Maintenance News

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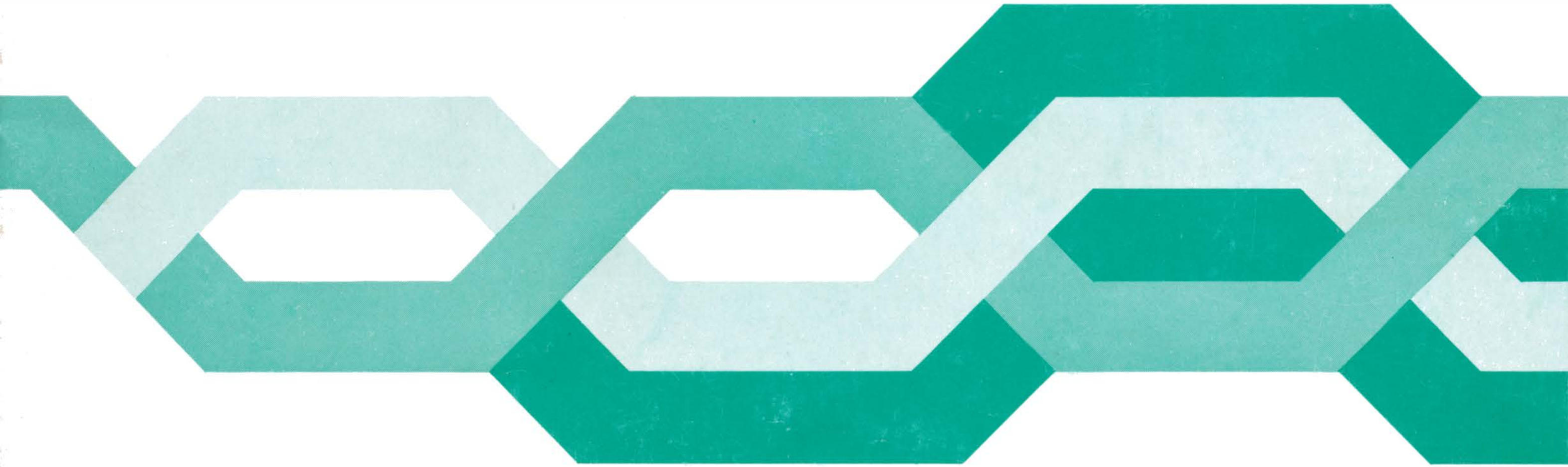
Spring
1976



STOP PRESS

If a meter could speak...

Every month about 180 Ohmmeters 18A are being returned for repairs to carrying case, meter movement or other components damaged by maltreatment. If an Ohmmeter could speak it would surely say, "I can save you a lot of hard work but I have a delicate constitution. Please treat me gently".

Don't throw an Ohmmeter in the back of the van and don't balance it on MDF ladder steps or cabinet roofs: get longer test leads.

Contents

Editorial

There are five contributions from Regions and Areas in this issue but, I am sorry to say, no letters. One telephone caller suggested to me that would-be correspondents think there might be a come-back from local management. I do not see this. I would not wittingly publish letters showing particular managers (or staff for that matter) in a bad light, unless there was good reason to believe that the failing or misunderstanding was a common one. Letters critical of management in general, and of THQ in particular, have already appeared in our columns – with replies, of course. As for unpublished letters I have never yet sent any back down the tree. If I did get a letter that seemed to give evidence of a drop-off by local management I would hope to be diplomatic.

Talking of drop-offs, another caller, from Manchester, took us to task for publishing in issue eight a photograph of a PO supervising officer not wearing his safety helmet on a building site. *TI M4 E3311* says that PO staff must wear helmets if the building contractor's staff are wearing theirs, but the Engineering Safety Division in THQ tell me they intend to strengthen the rules when the TI is next revised. My caller assured me that in Manchester they always wear helmets on building sites, so what Manchester does today. . . .

Thanks to all those readers who sent me their surplus copies of earlier issues. I can now supply up to 25 people wanting complete sets. I would be grateful if any readers would send me surplus copies of issue one and issue eight.

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Eric Partington - switched on to switching systems

Early this year, MN invited itself along to meet Eric Partington, who has been Head of Switching Systems Maintenance Division (Sv6) since April 1973. During the course of the interview, Eric openly discussed his life, his job and his thoughts about maintaining switching systems of the future.

Sv6 is responsible for maintenance policy for all switching and processor systems, from Strowger and crossbar to support for the new universal System X. In dealing with such a complex conglomerate of old and new technologies, Eric Partington sees the role of his Division differently for each type of system. As far as Strowger is concerned, his aim is to exploit the capabilities of the existing system to give as high as possible a success rate in completing calls, consistent with economy.

Computers play an important role in all switching systems and Eric Partington explained to MN that the policy of his Division is to use computers and other management tools, wherever possible, to relieve maintenance staff of any jobs approaching drudgery. He is very conscious of the demands made on field staff by the variety of new equipment and its maintenance. However, because certain of the new systems (TXE and TXK) are transitional, and although he would like to see design changes that would improve overall reliability and aid maintenance, he realises that scarce development effort can be more cost effectively employed elsewhere.

TXE4 was a stepping-stone towards System X, and Eric expects this new generation of switching systems to be even more efficiently maintainable than past and present systems. But to ensure higher reliability, it will be necessary to plan for it at the pre-design stage – and his support section for System X is making best use of its opportunity to get in on the ground floor – probably the first time a maintenance viewpoint has been given an entire eight years before the hardware appears.

MN asked about the various associated problems involved with introducing new technology to the staff. Eric made it clear that he is well aware that development in technology brings new demands of staff – that staff must be in touch with current practices and at the same time keep pace with emerging technologies. But how would this be achieved asked MN?
"By ensuring that staff received adequate training, and by encouraging them to develop and use their own skills".

Eric Partington went on to say that recently there had been discussions to see whether the PO should use highly skilled, specialist staff to maintain System X. The result of these talks was that the PO should use existing maintenance staff.

New developments in technologies also bring socio-psychological problems. The problem is two-fold – the psychological pressures on the staff created by the additional demand of the new technologies; and the tedium created by the mechanisation of human endeavour – the vacuum produced by computer and fast electronic systems taking over the jobs previously performed by the maintenance staff.

"How do you propose to overcome these problems?" MN asked. Eric Partington replied that in his day-to-day work, which involves a lot of travelling, he is tremendously impressed by staff enthusiasm for the challenges and opportunities offered by these new developments; one of his main concerns was to make sure that procedures do not become so stereotyped that jobs become less interesting. THQ have a special responsibility to see that job satisfaction is not lowered . . . and, after all, the main concern of the management and the staff alike is to give best possible service to customers, achievement of which is itself a source of job satisfaction.

To illustrate his views about the relationship between man and machine, Eric Partington quoted from an article by James G Griffin: "The versatile, high speed, high capacity telecommunications networks of the future will not be self-sufficient. They will need precise human inputs to achieve the level of performance envisaged by their inventors. That calls for interface with the

Eric Partington

human sides designed as skillfully as the machine sides".

Turning from his involvement with telecommunications, Eric Partington went on to open the door on his private life, which is just as busy and varied as his work. Born in 1915 at Budworth, Cheshire and educated at Warwick School, he went on to get an HNC in Electrical Engineering from Coventry Technical College. Before joining the PO Engineering Department's Circuit Laboratory in 1937 he had spent four years with GEC at Coventry. Most of the war years Eric spent in the LTR – this period of his life had been marred by a serious car accident in 1940 which kept him bed-ridden for eighteen months in bomb-torn London.

In 1943 he joined the Northampton Polytechnic (now the City University, London) as a part-time student and obtained an Honours Degree in Electrical Engineering, Design of Machines, Telecomms Power and Pure and Applied Mathematics. The post-war years (1946-49) were spent with Engineering Department HQ, Telephone Branch.

In 1949, looking for broader horizons he emigrated to Australia and spent five years with Australian Telecommunications working as Group Engineer – first with design and procurement of long lines and cables, and, later on, organising installation and maintenance for a large part of Melbourne. Returning to the British PO in 1954 he spent the next six years with the Stores Liaison Section.

In 1960 he was promoted to Senior Executive Engineer, and worked on Exchange Contract Supervision for all of LTR. Not long after, in 1963, Eric Partington decided to leave the dull grey skies of London for the scorching sands of Sudan. There he spent the next two years as Chief Engineer, Posts & Telegraph Department, Khartoum. Being promoted *in absentia* he returned to THQ as Assistant Staff Engineer in 1965 to work in MSD applying work study principles to the maintenance of telephone exchanges, subscribers apparatus and cables. He was transferred to Customer Services Maintenance Division in 1967 and finally became Head of Division, Sv6, in 1974.

Eric Partington has two sons, and a daughter who was born in Australia. Among his hobbies he lists camping, travelling and home construction and maintenance. He is also involved with voluntary work servicing Talking Books for the blind, and is a steward at the Fairfield Halls, Croydon. He is a member of the IEE; and during 1974/75, he was Chairman of the London local section of the IPOEE; he is also a member of the Committee for Terotechnology, run by DTI. Among foreign languages he lists French, Arabic and German, in that order of fluency.

Eric Partington will be retiring from the PO this year. With his broad knowledge of telecommunications and engineering and vast experience, both at home and abroad, he is thinking about going into consultancy services – in particular for the Middle Eastern countries. MN wishes him a happy retirement and success in any new venture.

Naqi Ali TMk3.2.1 (01-432 4062)

How a rain shower led Jim Bampton to Fiji

Since its inception in 1974, the Network Maintenance Division (Sv7) has been headed by Mr J F 'Jim' Bampton. This new HQ Division was set up with the special responsibility for ensuring good performance of the network as a whole and was a positive step towards better maintenance control.

The Network Maintenance Division has many responsibilities. These include maintenance of radio and coaxial systems, PCM, trunk circuits, private circuits, datel and private networks. The Division controls the TV network and outside broadcasts and maintains Confravision. It runs the National Network Co-ordination Centre, carries out reliability studies and finally is responsible for the performance the subscriber gets when dialling STD calls over the network.

Recently, MN visited Jim Bampton at his office in London's Tenter House and quizzed him about his past career, his current responsibilities and his ambitions. MN began by asking how he first joined the PO. Had it been a life-long ambition ?

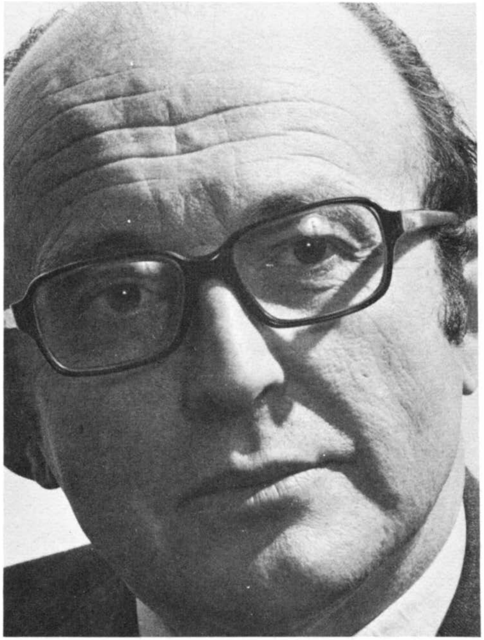
"A shower of rain played a large part in my decision to join the PO. Cycling down the Edgware Road I got caught in a downpour and took refuge in a friend's house. They had a visitor, who happened to work at Dollis Hill, and conversation got round to communications. I became interested and a few months later, at 16, I started in the Carrier Lab. at DH. After three years I got my first promotion as an Inspector with the LTR Telegraph and Power section, and in 1942, I was appointed EE in the old Lines Branch at Alder House".

By now, the war had interrupted Jim Bampton's career. Before long he was sent out to advise the Indian Railways on their ailing telecommunications system. This presented him with one of his first major challenges : the equipment being used was generally obsolete, and in many cases communication was achieved using morse telegraph equipment.

By the time Jim Bampton left India in 1946, things had changed. He had modernised at least part of the Indian railway telecommunication system and had even introduced teleprinters and carrier systems into the network – a revolutionary step for the railways.

Back with the PO once again, Jim Bampton next became involved with submarine cable systems. Travelling opportunities increased once more, following his appointment to the team working on the first trans-atlantic cable, TAT 1. By this time he had become a Senior Executive Engineer, and his new responsibilities meant many visits to the North American continent. Armed with TAT 1 experience, he later went on to help oversee COMPAC (the Commonwealth-Pacific cable) and SEACOM (the South East Asia cable) which for the first time linked the Far East directly to the rest of the Commonwealth.

On COMPAC, he and his team of



Jim Bampton

transmission experts worked their way from Vancouver via Hawaii, Fiji, and New Zealand to Australia. In addition, work on SEACOM led Jim Bampton to Singapore and Sabah, in North Borneo.

In 1965, Jim Bampton moved to transmission maintenance in THQ, and subsequently extended his work load to include switching and other aspects of network performance when SvD was formed in the 1968 reorganisation. MN asked him how he saw the role of his Division, particularly the relationship with that other major function, Development.

"Maintenance and Development Divisions work together", he told MN. "This is particularly important for us as we are responsible for looking after equipment, often for 20 years or more once it is installed. Maintenance is an on-going commitment – we continually take on new systems but we rarely lose the old ones.

"One of my responsibilities has been the MAC project. MAC stands for Measurement and Analysis Centre and is a good example of a tool for Network Maintenance. This system will provide new facilities for the maintenance staff in locating weak spots in the telephone network. The MAC principle is that a mini-computer at each Centre directs patterns of test calls to other exchanges, both far and near, and assesses the service that customers are getting.

"Sv7, Network Maintenance, works very closely with Sv6, Switching System Maintenance and Sv5, Customer Services Maintenance".

"What about the common complaint that THQ are out of touch with attitudes in Regions and Areas?" MN asked.

"We keep communication lines open with Regions and Areas. Last year, the Service Divisions visited every Region and a number of Areas, for discussions on pressing problems. These discussions were always very worthwhile".

It is clear that the responsibilities of an SvD Head of Division are not light. But that does not mean that once home, Jim Bampton puts his feet up. He is actively involved in running the local Church's youth club, where he finds his skill at table tennis and billiards, acquired long ago, stands him in good stead. He sails a dinghy when he can. One might dare to suggest that wherever he is, Jim Bampton always manages to *maintain* an interest . . . ! !

Richard Beet TMk3.2.1 (01-432 5299)

CSS1 – simpler operating plus a better service to customers

by **D R Trent,** Sv6.5.3

The increasing penetration of STD has meant that most customers can now dial most of their calls. But despite this there is a continuing demand for operator assistance – largely due to the popularity of certain special facilities such as transfer charge and credit card calls.

Operator assistance is given from the AMC – the automanual centre. For some years the sleeve control switchboard (SCS) was the standard system and still is the one installed at the majority of AMCs. In 1956, however, a cordless switchboard came into operation at Thanet exchange. Similar installations followed at Middlesbrough in 1959 and Stafford in 1961. The principal features of these switchboards were the queuing of incoming calls to give customers a better service ; and operator keying instead of dialling, for greater operator efficiency.

In the light of experience gained at these experimental installations certain design modifications were made and incorporated in a later development known as the cordless switchboard system no 1 (CSS1). The first switchboard of this type was opened at Croydon in 1969 and now there are about 40 others in service.

With the exception of one or two circuits the CSS1 system uses conventional, rack-mounted electromechanical equipment such as relays, uniselectors and motor-uniselectors. A connecting relay set, controlled by a key on the operator's position, replaces the cord circuit of the sleeve control system. This means that neither answering nor outgoing multiples are required. The operator's position is therefore very much simplified, consisting of a display panel for call supervisory lamps, a keyshelf with connecting circuit keys and keysender, and a writing surface.

Unlike the sleeve control switchboard the CSS1 position does not contain a great deal of control equipment; instead, this is housed separately. In this way the weight of the switchboard has been considerably reduced, allowing the switchroom to be housed in office-type accommodation with lower floor-loading limits. The absence of the multiples also means that the positions do not have to be arranged in long suites. Instead, an office environment is created by placing them in small groups across the width of the switchroom. The office atmosphere is enhanced by the modern grey textured finish of the positions and writing surfaces are covered in blue PVC.

CSS1 AMCs are normally housed in the same building as the local exchange but they can be installed in a different building. This, for technical and economic reasons, is normally not more than one kilometre away; this arrangement is known as 'detached working'. There is a third possibility where the control equipment is housed in the local exchange building but the positions are in a separate building, again upto one kilometre away. This is known as 'detached working with remote control'.

Operation

The block schematic diagram of the CSS1 shows how calls from customers dialling 100 are passed, via an incoming relay set and a distributor hunter, to the main queue distributor. At this point the queue control equipment allocates the call a queue place.

A cordless AMC can be equipped with two, three or four main queues depending on the traffic it handles. A minimum of two queues must be provided in case one queue fails. Automatic queue-balancing equipment ensures that incoming calls are directed to the shortest queue; random allocation occurs when all the queues are of equal length. Up to ten calls can wait in each main queue and engaged tone is returned to a caller when all queues are full. When traffic conditions warrant it the chief supervisor is able to close queues or reduce their length by means of locking keys on her control console. The equipment automatically ensures that at least one queue is left open.

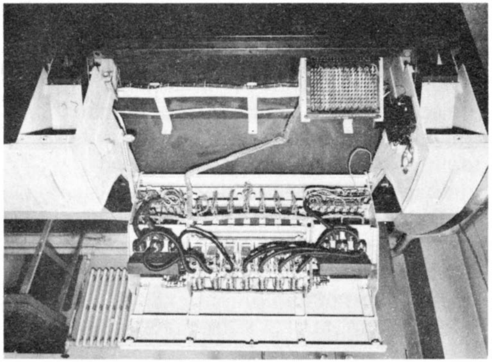
Each operator's position is equipped with seven connecting circuits and can handle calls from two queues. Each connecting circuit is dedicated to one of the queues. A display on the position indicates the number of calls waiting in each queue and a 'head of queue' alarm lights when the first call in the queue has been waiting for more than a certain time. (This time is selected from the supervisor's control console.)

An operator accepts a call by operating one of the connecting circuit keys to the

Board showing improved layout

'speak' position and operating the 'connect answer' bar. This signals to the queue control equipment that an operator is available and the main queue distributor, which is holding the call at the head of the queue, then hunts for the free connecting circuit. Once the call details are known, the operator is able to direct the call to its destination by means of the keysender. While doing this another call can be monitored simply by leaving its connecting circuit key in the monitor position.

Miscellaneous facility calls such as enquiry (EQ), directory enquiry (DQ) and changed number and service interception (CNI/SVI) are directed to subsidiary queues. The number and type of subsidiary queues provided are dependent on the size of the installation. These queues operate in a similar way to the main queues except that they contain only five places. Each position is able to handle calls from two subsidiary queues, but their allocation is dependent



Switchboard open and ready for maintenance

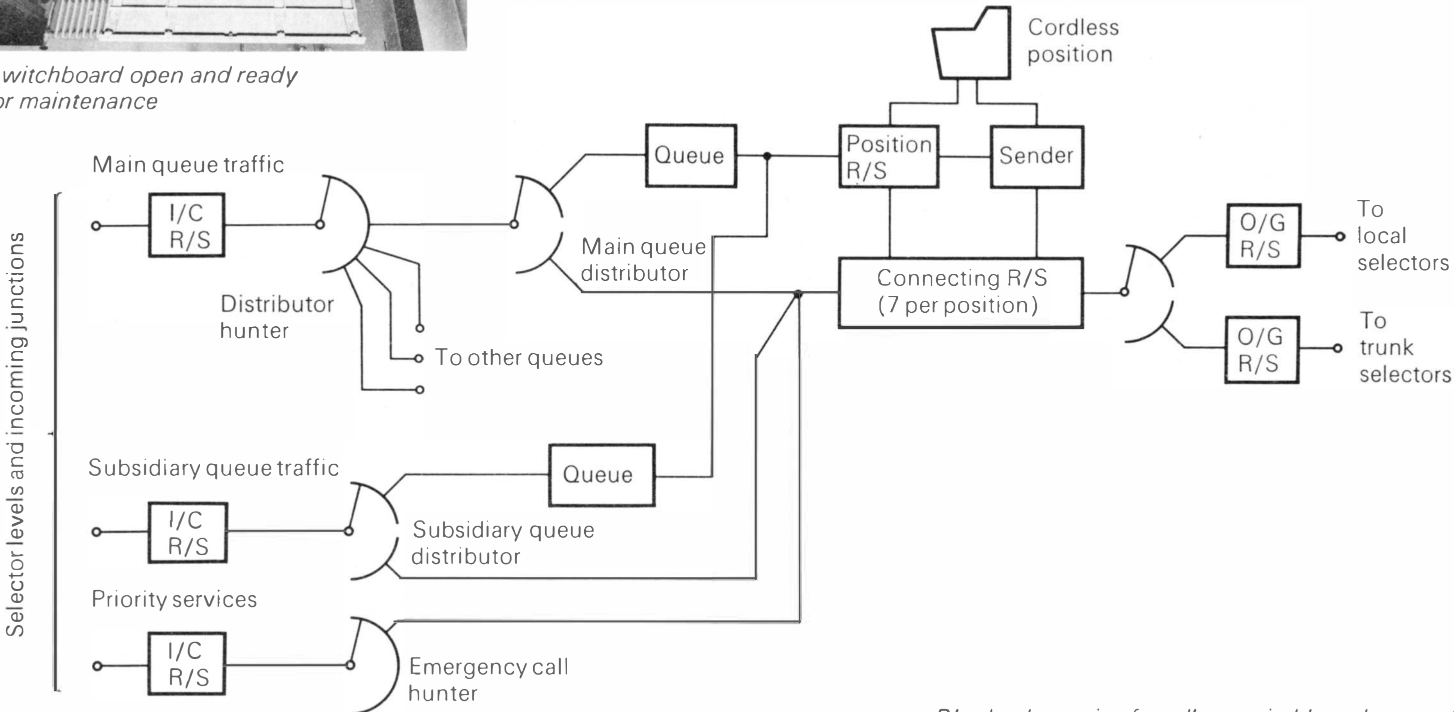
upon local requirements.

Emergency calls are not queued and can be answered at a group of from two to six positions. A "999" call sets off an audible as well as a visual alarm in the switchroom; the first operator on one of the nominated positions to operate a free connecting circuit key and depress the 'connect answer' bar receives the call. The position on which the call has been answered is indicated by red pilot lights on either side.

In periods of light staffing it is essential that all types of call can be answered on a small group of positions. This is done by ensuring that each queue and the emergency services appear on the group of positions known as the concentration suite.

The keysender

A keysender – a keypad on the position and a sender on the equipment floor – was specified in the original design. The idea



Block schematic of cordless switchboard system 1 was that the operator would be able to write out the ticket while sending was in progress, resulting in maximum efficiency.

The sender in use at most cordless AMCs is of an electromechanical type and, although it works satisfactorily, it suffers from the disadvantage that it does not begin to send until all the digits have been keyed in and the send finish key has been depressed; another problem is that it can only send 12 digits at a time – any routing with more digits has to be made in two stages. Because of their disadvantages a new electronic sender has been developed, and this is gradually being installed at all CSS1 exchanges. It has a storage capacity of 20 digits and begins to send as soon as the first digit key has been depressed.

Apart from a few miniature relays, for interfacing with the exchange equipment, the new sender is entirely electronic using transistor-transistor logic integrated circuits. The circuitry is mounted on six plug-in cards. The 5V to power the integrated circuits is derived from the —50V supply by converters, each of which powers up to five sender units. Being almost entirely electronic the sender will be considerably more reliable than the electromechanical type.

A new keypad will also be installed very soon at all installations. It uses a reed type key and has an improved key layout. This means that a new position top panel will have to be installed and at the same time several other minor improvements will be made. The picture on page 6 shows the new layout.

CSS1A

The sending speed of the CSS1 is limited by having to send 10pps loop-disconnect pulses; but the CSS1A was designed to take advantage of the fast call set-up times possible with the crossbar exchanges which are to be used at the London SSCs. In this version the position sender is dispensed with and instead the digital information is keyed directly into the registers of the crossbar exchange with a two-out-of-five voltage code.

A new 10pps sender was also developed, which used transistors and reed relays, for use at strowger exchanges. In this version of the CSS1A, a common pool of senders is shared by a number of positions and the digital information is keyed into them using the two-out-of-five code. There are, however, only four of this type of exchange, all in London.

Maintenance arrangements

The cordless switchboard system is considerably more complex than sleeve control equipment and therefore greater maintenance effort is required. The design does mean however that most of the work is done in an engineering environment. The switchboard is hinged and opens forward for maintenance, as can be seen from the picture on page 7. The main items of equipment such as the keypad and call timers are connected by plugs and sockets so that they can be removed as complete units for maintenance. In this way the office atmosphere of the switchroom is preserved.

Since the rest of the equipment is standard, normal maintenance procedures apply. Testers are available for testing certain items of equipment.

Like all manual or auto-manual systems the maintenance man relies on fault reports from the operators. At sleeve control AMCs faulty outgoing circuits can be held on the test and plug-up positions; but at CSS1 exchanges, no multiple is available to the fault telephonist – nor does the controlling operator know the identity of the outgoing circuit. To allow a faulty outgoing circuit to be held, without taking a connecting circuit out of service, a special circuit known as the Fault Mark and Hold (FM and H) circuit was designed.

With this facility, an operator coming across a faulty circuit first calls the fault telephonist on another connecting circuit and then reports the position number, the connecting circuit number, and whether the fault is on the calling or answering side. The fault telephonist then keys out a code to access the Call Marking circuit and then keys in the required information. If the Call Marking circuit has accessed the correct connecting circuit, its supervisory lamp flashes and the controlling operator confirms this to the fault telephonist. The fault telephonist then operates the 'ring key' which causes the Call Holding circuit to hunt for, and hold, the marked outgoing relay set. The controlling operator can then release the connecting circuit in the normal way.

Once this has been done the faulty circuit is automatically held and is then under engineering control since it can only be released by an engineer in the apparatus room.

Future developments
Before its development was abandoned in 1973, CSS2 was to have been the new standard automanual board. One of its many innovations would have been automatic call recording and billing, dispensing with the need for the operator to make out a ticket. A new switchboard system is not now planned until the introduction of the new national telephone system – System X. To save operator costs, however, the automatic billing facility is considered so important that an automatic call recording equipment (ACRE) is being developed. This will be a 'bolt-on' unit to be added to both sleeve control and cordless switchboards. Calls will be presented to an operator on a visual display unit; as soon as the details of the call have been checked they will be recorded on magnetic tape for later billing.
Sv6.5.3 (01-432 1304)

The mini SSAC9

by **B M Bray** Sv7.2.3

In the late 1950s the AC9 signalling system (SSAC9)*, was introduced into the inland trunk network for supervising calls and transferring numerical information over trunk circuits; it uses a single frequency in the voice frequency range (2280 Hz) The system has since become standard for inland trunk network signalling.

The original design used electro-mechanical components for logic and timing functions with thermionic valves for detecting the voice frequency signal. In the mid-1960s the VF receiver function was redesigned using semiconductor technology but the design still retained the use of electro-mechanical components for logic and timing. Because of their complex functions, SSAC9 relay-sets were rather large and only 40 or 50 depending on the VF receiver used – valve SSAC9(V) or transistor SSAC9(T) – could be accommodated on a single equipment rack. The technology current in the late 1960s promised greater packing density on racks, reduction in power consumption, reduced maintenance, increased life and reduced initial costs. Studies showed that redevelopment was justified and a design project was started by Telecommunications Development Department in the early 1970s.

**Signalling system alternating current 9.*

All this led to what is now called miniaturised SSAC9 equipment, SSAC9(M), which uses transistor-transistor logic (TTL) micro-circuitry for the logic and timing functions. SSAC(M) supercedes earlier designs. As the micro-circuits work at low voltage, an interface of discrete components and miniature relays is included in the design to connect these sensitive elements to the electro-mechanical switching equipment, existing test equipment and the line circuit. The new VF receiver uses 'operational amplifiers' – miniature encapsulated devices which detect the signal frequency; they also ensure that no other frequencies are present before passing a signal into the logic elements. The three parts of the circuit, the logic, interface and receiver, are produced on separate printed circuit boards which are clamped together to form one signalling unit. One hundred and thirty two of these units plug into one 62-type rack, giving a packing density of about six to one compared with SSAC9(V) equipment. The new design necessarily interworks with SSAC9(V) and (T) relay sets.

The TTL micro-circuitry and operational amplifiers require additional power supplies at 5V and ±15V. These voltages are provided by dc-dc converters operating from the exchange –50V busbars. As each power unit supplies 22 signalling units, there are six on each rack, with one on every third shelf.

Signalling units can be tested using a test access circuit on each rack. This circuit employing a common test highway to any selected signalling unit, provides access to the trunk maintenance control centre, an SSAC9 relay-set routiner and an SSAC9(M) tester.

Repair
To keep circuit out-of-service time to a minimum, complete replacement signalling and power units will be held at each exchange. Specialised equipment is needed for fault diagnosis and repair, and since failures are expected to be infrequent, it would be uneconomic to provide this test equipment at every exchange with SSAC9(M). Instead, PO Factories Division will undertake diagnostic testing and repair of faulty units from the whole country; they have already developed the special diagnostic testers needed, and the Birmingham Factory has now started to repair units from the first installations. Test access circuits can also become faulty, but since these are few and since the fault rate is expected to be low, arrangements have been made for regional equipment service centres to repair faulty printed circuit boards.

Test equipment
Using the same technology employed in the main equipment, a new tester (tester SSAC9(M) AT 61421) has been developed for testing signalling units; it can fully test a signalling unit but can only indicate whether or not it is faulty, since this is as far as diagnosis needs to go in the exchange. The tester will only be required until an automatic routiner, now being developed, is available. The new routiner will be mounted on a 62-type rack together with signalling units and will test SSAC9(M) equipment only. RT 1000-type routiners will still be needed for SSAC9(V) and (T) equipment; these will be modified to test SSAC9(M) in exchanges extended with the new equipment if their continued use is economic.

Aberdeen is the first GSC to be equipped with SSAC9(M) and some equipment is already in service. Teething troubles are being overcome and the failure rate should settle to a long-term performance better than one failure per signalling unit in 13 years, which is the rate calculated from known component failure rates. Recording of performance statistics has begun and will be continued long enough to see whether the new equipment achieves this expectation.
Sv7.2.3 (01-432 1359)

A new teleprinter for the telex service?

by **D Popham** Sv5.3.5

For some time now THQ have been laboratory testing the latest 'semi-electronic' ITT Creed Telex Terminal, the ITT 2300. Results so far look promising enough to extend the evaluation process to a trial in customers' premises. About 40 machines will be placed in working telex installations, chosen to provide a represenative range of uses and working environments. The trial should start early in 1976 and last for six months. Field maintenance during the trial will be carried out by Area telegraph staff who will be given a course on the machine before the trial starts.

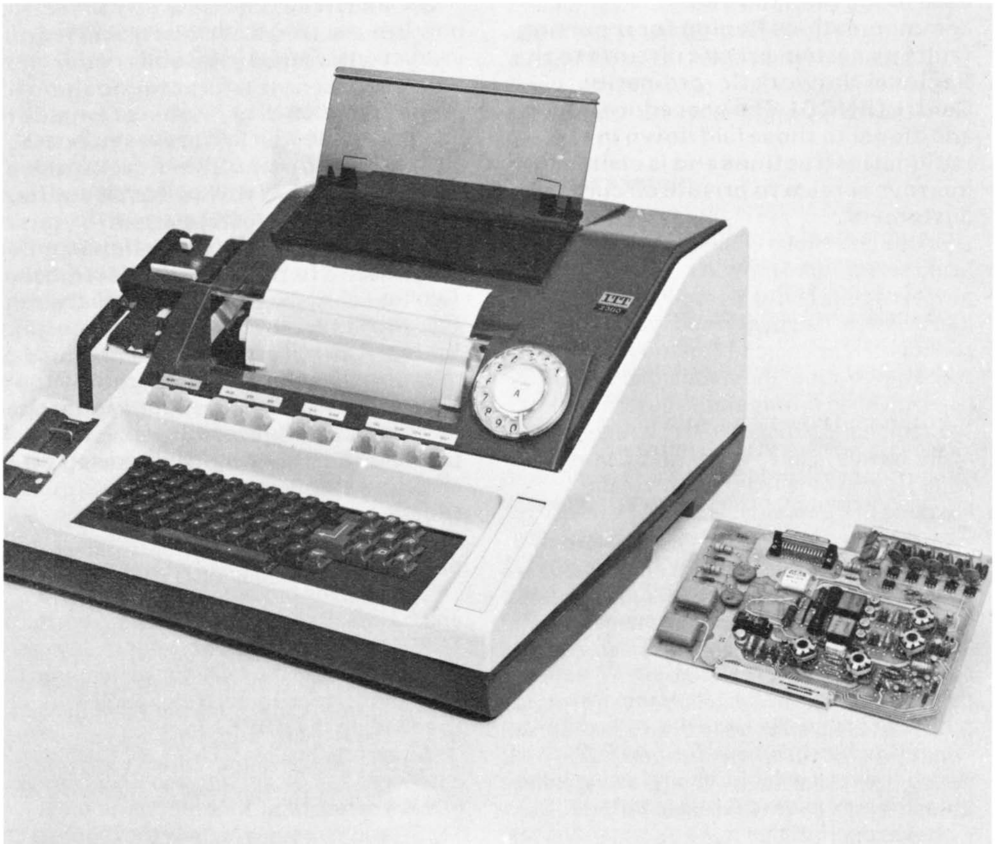
The electronics section provides a buffer between the line and the mechanical operations of printing, key depression, tape punching and tape reading. Signals coming in from line are examined by the electronics section which then controls the printing and punching operations. Similarly, the signals sent to line are electronically generated, being only initiated by operation of the keyboard or tape reader. The mechanical elements of the machine can thus be simpler and less critical in adjustment than in a conventional teleprinter, where they are required to respond directly to incoming signals and to produce the signals sent to line. From this should follow fewer faults, less maintenance and better service to the customer. All controls and calling/clearing/supervisory circuitry are built into the machine to make it a complete terminal rather than just a teleprinter, but a separate

80-0-80V signalling power unit is required to replace the in-built low voltage supply and enable the terminal to work on British Post Office telex lines. The unit also incorporates a low-pass line filter.

THQ will be looking to everyone involved in the trial – maintenance staff, operators, TGSRs, sales and installation staff and, not least, the customers who use the telex service – to provide every scrap of information they can about the machine. We have to establish whether it can be marketed and maintained to the standard required to give our customers the service they want, at a price they can afford to pay, and still give the PO the profit it must have.

Much money will have to be committed by the PO before a single machine is marketed. We shall have to buy initial stocks of terminals, and these are expensive items. Further terminals will be required for maintenance spares. Stocks of mechanical parts and electronic modules will have to be built up. We shall have to train maintenance staff and provide them with new test equipment and documentation, and also train sales and service staff and provide their back-up material. All this will be hanging on the results of laboratory testing and the customers' trial.

We can't afford to be wrong !
Sv5.3.5 (01-432 9178)



Private circuit fault reporting— MTR method 'an improvement'

This article describes a method used in the Midland Telecommunications Region for reporting faults on certain private circuits to the Regional Network Co-ordination Centre (RNCC). The procedure is additional to those laid down in national instructions and is claimed to improve service to private circuit customers.

In the late 1960s when RNCCs were first being set up, rapid growth in the demand for private circuits (PCs), particularly for data transmission, had begun and was confidently expected to continue. Little was then known about the standard of service being given to private circuit customers and so a regional instruction (RI) on reporting major service failures to the RNCC was issued giving detailed attention to the handling of PC reports. This part of the RI was overtaken by national instructions— the TIs now are *E1 C1156* on private circuit (PC) fault reporting procedures and *E1 E2016* on compiling statistics. The latter made it debatable whether any of our PC procedures were still needed, as comprehensive PC statistics were now produced nationally. Later the instruction on reporting major failures – *TI E1 A1500* – was issued; this called for PC faults lasting more than 72 hours to be reported to the RNCC.

It was decided that more information was needed: a simplified procedure for giving the RNCC more details was introduced and has now been running for three years. The instruction is *TI E1 A1500 MTR*.

Main features

The procedure is limited to private circuits with class of service codes 12 (amplified improved) and 52 (multipoint improved). All class of service codes are given in *TI E1 C1156*. Customers report faults on these circuits to Trunk Maintenance Control Centres (TMCCs), which deal with them in the ordinary way but also pass particulars of the report and clear to the RNCC by telephone. This direct reporting provides a representative sample of the service being given to this high-revenue earning sector of the PC field. In this way management can stay more closely in touch with the situation, and since the reports identify customers by name, those suffering particularly poor service can be identified.

Limiting the procedure to category 12 and 52 circuits keeps down extra work in TMCCs, where the category has in any case to be entered on the fault docket required by the national procedure. It also avoids overloading the RNCC.

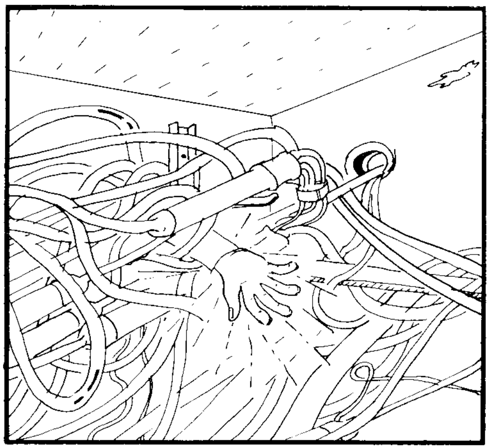
Since practically all TMCCs control some category 12 or 52 circuits, the RNCC is kept in more or less regular contact with most TMCCs, instead of with only the biggest. These formal contacts have been found to foster informal ones also, mutually helpful to both RNCC and TMCCs.

Procedure in action

The RNCC itself is able to keep a watch on the PC fault pattern, receiving on average about eight reports a day. It also sends a daily summary, with clears and durations, to the regional Head of Group with special responsibility for PC maintenance. If dubious about the treatment of any report, the Head of Group asks the RNCC to obtain from the TMCC a detailed breakdown of how it was handled and takes up any necessary action with controlling officers. Only about five per cent of reports need this follow-up treatment.

Since the RNCC receives A2915 forms giving statistical analyses of reports on all PCs, it is possible to identify Areas whose TMCCs are not following the procedure. The value of informal contact between a TMCC and an RNCC is sometimes seen when a TMCC is trying to satisfy an irate customer demanding immediate action but cannot make progress on the fault because of difficulty in getting co-operation from the distant end of the circuit. If the AEE in charge of the TMCC is not available to take up the matter, the RNCC can be asked for help. Contact with the distant RNCC usually sorts out the difficulty quickly. In MTR, this sort of action is taken about once a week.

Again, a TMCC may be faced with multiple failure of PCs and public traffic circuits. If this is due to a major HF failure in a remote part of the network the RNCC is likely to know of it before the local repeater stations, and a call to the RNCC can often save the TMCC time in chasing faults on individual circuits. Conversely, reports from TMCCs of multiple circuit failures can alert the RNCC to a major HF failure or can confirm one already suspected.
RNCC, MTR



Who needs cable bearers ? – pass the blowlamp Fred!!

How's your transmission efficiency?

The Area Transmission Efficiency Officer (TEO) is a specialist AEE who supports and advises maintenance staff when they have especially difficult or unfamiliar transmission problems to solve*. In most Areas the TEO has a few staff. The TEO is concerned not only with repeater stations but also with the increasing variety of transmission equipment being installed in exchanges and customers' premises. Where maintenance staff are not primarily transmission trained it is important for them to have a specialist duty in the Area from whom they can seek advice and assistance if necessary. This article shows how the Birmingham Area TEO (Derek Smith) meets this need and highlights other aspects of his work.

TEO groups have grown from very modest beginnings in the early 1950s, when their efforts were concentrated on investigating sub-standard performance of valve-type transmission equipment and circuits. Analysis of A62 fault dockets and the A131 equipment fault record provided the information for deciding which equipment or circuits needed attention. Valve-type coaxial line systems needed regular inspection of recorder charts of line pilots to assess performance from the interruptions and level variations shown on them. After scrutiny by repeater station AEEs, the charts were sent weekly to the TEO who recommended whatever follow-up action seemed necessary to bring performance up to standard.

**TI E9 A2011* gives an outline of duties.

Modern systems

Modern transmission systems are transistorised, use printed circuit cards, and have much lower fault rates. Interruptions and variations are far less prevalent and recorder charts can be run at low speed It is still necessary for the TEO to monitor system performance and equipment fault rate, but efforts need only to be concentrated in the first six months after a system is brought into service. Thereafter it is sufficient to receive a monthly analysis from the maintenance staff to see any deterioration in performance.

In Birmingham, as in Areas throughout the country, the urgent demand for more trunk and junction circuits has reduced the time between commissioning and bringing into service new coaxial and PCM line systems. This means that the final tests made before the Area accepts a new system into maintenance have to be done quickly. This is the TEO's responsibility, and where the new system is of a type of which the Birmingham Area's staff have no experience, Derek Smith will give a talk and practical demonstration of faulting techniques. This is of particular value where PCM and audio transmission equipment has been newly provided in exchanges. Even so, because of the low failure rate and the small number of equipments installed, exchange staff are likely to acquire faulting experience slowly. A label is therefore fixed to the equipment racks giving the TEO's telephone number in case help is required.

External staff also have a part to play in PCM maintenance and here Derek will give talks to them as necessary.

Transmission complaints

Transmission complaints referred to the TEO can originate from a variety of sources, ranging from a residential customer with a single direct exchange line to a business with a nation-wide private circuit network for speech and data using complex PO-maintained terminal equipment in the customer's own premises.

Complaints of poor transmission on STD and ISD calls may be reported from RSCs or the International Reference Centre. Investigation of transmission levels, particularly in local exchanges and on the junction routes over which the unsatisfactory calls are switched, may reveal losses outside limits and enable the causes of faint transmission to be located. Some complaints passed to the TEO, however, prove not to be transmission faults at all. For instance, the customer may be expecting good results from a telephone in an excessively noisy situation, or his troubles may have been magnified by frequent experience of congestion. In a large Telephone Area there is always re-grading, re-cabling or other work in progress and to minimise congestion, closer liaison would seem desirable between maintenance, planning and works, and traffic divisions. It is fair to say that some problems that come to the TEO need not do so, if more attention to detail were given in fault diagnosis and staff were better trained.

Private circuits and networks

The ever-increasing range of facilities and equipments provided by the PO and manufacturers, particularly for private circuit customers and those using data transmission and datel services, has generally led to a busy life for TEO staff.

Liaison with customers, especially those renting 'lines only' private circuits, is important. Complaints are often confused because of the number of parties involved. It may be necessary to deal with the customer, the customer's contractor for interface equipment such as modems, and often a different contractor for data processing equipment. Sometimes the customer has not been made fully aware of the electrical performance parameters specified for the circuit he is renting and it is the TEO who has to inform him and demonstrate test results.

In large private communications networks for telemetry, data and speech, maintenance responsibility for different parts of the circuits is often split between RSCs and TMCCs. The TEO has to ensure that the fault reporting procedure is understood by both customer and PO staff and that they have the information they need. Difficulties arising from incorrect reporting can be averted by looking at TMCC fault dockets and repeat faults, and RWTs and FNFs can be selected for remedial action. This analysis can also provide useful statistics for Area management.

Interference cases

Occasionally large schemes, such as railway electrification and provision of heavy-current plant on industrial sites, may produce interference problems in the local network. Staff working with the TEO make measurements of the interference and co-operate with the external plant maintenance group in seeking the most economic solutions.

Conclusions

Derek Smith, his staff and in fact TEOs everywhere, have to meet new commitments and responsibilities every day. With the widening experience they gain they are able to help by the advice they give to maintenance AEEs, as well as to traffic, sales and circuit provision groups. It will all improve the quality of service given to our customers.

A C Tisdale and D R Smith (TEO), Birmingham (021-262 2091)

Breaking the moisture barrier

by **D W Finch,** Sv5.1.2

Polyethylene was used for specialised cables during the war and subsequently in the 1950s as sheath and conductor insulant for small local cables. After stress-cracking problems had been overcome it became a formidable competitor of lead for cablesheathing on grounds of lower cost, freedom from corrosion and lightness.

Water vapour penetration

As always in such changes there were snags in its use. Polyethylene is an admirable material for constructing waterproof containers. Even when used for cement bags, the water vapour penetration is not sufficient to cause significant deterioration during normal storage periods. Our cables however, have an average life of up to 40 years. A plain polyethylene sheath would admit more than an acceptable amount of water vapour over such a period. It might be thought that pressurising cables with dry air, which we do, to 620 millibars (9psi), would be the answer to this problem. Unfortunately dry air can diffuse through polyethylene in one direction while water vapour is diffusing in the other. Pressurisation has virtually no effect in preventing water vapour penetration. Similarly, it might be thought that in cables on a flow system of pressurisation (alas most are!) the continuous passage of dry air would tend to desiccate any moisture which did permeate the sheath. Unfortunately the desiccating effect is restricted to comparatively short distances, say up to a kilometre, from the air feed point.

The solution to the water vapour penetration problem was put forward in 1958 by D W Glover of the PO and Dr Hooker who worked for a cable contractor. They suggested that an aluminium foil should be interposed between the cable core and the polyethylene sheath. This was originally known as the Glover barrier but is now known as the moisture barrier. In its present form it consists of a longitudinally wrapped aluminium foil bonded to the inner surface of the polyethylene sheath. The foil is normally 150 micrometres thick but can be twice this for special situations.

Moisture barrier continuity

So much for the primary function of the moisture barrier – that of keeping water vapour from cable cores. There are however two other important roles – those of screening and of extending an earth connection from the terminal station along the whole length of the cable.

The continuous earth connection is essential for enabling pressure contactors, which are inserted at intervals along MU and CJ cables, to extend alarm conditions when the cable air pressure in their vicinity has dropped to an unacceptable level. With lead-sheathed cables this earth connection presents no difficulties as the lead is, of course, in contact with the earth.

Recent tests have revealed a disturbing number of cables in which the continuity of the moisture barrier is broken. This in some cases has rendered cable pressure contactors useless and placed cables at risk. Almost invariably the breaks have been found to be in joints.

Until recently barrier continuity across joints has been achieved by bridging the gap with a continuity wire soldered at each side to the aluminium foil. Unfortunately this did not always give a permanent electrical connection.

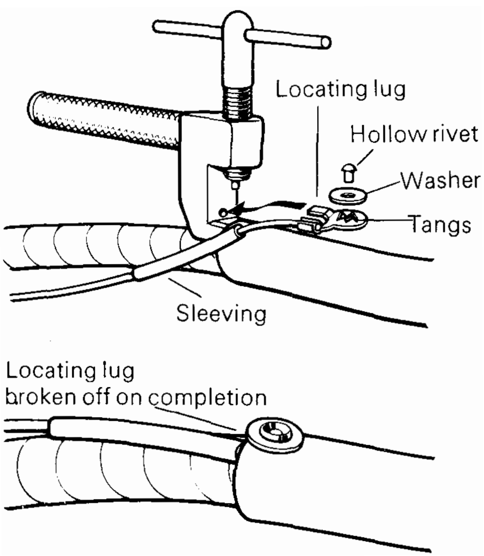
A more effective method of terminating the continuity wire to the foil has therefore been developed. This involves the use of a hollow rivet, tanged connector and a rivetting tool (Rivetter 1A) The technique is described in *TI A2 H2610*. Although mechanical, the joint stands up well to resistance tests and is now in use by all cable contractors and on most of our own installation work. The tool has been in short supply, but should be freely available as a ratebook item by the time this article appears in print.

Testing for breaks

In future, we hope to have much less trouble from broken moisture barriers in new cables. But what of the old? How are we to locate the many disconnections which exist? In the past this has meant opening joints and dc testing, a time-consuming and expensive business. By the way, please do not try pushing pins through cable sheaths to make contact with the barrier. This just leads to pneumatic problems.

To avoid repeated joint openings, ac methods of testing, which would merely involve placing a detector plate on the cable sheath, were discussed. Cable cores, however, form very easy coupling paths across disconnected moisture barriers to audio frequencies and above. For this reason a 17 Hz frequency was tried but even then, cross-coupling occurred. Test equipment using 3 Hz was subsequently designed, and this is now giving very

Rivetter 1A and barrier termination



encouraging results in the four regions where it is on field trial.

The output from the 3 Hz oscillator is connected between the isolated moisture barrier under test and earth at the MDF. (Identification at the MDF of the earthing wire connected to the moisture barrier of any particular cable has been made easier by fitting identity tags – see *TI A2 H2610)*

The detector unit consists of V-shaped pick-up plates associated with a tuned amplifier and an indicating meter. In use, it is placed first on one side of a joint with a suspected disconnected moisture barrier and then on the other. Marked difference in the 3 Hz signal level is an indication of discontinuity or of a high resistance continuity wire joint.

When the location equipment has successfully finished its field trials, suggested modifications and improvements will be incorporated in the final design where possible and will then be generally issued.

Our cables represent a very heavy investment, and it is vital that we should maintain them in first class condition. Closing the breaks in moisture barriers will be a very positive step in this direction. Sv5.1.2 (01-432 1306)

The PMBX 11

by **R Domville** Sv5.3.2

Since the PMBX 4/1A was introduced in 1968, it has given a lot of trouble. Both installation and maintenance engineers will be interested to learn that from early in 1977, a new PMBX, to be known as the PMBX 11, will be available for multiple position installations. However, the PMBX 4/1A will continue to be used for installations where a single position only is required.

In multiple PMBXs 4/1A, multiple wiring is taken via concentrator blocks at the top of each position. This becomes so congested that both installation and maintenance are made difficult. But with the PMBX 11, normal multiple wiring direct between jacks is used, and to aid installation, the multiple jacks are part-wired by the manufacturer.

Another improvement in the wiring arrangements is that the exchange line connection and common services strips have been removed from the bottom of the switchboard to a more convenient height for installation and maintenance; this can be seen in Fig 1, above the bottom five cord circuit relay-sets.

It can also be seen from Fig 1 that it is only a cord circuit relay-set, the one above the exchange line connection and common services strips, that has to be jacked out to give access to the cord rail for cord changing. This puts only two cord circuits out of action, much more convenient than the arrangements for cord changing in the PMBX 4/1A. Here it is an exchange line relay-set that has to be removed and this means waiting for its three exchange lines to become free of traffic and they are out of service while cords are being changed. In the PMBX 11 the exchange line relay-sets are housed in a custom-built cabinet as shown in Fig 2 on the third shelf down.

Altogether, access to the rear of the switchboard for maintenance is better than in the PMBX 4/1A. This has been confirmed by experience over 18 months in a trial of a prototype PMBX 11 installation at the Regional Training Centre, Paul Street, in London.

Externally the PMBX 11 is the same in appearance as the PMBX 4/1A, but a key-sender is fitted as standard instead of a dial. Separate group busy lamps are provided for exchange lines and inter-PBX circuits. So the needs of operators have not been forgotten in the new design. PMBX 11s connected to electronic exchanges will be equipped with exchange line relay-sets with circuit modifications. These will prevent operators receiving acoustic shocks when ringing trips on incoming calls, and will also prevent a false pulse being sent to line and detected in the electronic exchange when they set up outgoing calls.

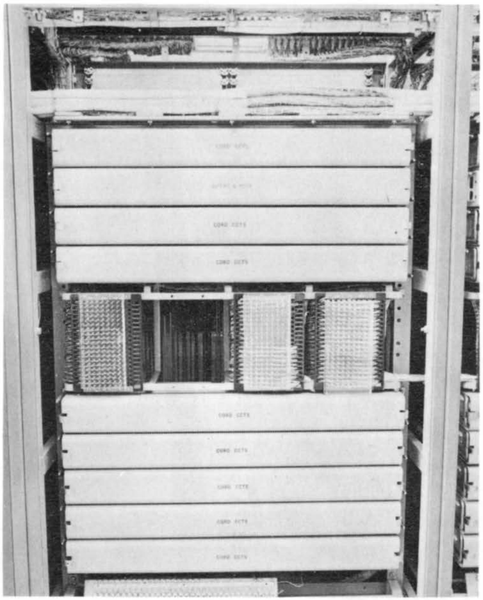


Figure 1

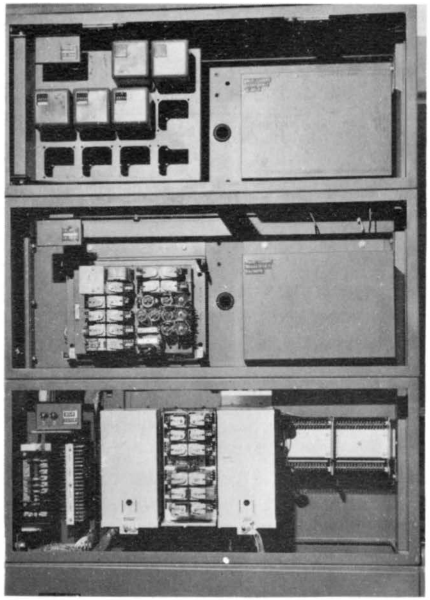


Figure 2

Batteries will only be installed where standby power is required ; normal operating power will be supplied by a new design of mains-operated power unit, which includes a ringing generator.

Diagrams and other documentation have been improved and will be easier for both installation and maintenance engineers to follow.

Certain design improvements in the PMBX 11 will also be introduced for new work on PMBXs 4/1A. Multiple and answering jacks will be in strips of 10 or 20 as required, assembled on a rigid one-piece frame, instead of being built up of individually replaceable jacks 4/DJA/18. Individual jacks flex every time plugs are inserted or withdrawn, and before long, the sleeve connections fracture. The cord termination block has been re-designed to take push-in type cord connectors. Plugs 316 will replace Plugs 321 because the white brass of which the latter are made dirties operators' hands. Finally, standard cords will be used instead of the thinner cords now fitted on the PMBX 4/1A, which do not last so long.

So much for improvements on the way. Finally, a note on a minor problem with the PMBX 4/1A. If you have been having difficulty with the fixing nuts for the exchange line and cord circuit relay sets, it is because you have been using the wrong tool. The right one is a ringdriver no 8, and it will be needed for the PMBX 11 also. There are ample stocks of the tool in Supplies Division, so make sure you get one.
Sv5.3.2 (01-432 1383)

Speaker circuits at cabinets and pillars

by **W R Larman,** Sv5.1.1

It has always been standard practice to allocate the first 'E' side pair of a cabinet or pillar as a test pair to be used when communication with the MDF is needed for testing, or for tapping out or pair identification.

As test pairs terminate on the MDF, they are no good for calls to supervising officers, works control, RSC, EPMC or routing and records, or for calls to automatic cable pair identification (CPI) equipment. The need for such calls, often necessary in external work, leads to the practice of borrowing a customer's circuit. This can lead to complaints from customers of being cut off or lines being reported as faulty. Sometimes the 'borrowed' circuit is left disconnected or wrongly reconnected after restoration, which means trouble if it is a shared service line.

The best answer is to provide dedicated 'speaker circuits' connected as exchange lines. But it is emphasised that where there is an acute shortage of spare cable pairs or calling equipment, speaker circuits must be surrendered until a main cable relief scheme or exchange extension has been carried out.

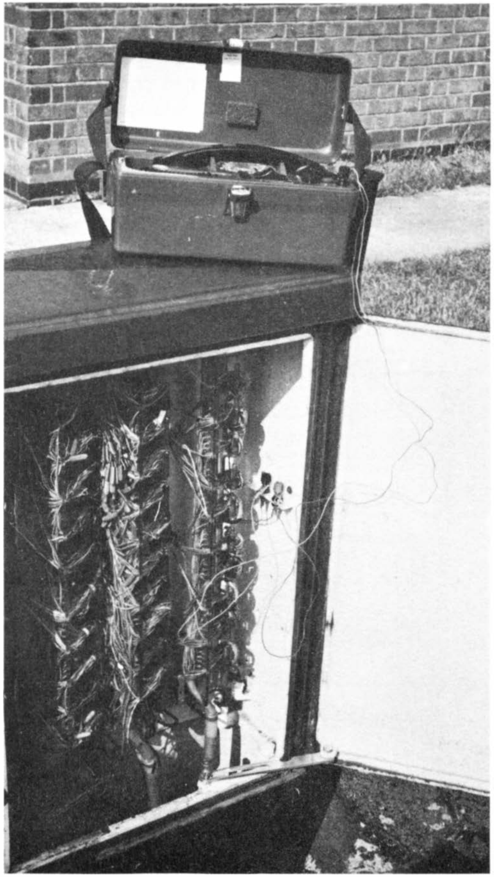
Originally, one test pair was provided for each cabinet, and teed to any dependent pillars. To provide exchange line speaker circuits on this basis would require too many main cable pairs and calling equipments. Hence omnibus exchange line speaker circuits are recommended for economy.

However, omnibus circuits mean increased transmission losses, limiting the practicable length of circuit. Because only short distance calls are made on speaker circuits, transmission limits worse than standard are acceptable, and the policy is therefore to connect as many flexibility points as possible in parallel, within the following limits:

Route distance to furthest flexibility point (km)	0 to 3.2	3.2 to 4.8	> 4.8
Maximum total length of teed cables (km)	32	26	19

These limits, which include the teed circuits from a primary cross-connection point (PCP) to any dependent secondary cross-connection points (SCPs), should ensure that attenuation will not exceed 20 dB.

The method of terminating speaker circuits at PCPs and SCPs will depend on whether the flexibility point is a cabinet or pillar. In a cabinet the circuit is terminated on a CN 10500 bracket. This has been designed to use the existing desiccator screw holes in the cabinet side wall, and carries two Terminals 33. Such a bracket with a Telephone 704A connected to make a call is



shown in the picture. In a pillar with PC100 assemblies, the circuit is terminated on pair E1. Where a pillar contains cross-connection strips 1, it is terminated on two Terminals 33 at the base of the mounting.

Because speaker circuits are used only for relatively short distance calls, they are barred from STD facilities. In parts of some areas where a call to the EPMC, for example, is beyond the limits of a local call, a service trunk call can be made via the operator.

As incoming calls are not necessary, speaker circuits should not be connected to the exchange multiple. If they were given multiple numbers, 'ring tone, no reply', fault reports could result, if someone rang a number in error. The circuits could also fail to pass the local line insulation routiner, since the insulation resistance of an omnibus circuit may be below the standard for an exchange line.

Speaker circuits are important for speeding external work without troubling customers, and every encouragement should be given to their use. Where they have not already been provided, areas are advised to do so in accordance with *TI E3 B0054*. Sv5.1.1 (01-432 1374)

Call failure counting equipment for TXE2

In a TXE2, if the common equipment fails to switch a call at the first attempt it makes another. If this also fails it is recorded on one of two second attempt failure meters. These meters are a valuable guide to the standard of service being given by the exchange and if an abnormal number of failures is recorded on them the maintenance officer knows that attention is necessary. For instance, he needs to monitor exchange performance after clearing a fault in a switching matrix, to prove whether his initial fault diagnosis was correct and whether the clear was satisfactory.

If he could 'read' the second attempt failure meters from a remote point it would prevent him from making unnecessary visits to the exchange. A device that in effect enables him to do this has been designed by the WMTB tester design workshop Called the call failure counting equipment (CFCE), this equipment monitors and stores the pulses that operate the second attempt failure meters. It is connected to spare calling equipment in the exchange and the maintenance officer can interrogate it by dialling the allocated number. When the equipment is seized, ringing tone is returned briefly and then called subscriber answer conditions are given. The caller then hears a continuous 400 Hz tone signal, which is maintained for five seconds to tell any subscriber who has mistakenly dialled the CFCE number that he has reached a non-working line. The CFCE then returns four groups of 400 Hz tone pulses corresponding with the thousands, hundreds, tens and units digits stored in the CFCE; (the digit 0 is signalled by ten pulses). The pulses are sent at a speed that permits accurate counting, and so the stored digits are 'read'. By comparing this with the reading he obtained on last interrogating the CFCE, the maintenance officer knows how many second attempt failures there have been over the period and by relating this to the known calling rate on the exchange he has a guide to the percentage of call failures.

When the four groups of digital signals have been sent, the CFCE again returns continuous 400 Hz tone to signify completion of signalling. If there are second attempt failures while the CFCE is being interrogated, the pulses are accepted and transferred to the equipment following cleardown of the interrogating call.

The device has been used successfully in TXE2s throughout WMTB and has proved a valuable maintenance aid. It need not be confined to TXE2s, but can be used wherever remote checks of meter readings are required. An electronic version has been designed using integrated circuit techniques, more reliable than the original electro-mechanical equipment and only

two-thirds its cost. A small quantity is being made in Factories Division for distribution to certain Regions.
P L Bushell, WMTB (0222 391406)

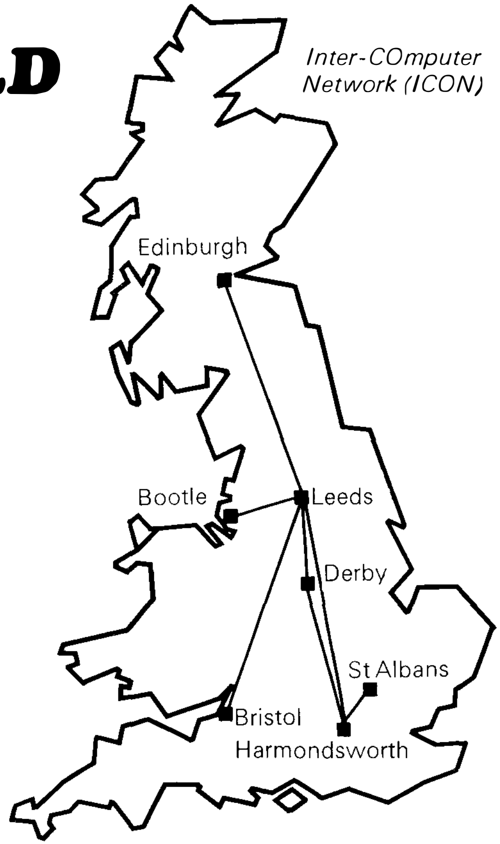
The use of the CFCE as a maintenance aid has yet to be evaluated by THQ Service Department. Seven of them from WMTB will be used in a field trial of an exchange maintenance unit (EMU) of TXE2s in the Bedford Area.
G Huggins, Sv6.1.3 (01-432 1404)

All will be TOLD

A description of Telecommunications On-Line Data

by **R W Winch,** Sv7.1.2

Many of this country's largest companies and financial institutions have, for some years, been using PO datel services to transfer information to a central office or computer centre, where it is processed and stored. We in the PO are using our own datel services and computers to speed wages and salaries calculation, telephone accounts compilation and recording, and directory collation. By the end of the year the system, called Telecommunications On-Line Data (TOLD), will be extended to all Telephone Area Offices and certain other offices. It uses PO Data Processing Services (DPS) computers interconnected by the Inter-Computer Network (ICON).



How TOLD works

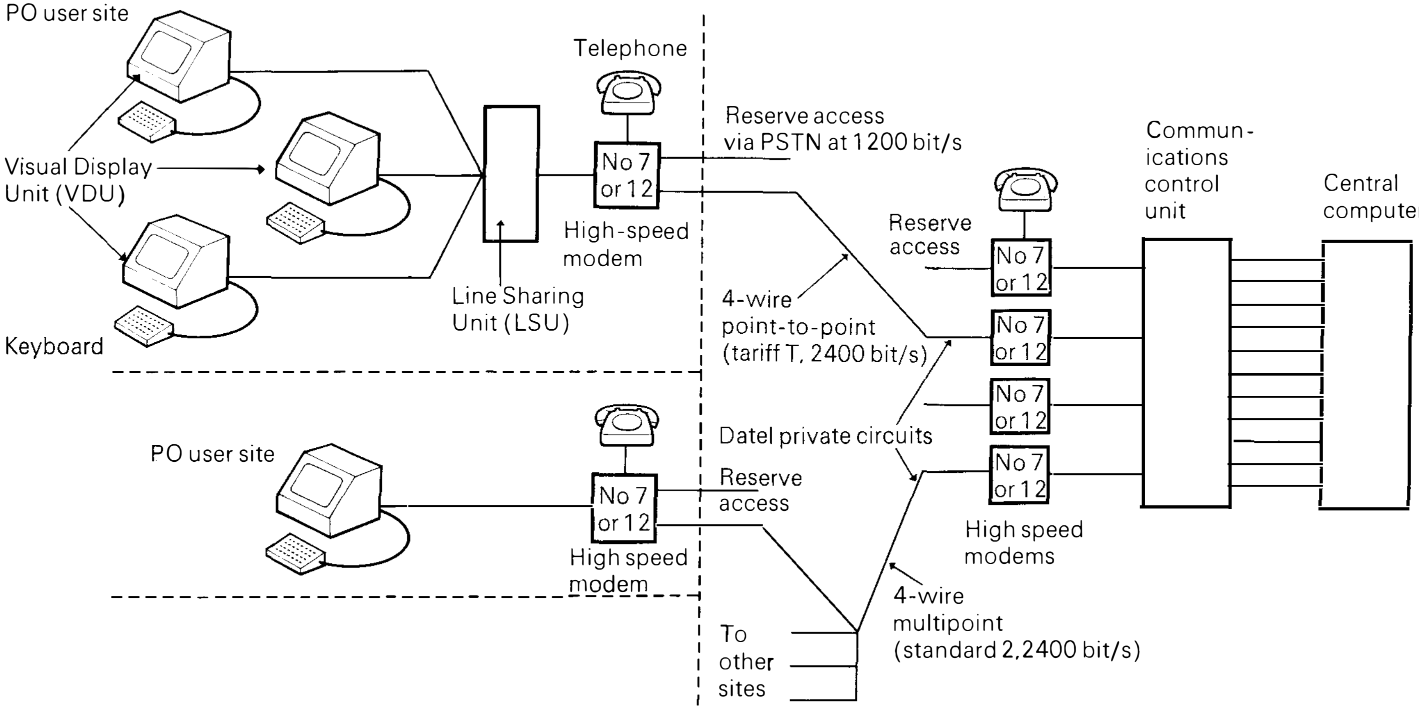
Before TOLD had been introduced, ICON computers were already being used to issue such things as pay slips and telephone bills. TOLD saves a great deal of the earlier routine manual work, for instance, completing and transporting special forms and punching, sorting, batching and checking the cards that convey input data to the computers.

With TOLD, ICON computers at the Harmondsworth and Leeds collection centres are always 'on-line' to outstations throughout the working day. These receive and transmit data at 2400 bit/s over high grade four-wire private circuits using high-speed PO datel modems at each end for converting data signals to and from voice frequency. If a private circuit fails, the outstation has to set up a call over the public switched telephone network (PSTN) which can then transmit and receive data at only half speed, or 1200 bit/s.

Visual display units (VDUs) are used at the outstations; these have television receivers linked to specially designed typewriters keyboard unit for keying input data into the system. The VDU displays characters typed on the keyboard so that they can be checked for errors before sending ; it also shows characters received from the computer over the datel circuit. The speed of data transmission ensures that, except for the delay for error-checking, the keyboard operator can type the information straight into the computer, thus saving much time, effort, monotony and cost.

Computer sharing
Information from an outstation to its collection computer centre is normally stored, automatically sorted, and processed by the required computer program. If the computer at the collection centre is not suitably programmed, or if it is necessary to share the computer load, the information is re-transmitted to another ICON computer centre.

Line sharing
Some 'small user' sites may need only one VDU. Here it is directly connected via the modem to the datel circuit. Most offices, however, need several VDUs in use simultaneously. Usually they are trolley-mounted and plugged into access points at the various work-stations when needed. The time taken to send messages over the datel circuit is so short and computer operation so rapid that up to 15 VDUs can be connected in queue fashion to the one datel circuit without the operators noticing delay.



Typical TOLD arrangements

The queueing device controlling which VDU is connected to the common datel circuit to transmit or receive data is called a 'line sharing unit' (LSU). Up to eight VDUs can be connected to one LSU. If there are more than eight, two LSUs are connected in series, with up to seven VDUs on the first LSU and up to eight on the second.

Maintenance

VDUs and LSUs will be PO maintained (initially with contractor's assistance) ; training is being geared to the installation plan so that staff have the necessary know-how well in time. Usually the equipment will be maintained by the specialists responsible for modem maintenance, but successful operation of the TOLD system as a whole, with its private circuits and reserve access via the PSTN, will also depend on many others. It will surely show our prospective customers that we have full confidence in our own datel services and, of course, in the DPS.
Sv7.1.2 (01-432 9152)

Cooling off in apparatus rooms

by **J W Jacobs,** SETR

Controlling air temperature in radio stations, repeater stations and exchanges is becoming increasingly important, both for correct operation of the equipment and for staff comfort. Use of new technologies has important advantages in reliability and space-saving. But miniaturisation has meant that heat is produced in greater concentrations, and this has to be dissipated by forced ventilation. In many locations the ventilating air has to be cooled before being distributed to the apparatus room, using an air-handling unit and ductwork – achieved with refrigerated cooling coils in the air input.

Air cleanliness is also important for both equipment and staff. So where necessary input air is filtered. As excess humidity can adversely affect equipment and wiring – for instance, in mist and fogs – provision is made for humidistat control of the air input and heating. In this country, however, full control of humidity is only needed for computer-type equipment and is not necessary for staff comfort.

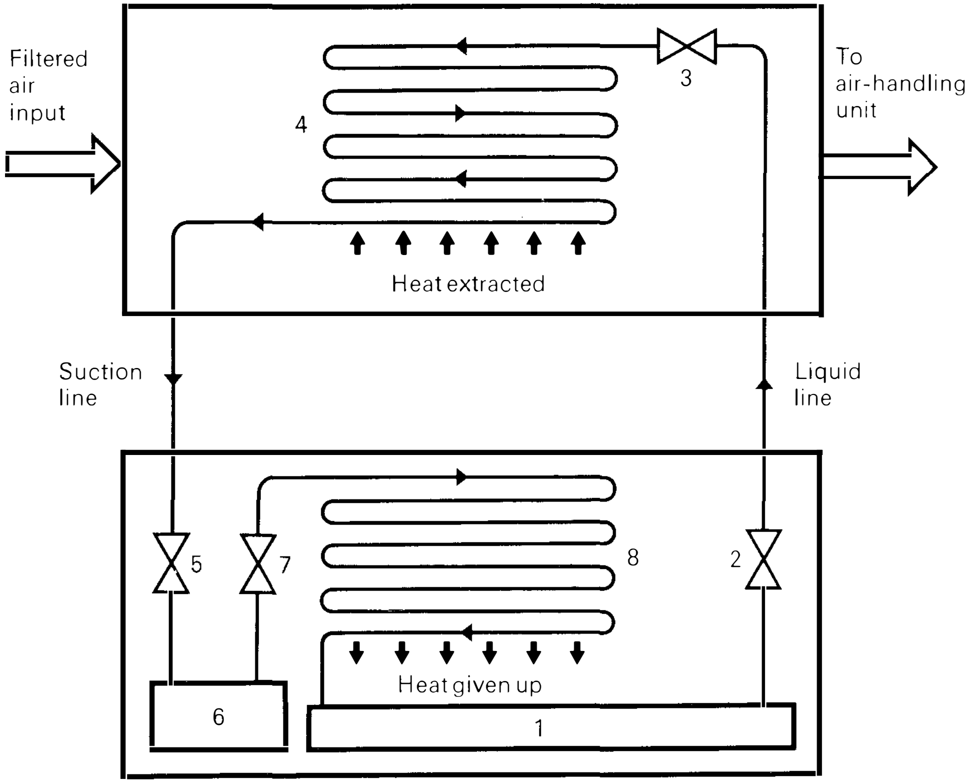
Refrigeration principles

Most refrigeration plants are one of two types – *direct expansion* or *chilled water circulation.* In the direct expansion system the air to be cooled is drawn by the air-handling unit over tubes (the evaporator coils) through which liquid refrigerant flows ; this is vaporised by heat absorbed from the passing air stream. In the chilled water circulation system – an indirect system used in larger installations – water is chilled by passing over the evaporator coils and piped to the cooling coils in the air input.

In both systems the same two basic refrigeration principles apply. The first is that, when a change of state occurs from liquid to gas, latent heat (of evaporation) is absorbed without a change of temperature ; and conversely latent heat (of condensation) is given up when gas is liquefied. The second is that a liquid can be vaporised or a vapour condensed at any desired temperature by changing the pressure.

The diagram shows the flow of refrigerant in a simple compressor refrigeration system of the direct expansion type. From the liquid receiver (1) liquid refrigerant at high pressure and temperature flows through the liquid line to the control valve (3), also known as the regulator or expansion valve. This valve separates the high pressure side of the system from the low pressure side, acting as a pressure-reducing and metering valve. It allows just enough liquid to pass to the low pressure side for it all to evaporate or boil off in the evaporator coils (4). The refrigerant boils at the low pressure inside the coils because it absorbs latent heat from their walls. This removal of heat from the evaporator coils cools the airstream surrounding them. The evaporation temperature is determined by the rate of refrigerant vapour removal from the evaporator coils by the compressor (6) through the suction line.

Refrigerant flow diagram



1 Liquid receiver
2 Liquid stop valve (service) *
3 Expansion valve
4 Evaporator coil
5 Suction stop valve (service) *
6 Compressor
7 Discharge stop valve (service) *
8 Condenser

* Used for servicing

The refrigerant vapour is then compressed, raising its temperature above the ambient temperature surrounding the condenser coils (8), in which it gives up latent heat to the surroundings, liquefies, and returns to the liquid receiver ready for re-circulation.

Refrigerants and oils

Refrigerants in this country are known by various trade names, such as Arcton, Freon and Isceon; all these are fluorocarbons. There are different grades of refrigerant for various applications, each identified by the same suffix number whatever the trade name. The grades most commonly used in the PO are:

Freon 11 This boils at +23.7°C (+74.8°F) at sea level: used in large plants with centrifugal compressors, for air cooling.

Freon 12 Boils at —29.78°C (—21.62°F) at sea level: used in centrifugal and reciprocating plants, for air cooling and general refrigeration.

Freon 22 Boils at —40.77°C (—41.4°F) at sea level: used in reciprocating plants, for air cooling and deep freeze.

Freon 113 Boils at +47.55°C (+117.6°F) at sea level: used in small to medium centrifugal plants, for air cooling.

Compressor lubricants are special 'refrigeration oils' and it is vital that the correct grade and viscosity is used as recommended by the compressor manufacturer. The oil mixes with the liquid refrigerant and is carried round the flow circuit with it, being transported in droplet form where the refrigerant is vaporised.

Refrigerant contamination

Refrigeration plant failure can be caused by the windings of the compressor motor burning out; but repair is often not limited to a motor re-wind. Where the motor and compressor are both housed in one hermetically sealed casing, and refrigerant vapour passes over the motor windings, the whole system can become contaminated with carbon and other debris. The cost of cleaning, de-hydrating and re-commissioning the plant may be ten times the cost of the motor re-wind.

The major causes of burn-outs are oil sludging and acid contamination. Oil sludging can usually be traced to excessively high compressor operating temperatures and the presence of any contaminant containing oxygen. Oil sludge can block filters and oil pumps and if this condition is allowed to continue the oil breaks down and acid forming in the system attacks the insulation of the motor windings.

In open units, where the motor is not hermetically sealed with the compressor, refrigerant contamination through motor burn-out does not occur. But oil sludging and breakdown can still have serious effects.

The presence of oxygen in a system is usually caused by one of the following:

—Carelessness... allowing water, moist air and soldering and brazing fluxes to enter the refrigeration pipe-line when the plant is being installed.

— Oxides being allowed to form inside joints through failure to use dry nitrogen when brazing copper tubes.

— Water not being evacuated from the system using a high vacuum pump. The whole system should be evacuated to 1 mm of mercury (1000 microns absolute) or below, to lower the boiling point of any water in the system so that it boils off and is extracted.

— Poor servicing, allowing air or moisture to enter the system when repairing and recharging it.

In large plants where the condensers are water-cooled and the water circulates to open cooling towers where it is exposed to the atmosphere, gases and solids in the atmosphere may dissolve in it, forming acids. These acids can perforate chiller tubes, causing refrigerant contamination. Preventive measures are given in *TI H9 H0013*.

High compressor temperatures may be caused by restricted air flow over air-cooled condensers, fouled tubes in water-cooled shell and tube condensers, sludge in cooling towers, and air in the refrigerant circuit.

Other causes of failure

Where the refrigeration plant is of the direct expansion type, there is a reduction in the volume of air passing over the evaporator coils if the air filter in the air-handling unit is not kept clean, or if the fan drive belt becomes slack. This condition restricts the heat transfer from the coils to surrounding air. As a result the liquid refrigerant does not all vaporise and is drawn into the crankcase of the compressor, diluting the oil. Too much dilution can damage the compressor discharge valves and gaskets.
SWTR (0272 295263)

A personal view of transmission inefficiency—by a TEO

I am a Transmission Efficiency Officer (TEO) in an Area and often have to deal with transmission complaints. We cannot clear up many of these it seems to me, to the complete satisfaction of our customers, simply because of excessive losses built into the network at the planning stage.

Local line planning
Take first the instruction to which local line planners work for direct exchange lines (DELs) – *TI A2 C4052*. This states that lines should normally be planned to have an image attenuation not greater than 10dB at 1600Hz; but it goes on to say that 10dB is not a rigid limit. In exceptional cases, presumably in rural areas, the TI allows the limit to be exceeded for the sake of economy. I can instance recent THQ approval of a new scheme for a rural 'business' area making two of the DPs 11.5dB and 12dB. The letter of approval said that in the 'unlikely event' of transmission complaints being received, the use of 'loop extenders' could be considered. But we have yet to see loop extenders.

With planners also being told to plan as far as possible for cables with aluminium conductors, we are getting many electrically and geographically long local ends. Planners still observe the signalling limit of 1000 Ω dc loop resistance, but they bend the rules for transmission.

I gather the 10dB at 1600Hz figure is also regarded as 'reference equivalent' for the transmission performance of the telephone with limiting loss in the local line and transmission bridge and switching losses in the local exchange. This makes me think that the limit for planning local lines ought to be less than 10dB.

Long local ends, of course, are not the only sources of transmission difficulties.

Trunk and junction planning
The instruction for planning of main network and junction circuits is *TI A3 A1205*. The design limit for the network from local exchange to local exchange via two GSC to GSC links is 19.5dB, as shown in figure 1; (for the transit network the limit is 19dB). The limit is made up of 15dB total circuit losses and 1.5dB switching loss in each of the three GSCs.

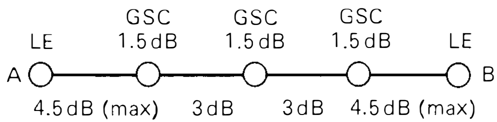


Figure 1

Note that the switching losses in the two local exchanges are not included in the 19.5dB: they are reckoned as part of the local network losses.

Junctions
Junction routes, limited as shown in figure 1 have a maximum loss of 4.5dB. They can be made up of loaded or unloaded cables, with or without amplifiers, or of PCM channels. For example, the maximum unamplified length of route for 0.63mm cable with standard loading is 10km, since the attenuation is 0.45dB/km. Cables with 0.9mm and 1.27mm conductors have lower attenuations, 0.25 and 0.12dB/km respectively. Hence unamplified circuits on loaded 10km routes can have losses between 1.2 and 4.5dB.

Two-wire amplified circuits should have 3dB loss but exceptionally 4.5dB is allowed. With a permitted maintenance tolerance of ±2dB, the worst circuits can be 6.5dB.

Existing PCM circuits are designed to have losses between 2.5 and 4.5dB. Altogether, 10km junction routes can, by design, vary between 1.2 and 6.5dB.

Main network
Main network routes, on which the permitted maximum loss is 3dB, can be made up of circuits on loaded audio cable, FDM carrier systems on HF cables or radio links, or PCM channels. Circuits on audio and FDM carrier systems are classified as amplified circuits and lined up to 3 ±0.5dB. Again there is a permitted tolerance of ±2dB in maintenance. Let us say, for simplicity, that such main network circuits

can vary from 3 to 5dB. Note that 24 channel PCM design limits are 2.5 to 4.5dB we can then see, that by design, a nominally 3dB circuit can in practice be a 4.5dB PCM channel.

So, on connections from local exchange to local exchange via two GSC to GSC links and 10km junction circuits, total circuit losses can vary from 8.4dB (figure 2) in the best case to 23.0dB (figure 3) in the worst. Including 1.5dB switching loss in each GSC, therefore, a nominal 19.5dB connection (figure 1) can in practice be anything from 12.9dB to 27.5dB.

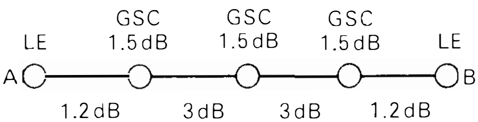


Figure 2

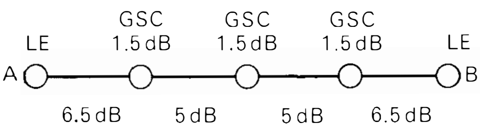


Figure 3

These results may first seem extreme. But are they ? It will be said that a large number of trunk calls are routed over single GSC to GSC links, and a large number do not use limiting loss junction routes. Agreed, the possible combinations are numerous. So are the combinations outside limits, especially with local ends up to 10dB. Quite often, because of the variations and tolerances we permit, transmission complaints are received about routings that do not fall outside design limits, for instance, complaints about differences of transmission on incoming and outgoing calls.

Trunk and junction routiners

The trunk and junction routiner is the maintenance aid that determines the standard of service we actually give in the main network. May I suggest that the transmission test it performs is suspect. The oscillator is calibrated to send a 1600Hz tone at 0dB and the tone detector in the answering equipment is adjusted to respond to tone received at —12dB. This 12dB loss is made up as follows:

3dB attenuation strapped into routiner
3dB total switching loss at outgoing and incoming ends
1dB oscillator variation below 0dB
3dB line loss, nominal
2dB additional line loss permitted

Thus if the line loss exceeds 5dB, the tone detector will fail to respond and an alarm will be given. This is the theory. In practice, as enquiries in many Areas show, the attenuation strapped into the routiner is 0dB, or at most 2dB. Overall switching loss rarely exceeds 2dB and regularly calibrated oscillators do not vary appreciably from 0dB. It will be seen, therefore, that the routiner can fail to reject a nominal 3dB circuit until its loss approaches 8dB.

We in the PO have specialist groups planning local lines, trunk and junction circuits, switching and transmission systems, and those responsible for customer equipment design. We have other specialists concerned with maintaining different elements of the network. So far as an Area TEO can see, constantly dealing with transmission complaints, *no-one* looks after transmission performance overall – and so the customer suffers.
R G Inns, Middlesbrough

Mr Inns is referring to what we call 'first generation' trunk and junction routiners. As he points out, if 3dB attenuation is not strapped into routiners in accordance with TI E6 R5438, circuits with losses greater than allowed in maintenance will be passed as satisfactory. As the TI states, tone detectors have to be adjusted to respond over a range, from —12 to —14dB. The nominal loss is therefore 13dB, requiring 4dB attenuation in routiners. The TI will be amended shortly.

Switching losses can vary widely, depending, for instance, on cleanliness of selector banks. A nominal value must, therefore, be assumed and it is assessed at 0.5dB per switching stage.

The type of oscillator used in first generation routiners will always vary in output and this has to be allowed for.

Second generation routiners, having the capability of testing circuits in the transit network, are coming into use in increasing numbers. Having more stable oscillators, and with more stable tone detectors in answering *equipments, they test more accurately. They can reject circuits above as well as below maintenance tolerance limits.*

N C Rolfe, Sv7.2.3. (01-432 1322)

Sv7 are Network Maintenance Division and the above reply comes from the group responsible for maintaining trunk signalling and switching systems. However, as Mr Inns' contribution takes planners also to task, we put it to the THQ groups concerned. The first of the replies below is from TD6.1.1 in Telecommunications Development Department, who are responsible for formulating the national transmission and routing plan. They can be said to 'look after' overall transmission performance since they advise the operational departments on the effects of consistently planning to or beyond the specified limits. There follow two replies from Operational Programming Department; from OP2.3.6 who are concerned with planning and providing junctions and OP2.1.5 concerned with planning of local networks. The last reply is from NP8.3.1 in Network Planning Department, who are responsible for implenting the national plan for the public switched telephone network (PSTN).

Editor

To reply exhaustively to all Mr Inns' points would fill more than one 'Maintenance News', but we will try briefly to remove the common confusion about reference equivalents.

For local line planning a simple rule of thumb is needed, and in the UK the attenuation of the cable at 1600Hz is used. When designing and assessing telephone networks, however, we are interested in the total mouth-to-ear loss, not just the loss between the ends of local lines; so we have to include the performance of the telephone. We compare the loudness of a UK standard telephone plus local line plus transmitter current feeding bridge with that of an international reference telephone system. The 706 telephone with a 'limiting loss' local line having nominal attenuation 10dB at 1600Hz (and 7dB at 800Hz) and standard transmission bridge, has a 'sending reference equivalent' (SRE) of 12dB and a 'receiving reference equivalent' (RRE) of 1dB. That is, in the sending direction of transmission it is 12dB quieter than the international reference telephone system, and in the receiving direction, 1dB quieter. The send and receive performances of the reference system were set quite arbitrarily and it will be seen that our reference equivalents and local line limits are related only indirectly. The point is, however, that the reference system is international and most countries express performance of their local ends in the way that we do. Hence, in considering connections between UK and another country, we can add our SRE to their RRE and vice versa. Then, by adjusting losses between countries, we can control the overall limit and make sure the difference between the two directions of transmission is not too great.

A network giving completely acceptable transmission to all customers on all calls is economically impracticable. The national transmission and routing plan of 1960 (see TI A3 A1205) was a compromise based on a maximum 'overall reference equivalent' (ORE) of 33dB between customers. With two limiting local ends, each of 12dB SRE and 1dB RRE, the nominal loss between local exchanges in the UK should therefore not exceed 20dB. Mr Inns' figure 1 shows that the plan meets this requirement with a small margin. Notice that this limiting case assumes two 'limiting loss' local lines (attenuation 10dB at 1600Hz) connected together through the network, a condition that will occur on only a very small proportion of calls. Customers on the fringe of an area will, of course, systematically get poorer transmission on trunk calls than those near their GSC and will suffer the most if local and junction network limits are exceeded.

Part of our work of assessing network performance involves statistical measurements and studies of network losses, noise power levels and attenuation distortions. It is described in some detail in the October 1972 POEEJ. To improve our assessments we would welcome some method of collecting complaints nationally, particularly if details of the local and junction circuits involved were given. We would be prepared to visit Regions or Areas for *informal lectures or discussions about our assessment work if they think it would be helpful.*

R A Fry, TD6.1.1 (01-357 3110)

Mr Inns is clearly concerned about the variability of transmission losses in the network, but there is no case for degrading circuits so that transmission on all calls approaches the worst. The point is discussed in paragraph 8 of TI·A3 A1205.

He is quite right, however, to question whether in maintenance, circuit losses should be tolerated 2dB greater than the limiting case (paragraph 17d of the TI) We should not assume without evidence that in the present network our circuits really are getting to be ±2dB from line-up. Perhaps Mr Inns and other TEOs could help with information on this.

G A Bryan, OP2.3.6 (01-628 7733 x477)

Planning local cable routes is a compromise between economics and meeting transmission and signalling requirements. In a few cases planners must take a calculated risk because of economics and allow the occasional circuit to exceed limits. They should understand the risks involved. We would be pleased to advise and assist in doubtful cases.

The average transmission loss of subscribers' lines is increasing and so is the number of subscribers on long lines. This confirms what Mr Inns says. Vigilance is needed to ensure that overall performance is not unacceptably degraded.

D Clark, OP2.1.5 (01-628 7733 x657)

It has always been recognised that on 'limiting loss' connections of 33dB ORE between customers (see the TD6.1.1 reply) about 50 per cent of customers can be expected to have transmission difficulty, when average values of noise and attenuation frequency distortion are taken into account. The plan therefore relies for its success on the assumption that on only a small proportion of calls will limiting conditions be encountered. In the case considered by Mr Inns, of calls connected over two junction and two trunk circuits, it is estimated that only three in 10 000 will exceed 33dB ORE. This pessimistically assumes that all customers make equal numbers of calls.

However, we must not consider only limiting cases, for tests show that the range of OREs preferred by customers is of the order of 6 to 18dB. To give acceptable transmission on as many calls as practicable it is desirable to tighten maintenance tolerances and ensure that planning limits are respected. We will be raising both matters during the forthcoming revision of TI A3 A1205. Whatever technical, operational and economic problems will be revealed remain to be seen.

Departures from the plan are sometimes made when routing traffic over the PSTN, usually for economic reasons or to meet unforeseen requirements. Such non-standard routings must be treated strictly as temporary expedients by network planners, including traffic routing duties, and by circuit provision controls. These duties should remain continuously aware of the requirements of the plan. The success of the plan likewise depends on a high and consistent standard of maintenance.

Those responsible for development of all types of line plant, transmission and switching equipment and customers apparatus also have a part to play in specifying adequate transmission performance limits. Again, use of the PSTN must be confined to those classes of service that are fully compatible with its facilities, performance and capacity.

As yet there is little co-ordinated evidence of any general deterioration in the overall transmission performance of the PSTN; but the contribution from Mr Inns shows there is no room for complacency. We think it could be valuable to have the observations of TEOs collected, rationalised and circulated regularly within THQ.

P C Kendall, NP8.3.1 (01-432 9117)

Readers will have by now caught glimpses of the planners' world from the above replies to Mr Inns. It would seem that some feedback to THQ about transmission complaints is needed. Have TEOs, or other readers, views on how this might be arranged?

Editor

Maintenance News aims to provide a medium for two-way communication – that is, between Headquarters and the field. If you want to write about anything you may have seen in *Maintenance News*, or indeed, about any maintenance topic, send your letter to: The Editor, Maintenance News, Room 4034, Tenter House, Moorfields, London EC2Y 9TH. Say what you like but the Editor may tone comments down if he decides to publish. Do please give your full address.

If you have a contribution to offer to Maintenance News other than a letter to the Editor, please forward it through normal channels to the *Maintenance News* agent for your Region or Telecommunications Board. The list is shown below. The editor cannot publish anything to do with current awards suggestions.

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