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# *'Multiphone'

* British Trade Mark Application No. 855077/63.

*A comprehensive telephone system is described integrating services that can be selected on a unit basis to provide system arrangements having wide application. It caters for up to 10 telephone stations and functions as a small private automatic branch exchange (PABX), an auxiliary private automatic exchange (PAX) or a multi-line system.*

THE value of a well-planned telephone system is widely recognized in both industry and commerce as a significant step towards higher business efficiency. Many organizations, however, expanding beyond the direct-line telephone stage frequently find this difficult to achieve, for with expansion comes the problem of assessing precise communication needs consistent with future growth and the particular nature and routine of the organization concerned; whether the system under consideration should be one providing internal service, external service or a combination of both.

As a ready and economical solution to this problem, a system of considerable versatility has been developed —'Multiphone'. Designed on the building-block or modular principle with relatively simple circuit units, the new system can be developed or varied in its application by simple addition or omission of units. In this way, the most effective installation can be provided to meet specific requirements at lowest cost.

Multiphone serves up to 10 telephone stations and embodies three system arrangements, permitting it to function as a self-contained or auxiliary 4-line sub-attended private automatic branch exchange, a satellite private automatic exchange, or a multi-line system giving access to 4 external circuits.

External circuits terminating in the system may be of the same classification or a combination of different types. These include direct public exchange lines; extensions to a PAX, PBX or PABX; private wires to other switchboards; control circuits to key points and radio links to remote stations.

Space requirements for the equipment are low. This feature, essential in any system, has been made possible largely through the use of single and twin press-key switching units which, together with transmission and supervisory components, are accommodated in each station telephone. The key units, because of their diverse switching applications, have substantially reduced the need for much of the common relay-switching equipment usually associated with fixed layouts offering service arrangements similar to Multiphone. For this reason, no floor-standing rack-mounting equipment is required; all relay switching as well as related 24-volt power unit apparatus is housed in a compact central-control cabinet which may be mounted in any position convenient to the subscriber, on table or wall.

Because all modules in a fully equipped control unit combine to provide PABX services (i.e. internal and external) this method of working is described first, followed by some of the many possible arrangements for connecting Multiphone to suit particular requirements.

### Multiphone as a self-contained PABX

Multiphone in this capacity is intended primarily for use in businesses where activities and layout of premises demand a compact system. Small companies working from office suites or large open rooms are in this category, as well as certain units of larger concerns that operate with a high degree of autonomy, for example, a research section or municipal architect's department.

To meet different requirements, the PABX may be arranged in two ways to give access to a maximum of two or four external lines. The 2 + 10 and 4 + 10 station telephones employed in these optional arrangements are shown in Figures 1 and 2. As in all Multiphone applications, the station telephones are physically and electrically similar, and differ only in the number, type and disposition of press-buttons employed.

No switchboard operator is required for the handling of incoming calls at the PABX, since these are dealt with at any predetermined station or group of stations. Outgoing calls can be originated from any station and, in addition to incoming calls, can be held for the purpose of information calls on other lines or transfer to any station. Calls may be repeatedly transferred throughout the system.

An important feature is that service on external circuits can be arranged in three separate ways.

(*a*) To allow any station to enter an engaged line at the request of the originating station.

(*b*) As (*a*) above, but to permit any station (up to the number of external circuits installed) to have exclusive use of one pre-allocated line. This exclusion feature is suitable for principal stations and is controlled by push-buttons in the selected station telephone.

**Figure 1—Multiphone station telephone equipped for 2 + 10 PABX working without optional line-exclusion facility**

(*c*) As (*a*) above, but to allow any selected group of stations priority of access to any pre-allocated line, the order of priority being determined by the particular arrangement of the stations in the external-circuit multiple. For example, station No. 1, on seizure of the line and operation of a control key, can exclude all succeeding stations 2-10. Similarly, station No. 2 can exclude stations 3-10 and so on.

**Figure 2—Multiphone station telephone accommodating extra press-buttons for 4 + 10 PABX working, including line-exclusion facility**

Communication between stations is by selective dialling of one-digit codes over a single transmission link. Simple strap adjustment in the control equipment speedily converts the link from non-secret to secret working according to requirements.

Both internal and external calls are signalled visually by combined line-and-busy lamps and

audibly by a.c. ringers. Audible indication of intercom calls is given by the instrument ringer and, for external calls, by ringers located convenient to the answering station or stations.

Because the system operates from a mains-operated power unit, provision is made to maintain external service on failure of mains supply. In this event, each station continues to have access to all external lines, incoming calls being signalled audibly at the answering station or first station in an answering group.

### Press-Buttons

The selection of any function at a station is by single or twin-type press-buttons located in front of the instrument handset cradle. A typical press-button arrangement is shown in Figure 3. Buttons are logically arranged for convenience of operation and easily identified by designations clearly impressed in white characters on the face of each button. External-line buttons are marked numerically and the remaining buttons by letters; ' H ' indicating the ' hold line ' function and ' I ' the intercom link. Control buttons X and O (when fitted) are for line-exclusion purposes.

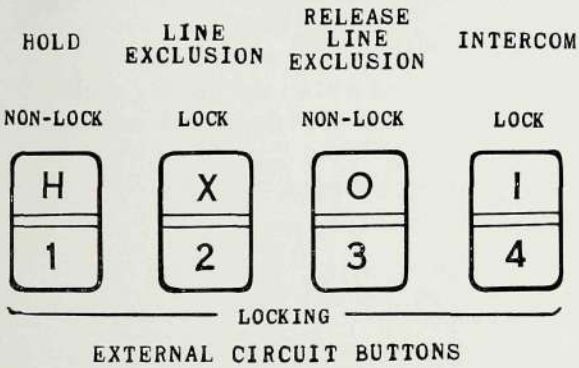


**Figure 3—A typical press-button arrangement**

A simple system of interlocking and trip release is employed between buttons and handset switch-hook, and between the buttons themselves. Buttons H and O are non-locking; all other buttons lock when depressed and release to normal upon restoration of the handset. In addition, with the exception of button X, any button when depressed releases any other previously operated.

Any station telephone may be easily adapted for line exclusion; on site if necessary. The operation merely entails minor revision of connections in the telephone, the release and withdrawal of the two inner single buttons held captive inside the instrument case, and their replacement by buttons of twin type. No further action is called for, because the simple springset assembly required for provision of this optional feature exists in all telephones.

### Lamps and Signals

Signalling lamps are designed to give satisfactory display even under conditions of direct sunlight and are of two types, clear and coloured, to assist ready identification of all calls held and in progress. Clear lamps are located in front of associated external-line press-buttons and below these to the left is the intercom lamp which is individually mounted and, in contrast, emits a red signal when illuminated.

For simplicity, signals are confined to three in number, these being a steady glow for busy lines, a rapid ' wink ' for incoming calls, and a slow ' wink ' denoting a line held. Both winking signals are markedly different, the rapid wink having equal on-off periods of approximately $\frac{1}{2}$ second whilst, in the slow ' wink ', current is removed from the lamp for about $\frac{1}{10}$ second in every two seconds.

### Internal Calls

Occupation of the intercom link is shown by a steady glow on the ' intercom ' lamp at all stations. This indication occurs as soon as a caller enters the link by removing the telephone handset and depressing the locking button I.

Connection to any station is established on dialling the single-digit code assigned to the called station. On completion of dialling, audible indication of the incoming call is given by a burst of ringing of approximately five seconds duration on the instrument ringer. Simultaneously, the steady glow condition at the called station changes to a rapid wink.

Removal of the handset and depression of the ' I ' button at the called station establishes connection with the intercom link and causes the visual indication to revert to the steady ' link-occupied ' signal. When the call is concluded, the ' I ' buttons restore at both stations as the handsets are individually replaced and, when both handsets are at rest, the intercom lamp is extinguished.

### External Calls

Any station can initiate an outgoing call direct by pressing any button associated with a free line. The call is completed in the normal manner and, during its progress, the associated line-and-busy lamps at all stations glow continuously.

On an incoming call, the incoming ringing signal operates lamp-flashing relays in the central control unit to apply the rapid wink signal to the appropriate line-and-busy lamps at each station, identifying the calling line. At the same time, an audible signal is given by the external ringer at the answering station. If there is more than one answering station in the system arrangement, the ringing signal received at the first station is repeated to the remaining answering stations by a transistor ringing generator in the control equipment. According to the particular requirements of an installation, interrupted or continuous ringing can be employed for the repeat signal.

Depression of the correct line button (shown by the winking lamp), switches the external line through to the answering station telephone. Ringing ceases and the winking signal changes to a steady glow, indicating to all stations that the call has been answered and a busy condition exists.

If the answering station wishes to hold the line, perhaps to make an enquiry call to an intercom station or external subscriber, the non-locking hold key is depressed. This action restores the exchange-line button, applies a hold condition to the line initially seized, and causes the associated line lamp to wink rapidly, serving to remind the user that the exchange caller is waiting to resume conversation.

With the hold condition applied, the enquiry line can be entered by operation of button I or any free external-line button, whichever is appropriate, and an information call originated. The enquiry call is made with privacy from the waiting caller and, on its completion, a return to the held line can be made by re-pressing the button initially operated. This automatically disconnects the enquiry line and causes the winking signal to revert to a steady glow.

If the enquiry call is to an internal station, this station can pick-up the external call by operating the external-line key above the winking lamp. This operation switches the take-over station to the external line and a steady glow condition replaces the winking signal, indicating the interception of the call. On seeing this signal change, the transferring station replaces the handset.

### Calls from Principal Stations

Stations equipped for line-exclusion can originate or answer an external call in secret on one line only. When the particular line is picked up, secrecy from succeeding stations connected to that line is imposed on depression of button X. At the conclusion of the call, replacement of the station handset releases both buttons and restores the excluded line to general use.

When a principal station wishes to transfer a call after secrecy conditions have been applied by button 'X', all excluded stations must be restored to line. This is accomplished by momentary operation of button 'O', its action releasing button 'X', thus restoring the cut-off stations and allowing transfer of the call to be completed in the normal manner.

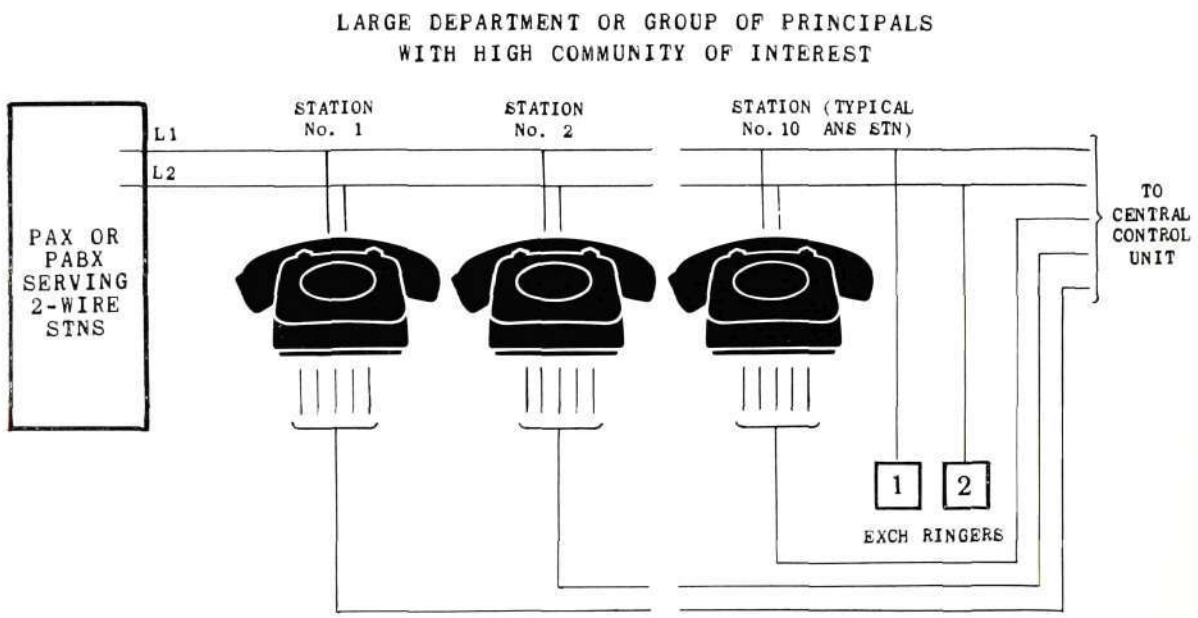


**Figure 4—Typical application of system as an auxiliary PABX**

### Multiphone as an auxiliary PABX

In an organization served by a PAX or PABX, there may be a department or group of principals with sufficient community of interest to justify an auxiliary system to the main. Figure 4 shows a typical arrangement providing intercommunication between the group and the main and between stations in the group. The group, first disconnected at individual line circuits, is re-associated with the main equipment by a 10-station Multiphone PABX connected by two communal lines to a similar number of line circuits. Calls within the group are completed by one-digit dialling, and outgoing calls to 2-wire stations by dialling two or more digits dependent upon the capacity of the main PAX or PABX.

is provided with a complete local system fully integrated with the main.

### Multiphone as a satellite PAX

Where a few extra stations are required on a PAX with no spare line circuits available, Multiphone station instruments may be substituted for individual groups of low-traffic PAX station telephones. For example, as illustrated in Figure 6, six Multiphone instruments, replacing an equal number of 2-wire telephones, are multipled to three PAX line circuits, thus freeing the remaining three line circuits for other uses. These circuits may themselves be utilized for the addition of further Multiphone stations to the PAX. In this application the intercom-selector unit

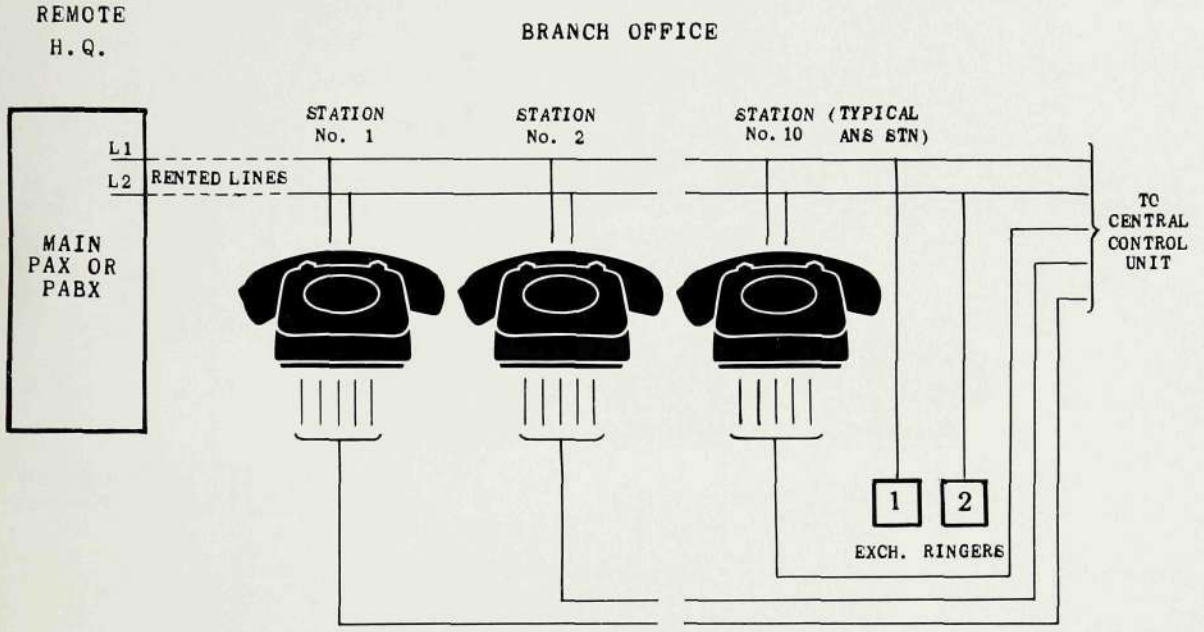


**Figure 5—An auxiliary PABX system over rented lines**

Because traffic requirements to and from the main are low, this system arrangement not only reduces dialling effort for the group but, more important, minimizes traffic load on the main and permits considerable line-circuit reduction to be realized.

A further example of Multiphone in this capacity is shown in Figure 5. This application is suitable where an existing PAX (or PABX) at the headquarters of an administration is some miles from an associated branch office or department. Connection between the two systems in this instance is made over two rented lines. In this way, the branch or department is dispensed with, but lamp flashing units are included to assist identification of calling lines.

### Multiphone as a Multi-line System

As illustrated in Figure 7, Multiphone can be applied to travel bureaux, booking offices and other organizations supplying information services of different kinds. With incoming lines multipled to all stations, a call can be answered by the first free attendant, ensuring even distribution of calls among members of the staff and quick speed of answer essential to good service.

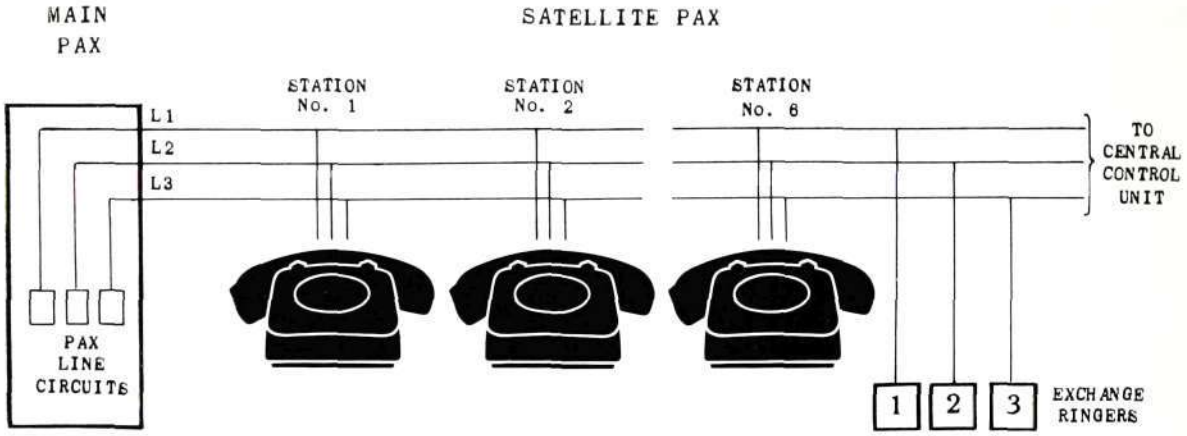


**Figure 6—Typical application as a satellite PAX**

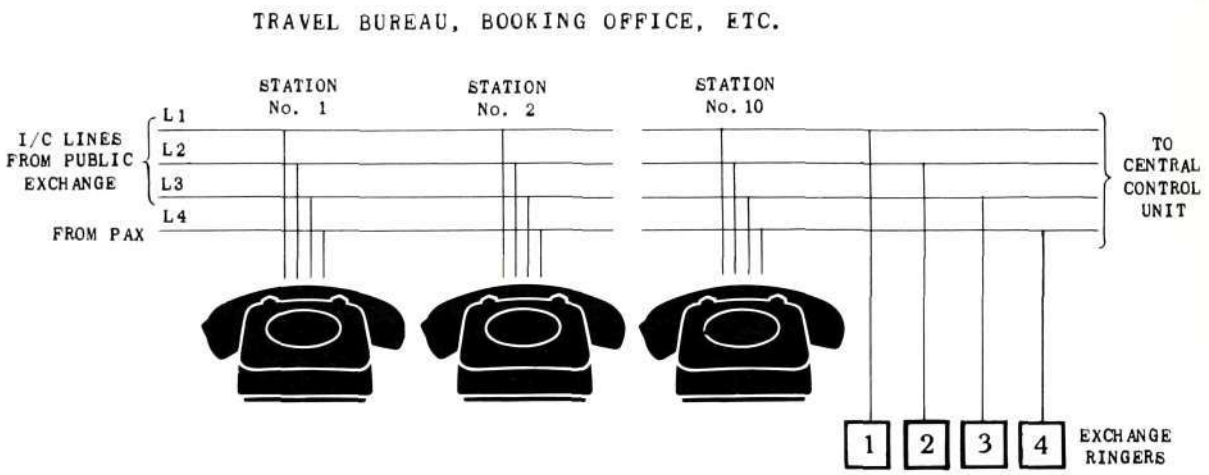


**Figure 7—Multiphone as a Multi-line system**

If one of the lines is incoming from a private exchange within the organization, the provision of the hold facility can be advantageous despite the absence of intercom and transfer services. By its inclusion, a call can be held on any of the other three lines while an enquiry call is made to any station in the associated private system.

### Miscellaneous

CENTRAL CONTROL EQUIPMENT

A metal cabinet 30″ × 13½″ × 11¼″ (74, 34, 29 cm) houses the central-control equipment, comprising switching relay sets, intercom-selector unit, power unit and transistor ringing generator. The cabinet, suitable for table or wall mounting, is arranged to be as nearly dustproof as possible consistent with ventilation.

All units are equipped with screw and lug fixings for quick assembly to a metal baseplate and upper structure. Power unit and ringing generator are mounted to the right, and relay units to the left, as may be seen from Figure 8, illustrating the complete equipment (cover removed) for a 2 + 10 PABX installation.

Up to 7 mounting plates can be accommodated for switching units consisting of four types; external-line, lamp-flashing, common-equipment and intercom-selector units. Each mounting plate is equipped

with screw terminals for jumper field interconnection of plates (see Figure 9) allowing speedy installation of a preferred arrangement and easy addition of units within the limits of the system.

Figure 10 shows one of the plates (the intercom-selector unit) in greater detail. Physically it consists of a 10-point miniature selector switch and associated major-type relays.

Power for the system is via a 3-point reversible shrouded plug which interlocks with the cover as a safety precaution. A range of a.c. supply between 110 and 250 volts at 50/60 cycles is allowed for by the transformer tappings.

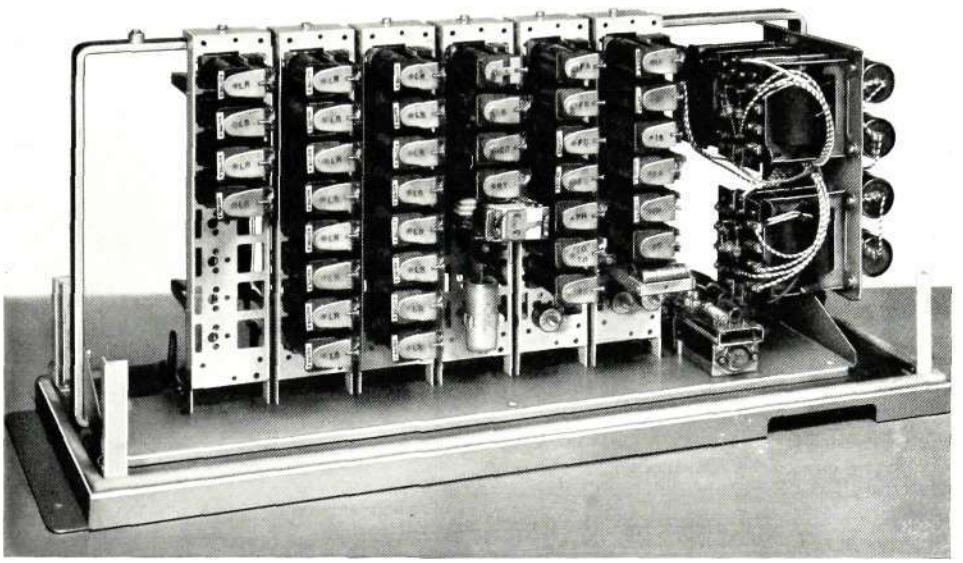

**Figure 8—General view of central control unit. (With cover removed)**

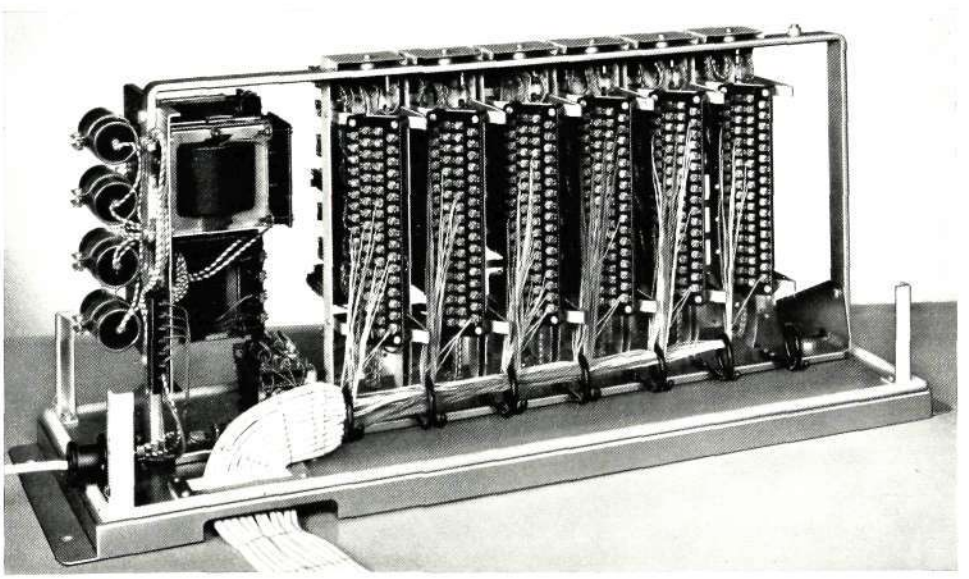

**Figure 9—Rear view of central control unit showing jumper-field interconnection of switching units.**

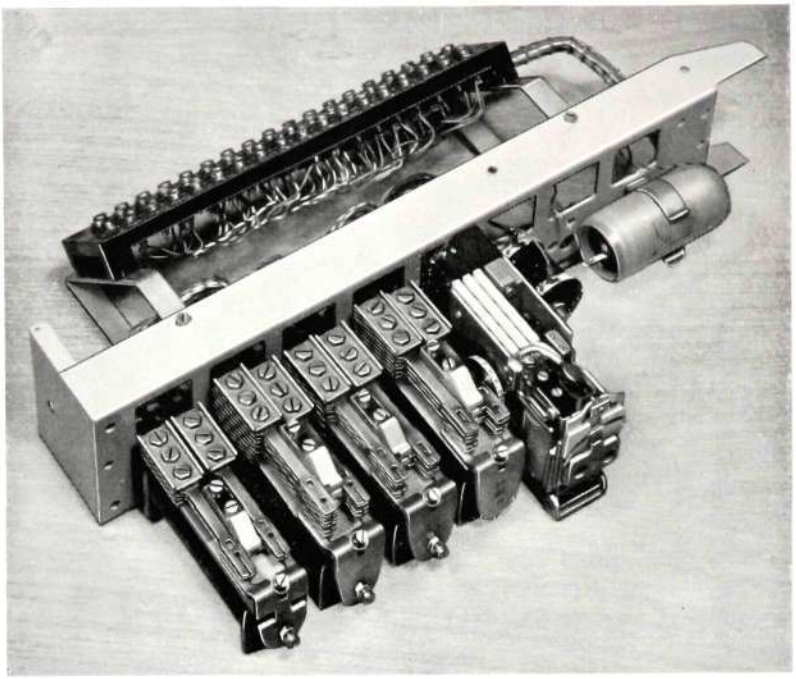

**Figure 10—The intercom-selector unit**

### Cabling and Line Limits

All lines terminate at the central control unit. For each exchange line or similar external circuit connected to the system, 6 conductors are required, multiple-connected via the instrument terminal blocks at each station. When internal communication is included in a system arrangement, each station requires 5 directly-connected conductors to the control unit.

The maximum transmission signalling limit from each station to the distant external line terminal is 1000 ohms loop resistance, less a loop resistance of up to 35 ohms allowed between stations and the control unit. This limiting resistance represents a station-line length of 220 yards (201 metres) $6\frac{1}{2}$ lb/mile cable.

### Conclusion

The highlight of the new system's design is undoubtedly its wide flexibility in use and, for this reason alone, Multiphone should have wide appeal. In addition, it has the advantage that only the apparatus currently required by the individual customer need be installed, a feature ensuring that idle equipment as well as investment are kept to the minimum. And further, the design permits faster installation and changes and, owing to the inherent simplicity of the switching apparatus throughout, it presents a low-fault liability.

*Brit. Patents Nos. 915,475 and 918,150 and corresponding foreign patents.*

U.D.C.621.318.5

# Miniature Relays

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*Some examples of the present range of miniature relays are described. An indication of future trends is given by a sub-miniature occupying one fiftieth of the space of a 3000 type, and a design approaching micro-miniature dimensions.*

DESPITE the challenge of solid state switching devices, the relay is at present being made and used in greater quantities than ever before. A factor likely to maintain the numerical demand is the continuing increase in new switching applications of all kinds.

The choice between relays and solid-state alternatives depends on considerations of cost, size and reliability in a given application, and their relative importance. The relay is at present considerably more economic where a number of switching actions are required, for these can be added up to the design limit with only minor increases of cost. It requires no ancillary components to secure its operation, and will withstand relatively high temperatures. A more incidental but potentially apposite quality is its immunity from types of radiation capable of ' paralysing ' transistor action.

To exploit such advantages, the relay must be made suitable for use in ' electronic ' equipment where its future undoubtedly lies. This implies, first of all, miniaturization. Additionally, its sensitivity and reliability must be such that the effectiveness of the equipment as a whole is in no way limited by them. The ideal is a sealed unit of indefinite life, of no concern to the equipment or maintenance engineer beyond what paths are provided via its terminals.

This brief review of the Company's range of miniature relays summarizes recent advances in design towards this end. The majority of the relays described were developed to fulfil specific services or NATO requirements, and the leading aim in design is suggested by the headings. The various specifications to some extent overlap, so that a primary characteristic of one group of relays, such as resistance to shock, will appear as a second characteristic elsewhere in the range.

### Relays to Withstand Shock and Vibration

Satisfactory operation and release at high values of acceleration is a necessary quality in many industrial and most Services applications of relays. Attempts to adapt standard designs by increasing the coil ampere turns and so raising contact pressure usually lead to unacceptable power dissipation and confer no immunity from misoperation when the relay is released. The only practical solution is to adopt a balanced construction for the moving parts of the relay.

This principle has been adopted in the design of a range of rotary armature relays. There are two forms, known as Type 2 and Type 3, distinguished by size and springset complement. In both types, the armature is inertially balanced and the springsets are distributed radially about its axis of rotation, so that the couples due to acceleration cancel out.

The mode of operation is explained by diagrams A to D in Figure 1. Referring to diagram A, it will be seen that the yoke is U-shaped and is symmetrical about the core-iron. The armature, seen in C, is of butterfly form, turning on the core-iron to close the double magnetic circuit via the arms of the U, and carrying a cam-ring to operate the springs. In assembly, the central boss of the armature is placed in the cupped end of the core-iron, the side slots of the cup clearing the wings of the armature to allow limited rotation. The annular gap between the cam-ring and the armature boss is sufficient for the cam-ring to clear the outside of the cup. An iron screw, shown above the armature in C, serves to complete the magnetic circuit and provide a pivot for the armature. The spring buffers are formed by projections on the upper face of the coil former, as shown in B. (The cut-outs shown here in the ends of the yoke serve to locate a centring-spider for positioning the relay in its enclosure). The action of

spring-operating cams and buffers on the springsets is explained by diagram D.

Both types of rotary-armature relay will operate and release satisfactorily under accelerations of 100g applied in any plane.

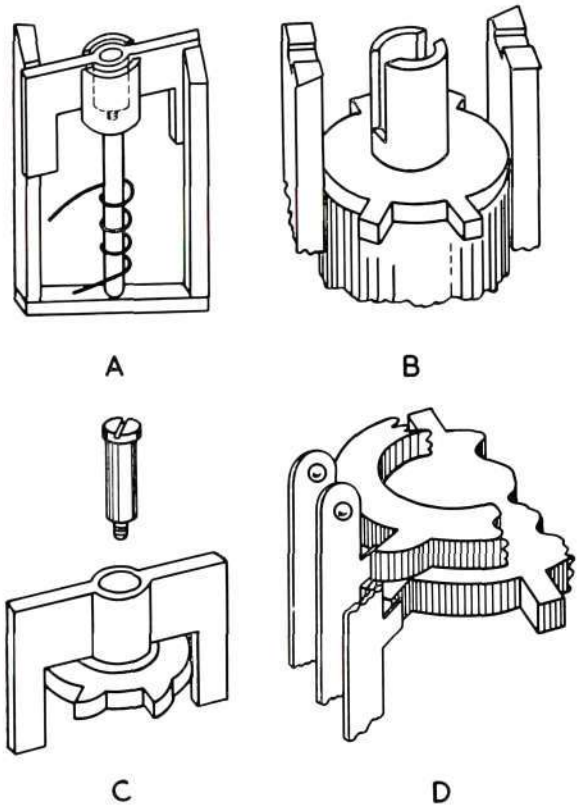



**Figure 1—Details of Construction of Type 2 and Type 3 relays**

### High-Sensitivity Relays

Transistorized equipment usually works at low power levels, and high component densities forbid excessive heat dissipation. It is thus doubly important that relays used in such equipment should be sensitive.

The Type 1A relay, shown digrammatically in Figure 2, is one of a group designed for maximum sensitivity and operates on less than 10mW. It will be seen that the return iron circuit of the yoke is interrupted near one end and the armature is positioned upon the gap. A lever system transmits armature movement to the springset, giving a single changeover action. The armature and springset are very carefully balanced and operation is unaffected by acceleration up to 20g in any plane.

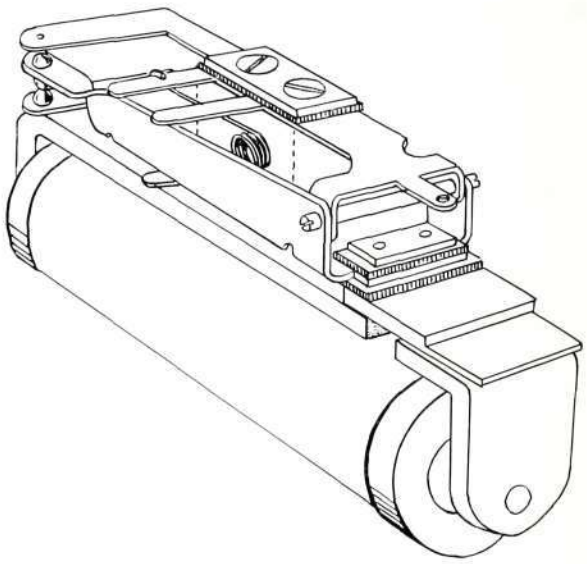


**Figure 2—Construction of Type 1A Relay**

Figure 3 shows the construction of another range of relays, employing polarization to attain a still higher order of sensitivity. A 'long-frame' and a 'short-frame' example are depicted. In both versions a torsionally suspended armature replaces the conventional pivoted arrangement. In this range, adaptations of a single design have produced a variety of performances and contact operation. Typically, a single-changeover long-frame example will operate on 0·043mW and a double-changeover on 0·087mW.

This design of polarized relay was used as a basis for the current range of 'choppers' (electromechanical contact modulators). The main problems in their design were discussed in Bulletin No. 44, pp. 24-27.

### General Purpose Relays

This group includes relays whose construction and performance fit them for a wide variety of purposes, with an expected stress on number and choice of springset actions. The available contact materials include all those in normal use, i.e. silver, palladium, platinum, silver-palladium and gold alloy.

The principal members of the GP range are conveniently classified according to the mode of springset operation; pin-lift or comb-lift.

#### Pin-Lift Relays

The prototype of this sub-group was first introduced in a 'walkie-talkie' power unit developed in

conjunction with the Signals Research and Development Establishment. A number of other versions, whose construction is represented by the example in Figure 4, have now been devised. These give a variety of normal and heavy-duty contact arrangements within a maximum of eight springs in two banks of four, the practical limit for pin-lift operation in a relay of this size.

A comparison between a GP and a 3000-type relay is afforded by Figure 5, also showing an assembly of five relays mounted on the base of an enclosure whose overall volume is the same as that of a 3000 -type relay.

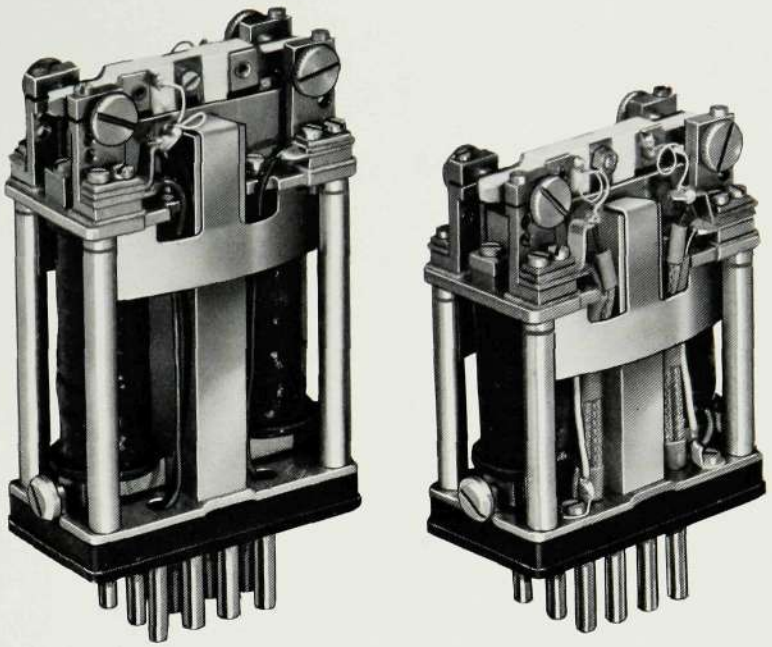


**Figure 3—Long-frame and Short-frame examples of polarized relay**

This enclosure is one of many designed for the miniature relay range to meet NATO and Service specifications, to provide for various modes of fixture such as embodiment in printed circuits, or to enable relays to replace units of U.S. manufacture. A representative variety of other enclosures is shown in Figure 6.

### Comb-Lift Relays

The comb-lift principle is used where the number of contact springs is in excess of eight. The difficulties in securing a satisfactory working life for a miniature design with heavier springset loadings have been overcome and these relays will work reliably over many millions of operations. Several variations of the type include the B.P.O. approved Type 16, shown in Figure 7, in a six-changeover version, and a special fast-operating relay Type GPST for use in computers and similar applications.

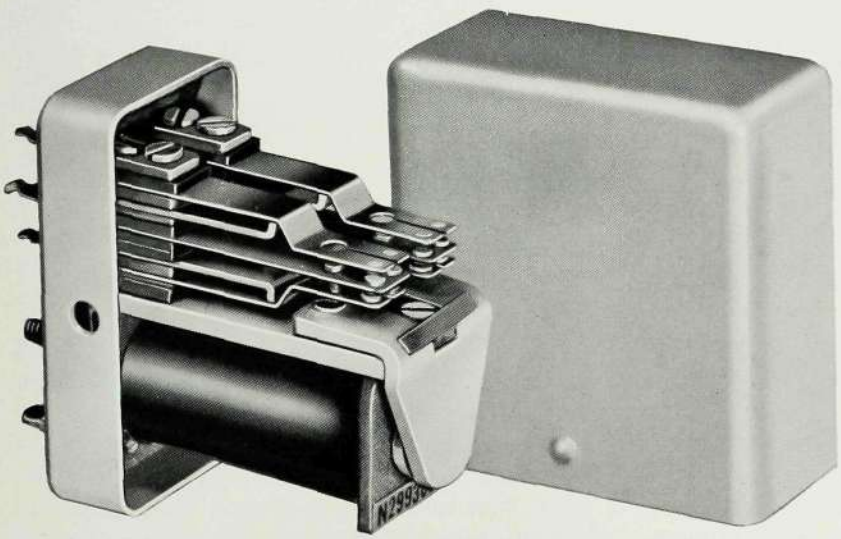


**Figure 4—G.P. Relay, 2-changeover pin-lift version**

### The Type 51 Relay

The Type 51 is a card-lift relay, dissimilar in design to the rest of the GP family but best fitting into the second subgroup. It provides up to eight change-over sets, or a maximum of 24 springs in two banks of 12 with many combinations of actions and, although larger in size than other GP miniatures, is considerably more compact than the 3000 or 600 type. Figure 8 shows a typical relay.

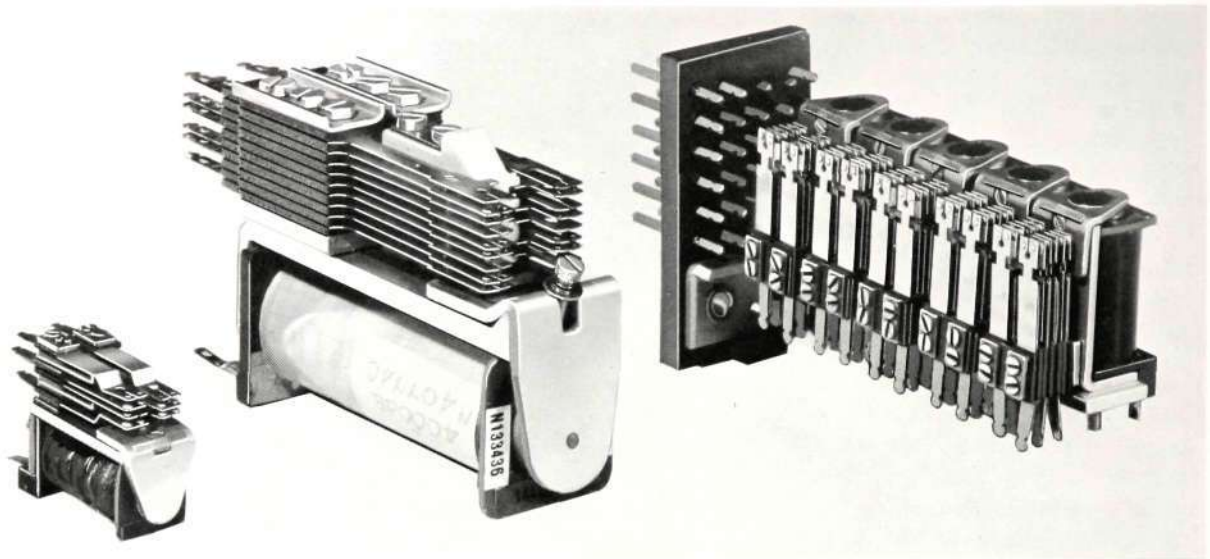


Figure 5—A G.P. relay in comparison with a 3000 type relay. The assembly of five G.P. relays is shown on right.

Figure 7—B.P.O. Type 16 version of the comb-lift G.P. Relay

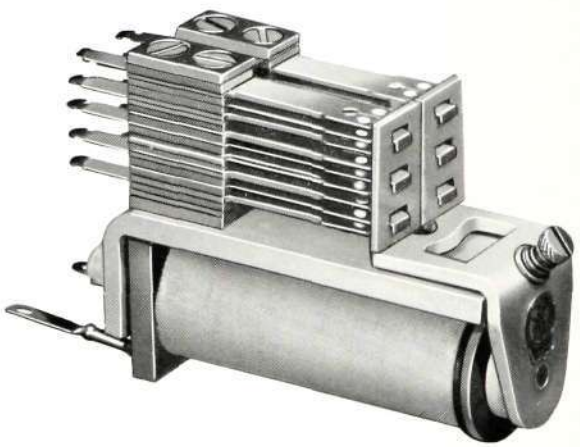


Figure 8—Type 51 card-lift relay; six changeover version

## Other GP Variations

### Low Capacitance Relays

In this design of relay the conventional flat springs are replaced by wire springs of silver-clad phosphor-bronze, mounted in moulded blocks. Spring separation is increased to give a further reduction of capacitance. A two-changeover action is provided, a typical relay being shown in Figure 9. Measurements at 1000 c/s show a capacitance value of less than 1$\mu\mu$F between any two springs, and less than 2$\mu\mu$F from any spring to frame. Suitable applications for this type of relay include the switching of video-frequency signals in television systems.

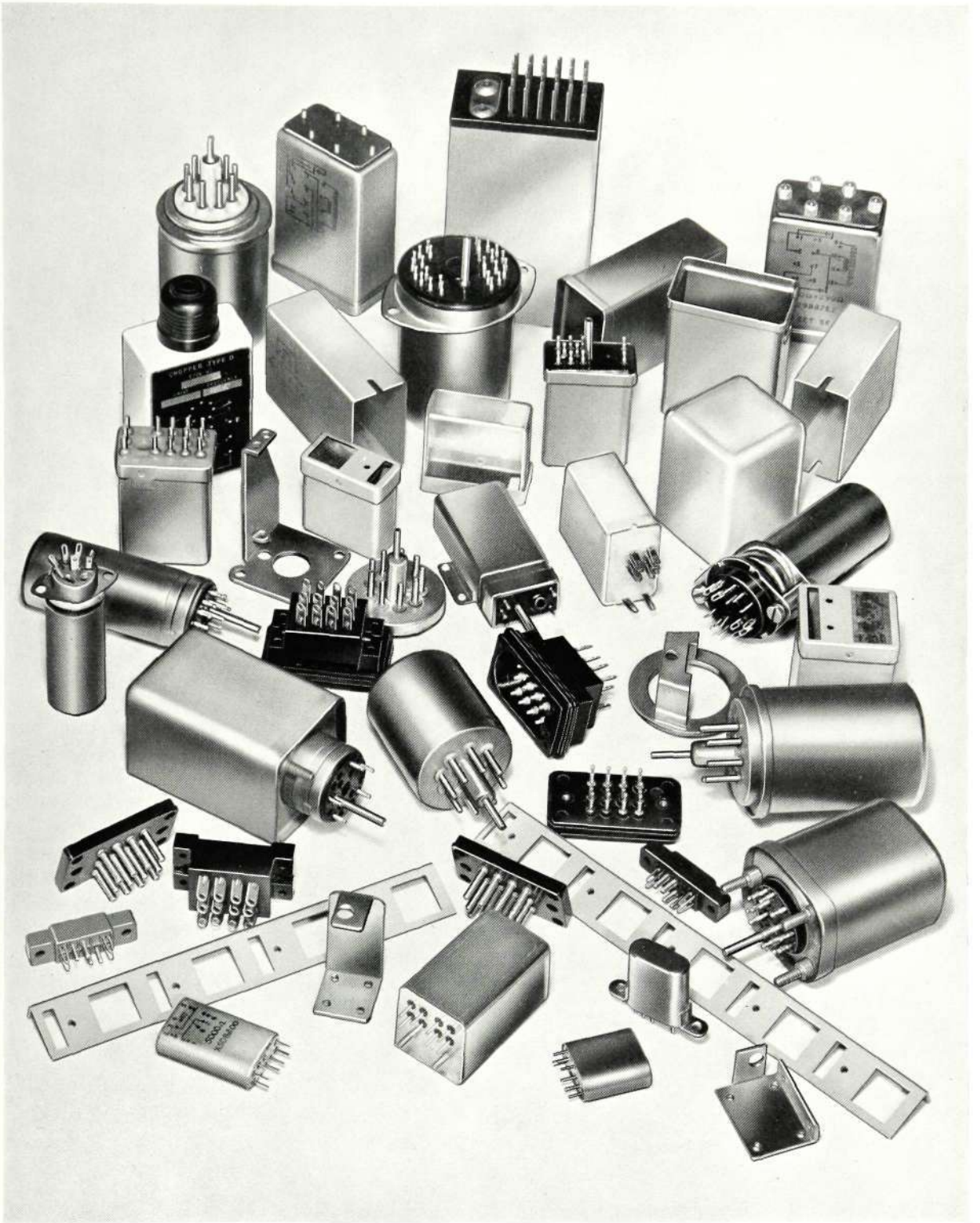


**Figure 6—A variety of miniature relay enclosures and mountings.**

Errata - Page 16
*Interchange captions and Fig. Nos. on Figs. 9 & 10*

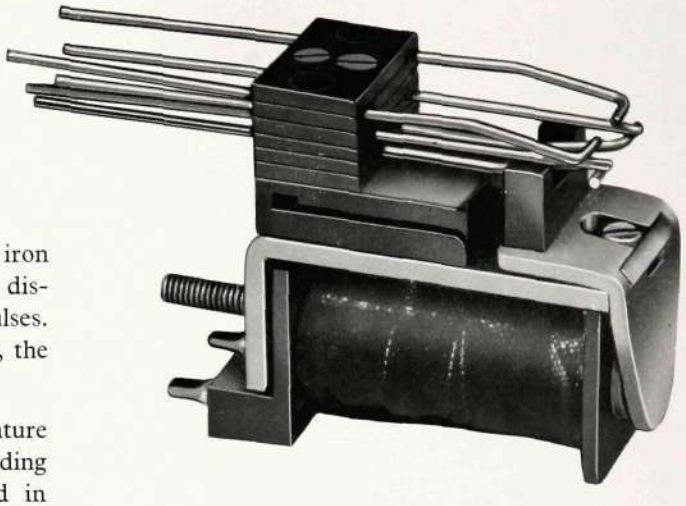


**Figure 10**
**Latching G.P. Relay**

THE LATCHING RELAY

By the inclusion of a permanent magnet in the iron circuit the GP relay becomes capable of discriminating between positive and negative pulses. The construction adopted is seen in Figure 10, the magnet being at the heel end of the core-iron.

At the two limits of its travel, the armature completes alternative magnetic circuits, both including the magnet. It will therefore remain latched in either position without holding current in the coil. A suitable current pulse of the correct polarity will overcome the latch and transfer the armature to its opposite position, where it will remain until a pulse of reverse polarity is applied.

The distribution of flux is such that immediately either latch is broken, the magnet assists the coil in setting up the opposite latch. As a result, the relay is more sensitive than the equivalent non-latching type.

Unlike other pulse-discriminating systems using remanent relays, the design avoids the need for a release winding and auxiliary or 'suicide' contacts. Both single and double wound versions are available.

## Sub and Micro-miniature Relays

The present trend in equipment specifications suggests that the acceptable limits of relay size will continue to decrease to a point well below what is now regarded as 'miniature'. There are in fact two parallel and increasingly evident requirements; greater compactness, and greater resistance to vibration and shock.

Fortunately, as regards relay design, the means of complying with the first is also constructive to the second. Moving parts when scaled down have a higher natural frequency and are therefore less susceptible to vibration; at the same time their reduced masses are subject to lower inertial forces on acceleration. The smaller coil-winding volume however means lower available ampere turns and correspondingly reduced contact pressures. Maximum efficiency of the magnetic circuit, improved contact performance and the exclusion of mechanical loss are therefore critical to the design of sub-miniature relays. In manufacture, the necessary standards of precision and finish are more exacting than in the production of larger units, and this implies a corresponding attention to tool design. In assembly, dust-free working spaces, and ultrasonic cleaning of the relays before sealing into their containers, are routine essentials.

TYPE 50 SUB-MINIATURE

The Type 50 sub-miniature relay, now in production, occupies less than 0·25 cu. in. (4·1 c.c.) and provides two changeover actions. It is a twin-coil

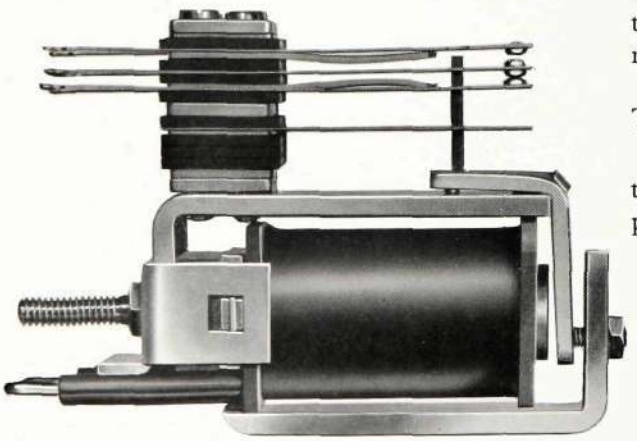


**Figure 9**
**Low-capacitance G.P. Relay**

balanced armature unit suitable for plug-in, wired-in or printed circuit applications. Several alternative mounting arrangements are provided including bracket and stud fixing.

Tests on production samples show a working life of between $10^6$ and $2 \times 10^7$ operations depending on contact loading. A rubbing contact action produces a very low and stable contact resistance throughout the life.

MICROMINIATURES

As an approach to the micro-miniature scale, a relay of approximately one half the volume of the sub-miniature is now being developed. This will incorporate a single changeover springset and have several new design features.

Figure 11 shows the prototype of this relay, and the Type 50 sub-miniature, in comparison with a 3000-type relay.

## Volume, Weight Ratios

A clearer conception of the small size and weight characteristics of the miniature relays discussed may be derived from the table below. The values tabulated relate to approximate volume and weight ratios between miniatures and the 3000 type.

| *Type of Miniature* | | *Comparison with 3000-type* | |
|---|---|---|---|
| | | *Volume* | *Weight* |
| Type 2 | * | 0·21 | 0·27 |
| Type 3 | * | 0·53 | 0·72 |
| Type 1A | * | 0·13 | 0·21 |
| Polarized (Long frame) | † | 0·57 | 0·5 |
| Polarized (Short frame) | † | 0·45 | 0·36 |
| GP | † | 0·14 | 0·09 |
| BPO 16 | | 0·15 | 0·1 |
| GPST | | 0·15 | 0·1 |
| 51 | | 0·29 | 0·33 |
| Low Capacitance | † | 0·12 | 0·1 |
| Latching Relay | | 0·19 | 0·1 |
| 50 | * | 0·02 | 0·03 |

*Relays with cover.
†Relays in Sealed enclosure

## Conclusion

The design of miniature relays is unlikely to become static in a period when equipment design is itself changing rapidly. It is intended that future designs will maintain and extend the areas of use where the relay can reasonably compete with solid-state devices.

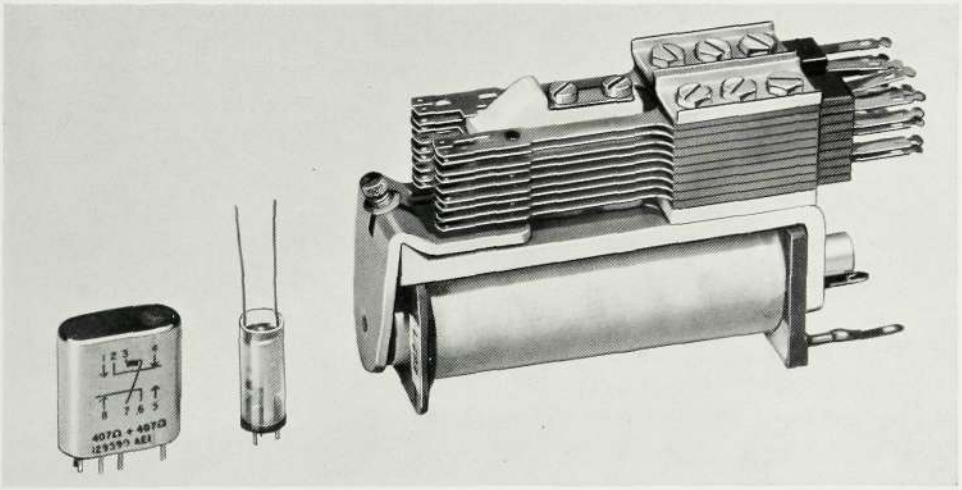


**Figure 11—Type 50 sub-miniature and prototype micro-miniature relays in comparison with the 3000-type relay**

*Brit. Patents Nos. 695,664. 748,313. 755,530. 772,008. 769,949. 845,935 892,844 874,207 896,565. 906,772 and corresponding foreign patents.*

U.D.C.621.395.006.3

# The Sunderland Branch Factory of Ericsson Telephones Ltd.

THE Sunderland branch factory of Ericsson Telephones Ltd. was opened in 1946 after some exploration of the area for suitable sites. The main intention was to take advantage of the freer supply of female labour in this area as compared with Beeston, Nottingham, the location of the parent factory. The creation of light industry in this part of the North had a topical exigence then, as now, and official encouragement gave further impetus to the move.

The original factory building at Southwick, on the outskirts of Sunderland, was then of recent construction with a floor area of 67,600 sq. ft. It had been intended for Services clothing manufacture, but was almost ideally suited to the initial purpose of assembly, wiring and testing of parts supplied from Beeston. Four members of the Ericsson staff moved to it and started recruiting and training local labour. Within months the complement rose to 200, and today the total labour force exceeds 2,000. In character the unit has always been more than a remotely-controlled extension of the main factory; much of the inspiration and effort going into its growth has been that of Sunderland people, and this has become so increasingly over the years.

The original floor space, now referred to as the ' old factory ', was in due course found inadequate for the volume of work which could be handled and, in 1959, the first ground was broken on the ' new factory ' site, on a parallel alignment some 50 yards from the old. Here, a block covering an area of 16,600 sq. feet was built and assigned to selector bank assembly and wiring, subscriber meter assembly, cord termination and other work transferred from Beeston.

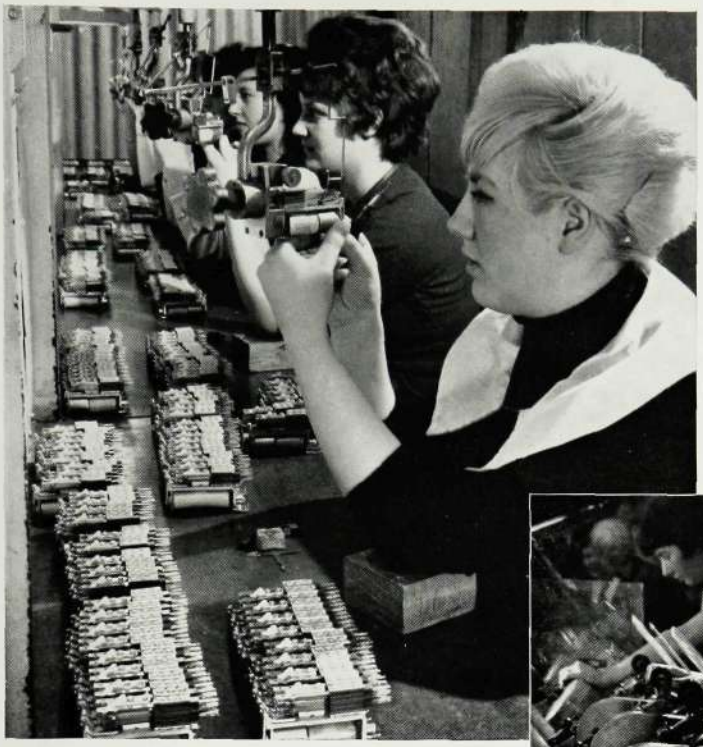
The pace of expansion at this stage was enough to show the need for local manufacture of piece parts rather than complete dependence on supplies from Beeston, and an extension to the new factory was accordingly planned and completed in late 1962. This comprises a large machine shop together with plating, finishing, heat treatment, tool room and material storage areas, an unloading bay and an office suite. The total new factory area was now 56,000 square feet. A further 27,000 sq. ft. extension to the factory, on neighbouring ground provided by the Sunderland Corporation, is currently under construction.

## PRODUCTION

### The 3000 Type Relay

Although the factory has taken on and quickly adapted itself to the assembly of a variety of products through the years, the undoubted highlight of its production is the 3000-type relay, now passing 40,000 a week in output. Apart from the bobbin and a few minor piece-parts, the relay is now manufactured completely at Sunderland from the raw material stage, an impressive achievement in view of the short time that the machine shop has been operating.

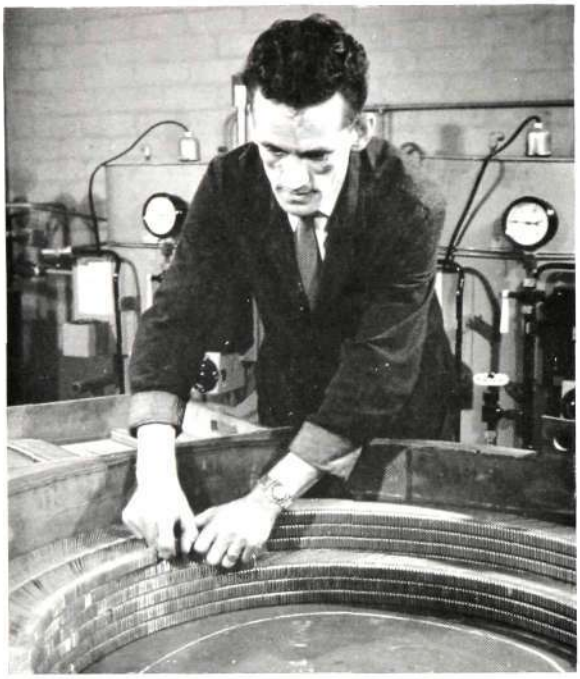
First introduced in 1932, the 3000-type relay still predominates in BPO switching equipment and in much of that supplied to overseas administrations. It is likely to be in sustained demand for many years to come, even beyond the general introduction of the electronic exchange. With a maximum complement of 18 springs, the relay can provide for literally hundreds of different switching combinations, and the very fact of this versatility excludes it as a subject for purely repetitive mass production. In the factory's weekly output, there are hundreds of separate batch-orders each having a different coil or springset requirement. Beyond the winding and gross assembly stages, each of these batches must be individually handled and the completed relays adjusted and tested to tolerance. A substantial part of the cost of a relay derives from the allocation of labour necessary in springset assembly, and the individual testing and adjustment of the completed



3000-type relay spring adjustment using beam balances. The operators are given a 10-minute anti-fatigue break every hour

600-type relay coils in production on Aumann machines. One operator is here seen tending three winds. Plastic hats over the stationary spools 'funnel' the wire out from the spools to jockey wheels, thence to the machines.

One stage in the final adjustment of 3000-type relays. The operator is adjusting the relay residual to bring the main operating parameters within tolerance. The operate and release times are checked by the Dekatron interval timer *(upper right)*



**Packing 3000-type yokes for heat treatment after machining. This basket takes 10,000, the cycle lasting 21 hours. Sufficient heat treatment capacity exists for 30,000 complete relay magnetic circuits per day**

items. At Sunderland the springset assembly has been speeded up as far as possible by the use of static track and by continuous work-study, but the processes of testing and adjustment remain specialized and, by their nature, time consuming.

The traditional method of adjusting a relay involves prolonged bench work with tensioning pliers. At Sunderland, this has been replaced by an improved method where the springs are tensioned to a pre-determined extent before assembly. Since errors in a manipulation such as spring adjustment are averagely in proportion to its amount there is in essence less trial and error in removing a small amount of tension than in applying a larger one. The detensioning is carried out in conjunction with a beam balance, the work being fixed in a jig at the operator's eye level. When the spring adjustment is satisfactory, the performance of the relay is checked by testers who determine the saturate, release, operate and hold currents of the relay and if necessary make slight adjustments to bring these within specification. The operate and release times are also checked by means of advanced electronic timing equipment developed at the main factory. This equipment, employing *Dekatrons, is also used for checking high-speed relays and is capable of measuring to an accuracy of 10 microseconds. All relays are flash-tested to specification.

A high standard of adjustment is maintained by constant quality control, where a randomly selected proportion of the relays is checked in all characteristics. As the Company is a major supplier to the BPO, the factory further submits all relays so contracted for, to a full-time BPO inspectorate maintained in the factory. Thus, as regards this part of the output, quality control is effectively doubled. Stringent control is justified by the present-day complexity of switching equipment, where breakdown due to failure of a relay may occasion a loss many times the cost of the component, and where capital outlay can only be amortized if installations have a definite minimum life expectation. The

**Operator assembling Type 12 relays. The relay armatures and coils have been fitted and anchored to the six-position yoke and the operator is now adding the springset sub-assemblies. The further addition of a captive nut and screw at each position will complete the relay strip**

* *Registered Trade Mark.*

criterion of inspection is not merely ' does it work ?' but ' how many years will it work ?'. If, for example, a moving spring of a relay does not lift off the buffer block, operation may still be normal when the relay is new, but it may be otherwise when some contact wear has occurred in use. Again, if the twin contacts on a spring do not make and break in unison, one contact will carry all the current for part of the cycle and wear will be, at least, doubled. Such defects are counted as major faults, and if more than one appears in a batch of 10,000 as randomly sampled, the whole batch must be reprocessed. Further to this, if the number of major faults in five consecutive batches is not less than five, ' tightened sampling ' is enforced, a measure whereby no major faults are allowed at all for five further consecutive batches. These measures are similarly applied upon the incidence of ' minor ' faults but with an allowable ratio of four minor faults to one major. Minor faults may be even quite small defects such as a skew label or a slight plating blemish.

**Jack-in relay set wiring. An operator wires in a capacitor box on an almost completed set. The rotatable wiring frames are in the background**

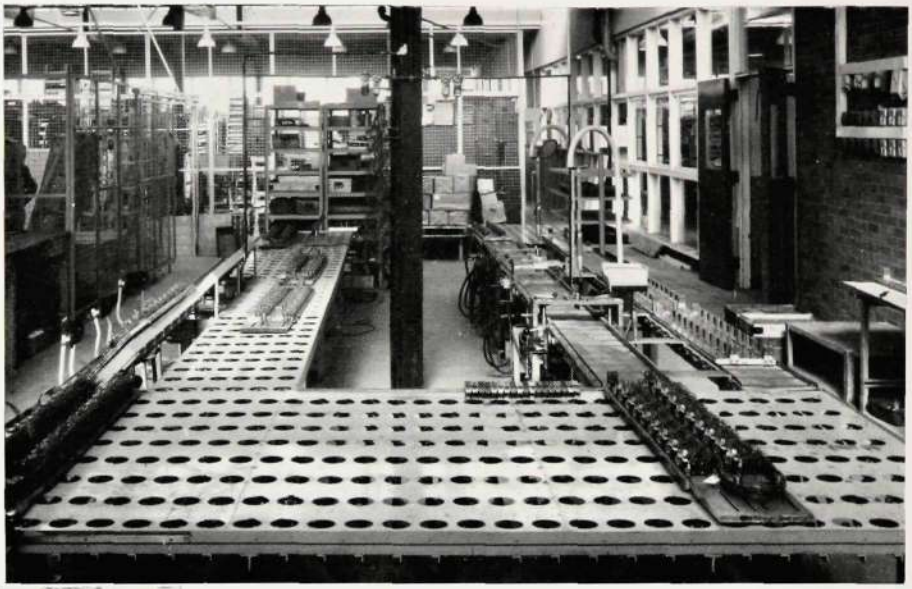
### Coil Winding

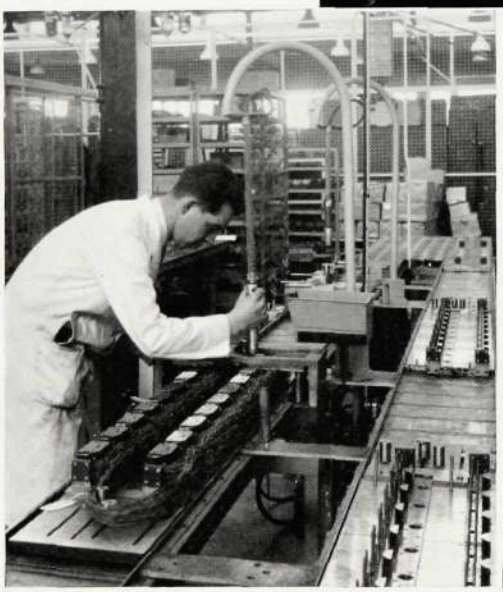
Constant study and improvement of coil winding techniques at the factory have steadily improved output to a present weekly figure of nearly 300 coils, or fully wound bobbins per operator. This is a notable achievement when it is considered that a coil may carry single or multiple windings (including non-inductive winds) up to 100,000 turns and must conform closely to specification in all respects.

Winding is divided between two types of machine; a Swiss (Micafil) and a German (Aumann). The former is a general-purpose machine having a much longer spindle than is actually needed in production, and it is gradually being replaced by the more recent and compact Aumann. Up to four Aumanns can conveniently be attended by one operator on long windings, whereas the Micafil, due to its size, is usually a one-operator machine. As many as possible of the shorter winds are therefore given to the remaining Micafil machines. Twenty-four further Aumanns are on order at present and are expected to save their cost in wages in less than a year.

Both machines operate on the stationary supply-spool principle. In this, the spool is fixed vertically and the wire comes off over the upper cheek, centrifugal force and air-cushioning preventing abrasions. No difficulties arise from the twist

Showing the assembly table with manual stacking positions at the left. A fully stacked two-bank multiple is seen entering the inspection track on the right. The table has inverted inset castors for easy movement of work





Impacting track. Stacks are impacted two at a time by the horizontal cross-member, seen with its actuating rams within the framework under the operator's hand. The operator is driving home the retaining screws before pressure is released

*SELECTOR BANK MULTIPLE WIRING (PILOT PLANT FOR INSTALLATION AT SUNDERLAND)*

Wiring and soldering line. The bank sectors in the jig on the right-hand track are being wired as the jig travels towards the camera. The jig is then transferred via a cross-over to the left-hand track which carries it to the fluxing station and thence to the solder-dips (*left of centre*)

imparted to the wire, or when the spool is nearing exhaustion, and the method obviates the varying strains unavoidable with rotating supply-spools.

No joints are permitted in windings, except where there is a resistive add-on. A certain loss in scrapped wire and operator's time is thus unavoidable, but this has been reduced as far as possible. Coils incomplete due to breakage or short-winding are removed from the bobbins on a turntable unwinding mill. This machine is unattended apart from fitting the rejected bobbins and feeding the empties back to the production line, and the accumulated scrap wire is recovered from it periodically. Another source of scrap arises from the need to discard supply spools from the winding machines before they are completely exhausted. There is a paper ' tally ' in the inner layers of the spool and it has been found more economic to complete the winding in hand and discard the spool on first sight of this, rather than attempt further windings.

The resistance of coils has to be held within close limits to conform with specification. Wires of the same nominal gauge differ somewhat in resistance, and the first coil off a new supply spool is given about three per cent more turns than normal. The resistance is then checked and turns removed to bring the coil to standard, the amended total of turns being followed in subsequent winds.

About ten per cent of the total coil production is impregnated to meet Services and overseas specifications, particularly those of the Australian Post Office, and also for preparation of fully tropicalized relays. These relays when fully assembled, receive further partial dips to seal the springset assembly. Interwind dipping is not now carried out except on certain specialized tropical coils as it has been established by prolonged research that adequate protection for most purposes can be given by outer dipping of sufficient thoroughness. For this reason, the dipping plant, originally planned to cater for interwind treatment, has a present capacity equal to any foreseeable demand.

### Miscellaneous Relays

Apart from the 3000-type relay the factory's output includes the smaller and simpler 600 type, the new Type 12 relay,[1] and high-speed relays. The sum total production now approaches 20,000 per week and is subject to a quality control similar to that applied to the output of 3000-type relays. The total consumption of enamelled wire on all relays is about one and a quarter million miles a year, roughly a mile every six seconds of the working day.

[1] *Described in Bulletin No.* 47, *pp.* 59 *to* 63.

### Jack-in Relay Sets

About a third of the output of relays is built up into fully-wired jack-in relay sets. The sheet-metal pressings for the sets are at present supplied from Beeston but final assembly work is completed at Sunderland.

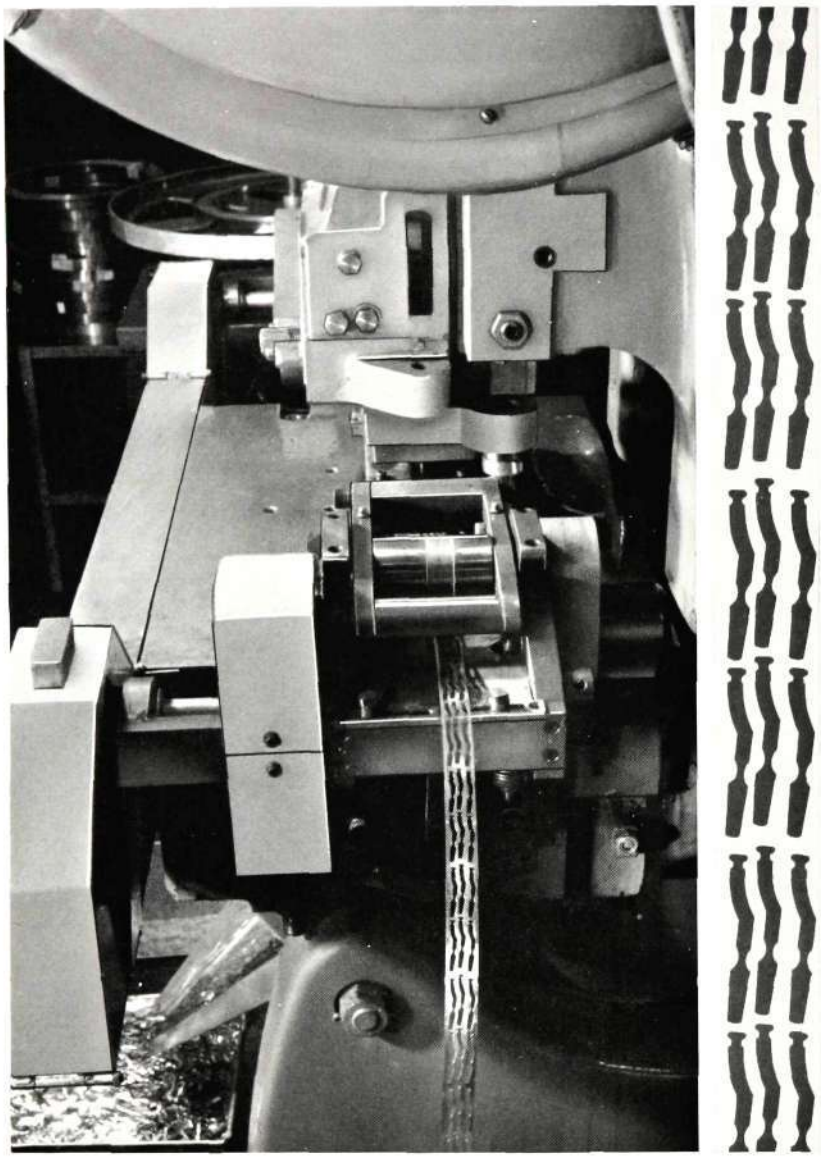
Wiring is carried out on four-sided rotatable frames in a large bay close to the relay assembly lines. Adjacent frames are filled up with unwired sets of the same type, and each operator is allotted a certain portion of the wiring, completing this upon each frame before moving to the next. The frames are ' fed ' with pre-cut and prepared lengths of wire arranged in dispensers by the side of the operator. Detail work, such as the addition of wire-ended components, is done afterwards on the bench.

Considerable method and preparation is called for in filling up the dispenser and docketing the colour-coded lengths to connote with the various wiring operations, and in dividing the work between operators to ensure full occupation.

The uninterrupted production of these relay sets is in one sense a rather special aspect of the Sunderland organization, for the nature of the work is perhaps less conducive to a uniform flow than any other in the factory. An order for a thousand relay sets may involve wiring in anything from five thousand relays to twenty-five thousand according to the size of the sets. Forward-load estimation of labour is thus difficult over any but short periods, and intelligent planning of labour requirements is necessary to meet the programme as the load rises and falls.

### Two-motion-selector Bank Assembly and Multiple Wiring

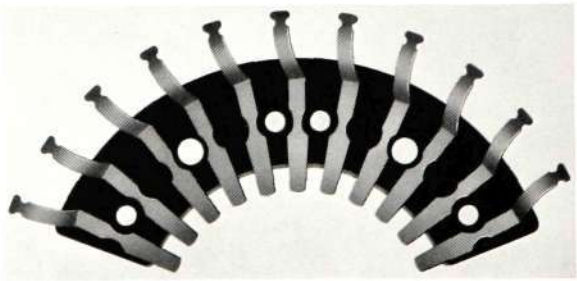
A weekly average of 3,500 selector banks are fabricated in the new factory and completely wired up into shelves. Since the flow of piece-parts from the machine-shop began, the output of banks has risen, and a further increase in wired banks is expected when a semi-automatic assembly line, now in process of installation, is completed. The present process involves hand assembly of the banks and wiring as two separate operations. The bank contacts are stuck by heat and pressure to varnished fabric sectors; the adhesion, though not strong, suffices to hold the contacts in position until the assembly is sandwiched up. The fabric is backed with bakelite sectors



**One of the automatic presses seen producing selector bank contacts. All the machine shop equipment was moved from Beeston in late 1962**

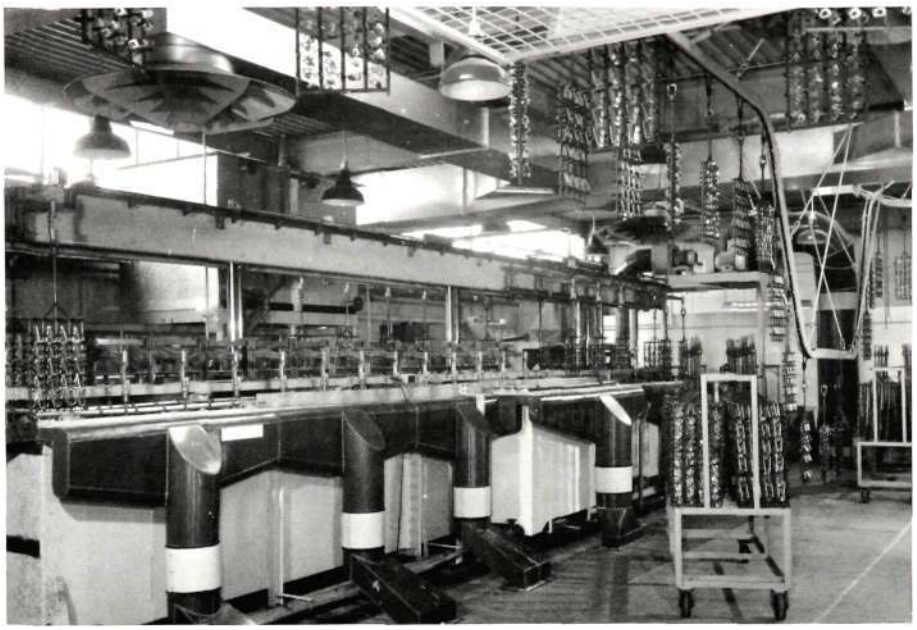
ground to thickness, and a level is assembled with the pairs of contacts facing together through an insulating separator of plastic. Aluminium spacers are placed between the levels, and the whole sandwich of 10 levels is lined up between containing cheeks of mild steel and compressed to about half a ton, while screws are inserted through the assembly and hand tightened. Constant watch is maintained on the individual thicknesses of parts to secure correct level-spacing since, within the normal raw material tolerances, the contacts, fabric and aluminium all vary appreciably in thickness. So far as these cannot be arranged to cancel, the grinding of the bakelite sector is varied to accommodate changes between different batches.

**A level of selector bank contacts ready for stacking**



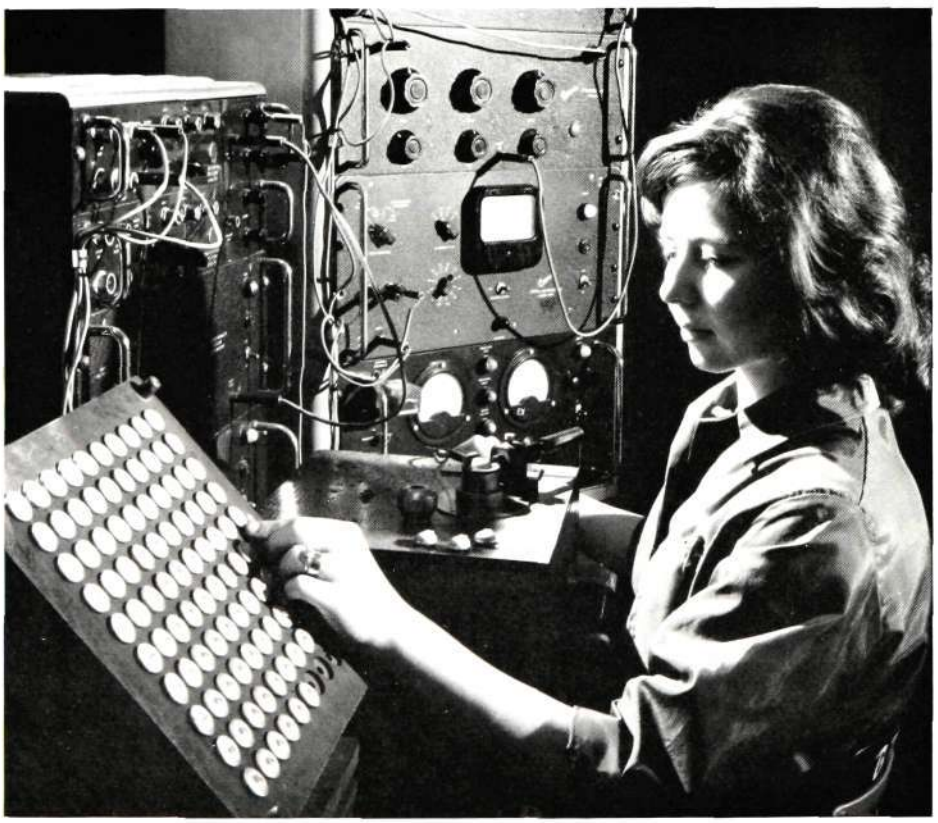
**Selector bank multiple wiring (the old method)**

**Final adjustment of subscribers' meters**



**Continuous plating plant**

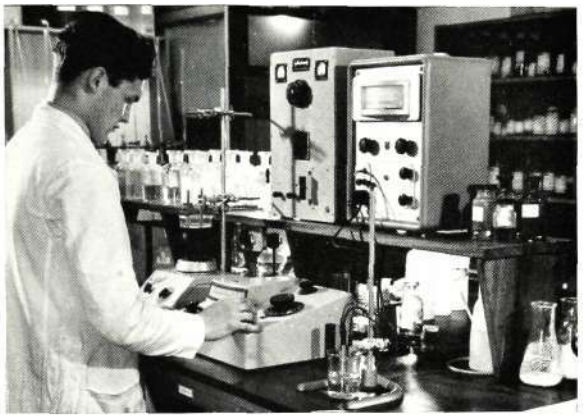
**This plant has a capacity sufficient for a daily output of 15,000 major relays. The nickel on chrome deposit is maintained to the close thickness tolerance imposed by by B.P.O. specifications.**



**Testing hearing-aid receivers. The factory has made very large numbers of these for the Ministry of Health. An improved telephone receiver inset based on the hearing aid receiver design is now in production at Beeston**

The 10-level banks when completed are arranged on jigs to form a shelf of 10 bank assemblies each comprising banks in tiers of 2, 3 or 4 according to the particular bank-switching requirements of individual 2-motion selectors. Following this operation the 2, 3 or 4-bank shelf is transferred to the wiring bay.

The semi-automatic or ' multiple wiring ' process combines bank assembly and wiring in one operation, with considerable saving in labour and floor space. The end product is a 2-bank shelf consisting of two wired rows of ten banks joined together by a swan neck. Three- and four-bank shelves are formed from this by subsequent manual wiring. Two three-bank shelves are, for instance, formed from three two-bank shelves by cutting one of the swan-necks.



**A corner of the laboratory showing calorimetric analysis of factory effluent**

Wiring is done on the individual levels of the banks, one level at a time, before the banks are stacked. A rotatable jig, in the form of a horizontal shaft, has twenty spring-loaded clamps at suitable intervals along its length. The jig is motor driven past the operators and pre-stripped lengths of wire made off on the contact tags. On completion of wiring, the jig is driven and rotated over fluxing rollers and into a soldering enclosure. The resulting wired string of levels is now detached from the jig and ' lanterned ' manually to bring the levels into the horizontal, and about the correct distance apart. The string is doubled up about the swan-neck and placed in a stacking jig together with nine further strings and the required separators and containing cheeks. The complete stacked assembly is now impact sandwiched by a pneumatic ram to a precisely controlled total thickness, secured by screws through the containing cheeks and ejected pneumatically from the jig.

Thickness selection of the bakelite is avoided in this process by the use of ribbed aluminium separators. Under impact, the ribs collapse to an extent compensating exactly for variations in the thickness of the other components of the stack, provided all materials have come from the same batches.

There is considerable pull on the contact tags during the wiring and manipulation of the strings, and sticking the contacts to varnished fabric is not satisfactory. The contacts are stuck instead to the bakelite. This is coated with a special varnish in a continuous spraying and heat-treating plant developed for the purpose. The bakelite is prepared in the raw-strip stage before grinding, since the grinding process must allow for inevitable variations in the thickness of the varnish. In preparation for the new process, the factory has been using this method of securing contacts for some months and the varnishing plant has been installed and operating satisfactorily over this time. An automatic machine to dispense and stick the tags on to the bakelite sectors has been developed and will shortly be in full operation.

### Other Products—The Future

Besides its main activities, the factory at present produces average weekly totals of 8,000 heat coils, 15,000 spark-quench and other resistors, 700 generators both of the rotating armature and rotating magnet type, 3000 subscribers' meters and 200 Etelphone-type plunger keys and springsets. In addition, some 15,000 cords of various types are bound and terminated.

New processes, methods and materials are continually under review. Changes in production methods must not only be basically sound but must gain the approval of the major authorities to whom the Group contracts. Other improvements in production, though evident, are frequently delayed by cost of materials. One instance is the use of self-fluxing and self-bonding wire in certain coil winding. A coil of this wire, when heated by a suitable current passed through it, bonds into a solid block completely impervious to moisture. The factory has had considerable experience of the use of this wire in winding small cheekless coils for hearing-aid receivers, but its present cost prevents wider use.

With the labour force of the factory almost doubled in size over the last two years alone, and new acreage made available for expansion, there is little doubt as to future progress in scale, but latent growth, as foreseen and planned for, is always ahead of the acquisition of new floor space and labour in an organization possessing vitality. This brief survey of the factory's activities, and of the gathered skills of those employed in it, shows this to be true of Sunderland.

621.394.34

# A Telex Concentrator

M. V. DUNN, Bach.Eng. (India)—Circuit Development Engineering Department

*The article describes a unique equipment designed specifically to enable Telex service to be economically extended to areas of low subscriber density which hitherto have been excluded owing to long distances and high costs.*

THE increasing expansion of automatic Telex service in many parts of the world has given rise to the problem of providing efficient service to isolated groups of Telex subscribers at reasonable cost. This problem is particularly acute in developing countries where the existing Telex network mainly serves principal cities and towns but where commercial and industrial growth demands interconnection with small towns often widely dispersed from main Telex centres. Because of low subscriber density, the linking of these small towns with the national network does not initially justify the separate provision of a satellite exchange. Moreover, individual connection of such subscribers to a main exchange is precluded owing to excessive distances, since it is both cumbersome and expensive to provide and maintain along a route a separate pair of wires for each circuit.

These drawbacks, retarding full coverage by the Telex service, are overcome by the Telex Concentrator, an equipment concentrating subscriber traffic over a group of junctions less than the number of teleprinter stations served. First of its kind to be designed and manufactured, it is particularly useful where economy of cost is a prime consideration and, in addition, affords a valuable means of connecting otherwise isolated groups of subscribers to the national network via a main Telex exchange. Basically the new design caters for up to 20 teleprinter stations connected over a maximum of 10 junctions.

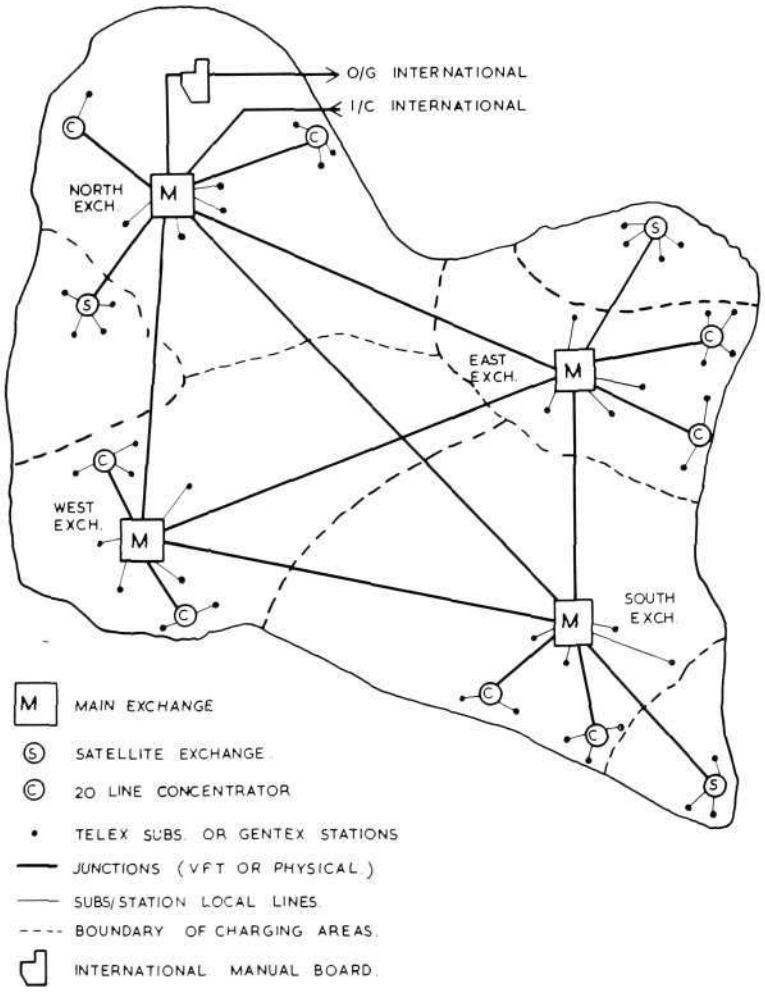



**Figure 1—Use of Concentrators in a typical National Network Area**

Integration with the national network presents no difficulties. Not being a satellite or dependent exchange, it requires no code digits or re-arrangement of numbering to route the traffic to and from the main exchange. This important feature, coupled with relatively low cost, makes the Concentrator an attractive and convenient system to install for immediate Telex service. Furthermore, its easy installation allows other Concentrators to be progressively added to an area to meet expanding needs until subscriber increase warrants the use of a satellite exchange. When this stage is reached, the equipment can be recovered and used elsewhere. Figure 1 illustrates the

use of the new design in a typical national Telex network area.

Careful consideration has been given to ensure compatibility with Telex systems in general use. For this reason the equipment, consisting of two separate units for individual installation at the main exchange and subscriber terminals, can be used with any Telex system employing conventional step-by-step switching with dial selection and type-B signalling over a 2-way simplex ± 80V transmission path. Junctions interconnecting the Exchange and Subscriber units may be physical or comprise a voice-frequency telegraph (v.f.t.) link.

Both units are completely self-contained and suitable for ready removal to other locations when desired. The Exchange unit is rack-mounted to conform with existing Telex equipment, and the Subscriber unit is totally enclosed in a floor-standing dustproof cabinet because of the likelihood of its installation at an attended telephone or carrier terminal or any building at the centre of subscriber demand. Jack-in relay sets are used throughout to permit savings in equipment and cost in areas where traffic is light and fewer than 10 junctions are required initially.

The system, using well-proved components throughout, has a high standard of reliability. This is further improved by the provision of a standby allotter and control set at the Subscriber unit, changeover switching being automatic after two successive faults occur. By this arrangement, continuity of service is maintained and the immediate need of servicing avoided; an important requirement especially when the Subscriber unit is unattended. In addition, the system includes comprehensive alarm arrangements. These conform in the Exchange unit with the existing main-exchange scheme and, in the Subscriber unit, with attended working practice. For occasions when the latter unit is used in an unattended capacity, provision is made for a fault-test facility to allow conditions at this terminal to be determined by dialling a number from the main exchange.

### Trunking Arrangement

Figure 2 shows the trunking arrangement of the Concentrator. A common group of 10 junctions interconnect Subscriber and Exchange units. Each junction-end terminates on the wipers of a single-motion switch, the bank contacts of which are connected at one end to the Concentrator stations via line circuits, and to the final selector multiple via exchange line circuits at the other. Calls to and from the Concentrator stations are connected by causing each pair of switches associated with a junction to

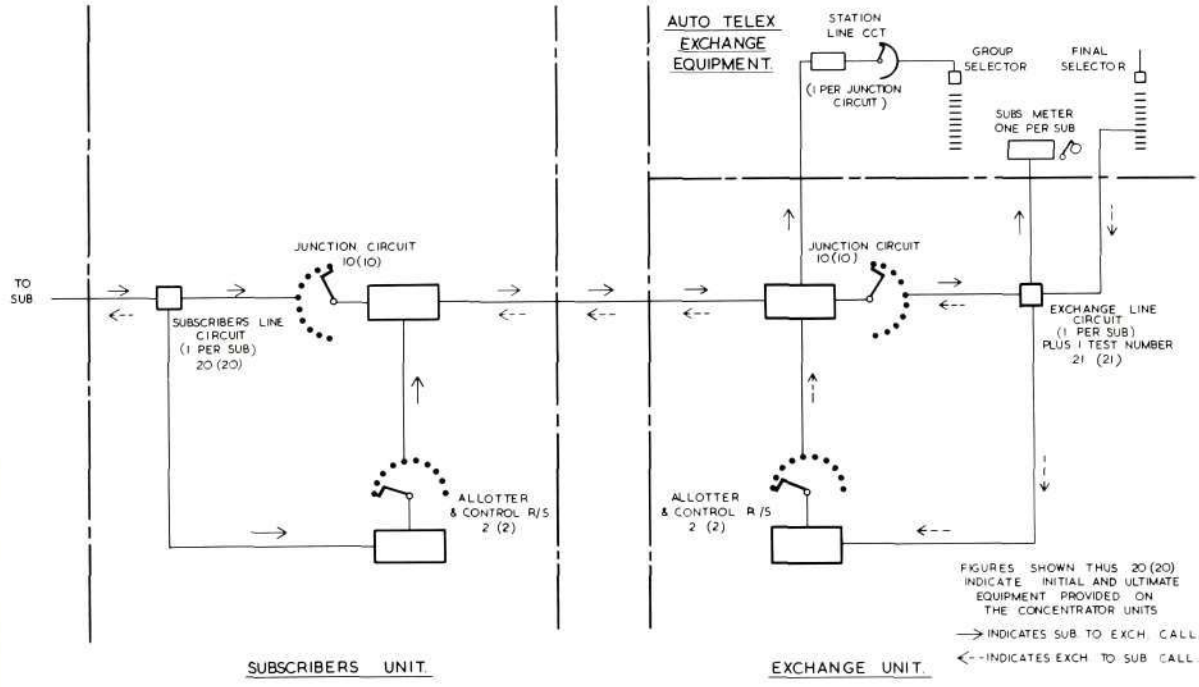



**Figure 2—Trunking Arrangement of Concentrator.**

step in unison until the appropriate contacts are reached.

At the Subscriber unit, the main and standby allotter and control relay-sets are interposed between the subscriber line circuits and junction circuits and serve to allocate a free junction and control the correct setting up of a call. These relay-sets are employed on subscriber-to-exchange calls only.

At the Exchange unit, a similar number of allotters and control relay-sets are provided for calls routed via the main exchange to the Concentrator stations. In this instance, however, both relay-sets are available for calls and function alternately, no standby being provided because of the ready availability of maintenance staff. The allotter wipers rest on a free junction to ensure that no time is wasted in ' junction finding ' when setting up a call.

MDF and IDF, the junctions pass through interception jacks on the Engineering Control Board (ECB) for test purposes. Similarly, in order to conform to normal exchange practice, the Concentrator subscriber lines are connected to interception jacks on the ECB, enabling faulty subscriber lines to be plugged out at the main exchange. Under this condition, the service signal DER (Line out of Service) is returned to the caller requiring the station associated with the faulty line.

### Traffic Handling Capacity

Using full availability traffic tables, 10 trunks can handle 3·96 erlangs with a grade of service of 1 lost call in 200 or 4·46 erlangs with a grade of service of 1 lost call in 100. In practice, these figures are bettered, owing to the fact that on calls from subscriber

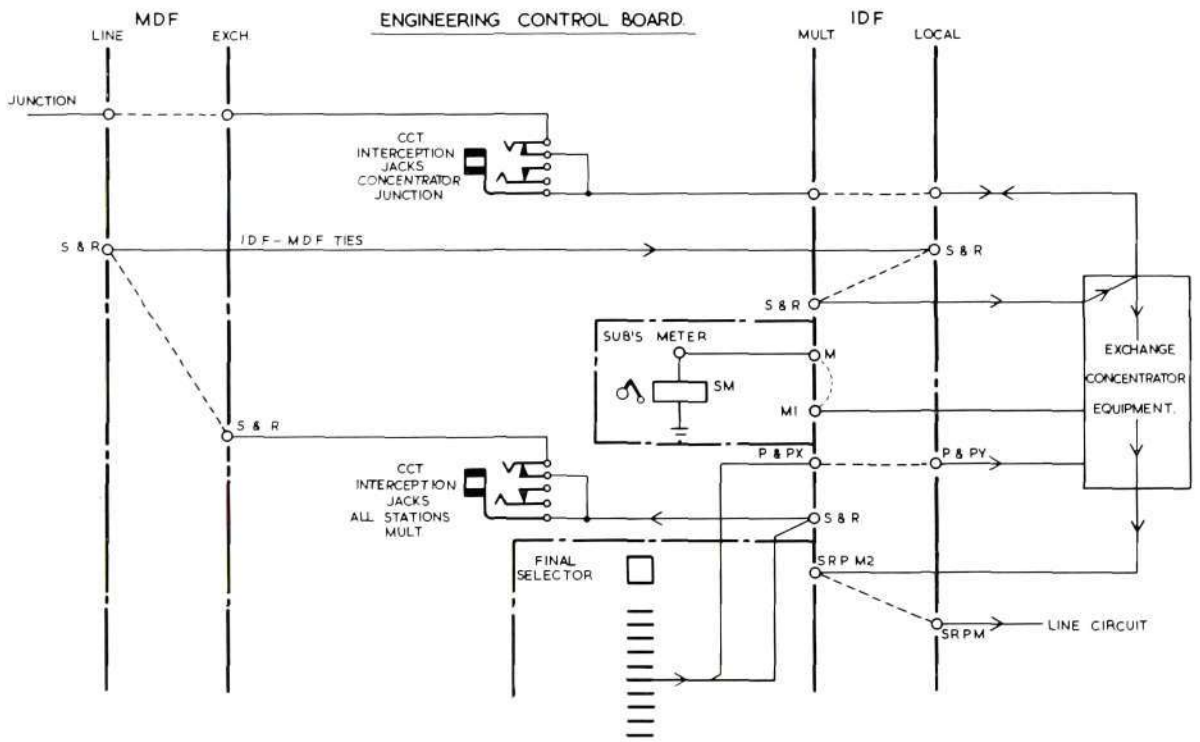



**Figure 3—Trunking the Exchange unit into main Telex exchange**

Figure 3 illustrates how the Concentrator Exchange unit is trunked into the main Telex exchange equipment. The incoming junctions, shown on the left in the diagram, are extended from the MDF via interception jacks to the IDF where any station line circuit and final selector number may be picked-up by adjustment of the jumpering field. Between the

to exchange, the traffic emanates from a small number of sources (*vide* BPO Traffic Table J). Although calls between two Concentrator subscribers occupy two junctions during the holding time, local Telex calls amount to a small proportion of the total number of calls (5%-10%), hence service is not degraded to any significant extent.

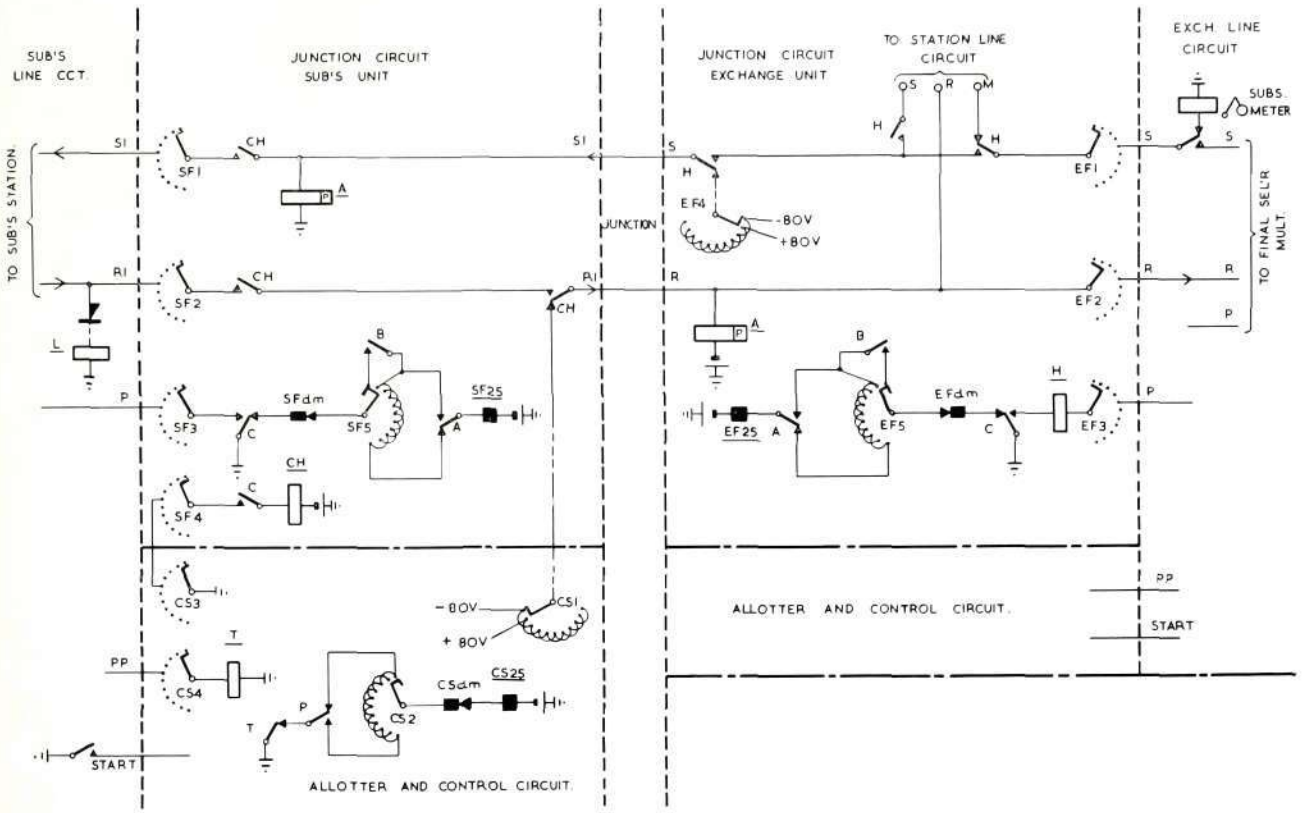



**Figure 4—Simplified Schematic of Subscriber and Exchange units**

## Basic Principle of Operation

OUTGOING CALL FROM CONCENTRATOR SUBSCRIBER (Figure 4)

A call from a Concentrator station is initiated by pressing the call button at the station control set. By this action, relay L in the Subscriber unit energizes to mark the calling line and, in addition, put forward a start signal to the allotter switch (not shown) which self-drives to seize a free junction. Following seizure, a pulse generator activates, its P contact pulsating to cause the wipers of the 25-point control switch (CS) to rotate one step every 30 m.s. As the switch rotates, the wipers of its arc CS1 extend ± 80V reversals at this speed over the R1 wire of the junction.

These signals, accepted at the Exchange unit, pulse relay A to step switch EF, causing corresponding signals to be repeated back to the Subscriber unit via the S wire of the junction to operate a similar relay A and step the Subscriber Finder switch (SF).

During simultaneous rotation of all three switches CS, EF and SF, the wipers of switch CS encounter the calling-line marking battery previously applied by line-circuit relay L. The T relay operates to this mark and stops the CS switch. This causes the cessation of the alternate positive and negative pulses via the CS1 arc and their replacement by a single sustained signal, its polarity being determined by the position of the CS wipers as they come to rest.

When received at the Exchange unit, the sustained signal operates a relay C (not shown) to arrest the ET switch and so apply a steady signal over the S wire. This signal is of momentary duration only, since it is governed by relay H which is subsequently operated from the C relay contact.

At the Subscriber unit, a similar relay C responds to the momentary pulse to stop the SF switch. At this stage, with all three switches at rest, the relative positions of all wipers are checked before the calling line is extended to the main Telex exchange equipment. This safeguard is essential to ensure that the meter proper to the calling subscriber is brought into circuit. All switches should be standing on corresponding outlets and this is determined by relay CH which operates only if switches CS and SF are

mutually aligned, these two switches being the first and last in the chain.

After successful checking, CH contacts remove the sustained signal from the R1 wire and simultaneously switch the calling line over the junction to the station line circuit in the main Telex exchange equipment. Indication of this is given to the calling subscriber by transmission of a pulse which causes the ' Proceed to Dial ' lamp to illuminate in the subscriber's control set. On observing the lighted lamp, the subscriber dials the number of the wanted Telex station and progresses the call further.

It is of interest to note here that the time elapsing between the pressing of the Control button to originate the call and the receipt of the ' Proceed to Dial ' signal is approximately one second.

INCOMING CALL TO CONCENTRATOR STATION

For an incoming call the ' check line-up ' feature is excluded since correct metering of the call is independent of the Concentrator equipment.

After the call has progressed to the final selector in the main Telex equipment and dialling of the wanted subscriber is completed, the final-selector wipers switch to a marked battery in the Exchange line circuit. From this point, the call is speedily extended to the wanted subscriber's line, switching time being substantially reduced by the provision made for the allotter to be always standing on a free junction outlet. Further reduction is achieved by direct simultaneous stepping of the EF and SF switches at each end of the junction. These two switches are operated by $\pm$ 80V reversals and arrested when the marking condition on the PP lead is found. At this stage, the Subscriber unit determines the conditions at the called Concentrator station and transmits the appropriate intelligence over the junction to the Exchange unit. If the wanted station is free, the incoming call is extended forward from the final selector in the exchange; if ' Busy ' or ' Absent ', the relevant service signal OCC or ABS is returned to the subscriber.

## Mechanical Layout

SUBSCRIBER UNIT

Figure 5 shows the Subscriber unit and its equipment arrangement. The apparatus is housed in a floor-standing metal cabinet, completely self-supporting and provided with a removable front transparent panel designed to permit easy observation of the equipment and to afford effective protection against the ingress of dust. Overall dimensions are 6′ 0″ high, 2′ 9″ wide and 1′ 2″ deep (183 x 84 x 36 cm), and the approximate weight when fully equipped is 570 lb. (265 kg). The standard colour of both cabinet and equipment is cream, but this can be varied to suit particular requirements.

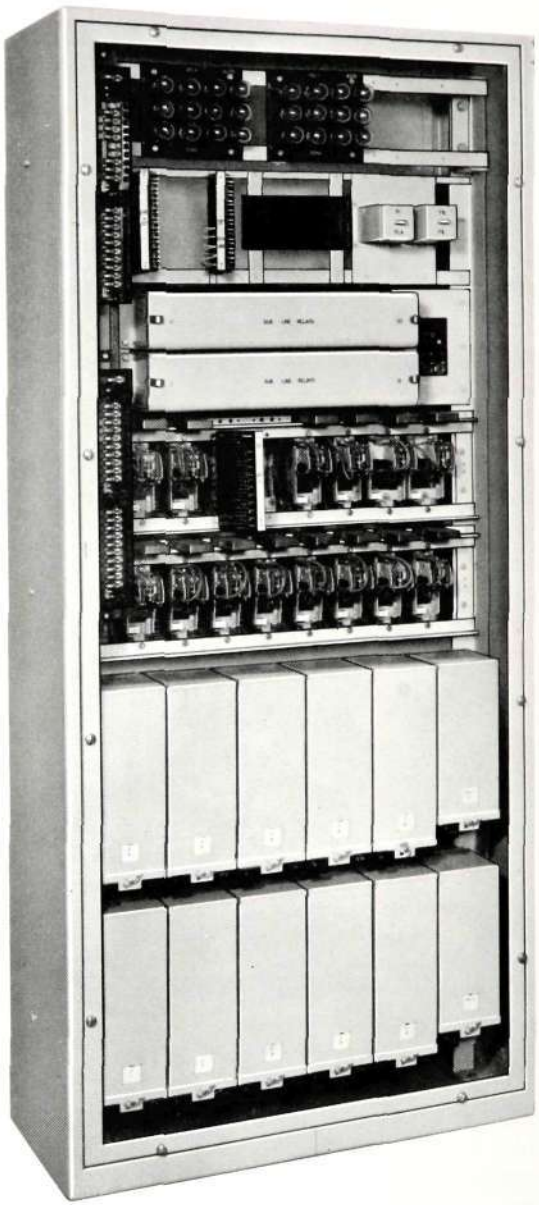


**Figure 5—General View of Subscriber unit**

The lower two shelves of the unit each accommodate five junction relay-sets and an allotter, all of jack-in type. Disposed on shelves 3 and 4 in an 8 + 2 arrangement are ten Subscriber Finder (SF) switches, alongside the smaller group being two pairs of Control and Junction Finder switches. Shelves 5 and 6 each comprise 10 subscriber line circuits and, at the top of the unit, are resistor bulbs in groups of three for use in the $\pm$ 80V signalling feeds.

Cable entry is from the top of the unit, and wires of the cables terminate as soldered connections on two tag blocks seen immediately below the resistor bulbs.

EXCHANGE UNIT

The equipment of the Exchange unit is mounted on a standard 2000-type open rack 10′ 6½″ high and 2′ 9″ wide (320 x 84 cm) to permit line-up and matching with existing automatic Telex exchange equipment. Fully equipped, it weighs approximately 630 lb. (293 kg). The mounting of the equipment follows a similar pattern to that of the Subscriber unit, as may be seen from the general view, Figure 6. The standard finish is cream throughout.

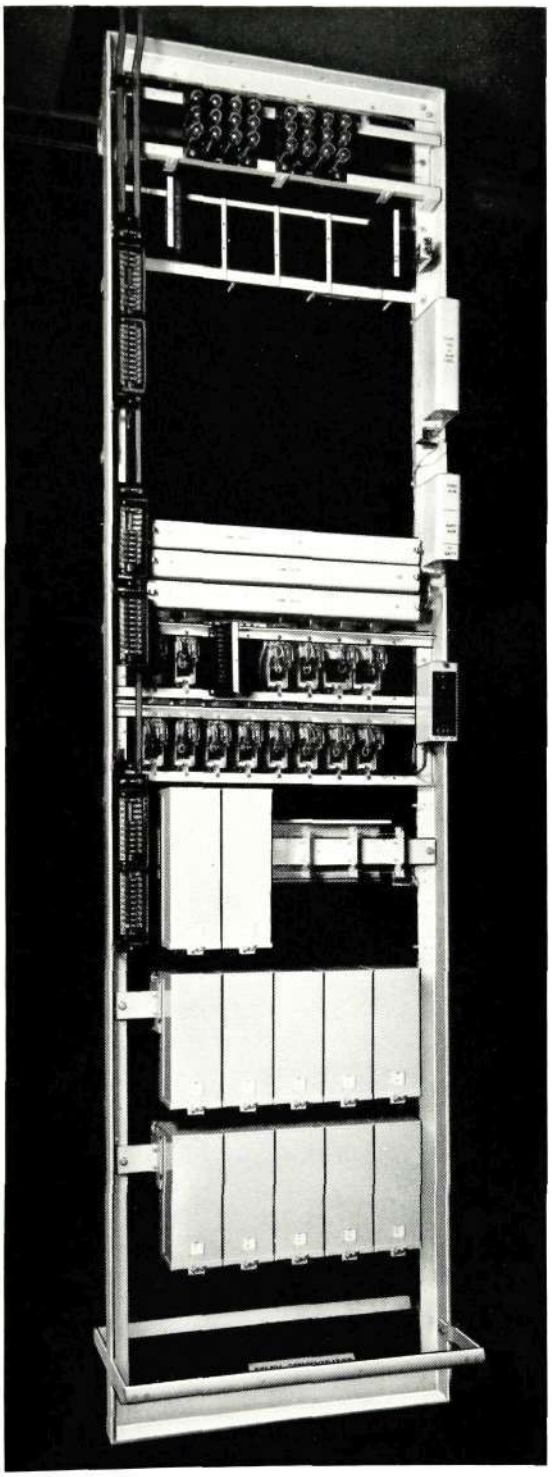


**Figure 6—General view of Exchange unit**

### Standby Equipment and Alarms

The standby allotter and control relay set in the Subscriber unit is brought into operation only after two successive faults have been detected in the regular relay set. Apart from ensuring that service is maintained, this arrangement is particularly desirable at an unattended terminal in order to avoid the unnecessary attendance of maintenance staff for faults of limited duration caused by transient line surges on the junctions.

When an allotter fault or blown fuse occurs, a condition is set up to mark the affected apparatus faulty, and to actuate a local alarm if desired.

For remote investigation of conditions at the Subscriber unit, the dialling of a fault-test number from the associated main Telex exchange gives prompt indication whether or not a fault exists. If a fault is present, the service signal ' OCC ' (Line Engaged) is returned to the teleprinter at the calling station; if absent, the signal ' ABS ' (Absent) is received.

At the Exchange unit no special arrangements are made, since it is considered that this equipment will be situated at an attended exchange. Normal alarm arrangements are made in conformity with Telex exchange practice.

### Power Supplies

The Exchange unit requires a nominal 50-volt supply for satisfactory functioning of the switching equipment and ± 80 volts for signalling and certain relay operations. Both supplies may be obtained from the existing batteries in the associated main exchange.

Average daily busy-hour load and battery drain are indicated below.

| | −80V | +80V | −50V |
|---|---|---|---|
| Busy Hour Load | 0·5A | 0·05A | 0·9A |
| Daily Drain | 6·0Ah | 1·4Ah | 11·2Ah |

The Subscriber unit, on the other hand, requires only a standard ± 80V supply for all working purposes, a feature of considerable significance in locations where battery space is limited.

### Line Limits

When physical junctions are used with the system, the maximum permissible resistance between the Concentrator teleprinter station and the Exchange unit is 1500 ohms per leg. If v.f.t. is employed, the subscriber's local physical line to the Subscriber unit can itself be up to 1500 ohms per leg.

U.D.C.621.395.342.21

# Mobile Rurax

D. C. BAILLIE—Etelco Canada Ltd., Engineering Department

*Rurax equipment is featured in a number of self-contained mobile automatic exchanges for service in remote areas of Canada.*

MOBILE automatic exchanges have long been an established part of reserve communications in Britain and are regularly deployed at large public gatherings such as race meetings and Royal Shows. They are also held in readiness to give temporary service where a permanent exchange has for some reason been put out of action or, less commonly, to provide service in advance of permanent facilities.

In Canada, although mobile exchanges have not formerly been used to a comparable extent, they are now the subject of increasing interest. One reason is the urgent need for better telephone service in many of the more remote districts, where obsolete magneto systems with extensive party-line working are still in use. A second reason is the rapid growth of new communities round the many recent mining and hydro-electric developments. These communities need, almost as the first requisite of organized life, an efficient telephone service.

The competitive context is a spur to rapid action. An opportunity to provide service will normally be open to two or more telephone companies, and the one offering the earliest installation date will usually acquire the franchise for the district. There can be no question of a permanent installation at the outset and the mobile unit used to open the service may have to remain in operation for a considerable period.

The situation has resulted in a demand for automatic equipment which can be taken 'off the shelf' and installed in suitable vehicles at short notice. It must be compact, robust in construction, and able to function for long periods without maintenance.

Rurax equipment has been chosen for a number of mobile units, in capacities from 50 to 200 lines. All the units are completely self-contained in trailers and require only an external a.c. mains supply and an earth connection to be fully operational.

## THE TRAILER

A typical journey from depot to site will involve long distances on main highways where high speeds are both practicable and necessary, but with a final stage over miles of rough, recently bulldozed tracks. The trailer must therefore be highly roadworthy with a first-class suspension and good ground clearance.

A suitable vehicle was already in production in Canada when the first Rurax installation was planned. Although not specially intended for telephone equipment it could readily be adapted to the purpose and has been standardized for all the Rurax mobile units so far completed. An example is shown in Figure 1. The body dimensions are 20′ 0″ x 8′ 0″ x 7′ 6″ approximately (6·1m x 2·4m x 2·3m) and the outer cladding is of bright aluminium, the walls having an inner skin of plywood at 2″ (5 cm) spacing with thermal


**Figure 1—Rurax Mobile Trailer**

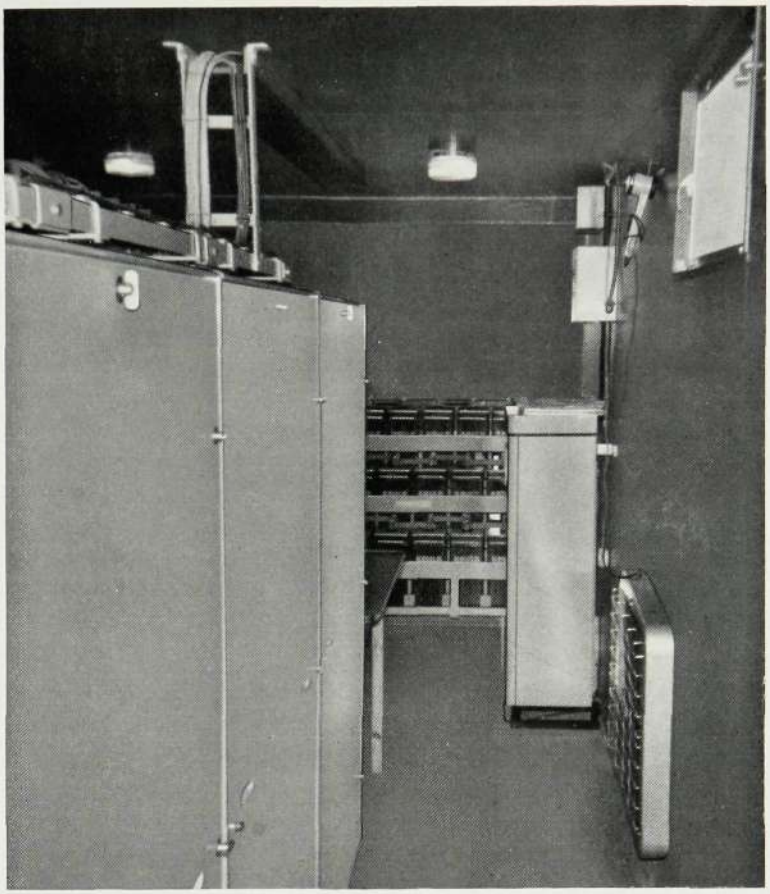


**Figure 2—Internal view of Trailer showing Rurax units on left**

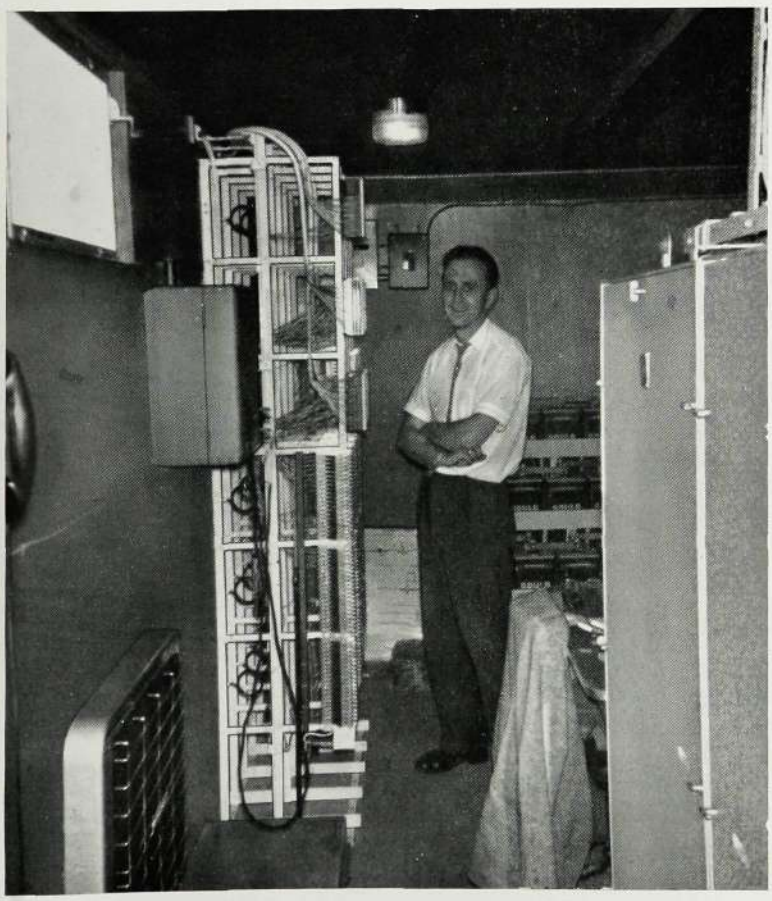


**Figure 3—Internal view of Trailer, with M.D.F. in background**

insulation in the cavity. A similar double construction is used for floor and roof, but here the insulation is omitted and the space is available for cable-runs. The maintenance of an even internal temperature is assisted by the high reflectivity of the aluminium cladding and the small window area. Two 1500 W thermostatically-controlled heaters are fitted and three internal dome-light fixtures provide adequate illumination.

Corner-jacks are used on site and the forward jockey-wheel may be left down as an additional safeguard. An important virtue of the close-coupled four-wheeled undercarriage is the relative stability compared with wide-spaced wheel arrangements in the event of a tyre deflation at speed.

### Installation of Equipment

The trailer is usually driven straight to the equipment warehouse on delivery, without previous preparation. A four or five-man team is necessary to get the apparatus on board. The main units are secured by heavy toggle bolts running through the floor, and subsidiary equipment is mounted at suitable positions on the walls. The batteries, being normally in the range 100-250 Ah capacity, require special attention in mounting and are accommodated in strongly built stands with ' earthquake proof ' bracing. Side-vents are provided in the trailer wall to dispose of gas; the vent plugs on the batteries are sufficiently well trapped to obviate any hazard to the equipment from acid spray. Prior to the journey to site, each battery is individually tied to the stands and temporary bracing is arranged from the upper parts of the main equipment to the trailer walls.

Because of the limited ceiling height, standard cable runways are not practicable and use is made of the floor or ceiling cavities, suitable holes being cut under or above the main units and wall-mounted MDF. Where the operational site is muddy or subject to dust and it is important to restrict the movement of linesmen in and out of the trailer, the MDF may be mounted externally in a weatherproof box. Cable exits are suitably trapped.

Figures 2-4 show internal views of a 150 line Rurax installation.

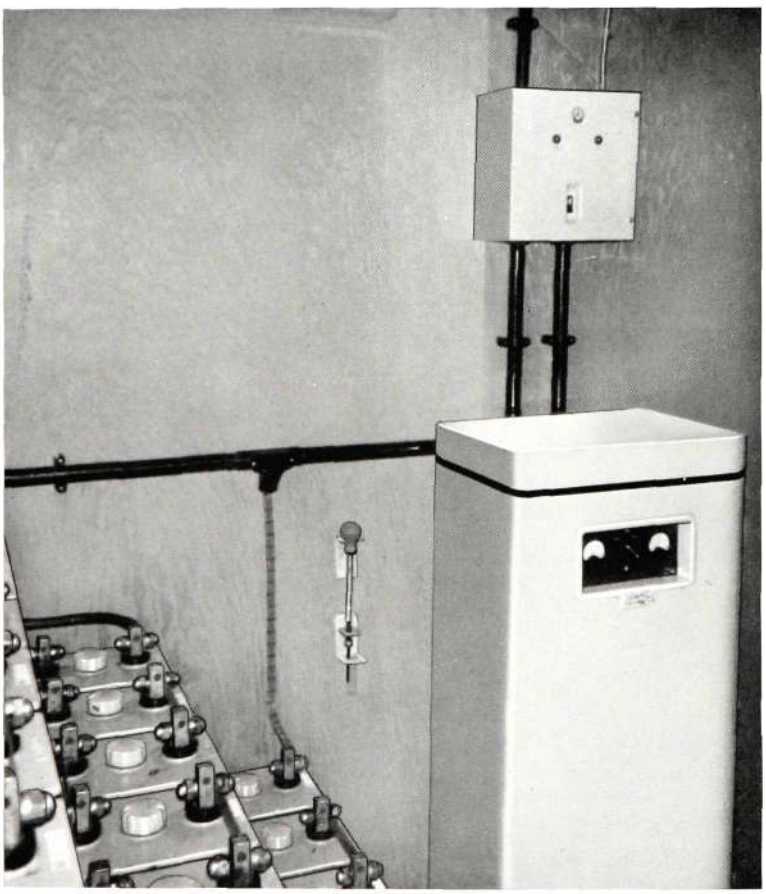


**Figure 4—Batteries and Charging Unit**

### General

At the time of writing, eleven mobile Rurax exchanges with a total capacity of 850 lines have been equipped, the largest unit being one of 200 lines, which is the ultimate capacity possible within the trailer dimensions and axle loading. By comparison, a standard 200 line mobile exchange used in Britain occupies two vehicles, each somewhat larger in size.

All the exchanges have been installed, tested and made ready for dispatch within two weeks of the trailer's arrival, and in several instances a 50-line exchange has been installed in less than three days. The trailer is suitable for transportation by rail flat-car and has in fact been delivered to site in this way where no roads exist. On main highways, speeds up to 60 m.p.h. can be attained with safety.

U.D.C.621.395.23.

# A 5+20 Indicator—Signalling Cordless PMBX

*Seven connecting circuits and an 'overcall' facility are among the features of the switchboard available for Auto or CB working. The switchboard is in two versions, both identical in size and general appearance, but individually equipped for 5 exchange lines and 20 extensions and 4 exchange lines and 16 extensions.*

GOOD appearance in office equipment was until recently regarded as an incidental consideration in design, quite subsidiary to the aims of utility. In consequence, almost the only examples of designs where progressive attitudes to styling found expression were those of equipment familiar to the general public. On the favoured side of the limitation was the telephone instrument, evolved out of all recognition over some forty years and, on the other, the cordless switchboard, virtually indistinguishable from its Edwardian predecessors throughout.

Traditional wooden construction and traditional component design imposed functional as well as aesthetic limitations on this type of switchboard. A maximum capacity of about three exchange lines and nine extensions, set by consideration of bulk, meant the generally unwelcome change to a floor-pattern board once the telephone needs of a business advanced beyond this capacity.

New constructional techniques have done much to remove these limitations, offering greatly increased

**Figure 1—General view of Indicator—Signalling 5 + 20 Switchboard**

capacity as well as transformed appearance. Several such redesigned switchboards have in fact been introduced as replacements for existing floor-pattern models, among them the example now described. This switchboard has two identically sized versions, respectively equipped for five exchange lines and twenty extensions, and four exchange lines and sixteen extensions with provision for adding-on to the full capacity. Both versions are arranged for two-wire extension working and are available in auto or CB forms.

### Physical Design

The basis of construction is a light but rigid welded steel frame surmounting a hardwood base. The case has overall dimensions 23″ wide, 12½″ high and 9½″ deep (58 x 32 x 24 cm), and is formed of grained plastic laminate, the top and back being a one-piece wrap-over. Figure 1 shows the general appearance. The tilted front panel and wrap-over are dove-grey in colour, the sides buff and the base black, bronze metal trims serving both to protect the edges and complete the overall visual effect.

Wedge-type keys and twin shutter indicators are employed throughout and are of well-established miniature patterns. The attendant's telephone is electrically equivalent to the Etelphone and gives the same standard of transmission efficiency. A rotating-magnet generator, having the low operating torque requirement characteristic of this design, is normally incorporated, but a transistorized ringing generator may be fitted as an alternative. Audible alarm is by an internal buzzer.

Figures 2 and 3 show the general accessibility of apparatus. The keys are mounted in separate vertical strips, readily removable from the panel for inspection, while the indicators detach individually, but are so arranged that contact cleaning can be carried out *in situ*. A similar ease of maintenance is provided for by plug connection of the dial and handset.

The miniature indicators show coloured numbering (exchange lines red, extensions green) on a white convex shield; the display being prominent and readily visible over a wide angle. As an aid to surveillance the indicator colours are repeated on the tips of their related keys, and the attendant's keys are tipped black. The well-defined vertical association of keys with indicators, and the pleasant handling characteristics of the keys themselves, are other features contributing to an outstanding simplicity of operation for a switchboard of this capacity.


**Figure 2—Rear view of switchboard with wrap-over panel removed**

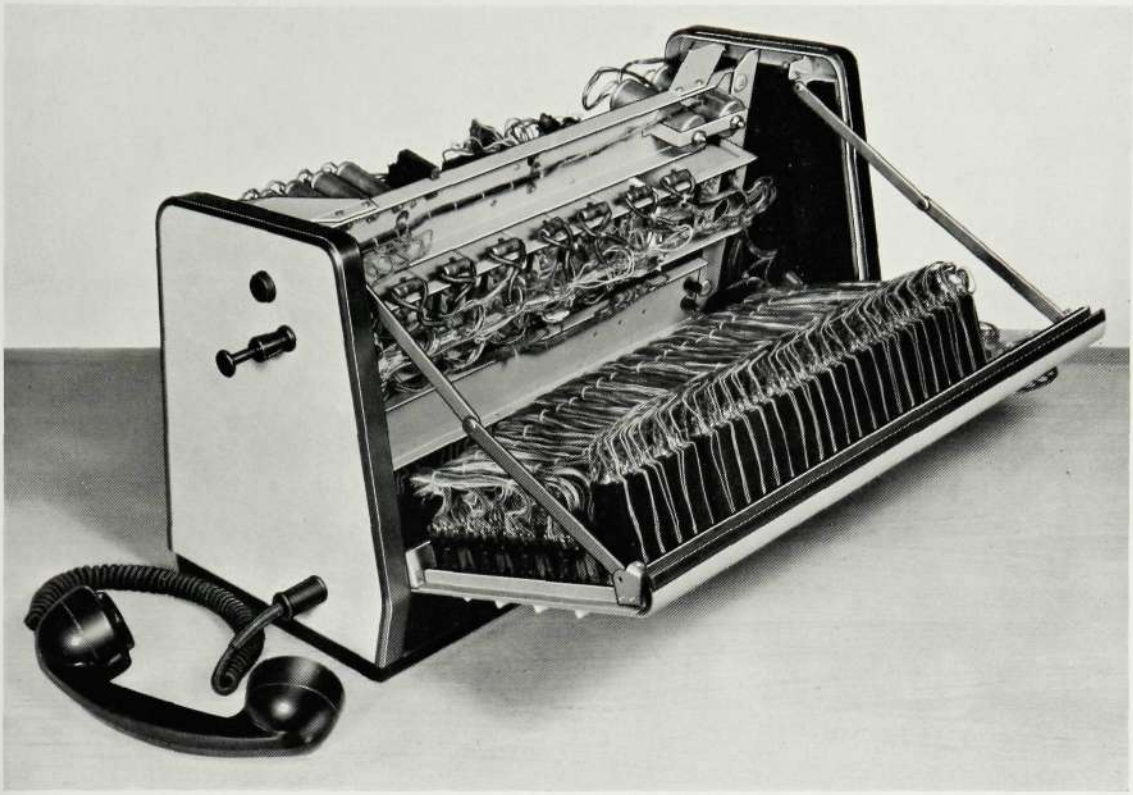


**Figure 3—Wrap-over panel removed and face-equipment panel lowered**

The equipment is fully tropicalized and proofed against the entry of dust and insects.

### Operational Features

The key arrangement follows normal practice and provides for seven connecting circuits, each exclusive to a particular level of keys and direction of throw in the usual manner.

Downward operation of appropriate keys in the bottom row produces three operating facilities: ' Hold Exchange ', ' Ring Extension ' and ' Overcall '. The ' Hold Exchange ' facility may be used when a wanted extension is not immediately available for acceptance of an exchange call, or to permit enquiries to be made at the extension in privacy from the exchange line caller, the appropriate exchange connecting key being meanwhile restored. The ' Overcall ' facility provides a means of answering further exchange line or extension calls when all connecting circuits are in use.

Extension indicators reset automatically on answering or clearing down, exchange indicators being manually reset. The termination of calls on inter-extension connections is signalled by the buzzer and the two indicators after both handsets have been replaced, and on exchange-to-extensions by the buzzer and extension indicator upon replacement of either handset.

Through-calling via the public exchange is available to extensions, and ' revertive ' calls, where the attendant is left to obtain the required exchange number and call the extension back, can be handled with minimum effort.

Any or all of the exchange lines may be connected to chosen extensions for night service, a key being provided to isolate the supervisory relays from battery and so eliminate current drain. Under night service conditions, no visual or audible alarm is given at the switchboard.

For the convenience of the attendant during normal working, the buzzer alarm may be cut off or transferred to a remote point by means of a further key.

### Performance and Power Supply

Transmission and signalling limits between the switchboard installation and the exchange are dependent upon the type of telephones used at extension stations. With Etelphone-type instruments, for example, the extension-to-exchange limit is as great as 1000 ohms.

The switchboard operates from a 24-volt supply which may be derived from a suitable lead-acid battery or, where a.c. mains are available, from a mains-operated power unit. Busy-hour current consumption is 0·84A.

### Conclusion

The main advantage of a cordless switchboard is that the attendant can combine its operation with other duties in a more satisfactory manner than with the equivalent floor-standing board. This switchboard extends the advantage to larger organizations than hitherto, while offering appropriate standards of operating simplicity and appearance.

*Brit. Registered Design No. 898,879 and corresponding foreign registrations*