bulletin

ERICSSON TELEPHONES LIMITED

ETELCO LIMITED

52
JANUARY 1963

bulletin

No. 52 JANUARY 1966

CONTENTS

ERICSSON TELEPHONES LIMITED
ETELCO LIMITED

Published by ERICSSON TELEPHONES LTD., Beeston, Nottingham, England, *and Printed by* DERRY AND SONS LTD., Nottingham, England.

U.D.C.621.395.345

D.S.U. Equipment Practice

N. Nicholson, B.Sc.—Electronic Switching Division

D.S.U. equipment practice is a mechanical design of equipment for telecommunications and data processing systems. The design incorporates robust jack-in units, suitable for mounting a great variety of components—from semi-conductors to power transformers—and the units accept both printed wiring and conventionally wired component panels. All components are accessible for maintenance, and unobstructed air flow allows efficient cooling. Cabinets and frameworks can be readily adapted to suit any installation requirements.

A rational approach to the mechanical design of equipment for use in telecommunications and data processing is necessary if an electronic or electromechanical system is to be produced in the most economical way. Units and frameworks must be such that the engineering time for new projects is reduced to the minimum and the cost of hardware must be as low as possible, consistent with the requirements for long life, reliability and interchangeability. If a standard, but highly adaptable, equipment practice is followed, development work is confined principally to overall system and circuit design and the allocation of circuits to units. With the D.S.U. system any of the devices normally encountered in communications and data processing work can be accommodated in one of many types of unit which may be constructed from a limited variety of components parts. This wide adaptability was the essence of the original design philosophy. As a result the system has, over the last few years, fulfilled all user requirements.

Basic Design

The basis of the system is the jack-in unit (figure 1) together with its companion jack assembly (figure 2). The most important components of any jack-in design are the plugs and jacks because these largely determine unit interchangeability and the potential reliability of the unit interconnections. An initial survey of the available plugs and sockets, particularly

Figure 1—Basic jack-in unit

Figure 2—Jack assembly

edge connectors, led to the selection of the 'Rurax' type, slightly modified to suit the conditions to be satisfied in electronic equipment.

Features of the Plug and Jack

A simplified drawing of the basic 16-contact plug and jack is illustrated in figure 3. The plug springs are assembled in pairs on a slotted mounting block and retained by a nylon clamping strip. The two springs in each pair are separated by a hard p.v.c. wafer of similar profile to the springs. The jack springs are assembled in a similar manner using a mounting block and clamping strip identical with those of the plug assembly.

Contact surfaces are plated with palladium, a material which withstands high contact pressures without scuffing and does not exhibit the tendency to cold weld. As a result, the force required to separate the plug and jack is very small; with an average contact pressure of 120 grams per spring, the withdrawal force for a block of 16 springs is typically 1 lb (0·45 kg). Palladium also has low contact resistance and freedom from tarnishing over long periods, characteristics which are essential for the low voltages and currents encountered in long-life electronic equipment.

The large surface area of the plug springs allows considerable latitude in the relative location, both laterally and back to front, of plug and jack assemblies. Location in the vertical direction is much more critical because to a large extent it determines the pressure exerted by the jack springs. This, however, presents no problem since the precise vertical location of the plug and jack assemblies is ensured by the unit plug plate and corresponding jack plate.

This simple design of plug and jack, in addition to allowing large tolerances in two directions, affords

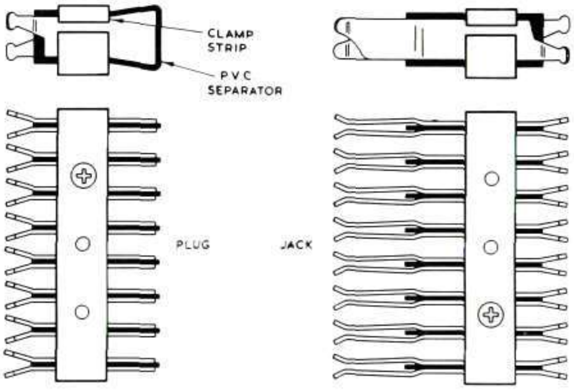


Figure 3—Simplified drawing of plug and jack

other facilities not readily available with other types of connector. For example, power supplies or signals may be connected to a unit in a specified order by simply varying the lengths of the plug springs.

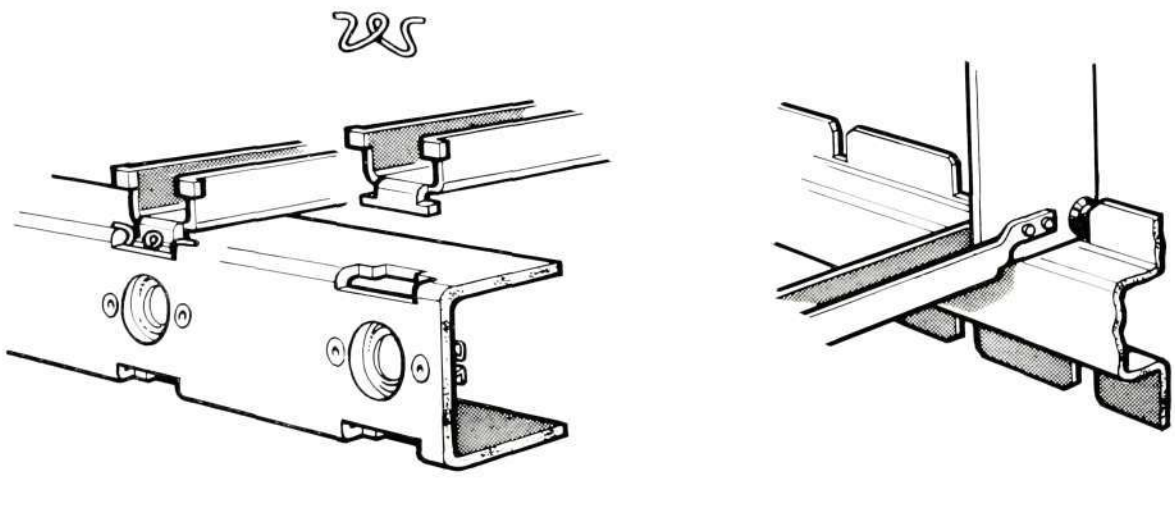
Jack-in Unit

The unit (figure 1) comprises a U-shaped solid aluminium frame, rigidly secured at the rear to a shrouded plug assembly consisting of up to six blocks each of sixteen contact springs mounted on the unit plug plate. At the forward end of the frame two brackets support the front panel on which is mounted a block of monitor sockets, keys, indicator lamps, etc., as required. The portion of the frame forward of the front panel is p.v.c. covered and forms a handle.

Jack Assembly

The jack assembly (figure 2) accepts the plug-in unit via guides, formed from aluminium channelling and secured to a jack plate which also carries blocks of spring contacts matching the blocks of plug springs on the unit assembly. The jack plate is of substantial gauge; the mortise already referred to may be seen in the figure. This plate and the unit plug plate, whose projecting tongue engages the mortise, are the only piece parts requiring close tolerances for the required accuracy of register, and hence the specified contact pressures.

The T-shaped tongues at the forward ends of the guides locate in slots in the pierced channels which form the upper and lower horizontal cabinet members



(a) **Front horizontal support** (b) **Rear horizontal support**

Figure 4—Method of mounting jack assemblies

Each longitudinal frame member is encased in a p.v.c. extrusion which has a dual purpose; to provide a bearing surface between the unit and its guides and, by integral channels down either side, to form a means of mounting back-to-back component panels (cards). The two are separated by a central web. The component panels are interleaved by a third panel also of insulating material. Double-sided nylon pegs at front and rear of this central panel serve to locate the component panels longitudinally, the central panel itself being constrained between the unit front panel and the forward edge of the plug plate and cushioned at the latter upon oval rubber grommets fitted to the edge. Metal chassis may also be mounted; the possible arrangements are described later.

supporting each row of units (figure 4a). Both upper and lower edges of these members are slotted to accommodate the guides of the rows of units above and below. The guides are not rigidly secured to the members but held in place by spring clips which, while preventing fore and aft movement, act as pivots allowing limited vertical float of the assembly. The rear edge of the jack assembly is again not rigidly attached to the corresponding rear members, the upper and lower edges of the jack plate resting in vertical slots in the 'top hat' section (figure 4b). The guides of each jack assembly are mounted on the jack plate such that they are slightly further apart at the front than at the rear. This taper does not affect the engagement of the plug and jack springs but is a fundamental feature of the design, for it allows wide tolerances on the spacing of the horizontal members. Typically a taper of $\frac{3}{16}$ in. (5 mm approximately) over the length of the guide allows a positional tolerance of $\pm \frac{1}{32}$ in. (0·8 mm) on all horizontal members.

Unit Dimensions

Length

Following a survey of known and foreseeable requirements it was decided that the units would be of fixed vertical dimensions and that the method of construction would allow the manufacture of units and jack assemblies in various lengths to suit different installations. This reduces piece-part variety to the minimum, the only parts affected being the U-shaped unit frame and the jack assembly guides.

In practice the unit length will be determined by the physical limitations on the size of the installation and/or the type of circuits used in the system. Most telecommunications and data processing systems employ large quantities of small wired-in components, and for this reason it is convenient to quote the length of a unit in terms of the number of tags fitted to a full length component panel (8 rows of tags as shown in figure 1). In theory the component panels can be made in any length but the recommended upper and lower limits are 80 and 40 tags (on $\frac{1}{4}$ in. or 6·35 mm centres) per row.

The upper limit is chosen arbitrarily, simply because a longer unit becomes difficult to manipulate. The lower limit is selected for two reasons:

(*a*) The permissible tolerances on units and jack assemblies would allow a very short unit to have an unacceptably large angular movement in the vertical plane, with possible risk of damage to plug and jack springs.

(*b*) The ratio of hardware cost to number of components mounted increases as the unit length decreases.

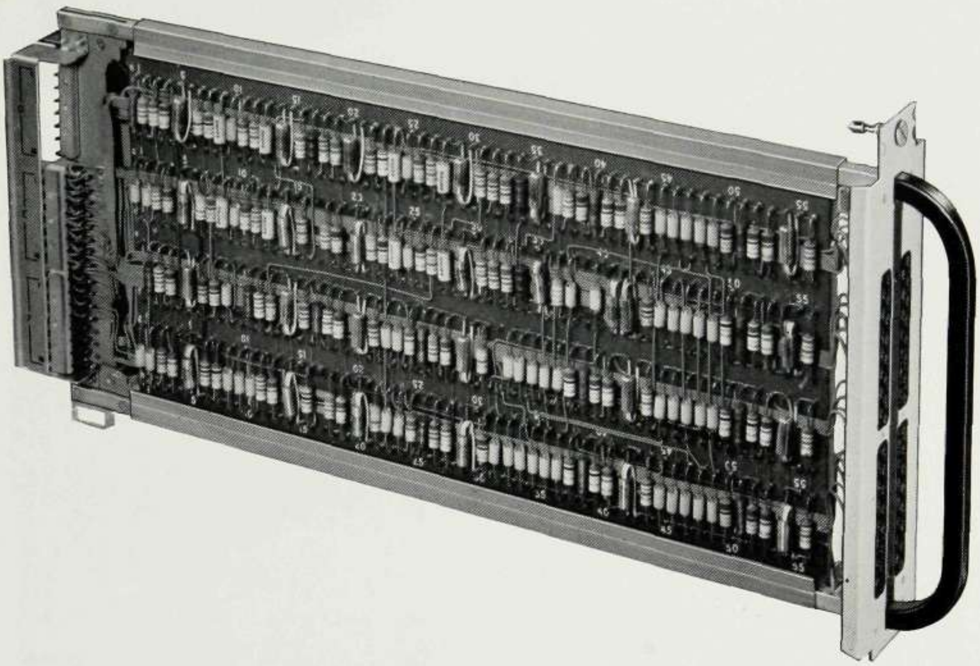


Figure 5—Digit counter unit

The above limits give component panels of $20\frac{1}{4}$ and $10\frac{1}{4}$ inches respectively (51·44 cm : 26 cm); the corresponding units will have 640 and 320 component spaces and the minimum cabinet depths required are $26\frac{1}{4}$ and $16\frac{1}{4}$ inches (66·7 cm : 41·3 cm).

Figure 5 illustrates a Digit Counter unit which has 56 tags per row and 448 component spaces.

Width

In this system the width of the front panel determines the maximum size of components which may be mounted on a single unit. The selection of single unit width for a specific project is therefore governed by the type of component *most used* in that project. Thus if a system is composed mainly of semi-conductor circuits, then the minimum front panel width (1·7 in. or 4·3 cm approximately) will be used. If, on the other hand, relays predominate, then the chosen front panel width will be appropriately greater.[1]

Multiple Units

One of the difficulties frequently encountered in equipment design is the accommodation of a variety of component types, shapes and sizes used in a single system. This problem is solved in D.S.U. practice by *multiple* units. Each consists simply of a number of single frame assemblies secured at front and rear and spaced such that the distance apart of the frames corresponds with the pitch of the guides in the cabinet. The use of multiple units therefore involves no modification to the jack assemblies or the horizontal supports of the cabinet. No interchangeability or location problems are presented, because the jack assemblies are individually mounted and free to 'float' *independently*. Each frame assembly in a multiple unit will, in general, be fitted with a plug plate of standard form and the lead-in on the jack-plate mortises is such that each jack assembly will automatically assume the position required by the frame assembly it accommodates. A typical example of a double-width unit is shown in figure 6; this unit is a d.c./d.c. power convertor used in ferrite-core register translators.

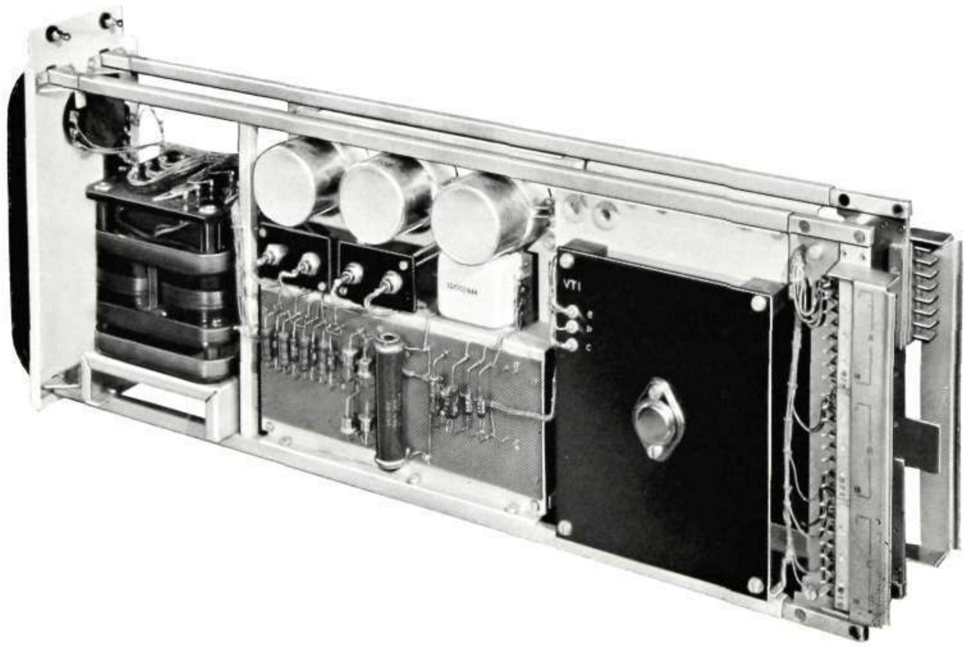


Figure 6—A multiple (double-width) unit

Mounting of Component Panels and Chassis

In the description of the standard unit it was seen that the centre panel provided a means of locating and cushioning the two outer component panels. The use of this panel also permits a variety of different mounting arrangements. For instance, where different types of components are to be mounted on one unit, it may be necessary to fit a metal chassis in addition to the normal type of component panel.

A typical example of this is the signal conversion unit shown in figure 7. In this unit, the metal chassis is in the form of a shallow tray, the upper and lower edges of which rest in the p.v.c. extrusion covering the legs of the frame. The centre card between the two component panels is cushioned by rubber grommets at both front and rear, the grommets at the rear being located on the plug plate in the normal way, and those at the front, on the back edge of the metal chassis.

[1]'PENTEX—A Small Electronic Exchange', *Bulletin No. 50A*, March 1965.

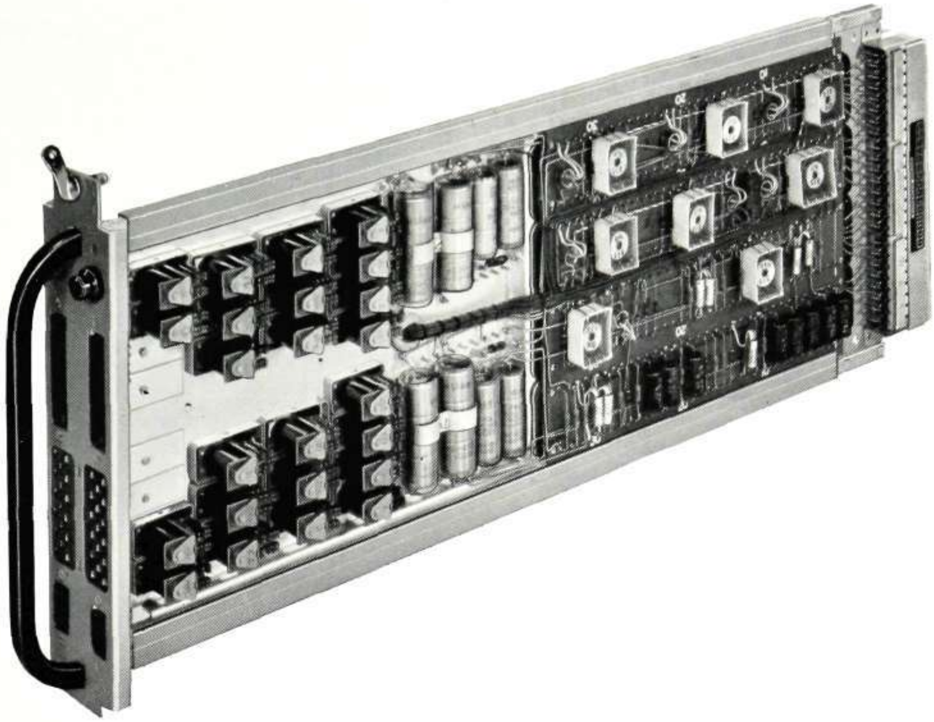


Figure 7—Signal conversion unit with relay covers removed

Figure 8—Power control unit with metal chassis in place of component panels

The centre panel may also be used as a 'mother' board to which a number of small etched circuit cards may be connected. As the whole unit assembly can be easily removed from the rack, the cards can be connected by soldered or wire-wrap joints to a tag strip mounted on the centre panel. Interconnections between cards can be made by wiring between the tag strips; edge connectors on the normal basis of one per circuit card are unnecessary, the only non-permanent connections being made via a much smaller number of contacts on the standard plug assembly.

Figure 8 shows an example of a unit where the component cards are replaced by a metal chassis, in this instance carrying P.O. Type 16 relays. The upper and lower edges of the chassis rest in one of the channels of the p.v.c. extrusion in the normal way. Simple clamps engaging the centre webs of the p.v.c. extrusions prevent longitudinal movement.

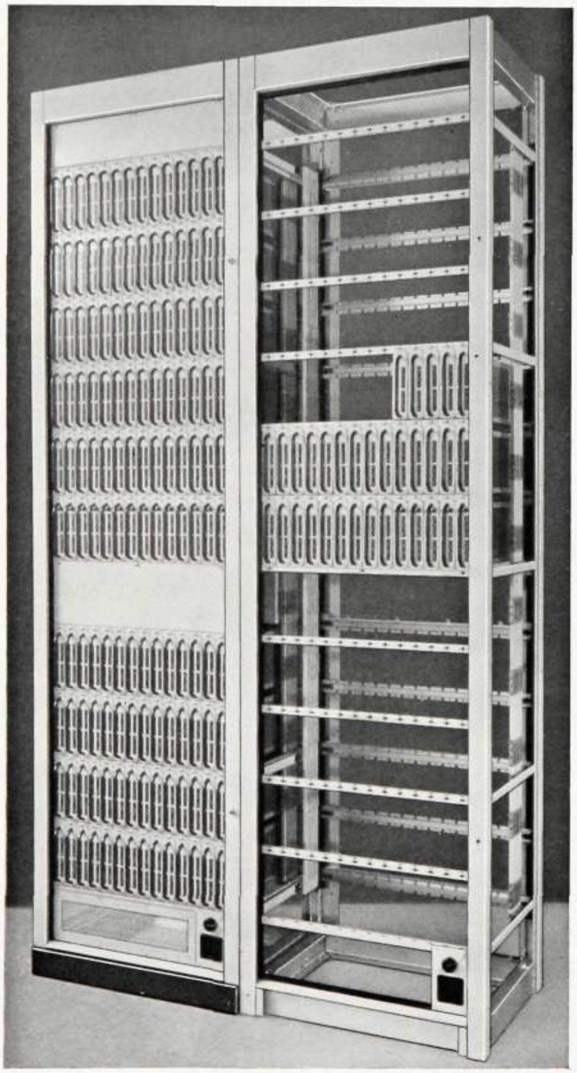


Figure 9—Partly assembled racks for ferrite-core register translators

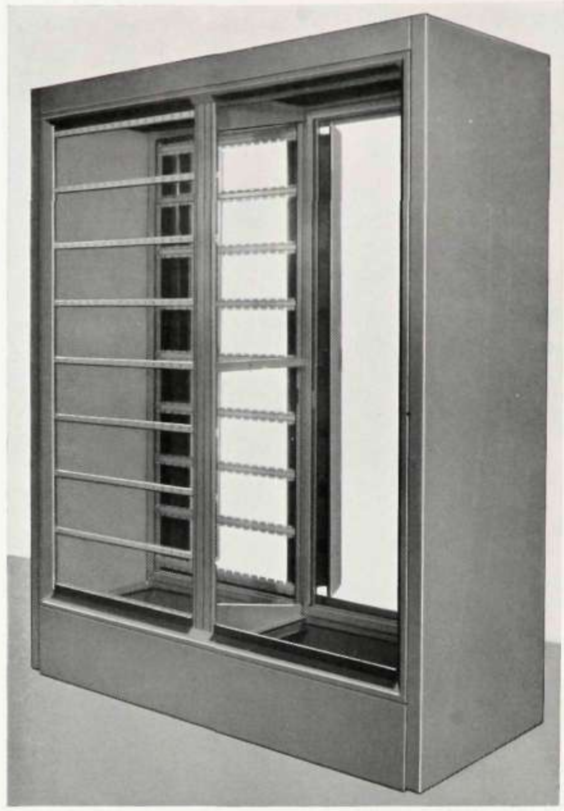


Figure 10—Front view of two-bay cabinet for a data processing system

CABINET ASSEMBLY

A complete definition of standard D.S.U. practice is implicit in the description of the units, the jack assemblies, the two types of channel section which respectively form the front and rear horizontal supports, and in the fact that these supports may be pre-cut to any normally required length. It follows that the framework or cabinet which mounts the supports may be of any type and size suitable to the application and to the number of units to be accommodated, within the limits of mechanical strength and convenient layout. Simple cabinet assembly techniques suffice because all critical tolerances are confined to and accounted for in the units and jack assemblies. The facility of tailoring cabinets to exact individual requirements is a central feature of D.S.U. practice, and is of great significance in the development stages, as well as in the permanent installation of equipment. Figures 9 and 10 are two examples of cabinets designed to comply with

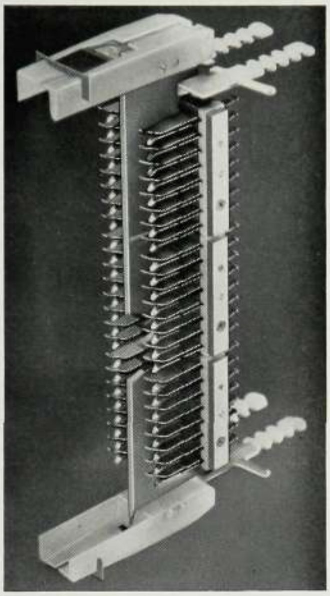


Figure 11—Jack assembly for pre-wired shelves

different customer requirements. The first shows partly assembled racks for ferrite-core register translators; these are 10 ft. 6 in. high × 2 ft. 9 in. wide (3·2 m × 0·84 m) and the equipment is cooled by natural convection. The second example shows a two-bay cabinet (part of a data processing installation) and this is 7 ft. 3 in. high × 5 ft. 6 in. wide (2·2 m × 1·7 m) and designed for forced air ventilation.

Rack and Shelf Assemblies

Pre-Wired Rack

Pre-wired racks, fully equipped on initial installation, are widely employed in telephone exchanges and represent a significant proportion of overall exchange cost. The rack construction typified by figure 9 minimizes capital outlay, being of simple and efficient design and low in cost. Basically it consists of four corner posts with front and rear supports common to two rows of units. Although primarily intended as an economic structure for full equipment, it can also be used as a partially-equipped rack where service needs are stabilized, for example, in systems of fixed capacity serving a specific number of subscribers.

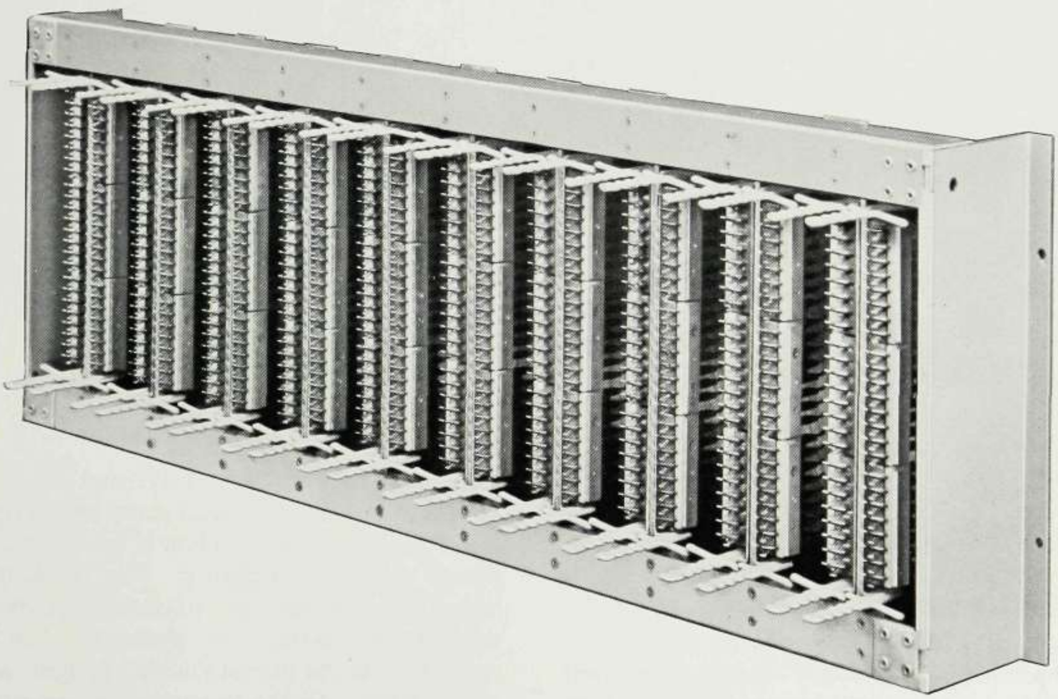


Figure 12—Assembled shelf ready for wiring

Pre-Wired Shelf Assemblies

Another important requirement of most telephone exchanges is that they must be capable of subsequent extension. This is fulfilled by a variant of D.S.U. practice based on pre-wired jack assemblies, mounted in frames and known as shelf assemblies. Their primary feature is that the guides associated with the jack units are detachable, thus permitting 'pack flat' delivery to site where the guides may be fitted on installation. The function of the jack assemblies and guides is precisely the same as in the standard practice.

Figure 11 illustrates how the guides locate in mouldings secured at the top and bottom of an otherwise standard jack plate. A spring clip retains the channels within the mouldings.

In the factory, these jack assemblies are mounted on a frame (figure 12) which, on installation, will perform the function of the normal top-hat section members at the rear of the rack. The jack assemblies are temporarily retained by thin rods which pass through the jack-plate mouldings and the frame members. Point-to-point or preformed wiring is now added.

Although the frame illustrated is of single-shelf type, a two- or three-shelf frame can be supplied, with inter-shelf as well as inter-jack wiring. Figure 13 shows a complete assembly ready for mounting on the rack structure.

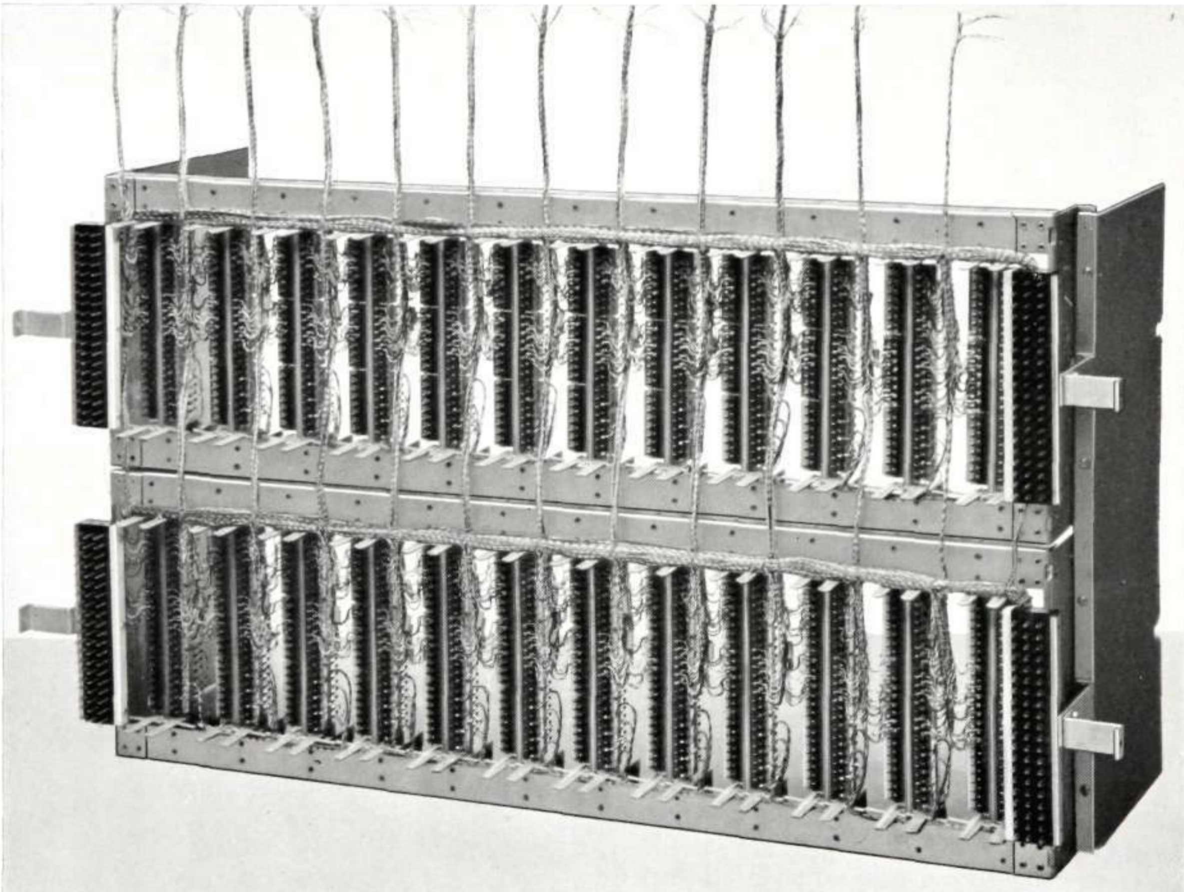


Figure 13—Two-shelf sub-rack, with inter-unit and inter-shelf wiring

Rack for Pre-Wired Shelves

The rack framework (figure 14) used for pre-wired shelves consists of two folded sheet-steel uprights of substantially box section, joined at bottom and top by folded sheet cross members. The standard front horizontal members are provided but the rear members are omitted. On assembly the shelf frames are secured to the rear of the rack uprights and the guides fitted. All the tolerances, in vertical alignment of the frames with the front members, in the front member spacing, and in the front-to-back dimensions of the rack are preserved as with the standard D.S.U. practice.

After inserting and locking the guides with spring clips, the retaining rods are progressively withdrawn, allowing each jack assembly to be moved forward so that frontal tabs on the guides can engage and be secured in the appropriate slots on the front horizontal member.

As with the standard D.S.U. equipment individual 'float' of jack assemblies permits multiple units to be accommodated.

To facilitate extensions in partially equipped racks, the shelf assemblies are designed to pass between the main rack uprights from the *front* of the equipment, so enabling additions to be made without disturbing rack wiring which may be present across the empty space.

Conclusion

The foregoing description of the D.S.U. equipment practice illustrates the versatility of the design and the standardization of hardware achieved despite the wide variety of installation and component requirements. Systems ranging from special-purpose computers to reed-relay telephone exchanges have been manufactured using this design, and in every case it has been possible to order the majority of the hardware before the detailed system and circuit design has progressed very far. In addition, the method of mounting components and the unit design has enabled the time for unit engineering, and the preparation of assembly and wiring information, to be considerably reduced.

ACKNOWLEDGMENT

The author wishes to acknowledge the appreciable contribution made by Mr. P. W. Battlemuch to the development of this equipment practice.

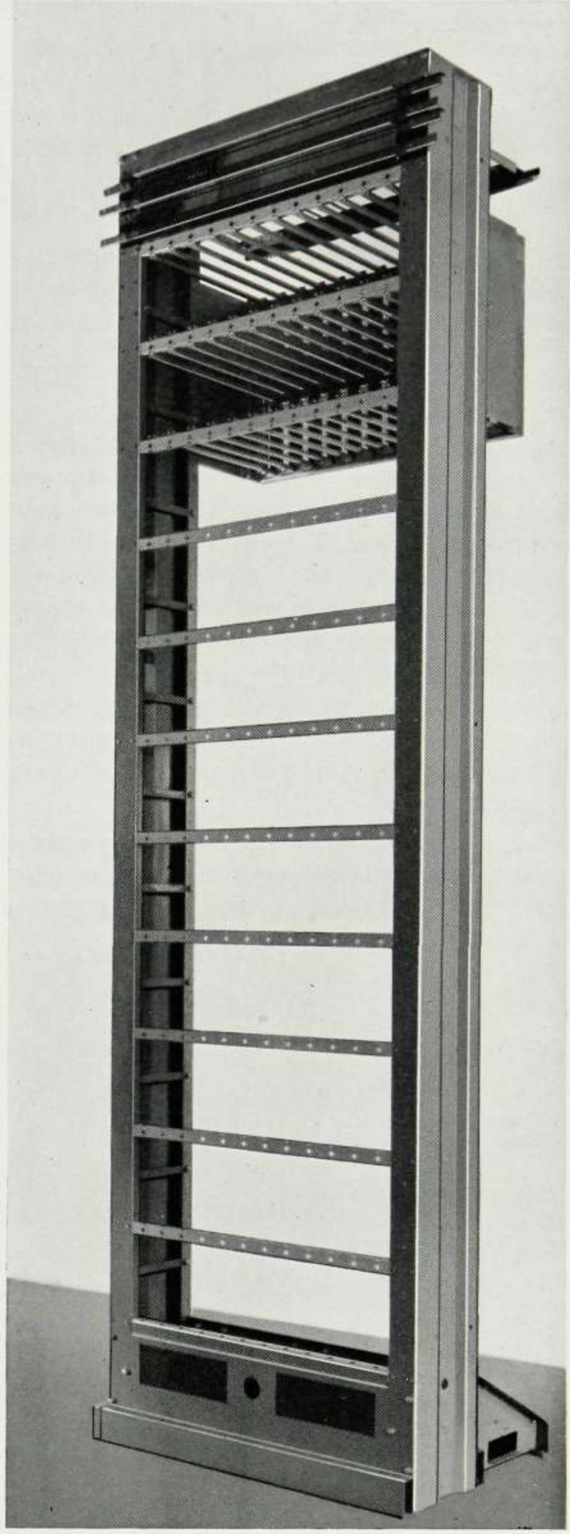


Figure 14—Rack framework with one sub-rack; (power bus-bars and alarm type fuses are also shown)

U.D.C.621.56 : 621.39

The Reed Relay

D. J. Williams, B.Sc., A.Inst.P. and W. D. Bishop, B.Sc.
Reed Division, Plessey Telecommunications Group, Beeston

The reed relay will be an important component of telephone exchanges of the future. This article describes the design, manufacture and application of a single pole normally-open switch or 'insert' designed specifically for use in relays for telecommunications applications. Break and changeover forms can readily be produced.

The Bell Telephone Laboratories first established the principle of the reed relay as long ago as 1936. Compared with the conventional electromechanical relay it offers many potential advantages. These include faster switching, lower power consumption, smaller size, lower cost, and the ability to operate very reliably and with no adjustment over a long working life even in dust-laden or contaminated atmospheres.

The realization of these advantages depends almost entirely on the design of the sealed switching element or 'reed insert' which, with the energizing coil, forms the complete relay.

Considerable manufacturing capacity for inserts and complete relays now exists within the Telecommunications Group. Although break and changeover actions can readily be produced, the type of insert likely to receive the widest use is the normally-open or make-action type, and the present discussion is confined to this type. Examples of its use in service include the Pentex[1] exchange installed at Peterborough.

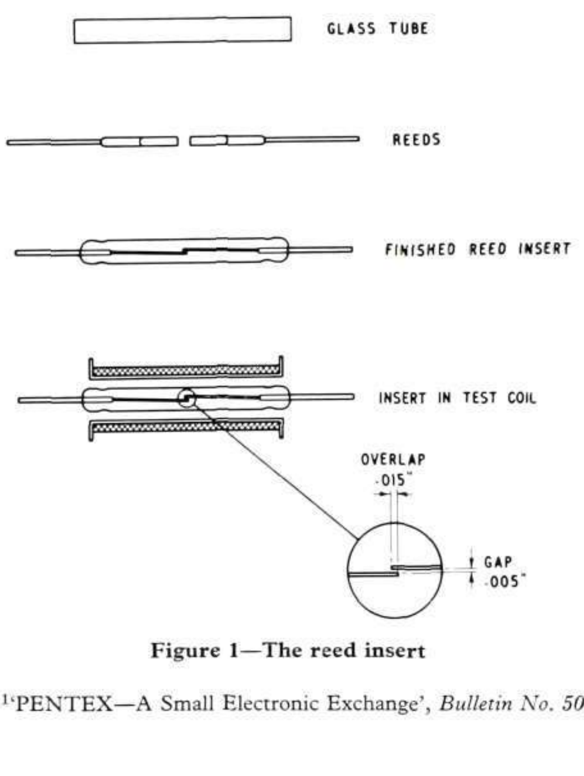


Figure 1—The reed insert

Insert Design Principles

The construction of the insert is shown in figure 1. Two flat magnetic alloy cantilever 'reeds' are sealed into either end of a glass tube; the free ends overlap and are separated by a small gap. When a coil surrounding the insert is energized, the electromagnetic field induces opposite magnetic polarities in the free ends of the reeds. The resultant magnetic attraction, acting against the elastic force due to reed deflection, reduces the gap.

The dotted line in figure 2 shows the elastic restoring forces on a pair of identical reeds initially separated by a gap X. These forces are proportional to displacement because the gap is small compared with reed length. The figure further shows the attractive force between the reeds in increasing magnetic fields 1, 2 and 3. Field 1 is seen to be the minimum necessary to maintain contact closure once the insert has operated. With this field applied to the *unoperated* insert, the gap is reduced from X to the stable gap X_1. An increase of field causes the stable gap to narrow until in field 2 the critical gap X_c is reached, where snap closure takes place. The contact force is then F_2–F_1. Curve 3 shows a field capable of snap closure from X, giving an increased contact force, F_3–F_1.

As the field is reduced, the contacts remain closed until F_1 is reached, when the gap reopens to X_1.

A suitable reed material will have high permeability with low remanence, good elastic properties, and be easily formed, plated and soldered. It should also be of low cost and give a matched seal with a commercial

[1] 'PENTEX—A Small Electronic Exchange', *Bulletin No. 50A*, March 1965.

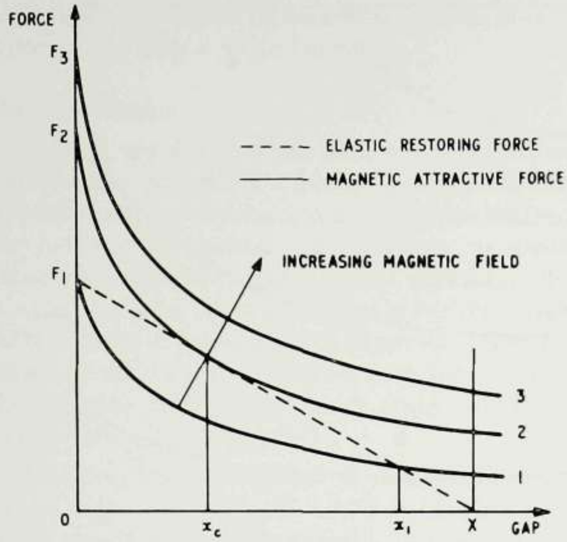


Figure 2—Reed force/deflection characteristics

sealing glass. A 50% nickel 50% iron alloy adequately satisfies these requirements and is now generally used in reed insert manufacture.

Although the insert described would operate in air, a nitrogen and/or hydrogen filling is generally provided for contact protection, whilst to withstand higher voltages the insert may be pressurized or evacuated.

Design Assessment by Simulator

The operate and release sensitivities are governed by the magnetic and elastic properties of the reed material, the reed dimensions, overlap, gap and thickness of contact plating. These same parameters affect the operate and release times and the contact bounce during operation.

Experimental investigation is facilitated by the 'reed insert simulator' shown in figure 3. The gap and overlap are capable of micrometer adjustment, which is checked by microscope before sliding the test coil into place. In addition to the use of a simulator in our own laboratories, two others have been supplied recently by the Plessey Telecommunications Group to the BPO Research Laboratories at Dollis Hill.

Typical static characteristics are shown in figure 4. As the gap is made larger, the reed deflection required to close the contacts increases, necessitating a greater magnetic force. Flux leakage and the onset of magnetic saturation result in a marked increase in operate ampere turns (AT) at gaps above ·006 in. (·15 mm).

For relatively small gaps the operate AT remain sensibly constant over a wide overlap range. The attractive force is proportional to (gap flux)^2/overlap; overlaps below the range show a marked increase in operate AT as the leakage flux rises, whilst overlaps above it lead to reduced gap flux density.

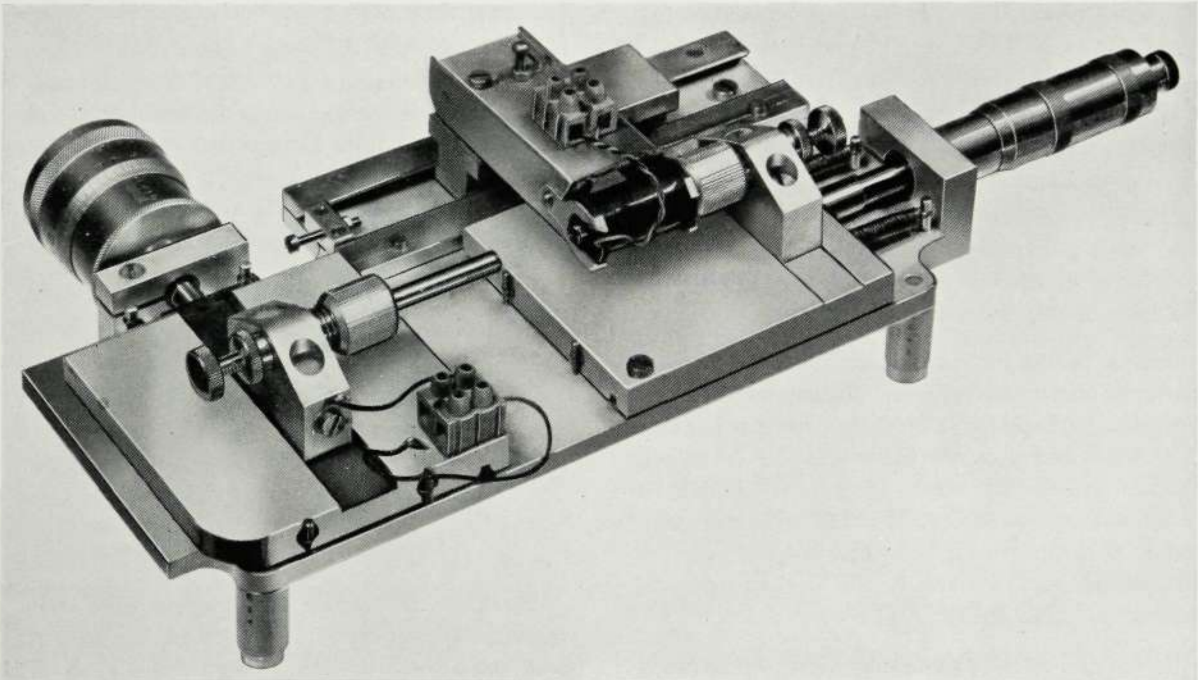


Figure 3—Reed insert simulator

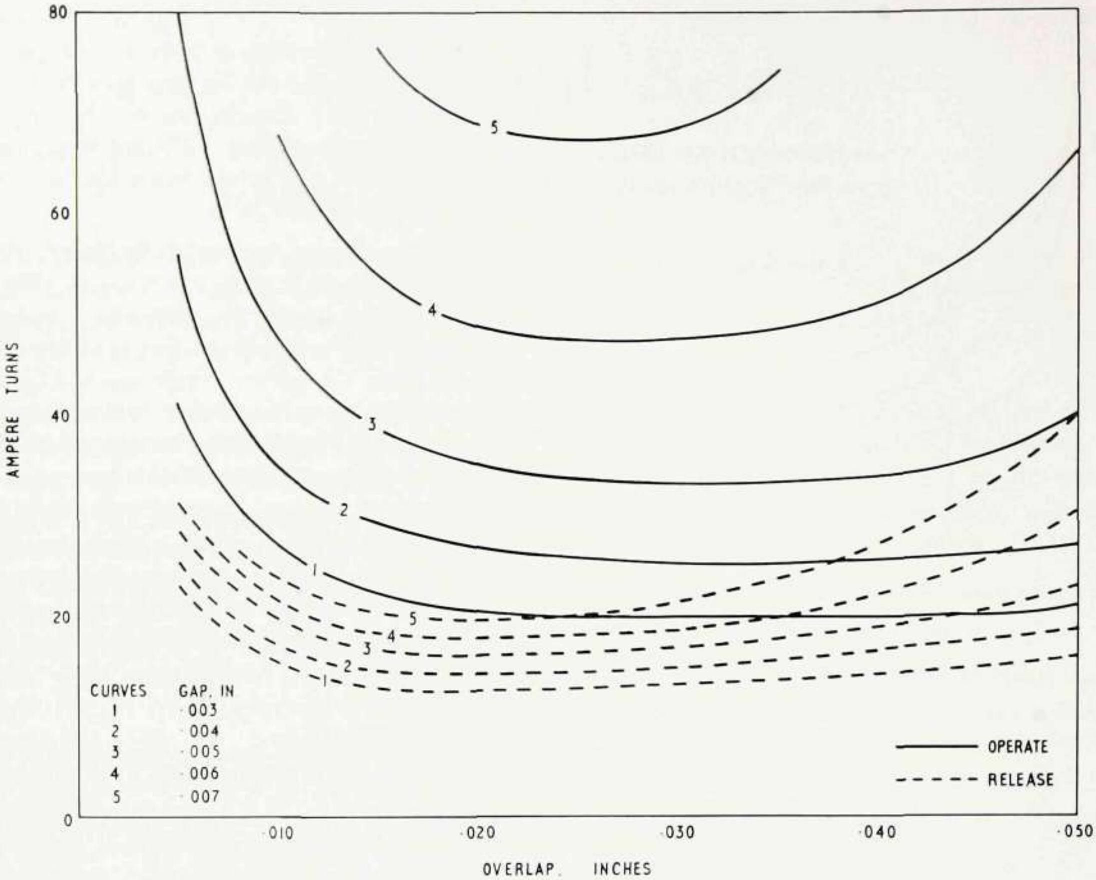


Figure 4—Insert operate and release characteristics

The shape of the release curves is similar, and has the same explanation. There is an approximately linear rise in AT with gap, because the elastic force is proportional to displacement.

For a fixed cross-sectional area, variations in reed thickness between ·006 in. and ·010 in. (·15 mm and ·25 mm) give operate and release curves generally similar to figure 4; a variation in thickness of ·002 in. (·05 mm) is approximately equivalent to ·001 in. (·025 mm) variation in gap, whilst the operate/release AT ratio remains substantially unaltered.

Similar curves have been plotted to establish the allowable reed misalignments. Misalignments shown by (a) and (b) in figure 5 result respectively in line contacts across and along the major axis, but (c) merely reduces the overlap area. In general (a) and (b) result in increased operate AT and relatively larger increases in release AT. Lateral displacement has virtually no effect on release AT but does produce slightly increased operate AT.

Whilst the above investigation gave useful design information, it is to be expected that in practice the three misalignments may occur conjointly, resulting in electrical contact over a small area only. Production tolerance limits can only be arrived at by life tests, since even a badly misaligned insert may perform adequately when new.

The reed momentum and lack of damping result in contact bounce on operation, the first-operate time and subsequent time to cessation of bounce being typically 0·3 ms and 0·7 ms. A limiting factor in switching speed is set by the combined operate and bounce times, whilst life under current switching condititions is clearly an inverse function of the number of bounces per operation.

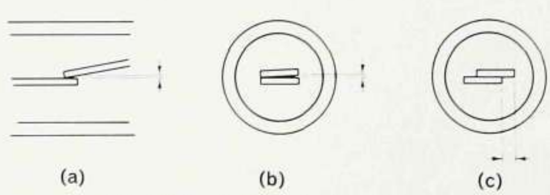


Figure 5—Reed misalignments

Variations in operate and bounce time show a markedly greater experimental spread than do operate and release sensitivities. Small gaps show little bounce; the minimum bounce time occurs with overlaps between ·010 in. and ·025 in. (·25 mm and ·64 mm) increasing rapidly outside this range.

Misalignments (a) and (c) have little effect on bounce time but (b) gives a marked increase.

Characteristics

As with any device where there are a number of independent parameters affecting efficiency and life performance, the required characteristics are attained by judicious compromise. For example, to obtain maximum senstivity and overlap tolerance, the overlap would be selected at the centre of the trough of the operate AT/overlap curve (figure 4). However this does not coincide with the overlap for minimum bounce time nor with the (much lower) overlap at which the contact force peaks.

Similarly, the requirements of maximum contact force, high sensitivity and minimum operate plus bounce time are all met by reducing the gap, but this also reduces the restoring force on release, the production tolerance in gap setting, and the break-down voltage. Finally, coil energization is high for maximum operating speed but low for minimum bounce.

The median characteristics achieved after a careful balancing of these factors are as follows:—

Operate; 30–58 AT. Release; 15–27 AT.

Closed resistance; 150 MΩ maximum at 0·1V a.c. Open resistance; $5 \times 10^8 \Omega$ minimum at 500V d.c.

Breakdown voltage; 600V d.c. minimum.

Operate + bounce time; 2 ms maximum. Release time; 100 μs maximum.

These characteristics conform with the current BPO specification T4547.

Life Performance

A directive[2] based on life-test data stipulates a minimum life under current switching conditions of 10^6 operations at 100 mA to 5×10^7 at 10 mA for inserts used in BPO exchange equipment.

Failure of an insert in service is almost invariably attributable to a contact fault, the contact either failing to open ('sticking') or becoming high resistance.

The necessity for low contact resistance at low working voltages and contact pressures, and the virtual absence of follow-through or wiping action, has led to widespread adoption of gold or gold alloys (particularly with silver or copper) as the plated contact surface. Stringent quality control is essential, particularly on plating thickness and adhesion, if an adequate life performance is to be achieved.

'Sticking' may result from 'pip and crater' defects, due to transfer of material across the contacts on switching d.c., the one or more pips and craters eventually causing mechanical latching. However, sticking has been observed even when no current flows, particularly after long 'make' periods. Possible explanations include that of cold welding, observed to occur with clean gold surfaces under pressure, and the 'wringing' together of flats worn on the solid gold contacts. If these are sufficiently parallel, all gas is excluded, external gas pressure then acting as towards an enclosed vacuum. The resulting force may equal or exceed the restoring force.

Both these effects are lessened by alloying the gold to give a higher surface hardness, or by subsequent heat treatment to diffuse the gold partially into the base nickel-iron. Although the latter technique gives better adhesion and less critical plating, these advantages may be offset by shorter life when switching high voltages or currents, and the earlier onset of gold surface perforation may lead to contact noise and an incidence of pip and crater defects. Considerable study of failure mechanisms is continuing in an effort to provide still better life performance.

Following early circuit life testing within the present Telecommunications Group at Beeston, Liverpool and Taplow, life test equipment has been designed and built by British Telecommunications Research Ltd. This enables 440 inserts to be simultaneously tested, at currents from zero to 100 mA. The equipment will operate at 20 pulses per second; every make and break is monitored and each failure recorded, whilst at every 1,000 operations the pulsing is interrupted to allow the application of a fuller test programme. In addition to development assessment with extended tests to 30 million or more operations, the equipment is used for insert acceptance testing by the BPO. Each batch is sample life tested—100 inserts at zero current, and a further 100 at 100 mA (non-inductive). All samples are tested to one million operations and catastrophic failure of any one insert results in batch rejection.

The Reed Relay

The association of one or more reed inserts with a coil constitutes a reed relay. No core, insulators, armature, springs, or additional contacts are necessary. The following account relates to the standard 4-insert normally-open contact relays of the Pentex system.

A mild-steel screening can is fitted, which combines

[2] P.O.P. Directive No. 2, issued by BPO, April 1965.

its primary function of shielding the assembly from the effects of adjacent relays or transformers with an improvement in relay sensitivity. The coil inductance increases by some 10% when the screen is added, and by over 200% with the addition of four closed inserts.

When two or more inserts are operated by one coil, the closure of the first insert provides a low reluctance path, increasing the operate AT of the remaining insert(s). In a typical case of one relatively high-operate and three low-operate inserts, the operate and release AT of the high-operate insert were recorded as 54 : 20 in an unscreened coil, 48 : 16 with screen fitted, and 62 : 24 with the additional three inserts. These effects result in a much greater spread in the characteristics of completed relays than in the inserts themselves.

The 'insert' and 'relay' ordinates of figure 6 show the present acceptance limits of performance applying in the two cases. A circuit incorporating the relay must, for example, provide at least 88 AT and 50 AT respectively for 'operate' and 'hold' under all conditions. The frequency distribution curves in figure 6 illustrate the normal situation in manufacture where workable tolerances must be allowed, the 'worst-case' or aiding configuration of these leading unavoidably to a percentage of rejects. The curves are for an early experimental batch of inserts and the present frequency distribution is appreciably narrower.

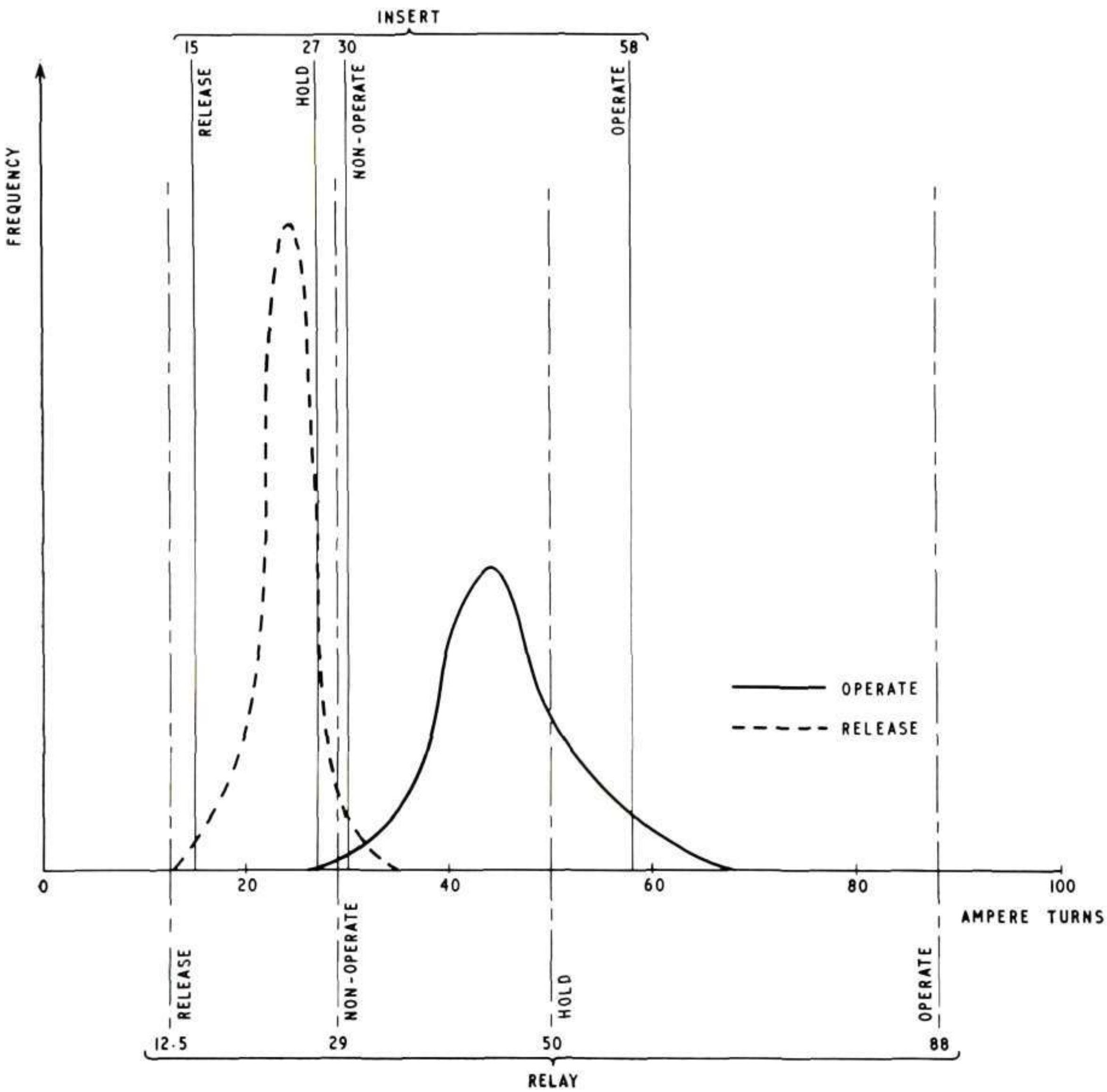


Figure 6—Insert and relay sensitivity limits

Considerable experience in the use of reed relays has been gained in the development of the Pentex system. This system incorporates some 15–20 relays per line, dependent on the designed traffic rate. Of these almost 70% are standard 10,500T 160Ω 4-insert crosspoint relays; the remainder comprises 14 variants, including some 3% of single-insert relays which are carried in standard 4-insert type mountings to simplify chassis design.

Insert operate + bounce time in Pentex relays varies with coil resistance and turns, coil drive voltage, and the external series impedance, but in no case exceeds 3 ms.

Manufacturing Methods

The reed insert, for all its apparent simplicity of design, requires complex manufacturing equipment and a high order of engineering control when it is to be made economically in very large quantities.

The starting point for reed manufacture is nickel-iron alloy wire. This is fed through a wire straightener and into a heavy-duty press, which coins sections of the wire to form reed blades and parts off the wire to produce a complete reed. Very close tolerances have to be maintained since the dimensions of the reed blades determine in part the characteristics of the finished insert. The blades must be as burr-free as possible and have a good surface finish.

The reeds are deburred and polished by tumbling or vibrating with a suitable abrasive medium. Thorough cleaning by a series of washing processes follows this operation. The reeds are then furnaced in a hydrogen atmosphere, the time and temperature requiring careful control. This anneals the reed material and develops the required magnetic properties. The process also assists in decarburising the reeds, reducing surface oxides, and in preparing the surface for subsequent sealing to the glass envelope.

The next operation is gold plating. The reeds are loaded into suitable plating jigs which are passed through a series of tanks to prepare the surface and perform the plating operation. Finally the reeds are washed and dried. Some types of reeds may have a further furnacing to diffuse the gold wholly or partially into the reed material. Alternatively, if a precious metal alloy is required, two platings may be applied sequentially and diffused together by such further heat treatment.

Reeds are now ready for assembly and are stored under vacuum until required.

In parallel with the reed preparation, lead glass tubes will have been cut to the required length and flame-polished at the ends. These tubes are carefully washed, dried and stored in dust-free low-humidity cabinets.

The reeds and glass tube are now assembled to form a complete insert. This operation, technically the most complex, may be performed on manually-controlled single-head assembly machines (figure 7), but for large-scale production, fully automatic assembly machines are used.

The assembly machine illustrated (figure 8) is a design built to our specification in the United States. Additionally the Plessey Special Purpose Machines Department have developed a novel type of machine performing the same functions.

On such automatic machines, reeds and glass tubes are fed into separate vibrating bowls. Attached to the reed bowls are devices for rejecting distorted reeds and for correctly orientating the remainder. The vibratory action of the bowls forces these components along fixed paths to transfer mechanisms, which feed a ring of assembly heads.

Each assembly head has a top and bottom chuck into each of which a reed is fed. A glass tube is similarly fed on to a central clamp between the two chucks, after which the chucks are moved together to give the correct reed overlap inside the glass tube. To ensure parallelism of the reed blades, one of the reeds is released from its chuck jaws and held in contact with the second reed by a magnetic circuit. While the reed is maintained in this 'floating' position, the glass tube is sealed to it by means of radiant heat from a platinum-rhodium heating coil. During this operation the assembly is flushed through and finally filled with a nitrogen/hydrogen mixture which has been carefully filtered and dried before introduction into the assembly head.

When the first seal has been completed, the seal to the second reed is made by a further heating coil. During this operation the two reeds are 'gapped'—that is, the reed being sealed is moved a precise distance away from the first reed to set the operate value of the insert.

After the seals have cooled, the complete assembly is transferred from the assembly head to a test head, where its main characteristics are measured. Information is fed back from the test head to the gap-setting mechanism of the head on which the assembly was made, and a correction to the gap of the next assembly to be made on this head is applied when necessary. Thus the machine is truly automated. The gap setting adjustment is very sensitive and corrects in steps of ·0002 in. (·005 mm).

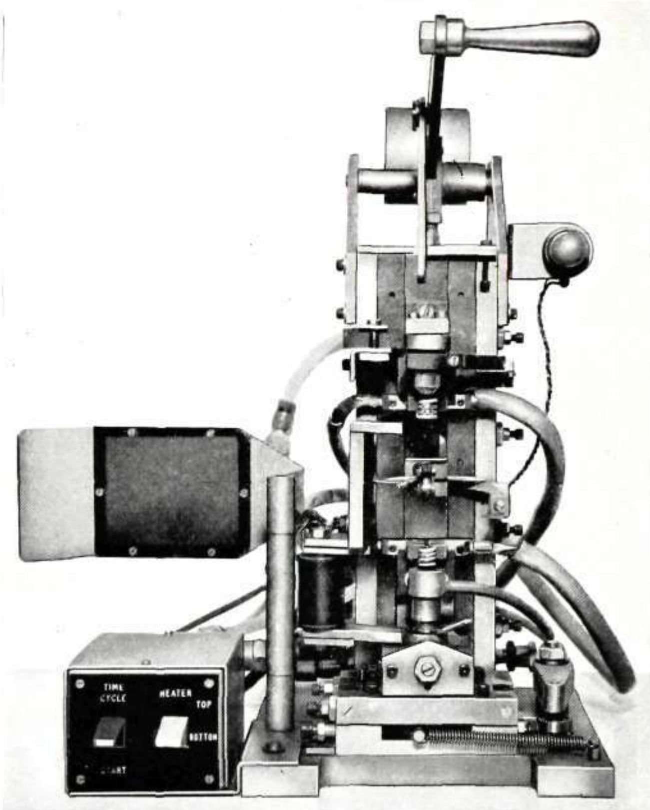


Figure 7—Single-head reed insert assembly machine

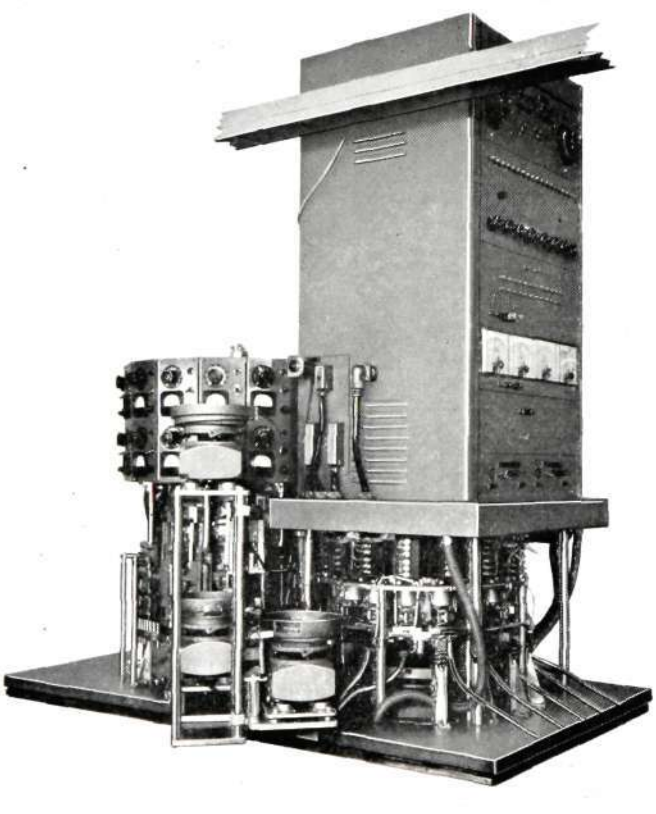


Figure 8—Multi-head reed insert assembly machine

The whole assembly operation is conducted in very clean conditions since contamination in the sealed reed insert may affect life performance.

The assemblies are now transferred from the test heads of the assembly machine to a tinning machine, which automatically prepares the external lead wires, applies a solder coating and washes and dries the inserts. The completed reed inserts then receive a comprehensive series of electrical, mechanical and visual tests. Samples are drawn for quality control investigations, and further samples are life tested before releasing the batch. The inserts are code marked and placed in primary packs for feeding to relay assembly.

Relay assembly is relatively straightforward (see figure 9). A two-piece moulded glass-nylon bobbin is produced,[3] one or more coils being wound on the assembled bobbin using conventional single station or multi-head coil winding machines. A separate sub-assembly consisting of a tag strip and four inserts is jigged and soldered. The free ends of the reed inserts are fed through the bobbin and soldered to a second tag strip which has been press fitted to the bobbin cheek. The mild-steel screening can is now fitted over the whole assembly and locked to the bobbin cheeks, after which the relay is given a series of electrical tests and code marked.

Precautions in Use

Although the reed insert is extremely reliable when correctly used, it is essential that the user be fully aware of the nature of the component if full benefit is to be gained from its potential performance. Incorrect handling and application can give rise to erratic performance and a short working life.

When operating a relay the following points should be observed:—

(*a*) The coil ampere turns must not be excessive. With the insert described in this article, energizations greater than 250 AT will increase bounce time markedly and may cause permanent changes in characteristics.

(*b*) In multi-insert relays the closure of the first contact will affect the flux available to the remainder. Thus the operate times and AT will exceed those for a single-insert relay.

[3] 'Glass nylon coil formers', *Bulletin No. 51*, July 1965.

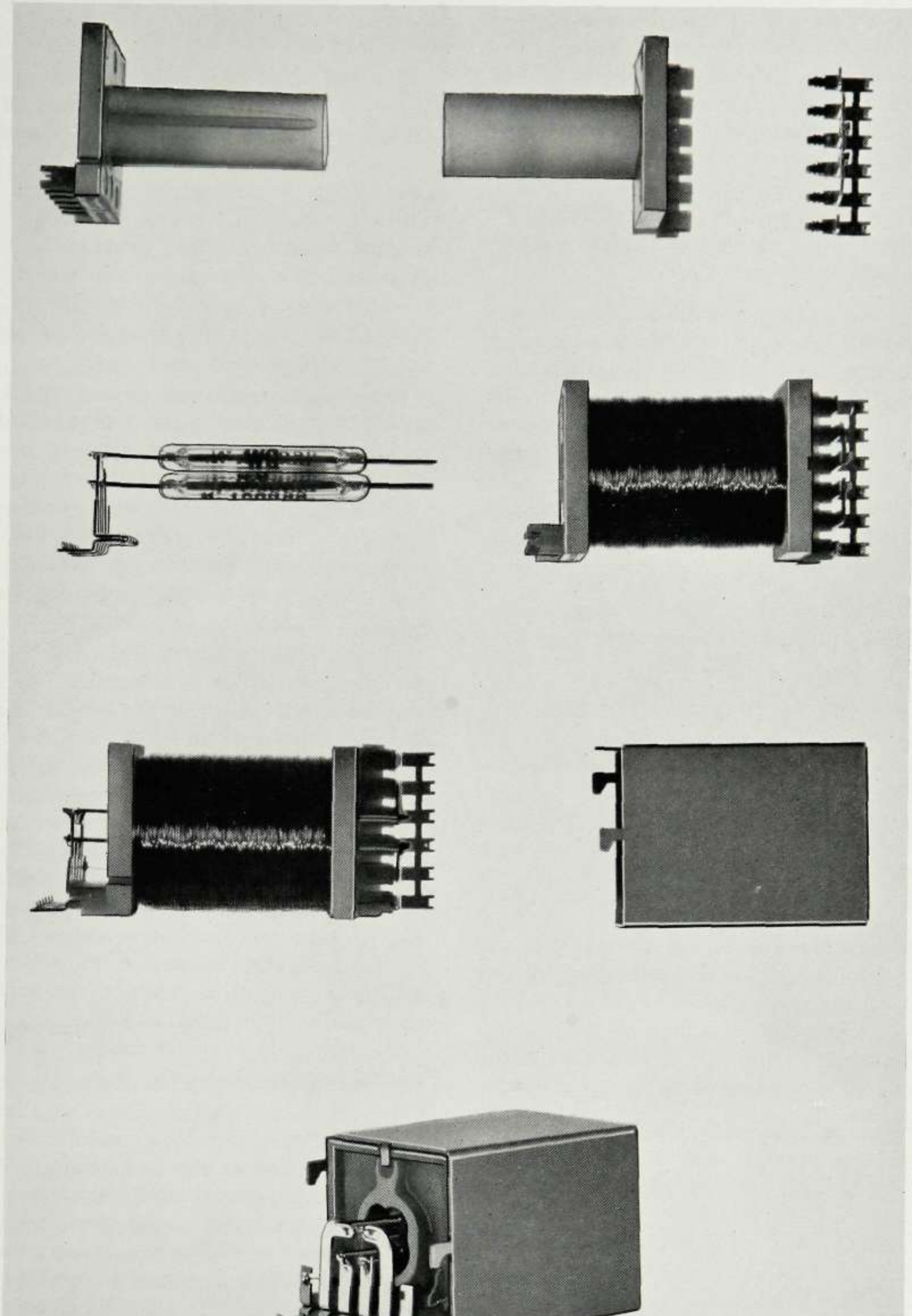


Figure 9 – Four-insert reed relay

(*c*) To obtain maximum life performance, it is essential that switching surges due to reactive loads should be quenched. This quenching is normally obtained by either a non-linear resistor or a diode across the load. The addition of these components materially affects the insert release time; a typical relay gives release times of about 70 μs unquenched, 140 μs with a non-linear resistor, and 1·2 ms with a diode. Again for reasons of maximum life, current surges must be limited if filamentary lamps are switched.

(*d*) The reed insert may be mounted in any position, but care should be taken to ensure adequate shielding from adjacent magnetic fields or ferromagnetic materials. The insert may be supported by either lead wires or glass, but precautions must be taken to avoid applying strains to the glass, particularly in the vicinity of the seals. Further, the bounce characteristics may be affected by different methods of support.

(*e*) Encapsulation of the insert is allowable, but the encapsulating medium must be adequately plasticised.

(*f*) Care should be exercised in the handling of the lead wires: if the wires are bent near the seal, glass fracture may result. It is desirable to solder only the end $\frac{1}{8}$ in. (3·2 mm) of the lead remote from the seal to avoid thermal shock. The magnetic circuit is affected if the leads are clipped or bent appreciably, causing changes in both operate and release AT.

General handling of the inserts requires some care. Although they will withstand reasonable shock and vibration, a fall of a foot or more on to a hard surfaced bench can affect the characteristics without any apparent damage. Damage to the tag strips of the completed relay can in turn damage the reed inserts.

Environmental conditions in which the reed insert will operate satisfactorily have a wide range. A temperature range of —50°C to 55°C can be tolerated. Under conditions of low pressure, high humidity or corrosive atmospheres, it is likely that limitations will be set by the relay coil rather than the insert. Reed inserts can be silicone coated to improve surface leakage resistance in conditions of high humidity.

In general, the measures to be taken are only those dictated by common sense. Provided these practices are followed, the full benefits of the care taken in design and manufacture will be obtained.

Applications

The reed insert has a wide range of applications. It may be operated by a suitable permanent magnet equally as by a current-carrying coil. Commercially it is widely used in such applications as switching lights in refrigerators or operating burglar alarms, where the opening of a door or window moves a magnet towards or away from a reed insert. However, it is in the telecommunications field where the greatest use is envisaged, the expected primary applications being in cross-point and logic switching circuits in telephone exchanges.

In cross-point applications the reed relay acts as the switching element in conjunction with solid state circuits. The insert characteristics of low contact resistance, complete isolation between relay coil and contacts, and extremely high off on resistance ratios (better than 5×10^9) make such a combination technically preferable to all-solid-state circuits.

The virtue of the relay is further enhanced by its suitability for use in logic switching work, where the stability of insert characteristics permits exploitation of flux sum-and-difference techniques. Of these, the simplest involves the use of two coils surrounding an insert. For example, an AND function is obtained if the combined fluxes of both coils will operate the insert, but neither flux alone is sufficient. In this case it may further be arranged that current through one coil alone will hold the contacts closed (a latching relay). Where either coil is capable of operating the insert, a simple OR function is obtained. An EXCLUSIVE OR function is achieved where the two coil fluxes are in opposition; either coil energized individually will operate the insert, but simultaneous energization results in flux cancellation.

In certain of these applications, a permanent magnet may replace one of the coils.

Conclusion

The versatility of the reed insert is becoming increasingly recognized and further types are being developed in the Telecommunications Group to widen its application in telecommunications. Such types are likely to include large varieties capable of heavier duty operation, changeover inserts to simplify logic circuit work, and mercury-wetted inserts where very low contact resistance and bounce-free operation is desirable.

British Patents Nos. 1,015,249; 49131/63 and corresponding foreign patents

U.D.C.621.395.34

Extensible Unit Type Exchanges

A. Foster—Circuit Development, Engineering Department

Experience has shown the need to increase the range of extensible unit-type exchange equipment to cater for larger exchanges, and the following article describes two such developments, namely, the ET.100 and its equivalent for use on the North American Continent, the Community Dial Office (C.D.O.).

IN the past various designs of extensible unit-type equipment have evolved for the smaller exchanges, outstanding among these being Rurax, with its facility for economic extension up to 400 lines and beyond this if necessary. Generally, however, exchanges exceeding this capacity have been largely met by custom-built designs. These have been based on large-exchange practice, requiring many different types of rack, each serving a particular category of equipment. Although economical and practical for the largest exchanges, this procedure can prove costly when applied to small and medium-size installations and lead to considerable waste of space because many of the racks may be only partially equipped. Moreover, large-exchange practice entails more fitting and wiring on site than is desirable for locations which are frequently remote from a resident installing force.

To overcome these problems, new extensible exchanges have been developed with switching equipment for 100 lines mounted and wired on an enclosed double-sided rack. A single unit, with accompanying MDF and power plant, comprise all that is needed for a small exchange, and this can readily be increased to a larger exchange simply by adding the required number of similar units.

Compared with conventional exchanges in the same capacity range, the new designs are not only more economical of cost and floor space, easier to install and extend, but more flexible in application owing to their use of standard units. These may be held in reserve by an administration and used to provide automatic service on demand, thus eliminating the need for long-term forecasting of service requirements.

The ET.100

This new exchange derives its name from the fact that it is of the extensible type and has equipment for 100 lines as a basic unit. Although having no theoretical limit in ultimate capacity, the equipment is designed for economical expansion to approximately 2000 lines. The exchange may be used as a terminal exchange, or function in conjunction with a sleeve control manual board as a group centre exchange. In either role the exchange may be incorporated in an STD network and also used to extend existing networks where step-by-step exchanges already form the basis of the country's telecommunications system.

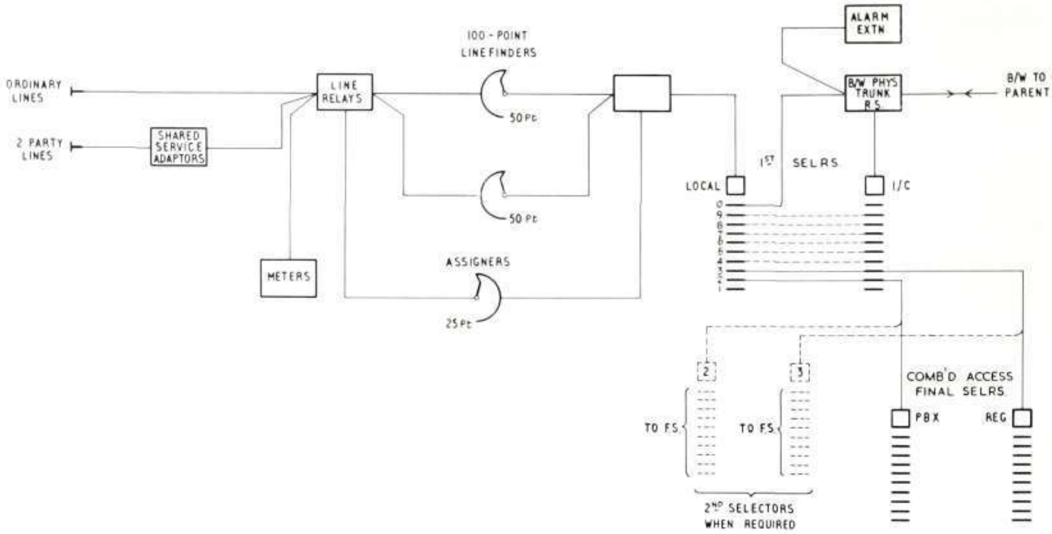
The basic switching equipment consists of heavy-duty uniselectors and either 2000- or 4000-type two-motion selectors. Because the design is for 100-line units the selectors are of the 100-outlet type.

Circuit Outline

As with most unit-type exchanges, a linefinder scheme is employed. For simplicity of maintenance and maximum reliability each linefinder utilizes two 50-point heavy-duty uniselectors.

The allocation of a linefinder to a calling line is controlled by an assigner (allotter) and there are two of these, odd and even, per linefinder group. Each of the two assigners controls half the quantity of linefinders and normally deals with calls from a sub group of 50 lines, but either assigner, under fault or congestion conditions, can control calls from the whole 100-line group.

To show the value of this arrangement, assume a fault in the odd assigner or an associated linefinder. After a period of 5 to 10 seconds the even assigner and associated linefinders take over the call and all subsequent calls for the whole group, the odd assigner being locked out and a deferred alarm given. In these circumstances, if a fault occurs in the even assigner, the odd assigner is unlocked and returned to service and the alarm indication changes to prompt. If congestion occurs in one assigner group while the other is locked out to a fault, the second assigner is returned to service as before, but the previous alarm indication, prompt or deferred, persists even if both assigners now function correctly. Because it is most likely that the fault causing an assigner changeover is either of a fleeting nature or only applicable to one particular linefinder in the group, this repetitive



Typical trunking arrangements

changeover ensures that the grade of service is not unnecessarily reduced.

If all linefinders of a sub-group are engaged, further calls from that sub-group are handled by the other assigner and linefinders without delay, until the congestion is relieved. This arrangement permits traffic to be regarded as originating from groups of 100 lines.

All subscriber line circuits have a lock-out feature. If a call is forced released from the group-selector stage under line fault conditions, or because of delay in dialling, the line circuit is locked out under control of the line fault or calling loop. When the condition is removed, the line circuit is restored to normal. The line lockout is a most important feature in this class of exchange, which may often be unattended; without it, line faults or subscribers leaving their handsets off would occupy switching equipment and could cause a serious degradation of service to other subscribers. When a line is in the lockout state, a visual alarm is given on the appropriate unit.

Lines can be connected for coin-box service in any linefinder group and the necessary discriminating condition controlled by the addition of a local strap. By this means any line can be strapped as a coinbox line, and separate groups are not required.

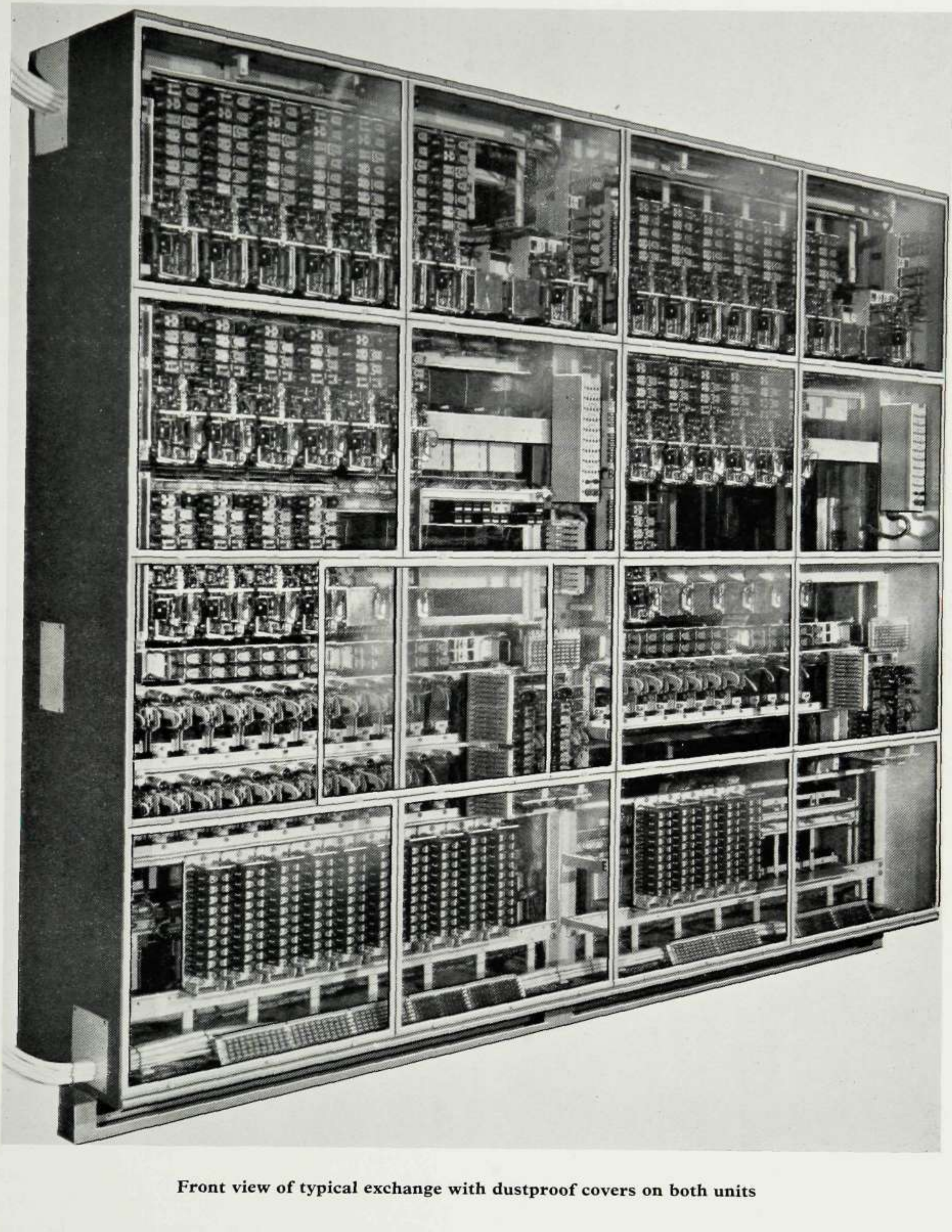
Local first selectors are directly connected to linefinders. The selectors are 100 outlet (i.e. 10 levels of 10 contacts) and fitted with the forced release facility described above, this becoming effective after a delay period of 3 to 6 minutes.

Incoming selectors are directly associated with incoming or bothway junction circuits to ensure no-delay dialling on incoming calls. Forced release is not provided on these selectors but an alarm to indicate a permanent seizure is given.

With terminal or end exchanges, second-group selectors will be required for exchanges of 700 or 800 lines or more; for group-centre exchanges this requirement will be necessary at an earlier stage depending upon the number of junction routes.

The 100-outlet final selectors may be either regular finals, suitable for connection to single- and two-party lines, or PBX finals for connection to single-, two-party and PBX groups of up to 10 consecutive lines. All final selectors can provide a meter pulse on answer and provision is made for either forced release or an alarm after 3 to 6 minutes under 'called-subscriber-held' conditions.

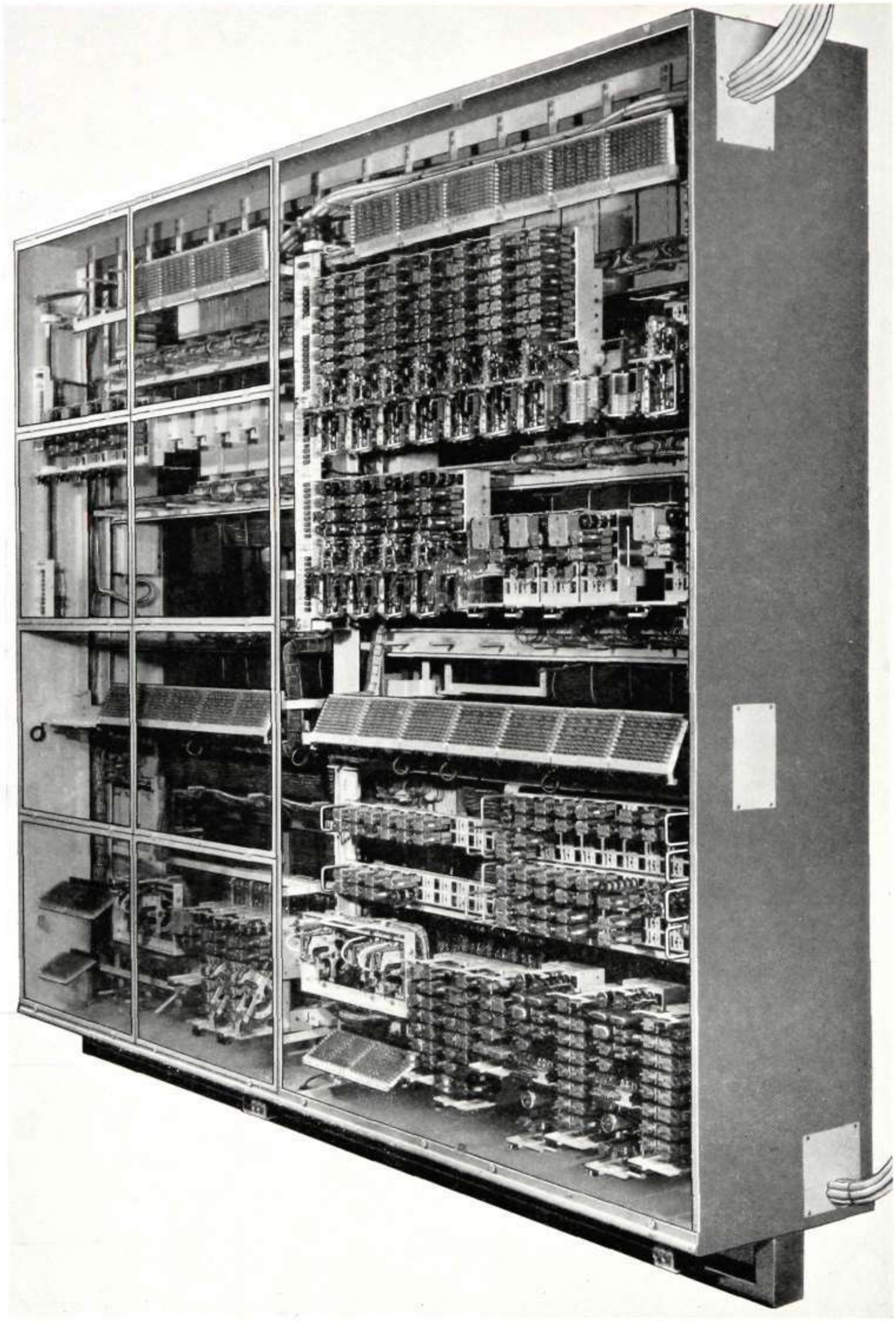
Junction and trunk circuits are provided for single or bothway working, the most economical arrangement being single-way junctions for the earlier choices and bothway junctions for late choices. Operation may be over physical wires, line and radio carrier or rural carrier. Outgoing and bothway circuits have access points incorporated so that auxiliary circuits can be added to provide multi-metering or periodic metering facilities for use in STD networks. Where the ET.100 is used as an end or terminal exchange, the cost of this additional equipment can often be avoided by providing metering back over junctions, i.e. the meter pulse rate is determined at the group exchange and each periodic pulse is transmitted back



Front view of typical exchange with dustproof covers on both units

to and detected by the end exchange in an inaudible manner. Positive-battery metering is employed, the positive-battery supply being derived from the exchange battery via a d.c./d.c. converter using transistors.

Transistor-type generators provide the continuous ringing and tone supplies, the necessary periodicities being obtained by an all-relay interrupter circuit. This important equipment is extremely reliable but, even so, because it is the only common equipment



Rear view with dustproof covers removed from one unit

upon which the successful operation of the exchange switching depends, it is duplicated and an automatic changeover is provided for use in the event of a ringing or basic pulse failure. Changeover can also be done manually, or by a maintenance engineer or parent-exchange operator dialling a specified digit or digits.

Normal visual and audible alarm arrangements give indication of deferred and prompt alarms. An alarm checking circuit is also included which, when a specified digit or digits are dialled, provides the caller with a tone indication of any alarm operative.

Sleeve-control manual switchboards, providing all normal operator and trunk switching services, can be associated with the automatic switching equipment.

For areas where the national numbering plan makes it necessary to interconnect a number of exchanges within a common numbering scheme, the ET.100 has also been designed for use as a discriminating-satellite exchange. This is achieved by using the same basic switching equipment but with slightly modified trunking arrangements.

Other services which can be incorporated in the ET.100 include: line testing, trunk offering, shared service, malicious call trap, alarm extension, traffic recording, and long-line repeater working.

Operating Data

The nominal exchange battery supply is 50 volts, although the equipment is designed to operate between 46 and 52 volts.

At 50 volts the maximum subscriber's line loop resistance is 1500 ohms including the telephone instrument. The minimum insulation resistance is 12,000 ohms between the legs of the line or between either leg and earth.

The maximum loop resistance and minimum leak resistance allowed on physical junction lines depend upon the type of operation required and upon conditions presented by the distant exchange equipment, but there is usually no difficulty in meeting requirements.

The free condition of a circuit is indicated by the presence of a negative potential on the testing-in wire and a hunting selector cannot test-in to a disconnection.

Each fully equipped unit can carry originating traffic of ·06 e and terminating traffic of ·067 e per subscriber. The originating traffic is based on conditions where the number of calls on which dial tone is delayed more than 3 seconds does not exceed 1·5%. The terminating traffic is calculated at a grade of service of one lost call in fifty, allowing one final selector position for trunk offer and testing. Experience has shown that this traffic-carrying capacity will meet the majority of demands but, of course, for higher traffic requirements, less than the full capacity of subscribers' lines would be connected to each unit.

Equipment Details

From the equipment point of view, the increasing demand for automatic telephone exchanges, particularly in outlying areas, has brought its own special problems, not least of these being the difficulty of allocating building and floor space to accommodate the equipment.

The use of unit-type exchanges helps to ease this problem because the number of racks is kept to a minimum by ensuring the maximum use of rack space. The ET.100 affords further space economies by having equipment mounted on each side of the rack. In designing this double-sided unit, particular attention has been paid to the accessibility of equipment for maintenance purposes; where necessary hinged mountings are used.

The detrimental effect of various forms of dust deposits on delicate electrical and mechanical apparatus is widely recognized and in recent years much work has been done to find effective and economical means of combating this problem. This work has resulted in the introduction of dust-proofing for complete racks and the principle has been applied to the ET.100. The units are completely enclosed with transparent plastic panels front and rear. These are held in position magnetically, and allow observation of the equipment while excluding dust. To this end the normal individual relay set and selector dust covers are not fitted. The panels are of a convenient size for handling, and allow maintenance to be carried out by exposing only a small area of the unit. An article on this subject appears in Bulletin 44, January 1962.

To gain the fullest possible advantage from the dustproofing feature, all connection strips on which jumpers or grading straps may need to be periodically re-arranged, are concentrated in a separate compartment at the top of the unit. This prevents the entry of dust and solder into the switching section while such work is being carried out. For a similar reason, battery jacks, isolation jacks for tones, etc., are mounted external to the dust proofing. When necessary, jacks giving access to the switches for testing purposes can also be provided external to the dustproofing.

The compact design of the equipment helps to restrict cabling to the minimum, because many of the connections which are normally cabled can be done by strapping and jumpering within the units.

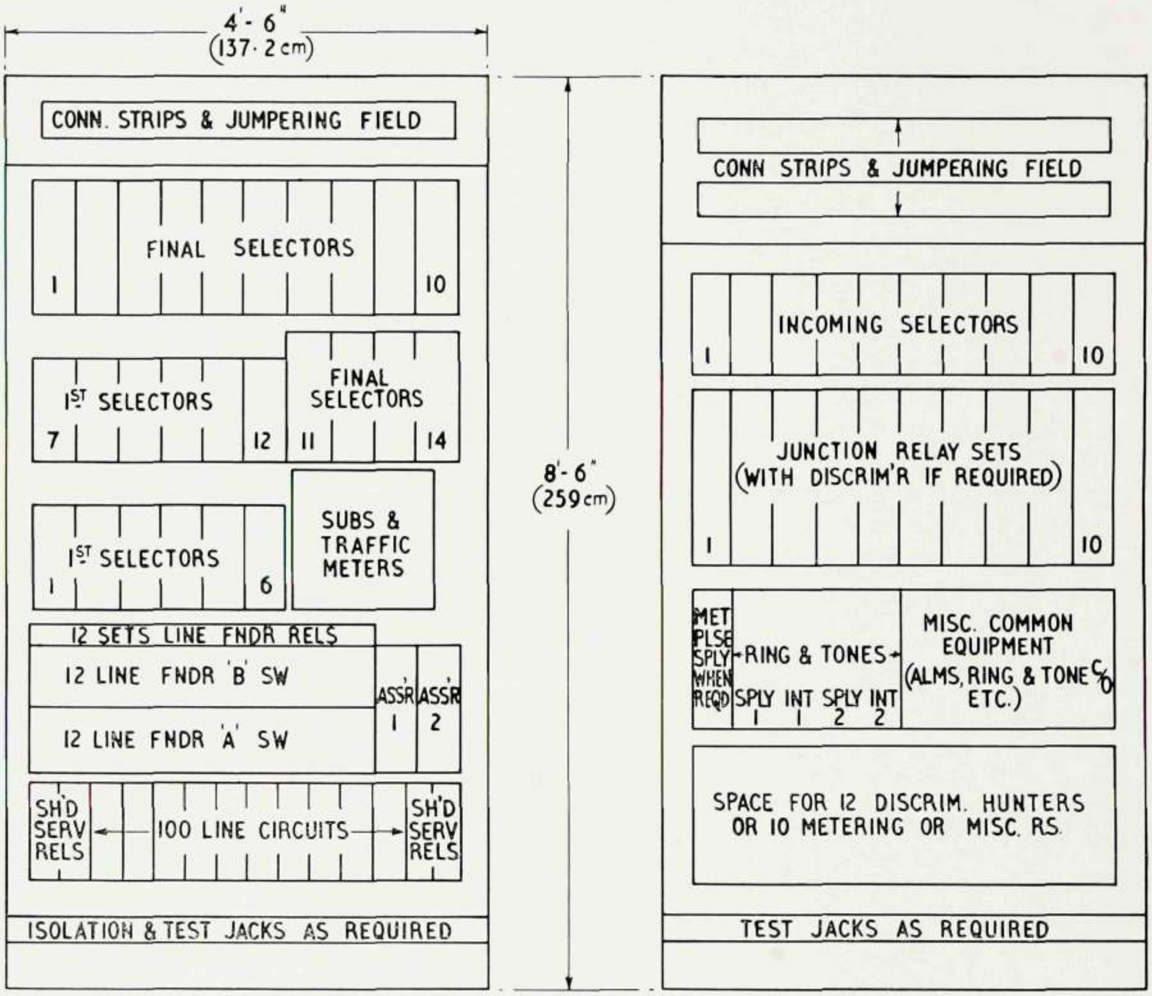
Connection strips are provided at the top of each unit, allowing interchange between line circuits and final selector multiple for distribution of traffic load. This interchange can be made by jumpering between units within the same suite. Similarly, where grading of selector levels is required, this is conveniently carried out by strapping on connection strips at the rear of the units.

All cabling between units in the same suite is enclosed within the units, the multiple cables being factory formed.

The above features have the effect of minimizing the amount of open-cable runway, providing considerable cabling economies, simplifying installation and giving the equipment an extremely neat appearance. This latter feature is further enhanced by an external opaline green enamel finish, and cream-coloured interior, the high light reflection of the latter being of special value in aiding the maintenance engineer. All equipment has a high-quality finish designed to withstand the adverse climatic conditions likely to be encountered in tropical areas.

In exchanges of more than 100 lines, much of the equipment on the rear of the first unit does not need to be repeated on subsequent units (e.g., ringing, tone and alarm equipment). This allows additional space for special facilities and for ranks of second selectors if these become necessary.

The dimensions and equipment layout of a unit are shown in the diagram.



Front of Unit **Rear of Unit**

Equipment layout and dimensions of ET 100 unit

THE C.D.O.

The Community Dial Office used on the North American continent requires slightly different facilities from the ET.100 but the basic unit design remains very similar, one exception being the height of the rack, which is only 7 ft. 6 in. (2·3 m).

Facilities required by the C.D.O. include multi-party line working and, for operation with the nationwide operator and customer toll dialling plan (D.D.D.), 7 number operation, interception of vacant levels and terminals, standard tones, etc.

Each subscriber, including multi-party-line subscribers, must be allocated a 7 digit number. This is made up of 3 digits for office code, and 4 digits for the local number but, in order to complete a local call, it must be possible to dial all 7 digits.

Special digit-absorbing first selectors and incoming selectors are employed to provide this facility and therefore the 2000-type switch option is not available for the C.D.O. The design of the digit-absorbing selectors is such that no limitations are placed on the numbering scheme other than those imposed by the office code and any other standard codes. Selectors provide the following standard digit-absorbing features:—

(*a*) Cut-in and trunk hunt on a single digit.

(*b*) Block specified levels and return All Paths Busy Tone before an absorb-once-only level has been dialled.

(*c*) Absorb repeatedly on a level or levels until an absorb-once-only level has been dialled.

(*d*) Absorb once only on a specified level or levels and all cut-in and trunk hunting on the following digit on all levels.

Additionally, special dual marking arrangements are incorporated which allow transfer of the marking of a level after the digit appropriate to this level has been absorbed, so allowing greater freedom of choice of office code and local numbers. Dual markings are: absorb repeatedly/absorb once only; absorb repeatedly/search.

As an example of the use of this facility assume an office code 253. If level 2 has dual marking absorb repeatedly/absorb once only, then the local number can also commence with digit 2. Level 2 is dialled as the first digit of the office code, the digit is absorbed, and when the selector is normal, marking is changed to 'absorb once only'. Levels 5 and 3 are marked 'absorb repeatedly'. When digit 2 is dialled as the fourth digit of the seven digit number, it is absorbed and all levels are unblocked.

Each party on a multi-party line requires a final selector number and therefore it is necessary to have more final selector numbers than line circuits. Moreover, multi-party lines require the use of final selectors designed to provide code ringing, etc. Therefore, in addition to regular and PBX final selectors, the C.D.O. also has multi-party final selectors available which, in addition to code ringing, include a facility whereby revertive calls (i.e. calls between subscribers on the same party line) are obtained by dialling the directory number of the required subscriber.

The first unit of an office can have two final selector groups, thus making it possible to have 200 terminals on the 100-line unit. The number of terminals on subsequent units can be increased because an additional final selector group can be mounted in place of certain common equipment required only on the first unit.

Should the proportion of terminal numbers to lines be high, it may be necessary to provide additional final selector groups on an auxiliary unit of the same size and design as the line units.

Conclusion

The above designs are good examples of the intensive effort devoted to the improvement of customer service by the exploitation of established switching principles, backed by high-quality apparatus and the latest manufacturing techniques. Their flexibility of use, range of services, economy, reliable performance and ease of installation will undoubtedly meet all present-day requirements of small progressive communities.

U.D.C.621.395.6 : 621.395.631.3

Pressetel

J. Bird and D. C. Emmonds—Circuit Laboratory, Engineering Department

This pressbutton telephone will work to any loop/disconnect system capable of operation by the conventional dial, and can also be adapted to systems permitting much higher digit signalling rates than are mechanically possible using the dial. No exchange modification is necessary—Pressetel is the simpler of two possible design approaches fulfilling this requirement, and is thus most economic for general subscriber use.

PRESSBUTTON signalling is being introduced into telephone systems to enable the subscriber to save time in the setting up of calls. In practice this saving is more than that conferred by increased signalling speed alone; with the ability to deal with the digit sequence more quickly there is less strain on the short-term memory performance of the subscriber. Wrong numbers due to subscriber-error—a major source of lost time when they occur—are therefore less likely. A parallel improvement is the lessened preoccupation with the *mechanics* of signalling, as compared with use of a dial. Simple layout of the pressbuttons, larger digit areas and the absence of distracting movement are factors contributing to this.

In the provision of pressbutton facilities there are two main approaches. The first is in the type of instrument which permits the user to operate the pressbuttons at speeds as fast as his physical capabilities allow. A multiple store is necessary to enable the digital information to be re-transmitted to line at the rate required by the exchange equipment. Such a store with its associated sequencing elements is necessarily complex and, at the present state of manufacturing technique and component costs, an instrument of this type will be too expensive for some subscribers.

The second approach is represented by a simple and more economic type of instrument, using a single digit store. Successive digits can be keyed into this store at a rate governed by the requirements of the exchange. The information corresponding to each digit is converted into line pulses and, when these have been transmitted, the next digit may be keyed in. The function is analogous to that of the conventional dial, but electronic techniques permit a keying rate to be achieved which is the actual maximum the exchange will accept; certain features of dial operation preclude this possibility.

The principle of single-digit storage is used in the Pressetel, which is primarily designed to replace the dial instrument; its output is of loop/disconnect form and it will work to any exchange accepting this form of signalling via the normal 2-wire line connection. Although such exchanges will usually be of Strowger type, the output pulsing speed is widely adjustable to cater for other systems. The design is in fact adaptable to pulsing speeds and corresponding digit signalling rates which exceed the subscriber's fastest keying capabilities, and make it comparable, as regards facilities, with the more complex instrument discussed above.

A principal operating feature of Pressetel is that keying of a digit into the store can take place during the interdigital pause period. To permit the user to take full advantage of this facility and so achieve maximum signalling rate, a 'signal barred' lamp is extinguished at the end of pulsing.

The interdigital pauses are the minimum necessary for correct functioning of the exchange equipment, whereas with a conventional dial, the user's reaction and operating times are both added to the basic interval provided by the mechanism, and the effective inter-digital pause is substantially longer than the minimum. Pressetel moreover eliminates the superfluous pause before the first digit, an unavoidable feature of dial operation.

To supplement the safeguard afforded by the 'signal barred' lamp indication, it is arranged that the press-buttons are ineffective whilst this lamp is lit. It is impossible therefore to mutilate a digit by operating the next button prematurely.

Outline of Logic

The logic is confined to that necessary for the storage and pulsing out of one digit at a time and, in consequence, the circuitry is relatively simple.

To summarize the operation; information corresponding to the required digit is 'written in' to the store when a button is pressed. The store is set to the empty or 'home' condition on lifting the handset and also after each digit has been pulsed out.

When a digit is stored, a gate controlled by the store is closed and a switching circuit associated with the gate removes an inhibit condition from the pulsing device, an astable multivibrator. This free-runs, pulsing an 'A' relay to transmit pulse signals to line. The multivibrator also feeds pulses at the same rate back to the store which counts down to the 'home' condition. This is reached when the number of pulses transmitted is numerically equal to the digit stored. The gate controlled by the store now opens and re-imposes the inhibit condition on the multivibrator.

During pulsing, off-normal relays are operated by the switching circuit associated with the gate. One of these (ONA) causes the 'Signal Barred' lamp to glow.

At the end of each pulse train a timing device, the Inter Digital Pause (IDP) Generator, is operated to place a second inhibit condition on the multivibrator, independent of that from the store-controlled gate. Therefore, although the next digit may be stored at any time after the end of pulsing, the multivibrator will not free run until the IDP inhibit is removed. A fixed minimum delay is thus obtained between the pulse trains.

Store

The store consists of a chain of four complemented bistables of the type shown in figure 1, these being interconnected in the manner indicated to form a binary counter. Conventionally, a bistable is said to be in the '0' state when X1 is 'on' (conducting) and X2 'off', and in the '1' state when the reverse situation applies.

Considering the bistable in figure 1 as the first in the chain, the waveform from the multivibrator is fed in at point A. This waveform is differentiated to produce positive and negative pulses which are applied to the junction of diodes D1, D2 and D3. Only the positive pulses are effective because of diode blocking action. There is one such effective pulse, termed an input pulse, per line pulse.

Each input pulse is steered by D1 or D2 to the collector of whichever transistor happens to be 'off', causing this transistor to be turned 'on' and the bistable to change state from '0' to '1' or from '1' to '0'.

It will be seen that transistor X1 goes from an 'off' to an 'on' condition with alternate changes of state. The resultant positive-going potential step at X1 collector is fed to point A of bistable No. 2. This bistable thus changes state upon every second input pulse to the store. Similarly bistable No. 3 changes state upon every fourth pulse and bistable No. 4 changes state upon every eighth pulse.

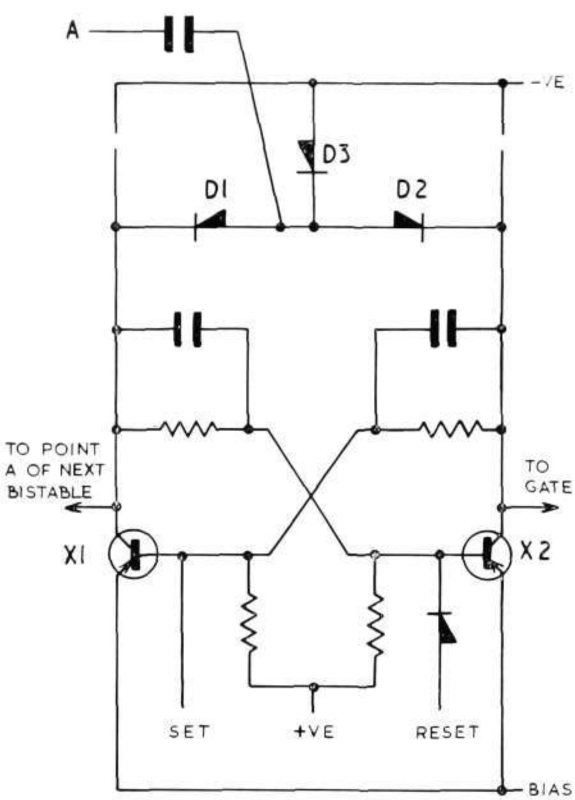


Figure 1—The basic bistable circuit

If the store were initially reset to the '0000' (home) condition, it would reach a '1111' state on the 15th pulse and revert to the '0000' state on the 16th. Each intermediate state is unique, i.e. involving a different combination of '1''s and '0''s from any other.

The most convenient way to store a digit 'x' is to set the store to the state it would have reached if (16–x) pulses had been fed in. Then 'x' actual pulses will return it to the '0000' or 'home' condition. This method of storage is adopted in Pressetel. To control the multivibrator the gate associated with the store need only distinguish between the '0000' state and any other; a relatively simple requirement.

Gate

The gate is the AND device shown in figure 2. The negative leads of the four diodes are taken to the collectors of the right-hand transistors X2 (figure 1) in the bistables.

When the store is in the home condition all of these transistors are 'off' and a negative output is provided from the gate to the transistor switch. This switch is as a result 'on', which causes the control transistor to be switched 'off' and the multivibrator to be prevented from free running; the 'A' relay is held operated.

When a digit is stored, i.e. one or more bistables are in the '1' state, the diodes associated with these

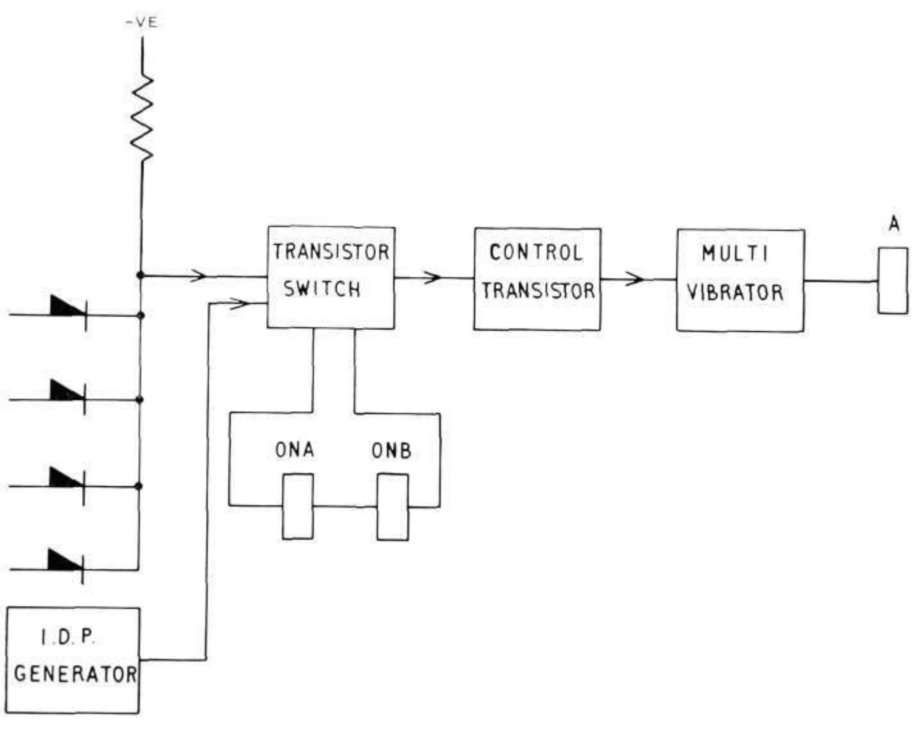


Figure 2—Simplified pulsing control circuit

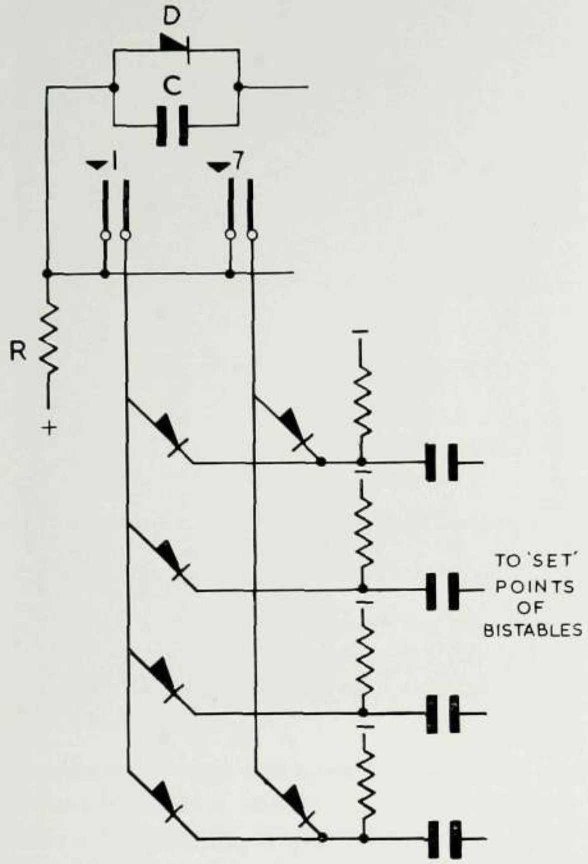


Figure 3—Write-in circuit showing diode matrices for digits 1 and 7

bistables conduct more heavily and the gate output potential is now such as to turn the transistor switch 'off', provided that no inhibit is being applied by the IDP generator. The control transistor is accordingly switched 'on', and the multivibrator free-runs.

Interdigital Pause

Whatever the digit stored, bistable No. 4 changes state from a '1' to a '0' condition once only during emptying of the store, that is, at the conclusion of pulsing.

This event is used to initiate the IDP. A pulse developed by the bistable triggers the IDP generator, which is a monostable multivibrator, to the quasistable state. This state, of duration equal to the required IDP, is marked by a reversal of conditions in the monostable; the normally 'off' transistor is 'on' and the normally 'on' transistor 'off'. The resulting output potential from the collector of the latter is applied to the transistor switch (figure 2). Its effect is to override the control exercised on this switch by the gate. Thus, irrespective of whether a new digit has been stored or not, the multivibrator cannot free-run until the IDP has expired.

Pressbutton Circuitry

As already implied, the function of the pressbutton contacts is to set selected bistables in the store to the '1' state, the configuration being appropriate to the digit required. That for digit 7, for instance, would be obtained by expressing (16–7) = 9 in binary form, i.e. 1001; to store this digit, therefore, bistables Nos. 1 and 4 are set to the '1' state.

Setting a given bistable requires the application of a positive pulse on the 'set' lead (figure 1) thus switching the left-hand transistor 'off' and the right-hand transistor 'on'.

Figure 3 shows the pressbutton contacts and associated circuitry for the digits 1 and 7. The diode matrix is a simple and reliable means of deriving a number of effective make contact actions (in this case a maximum of four) from the single pair of contacts associated with a given pressbutton.

Prevention of Mutilated Digits

The common supply lead to the pressbuttons, which requires a potential at or near supply positive for the pressbuttons to be effective, is returned to a point in the circuit of the transistor switch (figure 2). This point is in the effective potential range only when the switch is 'on', i.e. the multivibrator is not running. Therefore, if a button is operated prematurely, there will be no effect on the digit being pulsed out.

The effect of any contact bounce in the pressbutton springsets is masked by components C, R and D (figure 3).

Ancillary Functions

A second off-normal relay (ONB) operates in series with ONA during pulsing out. Contacts of this relay short circuit the telephone transmission elements to establish a metallic 'dialling' loop during pulsing out and to prevent acoustic shocks in the receiver.

A 'reset' relay (not shown) operates during the charging time of a capacitor upon power being applied to the circuit by handset removal. Contacts of this relay momentarily connect the 'reset' points of the bistables (figure 1) to supply positive, ensuring that the store is in the home state and ready for insertion of the first digit.

Pulsing Speed and Ratio

Preset adjustments in the multivibrator circuit allow for make and break times to be varied independently, giving pulse speeds from less than 10 pps to more than 20 pps, with make:break ratios between 30%:70% and 40%:60% at any speed within this range.

The above adjustments will cater for all normal Strowger and crossbar exchange systems. For exchanges requiring faster operation the pulse speed, pulse ratio and IDP would be modified accordingly.

Construction

The basis of construction is the Etelphone with a modified layout of transmission components and ringer, and a steel baseplate in place of the normal high-impact plastic. Figure 4 is a general view of the instrument with cover removed.

The majority of the logic-circuit components are assembled on two printed cards seen parallel to the base of the instrument and towards the front. The lower card is secured by screws to the baseplate and the upper card, which carries the two preset controls for make/break time adjustment, similarly affixed to brackets projecting downwards from the pressbutton assembly. The latter can be readily detached by withdrawing screws securing it to the baseplate and instrument bracket, and the whole assembly swings aside to allow either the upper or lower card to be inspected or, if necessary, removed.

A third, smaller card is mounted immediately under the pressbutton set and in a plane parallel to it. This card carries the matrix diodes and associated components and, like the other cards, may be inspected or removed by detaching the pressbutton set from the instrument.

The remaining components associated with the logic circuits are the four relays and the 'signal barred' lamp, the latter being visible in figure 4. The relays, of a recently developed miniature-reed type, are secured to a transverse mounting strip between the sides of the instrument bracket.

The plunger-type pressbuttons, which are arranged in the 2 rows of 5 configuration at present used by the BPO, have a suitably light operating pressure and feature pre-tensioned contact springs. Electrically, operation occurs when a pressbutton is approximately half-way to the limit of its travel. A step on the plunger stem controls motion of the moving spring as far as this point; beyond it, the step separates from the spring, and contact pressure thus depends only on the pretensioning. The moulded ridges in the instrument case between the buttons (seen in the photograph at the head of this article) prevent accidental operation of two adjacent buttons in the same row due to inaccuracies of 'aim'.

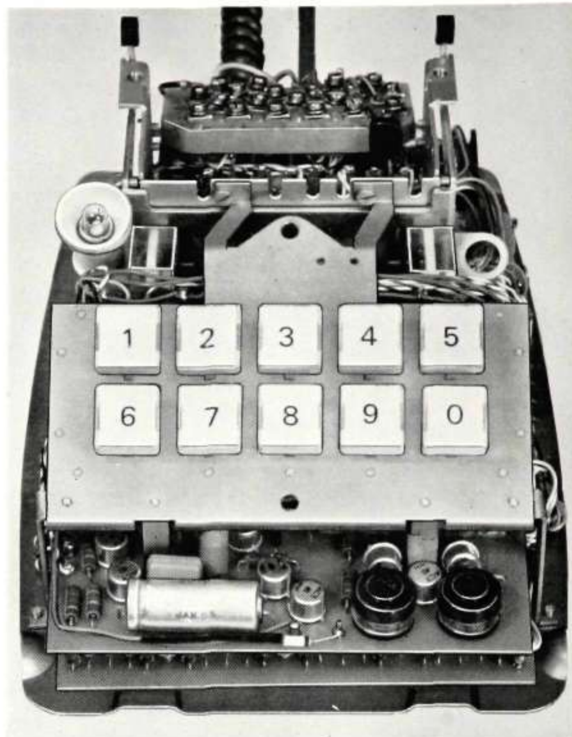


Figure 4—Instrument with cover removed

The 'signal barred' lamp is provided with a clear lens in the instrument body, and forward intensity is adequate in the brightest ambient lighting.

Power Supplies

The instrument requires a supply of 12, 24 or 50V d.c. voltage, selection being by strapping on the terminal block seen at the rear of the instrument in figure 4.

A 12V supply would normally be obtained from a small a.c. mains-operated rectifier unit mounted at some convenient point near the instrument. Supplies of 24V, or more usually 50V, could, for instance, be obtained over an additional pair of wires from the exchange.

The transistors and electrolytic capacitors are fully protected against damage from the accidental reversal of supply polarity.

Conclusion

Pressetel is a simple economic and reliable means of providing pressbutton-dialling facilities to subscribers on any exchange which accepts loop/disconnect pulsing and where local or administrational approval is forthcoming.

British Patent Applications Nos. 40382/64; 40989/64; 10734/65 and corresponding foreign applications

U.D.C.621.395.24

A Small Economic P.A.B.X.

R. E. Dennies—Circuit Development, Engineering Department

This attractive 2 + 7 private automatic branch exchange has been designed to meet the essential requirements of small organizations—simplicity of operation and installation, minimum maintenance and, above all, economic as well as efficient telephone service.

COMBINED external and internal telephone service as provided by modern private automatic branch exchanges can frequently lead to increased business efficiency at lower cost. This fact is widely accepted by small and large organizations alike, and a wide variety of equipment has been developed to meet customers' different requirements.

Recently a small-capacity PABX accommodating 2 exchange lines and up to 7 internal stations has been added to the available range. The new design provides most of the facilities offered by larger installations at a cost well within the budget of small organizations and is suitable for use as an exchange in its own right with direct connection to the public exchange, or as a subordinate exchange to another PABX, or a PAX. In either of these auxiliary roles the design constitutes a switching unit for a group of persons with a close community of interest, affording them the additional facility of communication with the parent-exchange stations via 'exchange lines'.

Because the exchange is designed to occupy standard office space, special attention has been paid to making it compatible with the appearance, ease of operation and small-size characteristics of the subscriber's other office equipment. Emphasis has also been placed on simplicity of installation and maintenance—two requirements that assume more than usual importance when skilled staff is not available.

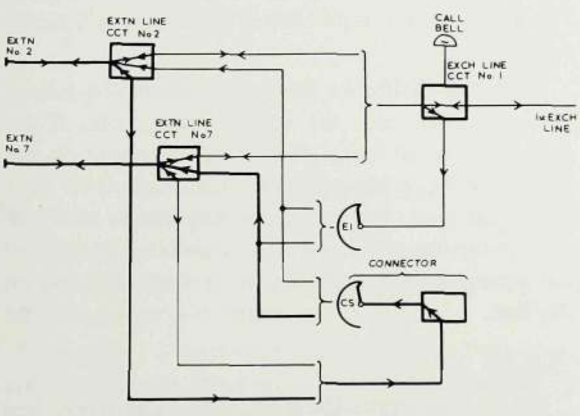


Figure 1—Routing of extension-to-extension call

Facilities

General

The exchange permits the setting-up of three simultaneous calls, i.e. two external calls and one internal call.

Stations engaged on exchange-line calls can make enquiry calls to other stations without occupying the internal link (connector) and can transfer exchange line calls to other stations. During enquiry, the exchange line is held and the caller prevented from overhearing.

An intrusion facility permits urgent enquiries to be made or exchange calls to be offered for transfer when the wanted station is engaged on an internal call. Other than this, full secrecy is afforded on all calls.

A single non-locking pushbutton on each telephone instrument serves for originating or answering public exchange calls, for access to the enquiry (callback) link associated with either exchange line, and for regaining the exchange line after enquiry. No misoperation of this button can affect service at other stations.

Internal calls are signalled by the instrument bells, and incoming exchange-line calls by an externally-mounted bell serving both lines. This bell may be sited at any convenient point within hearing range of a designated answering station, or stations. Additional call bells up to a maximum of three may be paralleled-in if required.

During mains failure, or night service conditions (i.e. with PABX switched off) the exchange lines are directly connected to two of the stations.

Internal Connection

Figure 1 illustrates an internal connection. The calling station seizes the link or connector when the handset is lifted and, on receipt of dial tone, dials the

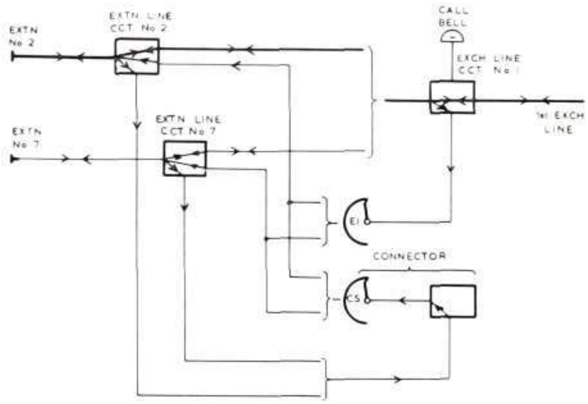


Figure 2—Routing of extension-to-exchange call

single-digit number of the required station. The uniselector of the connector responds by stepping to the contacts associated with the required station line and, if the line is free, ringing current is applied to the wanted station's telephone. When the handset is raised in reply to the call, the ringing is disconnected and the connector provides transmission battery to the calling and called lines.

The 'link occupied' indication is the absence of dial tone, unless both exchange lines are also engaged, when 'system busy' tone will be heard.

External Connection

The path taken by an external connection is shown in figure 2. If the call is outgoing, removal of the handset and depression of the instrument button causes the station to be connected to one of the exchange lines and to receive exchange dial tone, provided both lines are not engaged. The instrument now operates as a direct extension on the exchange and calls may be made in the usual way, with privacy from other stations.

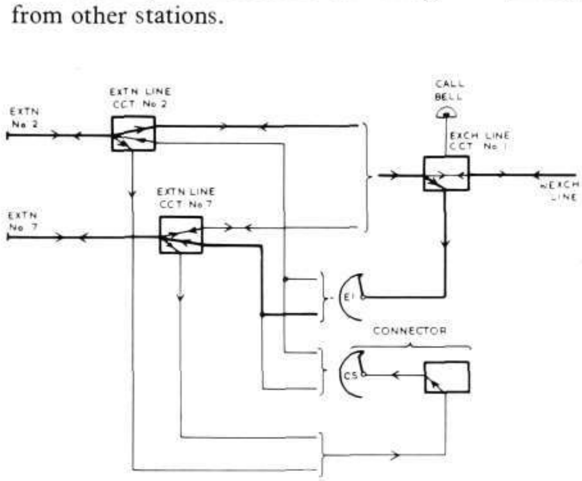


Figure 3—Routing of enquiry call

If the call is incoming from the public exchange the call bell rings and the answering station removes the handset and depresses the instrument button to take the call.

Enquiry Call

Assume station 2 is engaged on exchange line 1 and wishes to make an enquiry call to station 7; the path taken is as indicated in figure 3. Station 2 depresses the instrument button momentarily to connect a holding loop across the exchange line and also to seize the enquiry (callback) selector associated with exchange line No. 1. Dial tone is returned and the originating station dials the wanted subscriber's number (7) causing the seized selector to step in sympathy and ringing to be applied to the called line, if free. Connection between the two stations is established immediately on pick up by Station 7 and

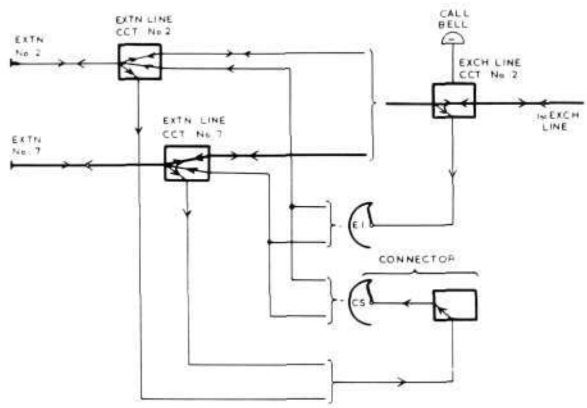


Figure 4—Routing of transfer call

conversation can take place in complete secrecy from the exchange subscriber.

On completing the enquiry, station 2 can resume the exchange-line conversation by again pressing the instrument button momentarily; the enquiry selector is then freed.

If a station dialled for the purpose of enquiry is busy on an internal call, the calling station can, if the enquiry is of sufficient importance, intrude on the connection by dialling the intrusion digit '1'. Busy tone is disconnected and the calling station teed into the connection. To warn the conversing stations of the intrusion a distinctive tone is superimposed on the line.

Transfer

Figure 4 illustrates the transfer of an exchange line call, again from station 2 to station 7. It is assumed that the latter is not already occupied on a call. Station 2 contacts him by the normal enquiry procedure and, upon transfer being accepted, replaces his handset. The exchange line is then automatically transferred to station 7.

If station 7 is busy on the local link, station 2 can still offer the exchange call by using the intrusion facility. Should station 7 agree to accept transfer, station 2 requests both interrupted stations to replace their handsets, thus terminating the local call. This done, the accepting station receives ringing and, on picking up again, will be connected to station 2 by the normal enquiry path. The latter now replaces his handset to complete transfer.

If station 7 is busy on an outside call and therefore not accessible to intrusion, this fact is made known by the continuance of busy tone after the intrusion digit is dialled.

Night Service

A form of night service may be given by switching off the a.c. power supply to the PABX. The exchange lines are then connected respectively to stations 1 and 2 which in all respects function as direct extensions on the exchange. Because incoming ringing is signalled on the instrument bells instead of the call bell, there is complete freedom in the siting of the stations.

The same provisions ensure exchange-line service at these stations when the system is otherwise inoperative due to mains failure.

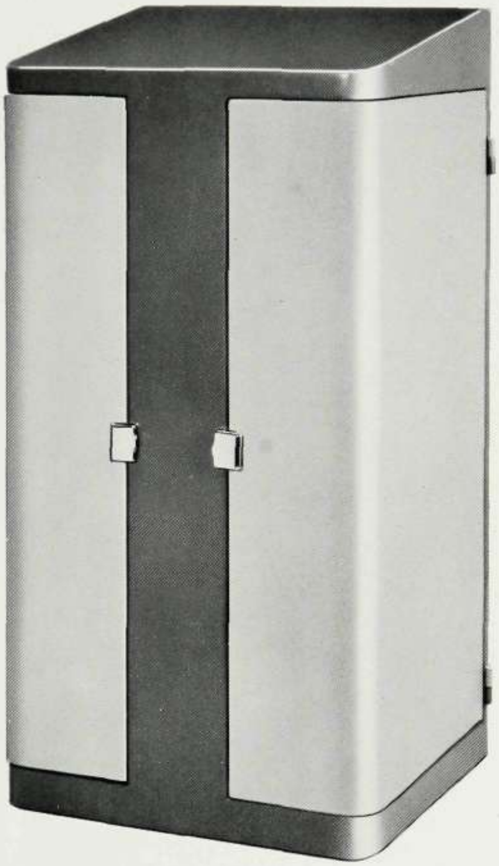


Figure 5—General view of exchange when installed

EQUIPMENT

Since it was considered essential that any reasonably competent technician, not necessarily a specialist in telephone equipment, should be able not only to install the system but take charge of it, special attention has been given to accessibility and to the choice of durable and trouble-free components of well-proven type.

The complete exchange equipment, including tone, ringing and power supplies is housed in an attractive brown and cream enamelled sheet-metal cabinet fitted with removable hinged wrap-around covers (see figures 5 and 6). It occupies small space, being only 2 ft. $4\frac{3}{4}$ in. high, 1 ft. 2 in. wide and 1 ft $0\frac{1}{2}$ in. deep edge to allow access to the wiring and screw-type terminal strips behind. Cables for connection of the station telephones, the call bell and mains supply are brought in through the base of the cabinet via an aperture in the rear face of a shallow plinth.

The apparatus includes heavy-duty uniselectors, 3000-type relays, and strip-relay units[1] which are used exclusively for the line circuits. Space is

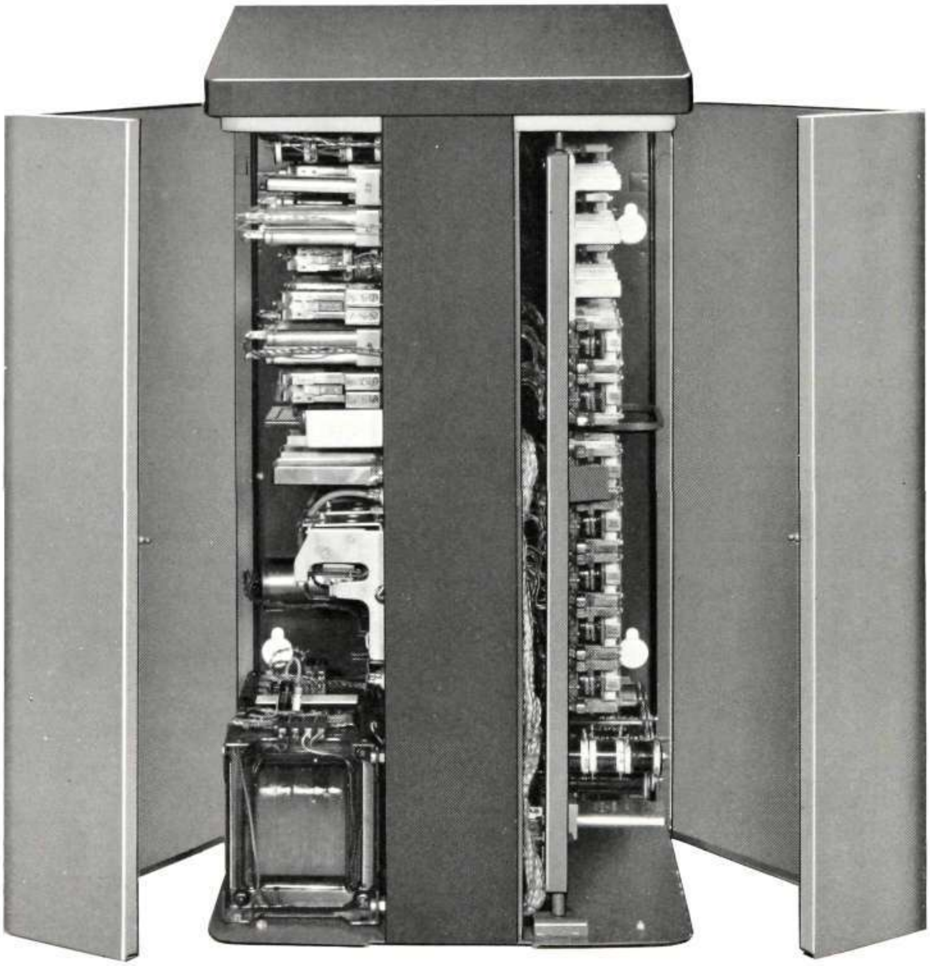


Figure 6—Hinged covers open, showing exchange interior

(i.e. 73 cm × 35·6 cm × 31·75 cm) and can be installed in any dry and reasonably dust-free situation, either wall-mounted or free-standing on a desk or bench.

As illustrated in figure 7, the components are mounted on two vertical back-to-back frameworks, the one on the right-hand side being hinged on the front available for an additional three strip relays, permitting the system to be extended to 10 stations at installations where traffic load is light.

The strip units can be seen in figure 7. They consist of up to five relays mounted on a common yoke which also serves as the core-iron and primary anchorage for the main components. The design of

[1]See 'Improved Strip Relay, Type 12'; this issue, pp. 38-40.

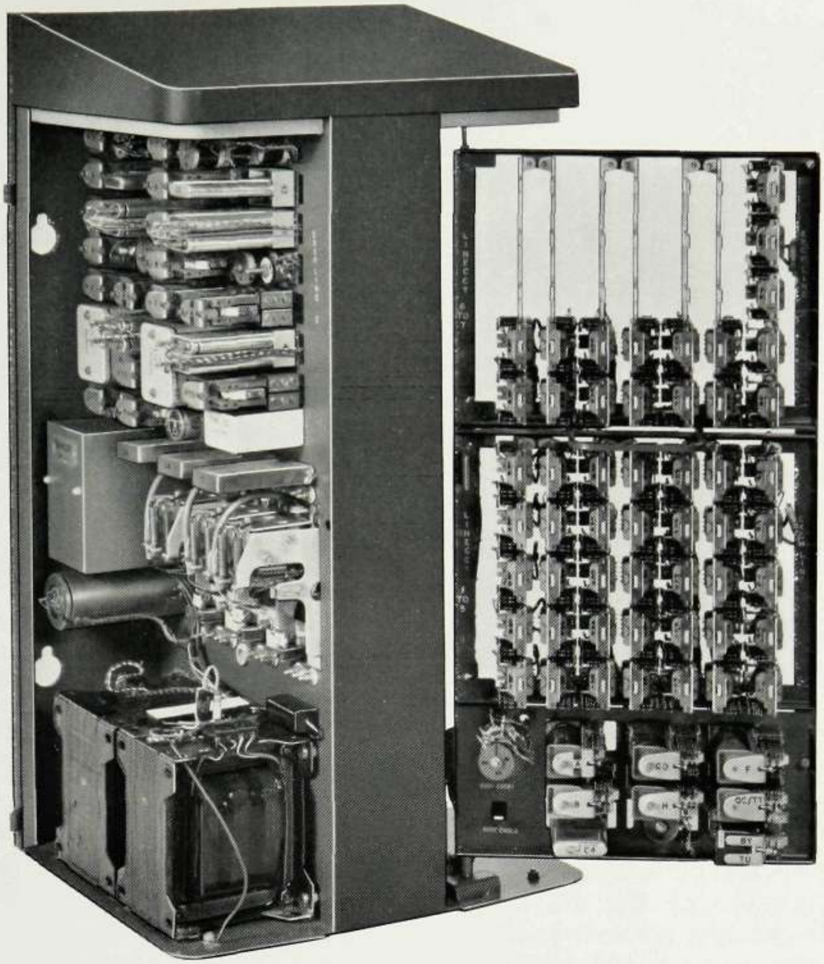


Figure 7—Covers removed and gate swung open for access to terminating strips and internal wiring

these relays ensures a high degree of contact reliability with unvarying contact pressure under all circuit conditions. No spring or armature adjustment is necessary under any circumstances; should the springset become damaged it can be freed from the assembly for replacement merely by withdrawing a single screw. When reassembled with the new springset unit, the relay will automatically attain correct adjustment. Detachment of the springset also permits removal of the coil, which may be replaced with similar ease.

All items have tropical finish, and pvc insulated wires are used throughout. *Maximum reliability* is thus ensured even under the most adverse climatic conditions.

Power Supply

The PABX incorporates a mains rectifier unit, a.c. supplies of 100–125 or 200–250 volts 40/60 c/s being suitable for its operation. Voltage adjustment is by 5-volt steps in the lower range and 10-volt steps in the higher, selected by tappings on the mains transformer.

Line Limits

The maximum loop resistance of a station line, inclusive of the telephone is 500 ohms, whilst exchange-line loop resistances up to 1000 ohms are acceptable.

Telephone instruments of Etelphone type are employed, ensuring a high transmission performance unaffected by differences in line loss between stations or from stations to the exchange.

Conclusion

This new unit represents a successful scaling-down of the modern PABX formula in size and cost, though not in capabilities. Maintenance, which under all normal circumstances will demand no more than periodic contact cleaning and lubrication of uni-selectors, should not prove a liability even to organizations with minimum service resources.

U.D.C.621.318.56

Improved Strip Relay, Type 12

J. Searle—Apparatus Engineering Department

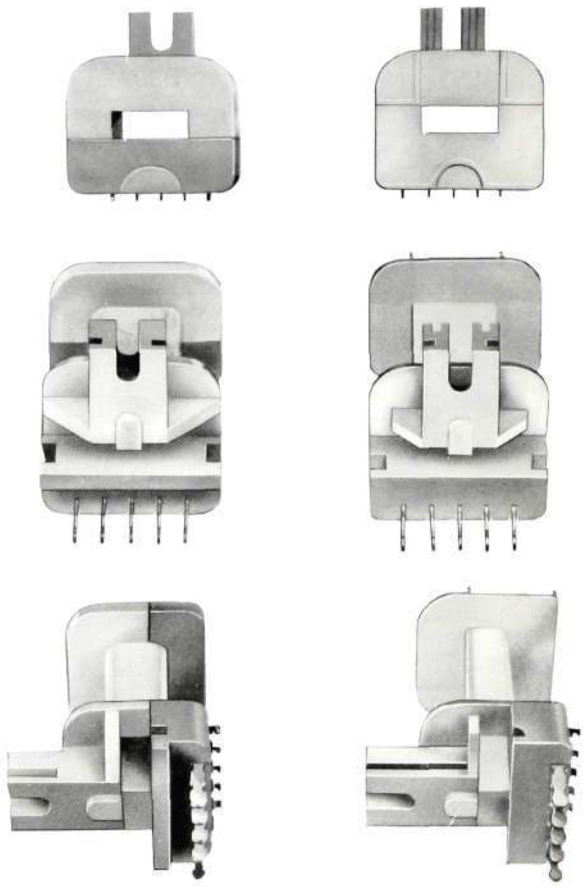
This particular redesign gives increased winding space, longer coil to yoke leakage paths and improved pivot performance. The coil former resists deformation at high temperatures or melt-up due to possible power line faults.

The Type 12 relay, described in Bulletin No. 47, was specially designed for the line and cut-off functions in subscriber linefinder application. Although such a design obviously cannot form the basis of multi-purpose variants, the success of the relay within its intended field has naturally encouraged efforts to widen the scope where possible.

It was evident that an increase of coil winding space would be the most practicable and directly useful change, enabling the relay to meet the longer line requirements of certain Administrations. Experience in manufacture had accumulated to the point where this modification could be combined with certain other detail improvements.

In the modified design all the changes are logically interconnected and have lowered the cost of production, besides enhancing the performance and reliability of the relay, with particular reference to conditions of high temperature and humidity.

One hazard to which the relay may be exposed in service is the application of mains voltage across the coil, due to accidental contact between the subscriber's line and power lines. In this event it is important that removal of the burnt-up coil should not be prevented by its seizing on the yoke, otherwise the whole strip will have to be replaced. The possibility of this happening with the new design is remote.



Old type **New type**

Figure 1—Views showing differences in construction of coil formers

The Coil Former

The increase of winding space aimed at was 20%; this has been attained by lengthening the coil former and reducing the thickness of the end-cheeks. No increase of core-iron length was necessary to accommodate the new coil.

The whole former is now of glass-filled nylon. This material gives the improved mechanical performance necessitated by the thinner construction and fulfils the non-seizing requirement mentioned in the introduction. A review of the properties of the material and its use in the manufacture of improved coil formers appeared in Bulletin No. 51.

It will be recalled that the previous coil former was a two-part construction of ABS (acronitrile-butadiene-styrene) and glass-filled nylon. The latter was employed for the tag bearing half, purely to eliminate possible movement of the tags during soldering operations.

The present design exploits the possibilities of the material more fully, the result being a component at least as mechanically durable and also more economical in production. The one-piece construction gives improved electrical performance, particularly in humid conditions, since there is no interface through which moisture can penetrate.

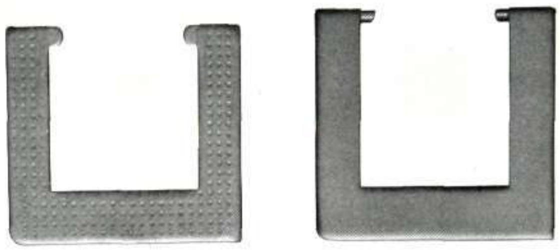
Figure 1 shows views of the new former in comparison with the old. The front cheek has been stiffened by webs, one of these having a semi-circular centre section serving as the armature back-stop. The rear cheek is adequately reinforced by the block carrying the tags and by a transverse web forming a platform for the rear vertical projection or 'turret'. The general wall thickness in this very strong construction is little more than ·03 in. (·76 mm). Two other new features are noticeable and will be referred to later; the modified pivot recess shape and the separation of the turret from the rear cheek.

The higher cost of glass-filled nylon has been offset by a saving of some 34% in total bulk. Obvious production economies include the replacement of two separate moulding operations, involving different materials, by a single operation, and the elimination of the tape wrapping, formerly necessary to hold the two halves together before winding and to reduce radial leakage from winding to core. In addition, winding time has been reduced by moulding a groove in the rear cheek to accommodate the start wire, thus making it possible to dispense with flexible connections and start-feed insulation hitherto necessary when terminating small-wire sizes. With this saving in time and materials comes the additional benefit of a more uniform winding for fine-wire coils.

The Armature

Some lengthening of the armature was necessary to clear the new coil former; figure 2 shows the difference between old and new. The actual increase in length is about 7%. However, because the rear cheek of the coil former is located further back, the armature pivot has been similarly displaced and the increase in magnetic circuit length is slight.

More than off-setting this is a reduced gap between armature heel end and yoke in the unoperated state of the relay. The armature is provided with pivots of quadrant section, the root of the quadrant being at the rear edge of the armature facing the yoke. The pivot recesses in the coil former, seen in figure 1, match the pivot section, but with a slight overall clearance. The armature edge is in very close proximity to the yoke in all mounting positions of the relay; one can hold a strip horizontally with the springsets uppermost and detect only a minute lift in the heel-ends of the armatures. During operation the pivots rotate in the recesses almost without friction.



Old type New type
Figure 2—Comparison between old and new armatures

In the old design a flat swaged pivot was accommodated in a rectangular recess, which of necessity had to be deeper than the pivot thickness to give the necessary clearances throughout movement of the armature. Consequently an appreciable separation was possible in the unoperated condition, between heel-end and yoke, unless contact was assisted by gravity.

The Springset Bracket

The springset bracket is dependent for its anchor-point on the turret of the coil former, the upper part of this turret retaining a quick-thread nut into which the securing screw is inserted. Figure 3 shows the old and new springset brackets in proximity to their respective coil formers.

Old type New type
Figure 3—View of old and new springset brackets with their respective coil formers

The bracket should establish an accurate square between the vertical flat at its rear end and the upper surface of the yoke. This is obtained if the cut-outs in the diagonal members, on either side of the flat, seat flush on the yoke. The vertical restraint provided by the turret anchor-point normally ensures this. However, if a backward tilt were imparted to the turret by, for instance, winding pressure on the coil former rear cheek, the bracket might also become tilted out of square. This is the reason for the separation of the turret from the cheek, as seen in figure 1.

It is quite permissible for the *bracket* to impart a slight tilt to the turret, that is, upon tightening the securing screw. The flexibility of the turret platform allows this, and the reactive force on the bracket is in a direction assisting its proper seating. The overall function of the bracket is to secure accurate verticality of the springset mounting blocks at the rear, and to provide a datum for each comb system at the front. The frontal tips of the bracket are anchored, as in the original design, by engaging slots in the crosspiece of a T-shaped clip which also serves to lock coil to yoke.

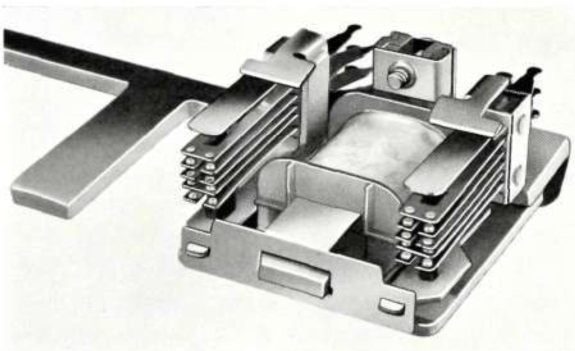
The two functions of the bracket are not entirely independent; in particular, the tip anchorages assist in bracing the springset mounting blocks. To increase this contribution the flanges on the arms of the bracket now extend along their whole length, instead of merely around the comb apertures.

The Clip

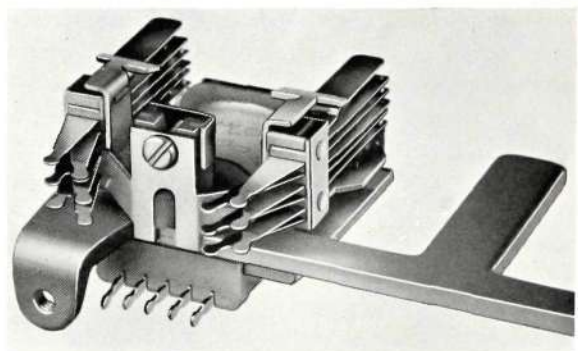
The clip is unchanged except that the tongue 'step', which abuts the front cheek of the coil, is nearer to the crosspiece to allow for the increased coil length. The original relay will accept the new clip; advantage was taken of this to introduce the clip before the other modifications, thus smoothing the production change-over.

The Complete Relay

Figure 4 shows front and rear views of the complete relay. These emphasize the full utilization of available space by the coil former, and the excellent pivotal contact between armature and yoke.



Front



Rear

Figure 4—Views of the complete improved relay

Conclusion

The scope of the modifications was such as to entail only moderate re-tooling, and the new relay was introduced with very little disturbance to production. The calculated improvement in performance has been fully realized in practice; one aspect of this is that, owing to the reduced root diameter of the coil former, the same ampere turns can now be obtained with a shorter winding length. Increased pivot life can be expected in mounting positions other than the normal, because of the all-round effectiveness of load distribution at the pivot points.

U.D.C.667.6

The Paints Division

C. W. Collier—Production Laboratories

Specialized paints, lacquers and varnishes are used in the manufacture of almost all telecommunications products. The paint factory within the Beeston Works is thus an important auxiliary; it is also one of the oldest-established. Attendant laboratory and development units contribute much to its reputation for quality and variety of products, many of which are in demand elsewhere in industry.

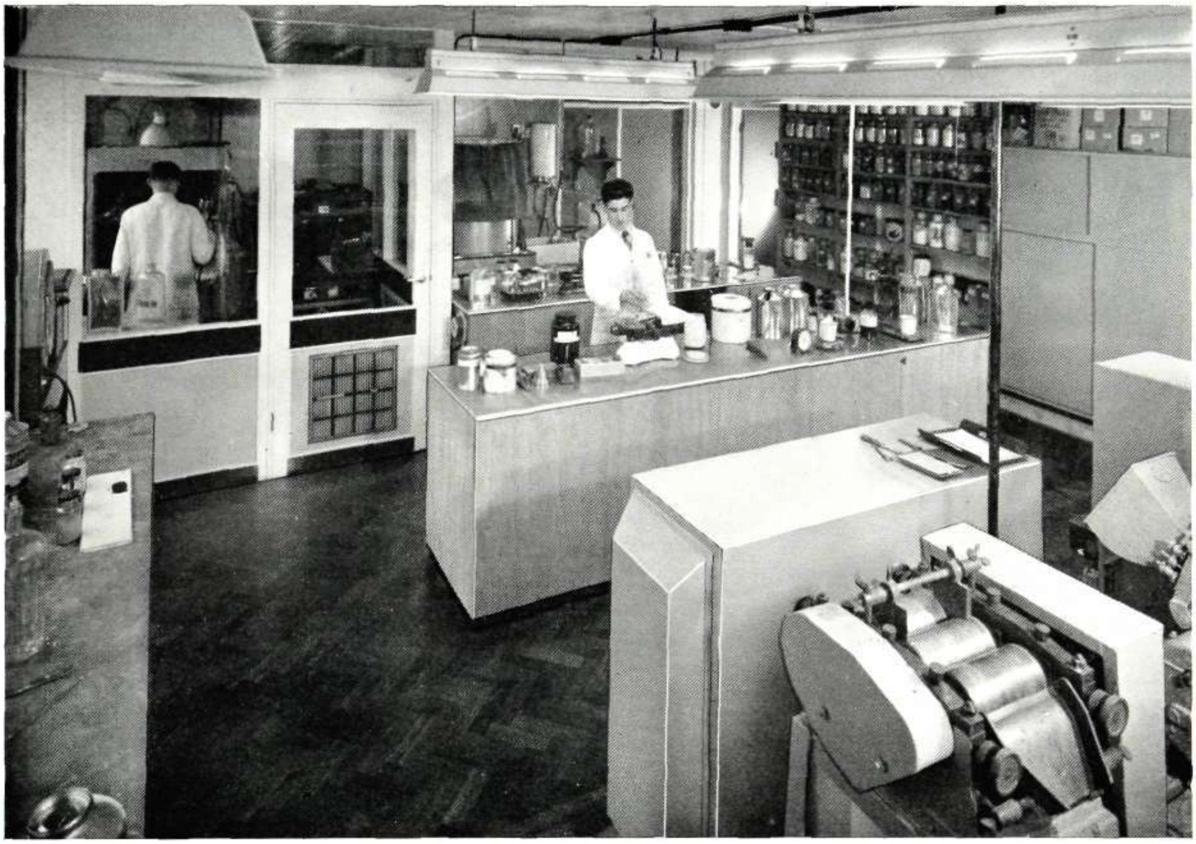


Figure 1—A section of the paint laboratory

LIKE the equipment they protect, the paints and finishes used in the telecommunications industry have undergone progressive change in recent years. Wherever practicable, stoved synthetic coatings have replaced air-drying nitrocellulose or oleo-resinous types, with the benefits of enhanced appearance and greatly improved durability. Progressive substitutions of a similar nature have been made in specialized finishes, for components where the many different specifications are continually reviewed to introduce the advantages that each technical advance can offer.

Telecommunications finishes must protect the equipment for long periods of service under both normal and adverse conditions. Particularly where apparatus details are concerned, the required performance and reliability may call for a selection of the type of finish to be used, and the study and preparation of suitable materials is therefore of a specialized nature.

Historically, paint manufacture at Beeston commenced in 1925, when a unit was established for the production of paints, enamels and lacquers. In order that materials possessing the special properties required by our industry might be evolved, a paint development laboratory was also installed, equipped for the evaluation and life-testing of the products and coatings.

To permit subsequent plant re-arrangement as new processes are introduced or existing ones modified, and to ensure maximum utilization of space, a barrel-vault roof construction requiring no supporting pillars was chosen for the manufacturing building. To the same end, major plant units are self-contained with individual drive.

Ancillary sections of the paint factory comprise raw material and finished product stores and varnish-making block. The solvents are contained in underground tanks, from whence they are pumped and metered to appropriate points within the buildings, thus minimizing fire risk.

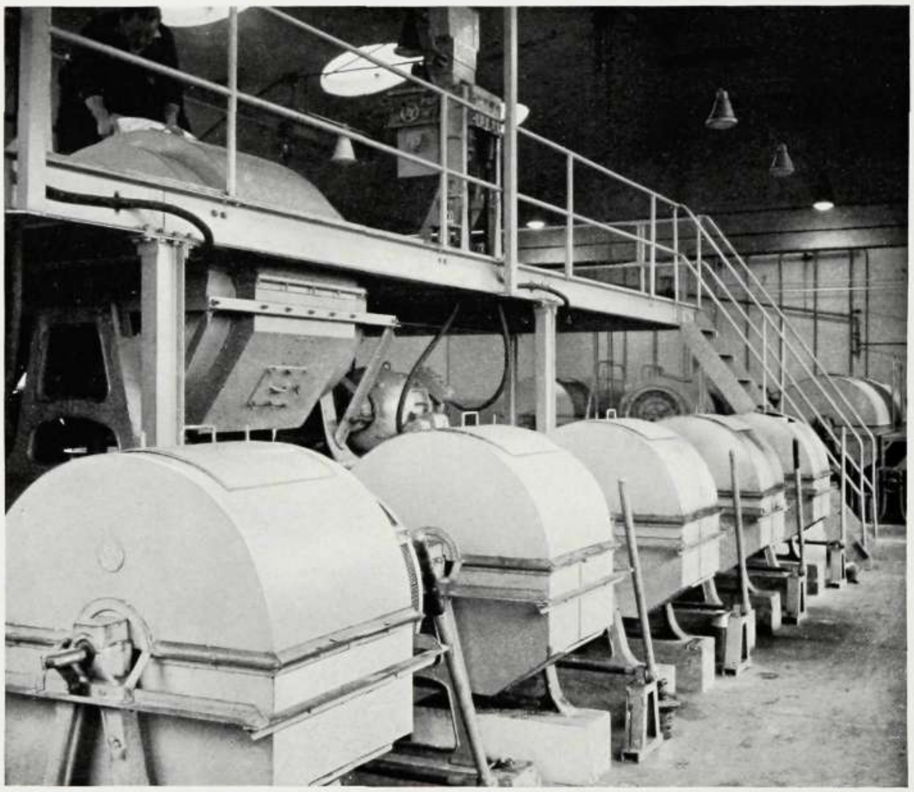


Figure 2—Battery of small ball mills with loading of larger mill in operation

The facilities for developing finishes for specific purposes, the benefits accruing from the direct control of paint specifications, and the potential value to other telecommunications manufacturers of a source of these specialized products, were expectations fully realized as the project became established.

In recent years the original paint factory was rebuilt, with an increased capacity to meet the steadily growing demand. The equipment was of the most advanced type and the unit remains abreast of the latest trends and operational methods in the paint manufacturing industry.

PAINT LABORATORY (figure 1)

The function of the paint laboratory is vital at every stage. It is here that formulations are initiated as a result of an intensive study of material performance, and control tests by modern instrumentation are conducted throughout manufacture. Finally the properties of the finished coatings are rigorously

Figure 3—Portable tanks in position for mixing

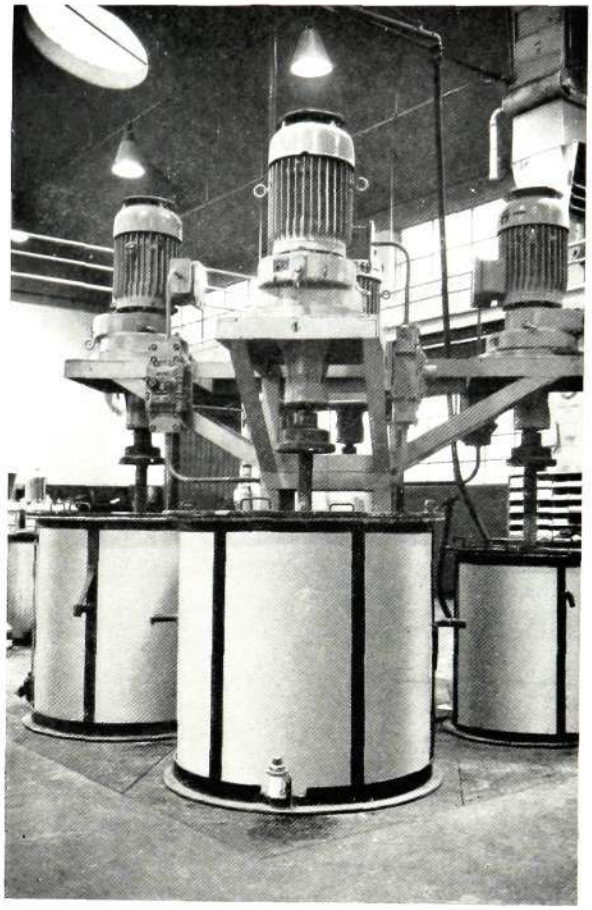


Figure 4 (*below*)—Single roll finishing mills

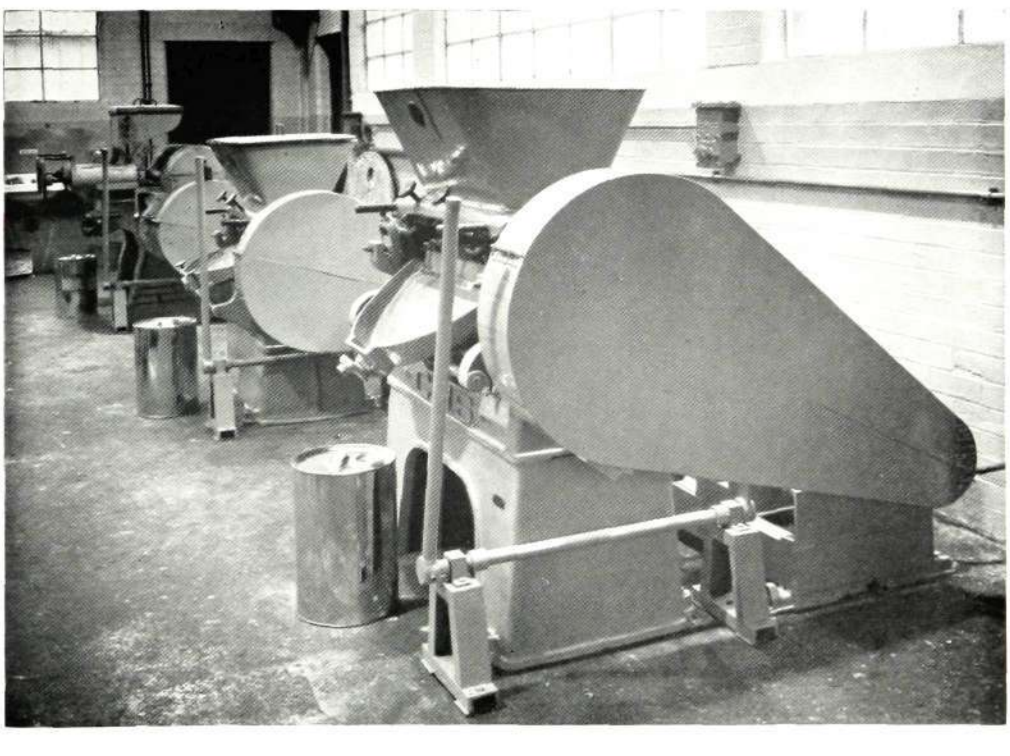


Figure 5—Dissolving tanks and solvent pumping system

examined to determine the ultimate durability of the finishes which must protect the equipment during its service.

PAINT MANUFACTURE

In the preparation of paints, ball mills of various capacities (figure 2) are used for the initial grinding and dispersion of the pigments in the media. The mills are sited in a separate room adjacent to the raw material store, and are gravity filled from overhead platforms. After grinding for the requisite period, tests for the degree of dispersion are made and, when approved, contents are discharged into portable tanks for transportation to the mixing room, where the next stage of the process takes place. A typical charge on completion of grinding consists of a concentrate of the pigments, finely dispersed either in synthetic resin media and solvents for ultimate conversion into stoving enamels, or in one of the cellulose or oil bases required for air-drying finishes.

For the mixing process the tanks are positioned under the paddle mixing heads illustrated in figure 3. Further resin bases and solvents, together with any necessary toning colours are added at this stage to complete the formulation. High gloss enamels can be subjected to a further finishing process, carried out by the high-speed roll mills shown in figure 4. Numerous laboratory tests are specified and conducted at this stage and, after approval, the batch is released for filtration, canning and despatch.

CELLULOSE LACQUERS

Clear cellulose lacquers are prepared by dissolving cellulose ester solids, resins and plasticisers in suitable solvent mixtures; for this purpose high-speed mixers (figure 5) or the slower paddle mixers already mentioned are employed. Coloured lacquers are prepared in a similar manner, but with the addition of concentrated pigment stocks which have been finely ground in roll mills.

VARNISHES

Impregnating and finishing varnishes for the insulation and protection of electrical windings are a further important speciality. Synthetic resins are introduced into the oils forming the bases of these varnishes, precise control being exercised with the critical time and temperature cycles necessary in the subsequent 'cooking' process. This is carried out in aluminium or stainless steel vessels, housed in a separate building.

CONCLUSION

Although the Paints Division was originally established to meet domestic needs and to contribute to the improvement of finishes in the telecommunications and allied industries, its activities are not solely confined to these fields. A comprehensive range of finishes to meet other exacting industrial requirements is also developed and manufactured. Whatever the identity of the product, however, a unifying factor in the Division's work is the relevance of its experience to the user's own finishing problems. This is so because manufacture has been continuously linked with a study of technological developments, raw materials and finishing techniques.

ERICSSON TELEPHONES LIMITED

ETELCO LIMITED