manufactured by Swedish Ericsson. Incidentally, we refer to Strowger, electronic and crossbar exchange systems as TXS, TXE and TXK respectively.

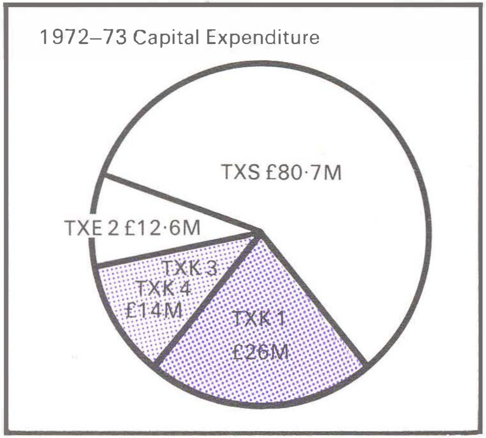
The table overleaf shows the types of exchanges we are buying with brief details of their application in the network.

Capital investment for crossbar

The chart below may help to put the crossbar programme for 1972/73 in perspective.

We expect that between now and 1980 about £350m will be spent on crossbar equipment and about £100m on TXE 4 as part of the modernisation of the telephone network. The present penetration of crossbar exchanges accounts for about 5 per cent of the total exchange connections; this should rise to about 10 per cent by 1978.

The remainder of this article deals with systems used for inland exchanges; these are TXK1, TXK3 and TXK4.



Post Office Code	TXK 1	TXK 1	TXK 1	TXK 2	TXK 3	TXK 4	TXK 5
Manufacturers' Code	5005	5005 Derivative	5005 Derivative	5005 Derivative	BXB 1112	BXB 1121	ARM 20/4
Type of exchange	Local Non-Director (LND)	Group Switching Centre (GSC)	Sector Switching Centre (SSC)	International Telephone Switching Centre (ITSC)	Local Director and Non-Director (LD and LND)	Transit Switching Centre (TSC)	International Telephone Switching Centre (ITSC)
Speech path switched	2-wire	2-wire	2-wire	4-wire	2-wire	4-wire	4-wire
Manufactured by	PTL and GEC	PTL and GEC	PTL and GEC	PTL	STC	STC	Swedish Ericsson
Number of exchanges in service	150	7	—	1 (Wood St, London)	24	21	—
Total number of exchanges planned	400+ by 1978	37+ by 1976	7	3	205 by 1977	37 by 1977	1
General information	First 5005 exchange was opened in November 1964 at Broughton (NWTB). The first production TXK 1 was opened at Bacup (NWTB) in October 1968.	First GSC opened at Dover 28 March 1973.	First SSC due to open early 1974. This system has electronic registers with stored program control processors (SPC).	ITSC handles ISD traffic into and out of the UK. It also switches a small amount of international transit and manual board traffic. Two further units are at the planning and installation stage.	TXK3 used for arge LND because of its high traffic carrying capabilities. From 1977 it is expected that TXK 3 will be superseded by TXE 4.	These exchanges form a 4-wire switched trunk network enabling full STD access to be given to all customers	The exchange is being installed at Edgware, London to supplement the TXK 2 unit. (This system was chosen by competitive tender.)

What sort of equipment is it?

Over the years Strowger has evolved as a standardised system conforming in all respects — electrical, physical, installation — to PO requirements. One of the big differences between TXS and TXK is that in TXK we bought proprietary designed systems. This means that we had little or no control over such things as the circuit design and physical realisation, but this situation is gradually changing.

In the case of Strowger, new equipment is subjected to fairly rigorous laboratory and field tests to clear any bugs out of the system prior to national introduction. No such tests were carried out by the PO on the crossbar systems. We bought them as a package deal.

In general all the equipment in the TXK systems is permanently wired-in using wire wrapping techniques.

The TXK1 uses double sided racks and to facilitate access to the rear the shelves are hinged. The circuitry is designed around relays closely akin to current PO types. Indeed the circuit diagrams and explanatory notes are very similar to the AT series. Shelves are dust protected by transparent covers.

The TXK3 and TXK4 systems, derived from the continental 'pentaconta' system, are very different from both Strowger and TXK1 practice. The racks are single sided and contain relays unique to the system. The shelves are protected by steel covers. The documentation naturally follows continental practice which although strange at first sight has many points in its favour.

Maintenance approach

Listed below are some of the features which we hope will give an improved service and lead to more economical maintenance. Some of these are also provided in TXS exchanges.

1 Automatic repeat attempt. If the first attempt to set up a call by the common control is unsuccessful due to a switching fault or equipment congestion, then an automatic repeat attempt is made. Customers are unaware that this is taking place.

2 Fault tolerance. The systems are designed so that failures of individual circuits do not put large sections of the exchange out of action. System security is ensured by duplication of vital areas.

3 Routine testers. These are provided for checking common equipment and trunk and junction circuit terminating equipment not covered by fault print-out facility.

4 Service meters. Provision is made at various points in the system to record traffic, congestion, second attempts and to measure the quality of the service offered.

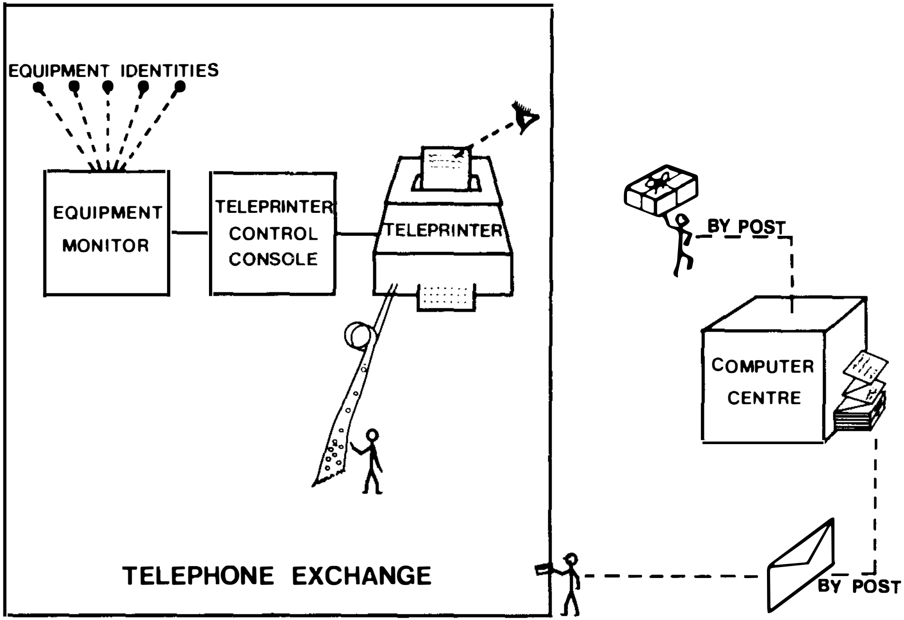
5 Test call senders. These generally operate in a 'Quality of service measurement' mode. In specific systems they can be programmed to 'stop on a fault'.

6 Fault print out. If a fault occurs during the setting up of a call, in addition to a second attempt being made automatically, details of the equipment used and of the switching path are printed out on a teleprinter. Facilities are also available to produce a paper tape output.

7 Computer aid. Visual analysis of a large amount print-out can be a long and tedious operation so to speed this up the paper tape output is sent to a computer centre for analysis and a printed output returned directly to the exchange (see sketch overleaf).

8 Diagnostic schedules. These will be prepared to assist maintenance staff in systematic location of faults.

TXK 1 fault information print-out and analysis



The overall maintenance requirements are lower than for TXS exchanges; the major portion of maintenance activity is spent on corrective rather than preventive work.

Maintenance activity in crossbar exchanges is of the following types:–

a) Corrective action. Localisation of faults following subscriber complaints, artificial traffic failures, alarms and faults registered by automatic fault detection devices and testers.

b) Functional testing. Such testing is intended to detect circuit malfunctions in those areas of the system not covered by automatic fault detection devices, for example, junction, transmission and call charging relay sets and time-out devices.

c) Inspection of mechanical devices (relays and crossbar switches). This work is of a preventive nature. The periodicity varies according to component reliability, circuit usage and its position in the system.

Experience to date

Because of the preponderance of TXS exchanges in the local exchange network the overall performance of individual crossbar exchanges tends to be similar to the average quality of service (QOS) for the area in which it is situated. Call failure rates for calls routed wholly within a crossbar exchange, that is own exchange calls, are significantly better than their TXS counterpart. It is therefore expected that as the proportion of common control systems increases then the overall QOS will improve.

The most important single maintenance aid in crossbar exchanges is the automatic fault recording device known as Equipment Monitor in TXK1 and as Incident Recorder in TXK3 and 4. These, with associated teleprinter and paper tape output, give details of faults.

The technique of using computers for analysis of fault print out information has already been introduced for TXK1 LND exchanges. To date about 50 exchanges are using the scheme which has a turn round time of a week from despatch of tape to receipt of analysis. Plans are in hand for a similar scheme for the other crossbar systems and further details are given in another article elsewhere in this issue.

To assess the feasibility of a new approach to maintenance of small common control telephone exchanges a field trial of centralised maintenance is being carried out in the Coventry area. The fault print out from several exchanges is concentrated at one centre from which the activities of maintenance staff are controlled. To date the trial is proving successful.

More details of in-service experience of individual systems will be given in the second part of this article which is due to appear in the next issue.

Maintenance costs

The target for LND TXK maintenance manpower figure is half that of an equivalent TXS exchange. From the returns available the results are encouraging in that the trend is downward towards the target figure.

Using centralised maintenance techniques, the indications are that further improvements are likely.

What of the future?

When comparing TXS and TXK systems we should bear in mind that TXS has been refined over a period of some 50 years while TXK is still very much in its infancy. In order to bring TXK to the same degree of refinement as Strowger, THQ relies very heavily on all of you at Area and Regional level to keep us informed of any problems encountered via the A646 and other procedures. Only in this way can we be sure of getting the bugs out of the systems. Faults can occur which cause loss of service to a large number of customers and occasionally the whole exchange, and these should be reported to the Area and then to the Regional Network Co-ordinating Centres in the usual way.

A scheme for distributing information and experience gained in an Area or exchange to other crossbar exchanges at short notice has been set up. The documents are known as 'crossbar maintenance notes'. We hope that the majority of the published information will still come from Areas with THQ acting mainly in an editorial and advisory capacity.

Although TXK systems were originally intended as an interim measure the recent PO board decision to spend £350m on modernising the network with crossbar equipment means it will be with us well into the future to the year 2000 perhaps. We must all therefore ensure that we get the best service from each of the systems.

(This article will be concluded in the next issue with some details of in-service experience of individual systems).

Sv6.1.1 (01-432 1391)

TXK exchanges - fault diagnosis by computer

Crossbar exchanges supplied to the PO have a second-attempt feature whereby, if a call fails to mature on its first attempt to find a path through the exchange, a second attempt is made using a different path. For calls failing to mature on either attempt an equipment monitor records the event and prints out, on a teleprinter, a report of the equipment used.

Much abortive effort of the maintenance staff would result if every single failure report were to be investigated. To avoid this, effort is only directed to equipment which has featured in several reports. A serious fault will result in many similar reports in quick succession — immediately apparent from the teleprinter record; but reports due to more obscure faults will be spread out through the record and will be more difficult to associate.

To assist in the location of these less obvious faults it was decided to prepare a computer program to receive and analyse the reports and print out in blocks those reports which showed the use of common items of equipment. The scheme is known as CAMP Follower no 1 because the output of the equipment monitor, being in telegraph code, is suitable for transmission over a line and for direct input to a computer, rather like the other tasks of the Computer Aided Maintenance Project (CAMP) at Leicester. An obscure fault still takes some time to become apparent because of the small number of reports associated with it; however, the second attempt feature ensures that the service to the customers does not suffer during this time. As an immediate response is not therefore required from the computer, it was decided to fit reperforators to the teleprinters and send the resulting tapes to PODP computer centres for off-line processing.

It would be uneconomical to extend the analysis to a point where a particular item of faulty equipment is indicated as this would mean incorporating in the program information peculiar to each exchange. The initial programs were therefore arranged to give an analysis common to all TXK1 local ND exchanges. The computer output shows the blocks of equipment apparently containing faulty items; further localisation is achieved using diagnostic cards and cross-connection charts proper to each individual exchange.

Trials were first made at Ingatestone and Upminster exchanges, and later extended to the exchanges of the Coventry centralised maintenance field trial. Having proved successful, the system is now being introduced nationally.

A similar off-line system is ready for use in the TXK4 transit exchanges, and another is being prepared for use in the TXK1 combined local and GSC exchanges, in the first months of next year.

Sector switching centres (SSCs)

Seven TXK1, stored program controlled (SPC), sector switching centre exchanges, each of a planned traffic carrying capacity of some 30 000 Erlangs are projected to carry the trunk traffic of the outer areas of the LTR.

The volume of print-out expected from exchanges of this size is such that an on-line computer system will be needed to handle the data. Information will be collected from the equipment monitor and from the trunk circuit routiner fault recorders. In view of the importance of these exchanges in the network, additional management information will also be prepared by the computer.

A local computer, linked to a central computer at Colindale exchange, will be installed in each SSC. The local computers will collect data from the equipment monitors and trunk circuit routiner fault recorders, give an immediate print-out of urgent (stored program control) reports, then compress the reports into a standard format for transmission over the data link to the central computer, receive data back from the central computer in compressed form and produce in standard format all the reports prior to printing. The central computer will store all the reports, analyse SPC and crossbar reports over a 14-day period, list the faults found on night routining; and having sorted these into work loads, it will transmit them to the appropriate exchange for print-out the following morning. It will also perform a seven-day repeat fault analysis of routiner and SPC only reports and produce management statistics.

It is anticipated that this system will be ready for use in September 1974, but as the first exchanges open before this date, an interim system is being prepared to come into operation in January 1974. This will be a daily batch process system with print-out arrangements similar to those of the TXK1 local system. Tapes will be taken to the Barbican computer centre for overnight analysis and the results returned next morning. Only failures due to the crossbar equipment will be analysed, all other information being printed out on the equipment monitor teleprinters for local attention.

Sv6.5.1 (01-739 3464 x 7764)

Measurement and Analysis Centres - MAC

A new approach to quality of service improvement

The quality of service provided by the switched telephone network is currently assessed from the results of a sample of customer dialled traffic taken at the input stages of local exchanges and Group Switching Centres (GSCs). The analysed results are circulated each month giving local and STD results for each local exchange with GSC, Area, Regional and national summaries. The process is recognised by most of us as Telephone Service Observations (TSOs) or simply as 'Obs'. As maintenance engineers we are concerned with failures due to plant, and in particular, defective and engaged plant.

Consideration is now being given to the alternative of using artificial test traffic to assess plant performance, the practicability of which has been proven during trials carried out by THQ groups in Sv5 and Sv6. A major advantage of the method is that artificial traffic enables the performance of individual switching units and sections of the network to be measured economically as well as end-to-end STD performance.

It is intended that measurements will be made from a centre in each Telephone Area, to which all the exchanges and GSCs to be measured would be connected by a sending path. Call distributors would be provided in each switching unit and test numbers allocated to ensure that test traffic flows through all plant available to the customer. At the centre the sending paths would be terminated on sending elements under the control of a processor.

The processor would be arranged to apply a number of test call programs through each of the exchanges or GSCs connected and to process the results of the test calls for both statistical purposes and service improvement purposes. A typical suite of programs applied to a local exchange would be:

Calls per month	*Line circuits to*
1000	test numbers in own exchange multiple
1000	exchanges within the local dialling area
500	distant (STD) numbers
500	(PIP5)

Calls would be sent during the day at a volume related to normal traffic and the results of the first three programs collated for the equivalent of CSO results. The results of these programs would then be further analysed by the processor to indicate when present performance limits had been exceeded and, in this event, print out all the failure details stored and also indicate any coincidence of failures seen from the exchanges connected.

The processing capability will be fully exploited to make maximum use of call-failure information as a result of quality of service measurement, providing a very fast-acting maintenance aid. The MAC staff would inform exchanges concerned, in much the same way as reference centre staff do now, so that improvement action can be taken. Provision would also be made for special analysis programs to be applied to any unit to localise more elusive troubles, with faulty calls held, if necessary, to aid location.

Implementation of the MAC concept combines measurement with system maintenance and management; this offers the prospect of further service improvement at the same time relieving exchange staff of the need to apply system surveillance through the use of locally based test-call senders.

Sv6.2.3 (01-432 1364)

Why reference centres?

The need for reference centres was recognised in the late 1950s when STD was first introduced. Before this, trunk connexions were controlled by trunk operators who reported any connexion difficulties directly to trunk maintenance controls (now TMCCs) for engineering attention: operators played a valuable role in helping to detect plant defects for maintenance action.

With the introduction of STD the customer came face-to-face with the trunk network and fully exposed to its defects. In this situation, customers experiencing difficulty are asked to dial 100 for help from the assistance operator. The operator offers the necessary assistance; as a by-product the operator obtains a great deal of valuable information on connexion failures, and the efficiency of the network from the customer's point of view.

Repair control officers (RCOs) at a repair service control collect similar information by virtue of their investigations into customer complaints about problems with outgoing calls. Although RCOs can deal with troubles up to the home group switching centre (GSC) neither of these reporting points are equipped to make direct use of the failure information passed on by customers; reference centres were established to turn the information to good account. (TI E13 A2001 refers).

Reference centres are now established at most GSCs, and arrangements are made for customer difficulties to be reported to them by both assistance operators and RCOs. They act as collecting centres for information on STD call failures inviting reports from any source. Analysis of the information by reference centre staff– technical officers with a detailed knowledge of trunk equipment and call routing and a nose for trouble – leads to the detection and location of failure points; this has a marked effect on service. The centres are usually equipped with call senders to probe suspect routing; many also make use of the information on route performance provided by trunk route service measuring equipments as well as call failure detection equipment outputs.

Few centres boast a low FNF figure. Not that this is expected of them. But they maintain a necessary watch on the operation of the trunk network as a whole, co-operating with each other to locate and clear defects that could otherwise cause either extended or catastrophic trouble.

Communication between reference centres and exchanges is usually over special faults circuits. RCOs try to provide the exchange with as much detail of the problem as possible to enable a location to be made with a minimum of testing. They are well aware of the abortive effort that erroneous or insufficient information can provoke. However, a short follow-up by the special faults officer, even though this may not locate the difficulty, enables the reference centre staff to eliminate at least one of the possible causes of customer difficulty and may lead them to the actual cause. Reference centre staff are a tenacious breed, coming back at you if the evidence stacks against your unit!

It is quite likely that your own Area already has a reference centre dealing with local network failures. If you would like to find out more about the way these centres work, why not arrange a visit to meet the staff and examine their techniques?

Sv6.2.3 (01-432 1364)

Test desk design trials

Conventional test desks are composed of three sections, one giving access to test junctions, the second providing testing instruments and the keys to control and connect them and the third section providing miscellaneous jack-ended circuits including incoming and outgoing lines.

We have now produced a new concept in test desk design, improving the appearance of Repair Service Controls by creating an office-type environment. This is shown in the artist's impression.

The new design features three table-mounted modules, providing similar facilities to the test desk but in a cordless form. The modular construction allows complete flexibility in position layout with position mobility to suit an office layout.

The three table mounted units are:–

1 **Testing module** This module is 430 mm long, 240 mm deep, and 210 mm high. It is equipped with a 0–50V voltmeter, a 25–0–25 microammeter and keys to give all necessary tests of voltage and current conditions. Access is provided to the conventional dial pulse speed and ratio tester which has a digital display to show the number dialled. A reduction in size of this module could be achieved by providing digit displays of pulse speed and ratio, so allowing removal of the microammeter. This is being investigated.

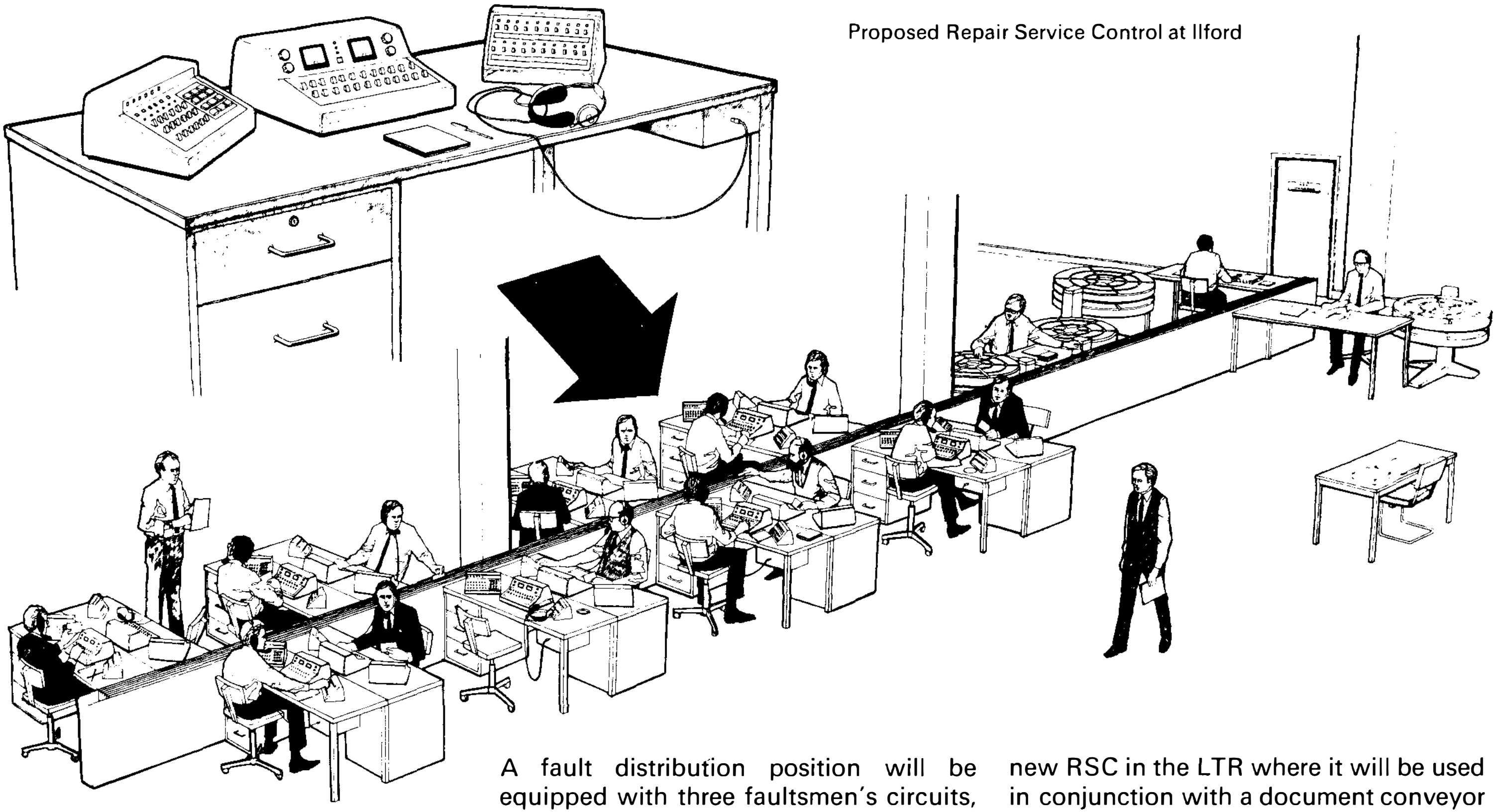
A speak key is provided to connect a line under test to the position tele circuit. Other facilities include a transmitter cut-off and monitoring circuit. The possibility of using this module in place of a tester AT5422 or TRT 230 in exchanges where test desks are not provided is also being considered.

2 **Test access module** This module is somewhat smaller in size being 365 mm by 235 mm by 190 mm. It has a key unit 4/1A (push button dial) serving any circuit needing dialling facilities on the position. There are three test access circuits each with its associated finder, controlled by exchange selection press buttons. These give access to any one of six groups of test junctions to any type of exchange. Keys associated with each test access circuit offer connexion to the testing module, ringing, interrupted earth and the howler to each test access circuit independently; and a private control key, speak key, dial key and operate and hold key. This unit also houses bothway speaker circuits to the MDF, and outgoing speaker circuits to the exchange special faults position.

3 **Reception module** This is a still smaller unit. It measures 230 mm by 178 mm by 125 mm. It has twelve circuits and two connecting link circuits. This unit can function in several ways: as a fault reception position equipped with 151-circuits; a direct exchange line; a PABX extension line and four speaker circuits to card filing positions; or as a fault distribution position.

Each reception position can have three incoming 151 lines, but normally only the first line on each position will be open to traffic; these positions are opened by plugging in the operator's headset. The other two 151-circuits on each position are opened by the RSC supervisor under key control, should traffic conditions warrant this. Calls are allocated to each staffed position in turn. Should a call be received on a position, but remain unanswered for a period of 'x' seconds after a first line circuit on any other position becomes free, that call will be transferred to this free first line circuit.

Proposed Repair Service Control at Ilford



A fault distribution position will be equipped with three faultsmen's circuits, and can have two 151-circuits, three both-way speaker circuits to telephone service centres and four speaker circuits to card filing positions.

The equipment may be used in any type of RSC layout, but will initially be installed in a new RSC in the LTR where it will be used in conjunction with a document conveyor system carrying fault cards from the filing units to the reception and distribution positions. This arrangement is the subject of a field trial which is due to start early in 1974.

Sv5.1.3 (01-432 1387)

Keyphones

This is the first in a series of articles to help subscribers' apparatus faultsmen become aware of the new products which the PO is offering its customers.

Keyphones are being introduced by the PO as a faster and more efficient method of originating a call. There are three types of keyphone: one is suitable for direct connexion to Strowger type public automatic exchanges, known as the self-contained type. The other two types are both designed for use on PABXs with switching systems other than Strowger.

Self-contained Strowger pulsing keyphone

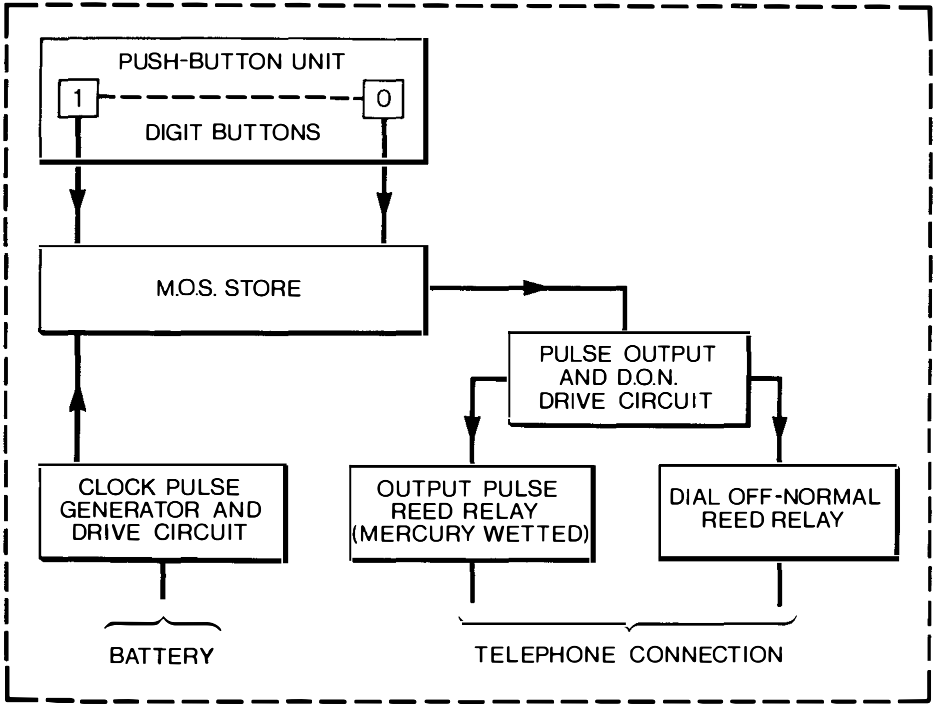
Unlike earlier types of Strowger keyphone, this does not require any additional equipment. Based on the standard 746-type instrument, the dial is replaced by the push-button unit and its associated circuitry. The telephone is easily recognisable from the two other types of keyphone by the 3×3+1 keypad layout. Each button has two independent 'make' contacts with a common snap-action microswitch which operates when any button is pressed. The buttons are connected in a grid pattern by row and column to produce a code input to the electronic unit. Power is supplied by a small nickel cadmium battery which is charged at about 3mA either from the exchange line or from a local power unit.

The diagram shows the electronic dialling unit. This has reed relays to replace the pulsing and off-normal contacts of the rotary dial, pulse driver circuit, oscillator, clock pulse generator, and two integrated circuits — one for digit storage and the second for timing. The telephone is capable of storing 18 digits, each digit being placed in store in one millisecond.

Other types of self-contained keyphone are at present under development. These will derive their power from the exchange line without any need for a battery or power unit.

Multi-frequency keyphone

This telephone, SA4258, uses signalling system multi-frequency no 4. It is capable of exploiting the high-speed signalling and switching techniques now being introduced in some types of customer-owned PABXs. The push-button unit has a 3×4 layout; digits 1–0 and in addition ✱ and ⌗. The 'star' and 'square' buttons are used to provide additional facilities if required. The signalling frequencies are generated by one oscillator with two tuned circuits each capable of providing four frequencies. Of the eight frequencies available seven only are required for operation. Depression of a button causes a tone comprising one frequency from each tuned circuit to be sent to line. This



BLOCK DIAGRAM OF S/C. KEYPHONE

telephone is line-powered and does not require provision of a power unit or battery.

Although telephone SA4258 uses MF signalling it is not suitable for connexion to public exchanges with MF capability. A new MF signalling keyphone is being designed to meet this requirement.

DC code C keyphone

This telephone uses the CCITT standard code C signalling, and is supplied by the PO for use on customer-owned crossbar and electronic PABXs.

It looks the same as the MF instrument but it can be identified externally by the code SA4252 which is marked on the base. Depression of a push-button causes different d.c. conditions to be applied to line, the conditions being derived by the use of diodes. As this is a polarized system it is important that the A and B wires are not reversed as this results in sending incorrect signals.

Sv5.3.2 (01-432 5535)

Trimphone performance: noisy transmitters inset No. 15

Complaints about noisy Trimphones due to faulty transmitter insets no 15 have for some time been running at a high level. In 1971, a study of the reliability of the latest version of Trimphone (coded 2/722 with improved tonecaller) found that with the exception of the inset 15 this instrument has a reliability comparable to the telephone 746. The 746, in the residential situation, has a fault rate of 16 faults a year for every 100 telephones. (Of these 16 faults, 1.2 faults are attributable to the transmitter inset no 16.) The telephone 2/722 produced 12.5 faults for 100 insets 15, that is, a fault rate ten times higher than that of the inset 16.

The problem of the inset 15 was studied by both THQ and the manufacturers of these transmitters. Many aspects of the design and manufacture were probed and the combined efforts led to a tighter control of manufacture and to changes in the design. The improved product that resulted was made the subject of a further field reliability study in February 1973 which showed that although a degree of improvement had been achieved (8.5 faults per 100 insets per annum) the level of reliability still compared unfavourably with that of the inset 16.

Efforts by Telecomms Development Department and by manufacturers to further improve the inset 15 are continuing. The present position is that further changes to the manufacturing specification will reduce the proportion of transmitters that become noisy during service. Furthermore, to relieve the working stresses on the inset, it will be shunted. It is expected that all new Trimphones produced from about the beginning of 1974 will include this shunt. To reduce the effect of the shunt on sending efficiency it consists of an inductor with series connected diodes. The action of the diodes is to maximise the effect of the shunt on short lines yet minimise the effect on long lines.

A modification kit (regulator no 7a) which will permit these components to be added to Trimphones in store or in service will become available about the same time.

The design of the modification kit is at present being finalised, orders will then be placed and production started. A THQ Circular with full details on how the kit should be fitted will be published as soon as this information becomes available. The combination of tighter manufacturing controls, improved materials and the transmitter shunt is expected to have a significant effect on improving the performance of the Trimphone by reducing the number of noise complaints. As Trimphones fitted with shunts become available, THQ will undertake new reliability studies to see how far we have gone towards matching the performance of the inset 16.

We have still to produce a transmitter for Trimphones that does not need the addition of a shunting device. The necessary development work is continuing but this will take some time. Far less time is required to produce the regulator no 7a which will provide the interim means of improving Trimphone performance and reducing customer complaints. The price to be paid for this interim improvement is a relatively small degradation in transmission.

NOTE: It is known that in some Areas attempts to overcome inset 15 noise problems have resulted in the fitting of various devices intended to limit the maximum transmitter feed current. Unfortunately, it has not always been appreciated that some of these methods can degrade the transmission efficiency of the telephone. It is emphasized that such action is not recommended by THQ.

Sv 5.3.2 (01-432 5535)

New training courses for faultsmen

A new scheme of training is gradually being introduced for Subscribers' Apparatus and Line (SA&L) faultsmen. The training consists of an initial course, E2-0-200, and a follow-up course, E2-0-201, which together complete the training for Tech 2As employed on these duties. Further courses are being designed which will cater for the special needs of Tech 1s and their reliefs on these duties. Ideally the initial course should be taken within two months of taking up the duty: the follow-up course should be taken about six months later.

The E2-0-200 deals in depth with the overhead and underground aspects of the SA&L duty, and also covers the facilities of almost the whole range of customers' apparatus. Locating and clearing faults on the same wide range of equipment to a limited depth is carried out using faults commonly found in the field.

E2-0-201 deals with the same wide range of customers' apparatus as E2-0-200, but includes diagram reading and circuitry to a much greater depth. Tuition on relay adjustment is included, and more advanced faulting practice is carried out.

Students who have successfully attended E2-0-200 and 201 will not be required to attend the following courses:–

E2-0-17 – Maintenance of PMBXs and associated apparatus.
E2-0-19 – Maintenance of HES 1 to 4.
E2-0-32 – Maintenance of PMBX 4.

The new courses are designed to improve the confidence of inexperienced SA&L faultsmen and to make new entrants to the duty effective as quickly as possible. However, achievement of these aims is possible only if the student is given the opportunity to gain experience over as wide a range of equipment as possible immediately on return to his Area.

N.B. Because of accommodation difficulties, these courses are not yet available in NETR, NWTB and Scotland.

TP 7.1.2 (01-432 3978)

Microwave relay systems

Automatic routiner for checking protection switching equipment

Introduction to switching

The national inter-city microwave radio network carries a high concentration of traffic. The network bears a large number of trunk telephony hypergroups, distributes television programmes for both BBC and IBA, as well as carrying wide-band data services. Reliability is of vital importance.

In order to ensure continuous service certain broadband channels are allocated as protection channels. Under normal conditions these channels do not carry traffic, but are available as alternative circuits should any of the main channels become unserviceable.

The ratio of main to protection channels is typically 6:2 on existing systems. The transfer of traffic between main and protection channels is carried out automatically — normally at 70 MHz the intermediate frequency — but on certain systems the transfer is carried out at base-band. Figure 1 shows a simplified schematic of a 6 GHz microwave link with six traffic channels and two protection channels, and equipped with intermediate frequency switching equipment (IFSE).

Switching normally takes place if a main channel is interrupted due to equipment failure. It is initiated by a fall in level of a continuity pilot which is inserted with the traffic signal at the input to the channel. Facilities are provided to inhibit certain switching functions under particular circumstances. The circuitry involved is consequently very complex.

The need for an automatic tester

Regular extensive tests are necessary to ensure that the switching equipment is functioning correctly. In the past the only way to check the switching was by time-consuming manual checks, involving co-operation from terminals and control points. It was decided that a routiner should be developed to do the necessary checks automatically, quickly and regularly without the need for staff attendance at the stations concerned. A transistorised prototype was developed, built and tested by Sv6.3.1 maintenance methods laboratory, but the unit was bulky. A further prototype using high density packed integrated circuits was of more acceptable size and had a higher potential reliability. This was the forerunner of the production routiner now in use in the field, the tester 190A shown in figure 2.

Design requirements

The tester 190A was designed to meet the following objectives:

a It should, by using simple plug-in interface cards, be capable of checking all IFSEs supplied by different manufacturers, whose choice of logic elements ranges from relays to integrated circuits.

b The intermediate frequency switching equipment (IFSE) should be comprehensively checked.

c The tests should involve a minimum of disruption to traffic.

Fig 1 **A microwave switch system (symplified)**

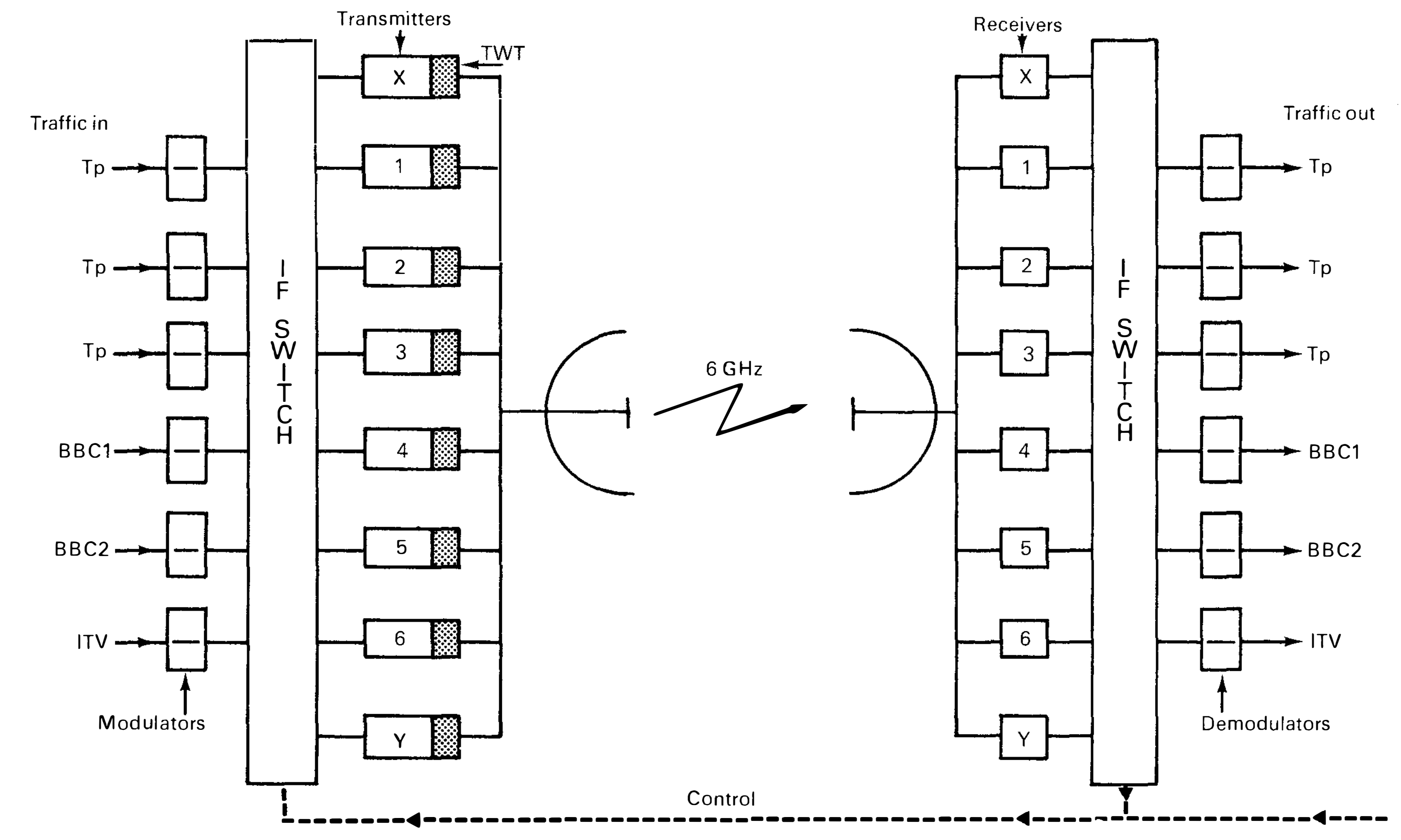


Fig 2

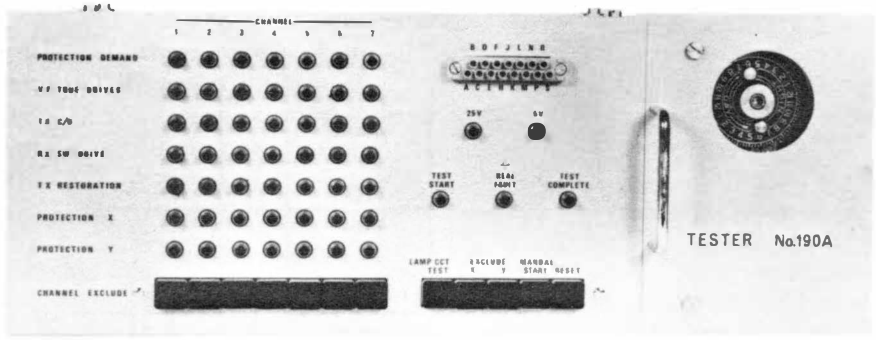
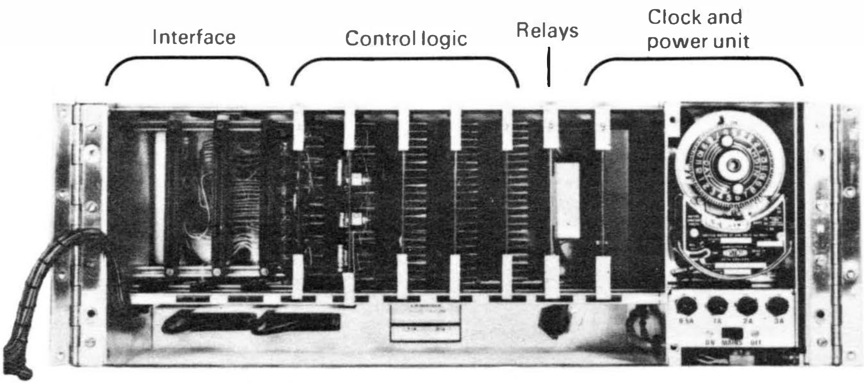


Fig 3



d The routiner should be capable of automatic action at predetermined times when traffic is light, and should be capable of manual operation at any other time.

e Test results should remain displayed until the routiner is manually reset.
f Test results should be easily interpreted.

g The routiner should not interfere in any way with the normal operation of the equipment, and must return all channels to their former condition at the end of any test.

h The routiner itself should be extremely reliable.

Method of operation

The continuity pilots mentioned earlier are monitored by detectors fitted to each channel. Although different manufacurers use different logic voltages, in general under normal conditions the detector output is, in effect, at zero potential. When the pilot level falls by say 4dB the detector output changes to –6 V and the IFSE responds by switching the affected channel to either the first or second protection channel. The factors determining which protection channel is selected are complex and are not described here; however, once the protection channel has been selected the IFSE executes the changeover in the following steps:

1 Traffic at the transmit end of the link is switched for parallel transmission over the protection channel.

2 On the successful completion of the previous step, the receive end is switched from main to protection channel.

On clearance of the fault, restoration by the IFSE is performed in the reverse order. The routiner simulates a fault on the first channel and monitors the logic in the IFSE to determine that:

i The first protection channel is available.

ii The tone conditions are correct.

iii The transmitter has switched.

iv The receiver has switched.

v Finally, the switches have restored to the normal conditions.

When each channel has been tested the sequence is repeated with respect to the second protection channel.

During the tests, any misoperation of the IFSE is indicated by a lamp. For example, the failure of the transmit end of a channel to switch to a protection channel causes the appropriate lamp to light up. Examination of the lamps which are alight at the end of the test helps determine which board in the IFSE logic network contains the fault.

The Tester 190A contains a mains-operated clock and power unit, and a control logic unit. Interface cards are used to match different manufacturers' equipment to the control logic unit (see figure 3). It can routine any number of traffic channels up to seven by switching them to one or two protection channels. Should a real fault occur, a lamp indicates this and the routiner excludes the worker and protection channels involved. Any channel can be excluded from the routine by the operation of a push switch.

The tester 190A has proved extremely reliable in use. A complete test of a full 6 + 2 IFSE takes some four seconds and is performed automatically once every 24 hours; the previous manual tests took considerably longer and if performed during the daytime constituted a hazard to traffic.

This article has of necessity dealt only in general outline with IFSE routining; for further details of IF switching systems the reader is referred to:

Intermediate frequency switching systems for microwave radio relay links' by R. D. Martin-Royle, Post Office Electrical Engineers Journal, July 1968.

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