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A Standard Unattended P.A.B.X.—P.A.B.X. No. 6

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For small private automatic branch exchanges (P.A.B.X.s) with light incoming traffic it is possible to dispense with the services of an operator and to allow extension users to deal with the routing of incoming calls. The first Post Office standard unattended P.A.B.X. (P.A.B.X. No. 5) was introduced in 1963. This article describes a superseding design (P.A.B.X. No. 6) with improved facilities.

INTRODUCTION

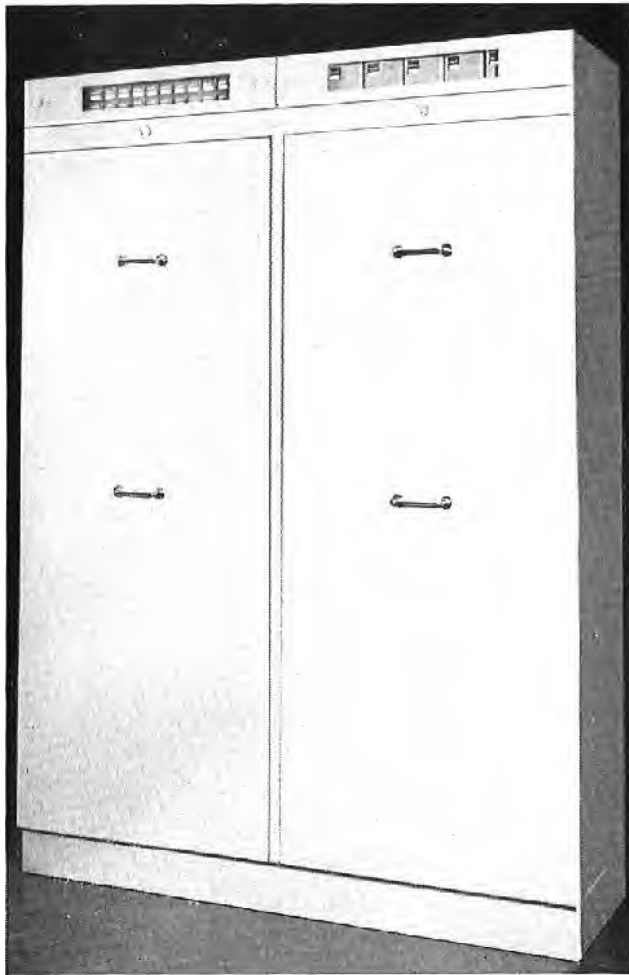
IN the conventional private automatic branch exchange (P.A.B.X.), extension-to-extension calls and outgoing exchange calls are connected automatically, but incoming traffic is dealt with by an operator for whom a special position or cabinet is provided. When, however, the installation is small and the incoming traffic is light it is possible to dispense with the operator and to allow extension users themselves to answer incoming calls and

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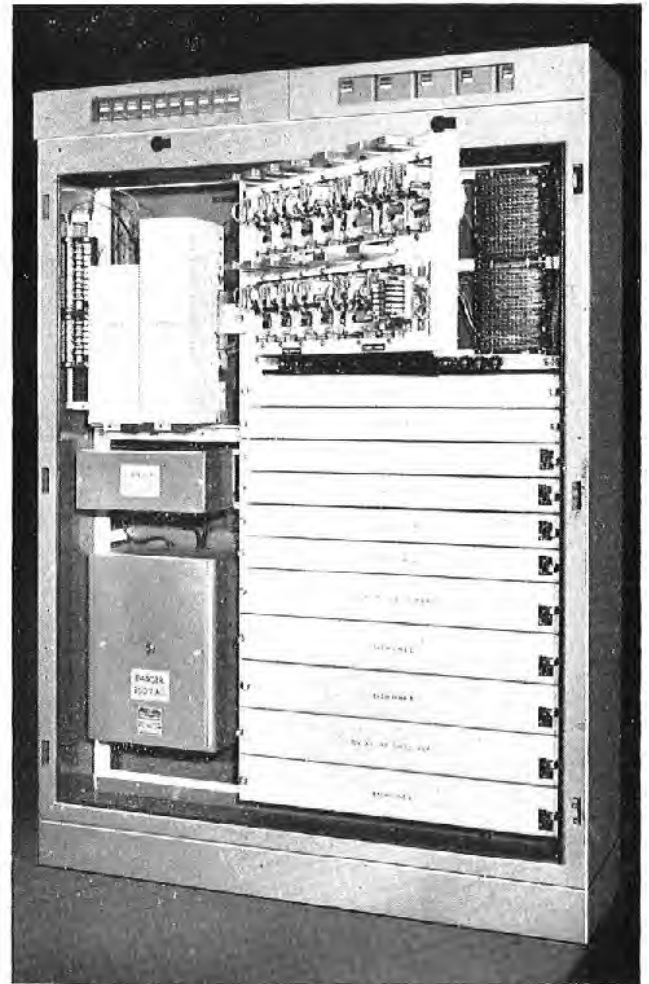
to transfer them as necessary. This type of installation, known as an unattended P.A.B.X., is cheaper than its conventional equivalent and has for some time been supplied by telephone manufacturers for the export market. To meet a growing demand the Post Office adopted one of the proprietary designs and introduced it in the autumn of 1963 as the P.A.B.X. No. 5. This design has certain limitations, however, and is to be superseded by the P.A.B.X. No. 6, which has been developed jointly by the Post Office and the manufacturers.

SIZE AND SCOPE OF THE P.A.B.X. NO. 6

All the equipment for the P.A.B.X. No. 6 is contained in a cabinet 3 ft 9½ in. wide, 5 ft 4 in. high and 1 ft 2 in. deep (Fig. 1). All circuits are designed to use standard components: 3,000-type relays and Post Office standard uniselectors, which act as linefinders and final selectors.



(a) Cabinet Closed



(b) Cabinet with Doors Removed

FIG. 1—P.A.B.X. No. 6

The P.A.B.X. No. 6 has capacity for five exchange lines, 20 extensions and four connecting circuits; two inter-switchboard circuits can be provided in place of two exchange lines.

The exchange-line circuits, inter-switchboard-line circuits and connecting circuits are all jack-in-type relay-sets of novel design. In appearance (Fig. 2) they

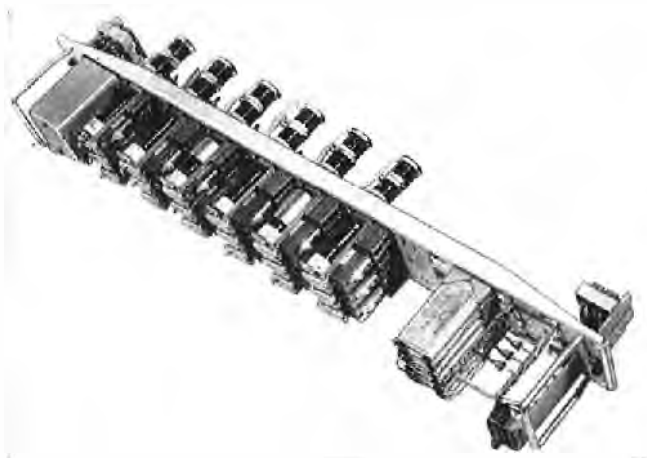


FIG. 2—STRIP-MOUNTED JACK-IN-TYPE RELAY-SET

resemble strip-mounted sets, and the wiring terminates on plugs that engage with corresponding jacks wired on the rack. Extension-line circuits are also strip-mounted, but are permanently wired to the equipment rack. A common-service circuit, which occupies two standard 2,000-type relay-sets, is conventionally mounted. Ringing current is supplied from a Converter, Ringing, No. 4¹ and the 50-volt negative d.c. power is supplied from a mains-driven power unit (Power Unit No. 70A).

Each P.A.B.X. No. 6, as stocked, is fully wired for the maximum of 20 extensions, four connecting circuits, five exchange lines and two common-services relay-sets. One strip of extension-line relays (extensions No. 21–20) is also provided together with the mechanisms for two connecting-circuit linefinders, two final selectors and two exchange linefinders. Additional equipment is fitted as required to make up a complete installation.

FACILITIES AND CIRCUIT OPERATION

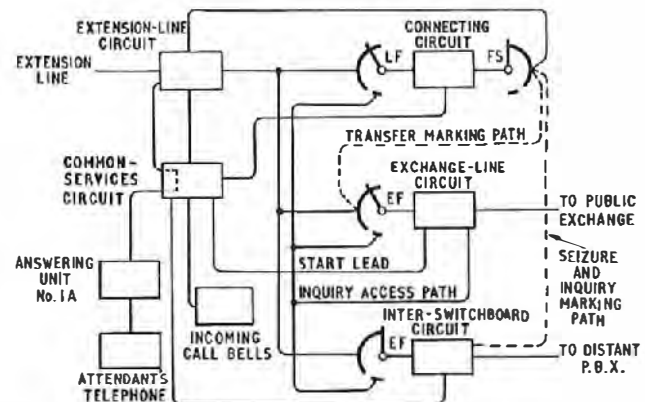
The facilities given by an unattended P.A.B.X. are generally similar to those of the standard P.A.B.X. No. 1 when the latter is switched to night service. Most of the facilities are common to the general pattern of P.A.B.X. design, but some call for particular comment.

Extension-line circuits appear on a common multiple on the banks of the linefinders associated with the exchange-line circuits and inter-switchboard-line circuits and on the banks of the linefinders and final selectors of the connecting circuits. The extension numbering range is 21–20 (10 extensions) and 31–30 (10 extensions). The final selector, which is stepped by dialled pulses, selects the appropriate extension in two stages by discriminating between the initial digit 2 or 3. If the first digit dialled is 2, the final selector remains on outlet 2 until the second digit is dialled; it then steps to the outlet between 3 and 12

¹MOORE, M. B., and GORE, J. S. A New Range of Ringing Converters for Subscribers' Apparatus. *P.O.E.E.J.*, Vol. 57, p. 187, Oct. 1964.

corresponding to the required extension in the numbering range 21–20. If the first digit dialled is 3, the final selector is automatically self-driven to outlet 13, where it waits for the second digit to step it to an outlet between 14 and 23 corresponding to the required extension number in the range 31–30.

Fig. 3 shows the trunking arrangements of the P.A.B.X. No. 6.



LF—Linefinder associated with connecting circuit.

EF—Linefinder associated with exchange-line circuit or inter-switchboard-line circuit.

FS—Final selector associated with connecting circuit.

Extensions No. 21–20 appear on outlets 3–12 and extensions No. 31–30 appear on outlets 14–23. These outlets are represented on this diagram by the first (large) sector on each uniselector arc. The remaining five outlets are used for inquiry and transfer purposes, and are represented by the second (small) sector on each uniselector arc.

FIG. 3—TRUNKING DIAGRAM OF P.A.B.X. No. 6

Extension Classification

Extensions are classified as designated or non-designated, according to whether they are or are not allowed to answer and deal with incoming exchange calls. Each class of extension may further be allowed or barred outgoing exchange-line calls, and non-designated extensions may also be allowed or barred transferred incoming exchange-line calls.

The class of an extension is pre-determined by suitable straps in the extension-line circuit that control certain relays in the common-services circuit when the extension user makes a call.

Fig. 4 shows the elements of an extension-line circuit associated with the common-services circuit and the terminals that require to be strapped, as indicated in Tables 1 and 2, for allowing or barring exchange calls to designated or non-designated extensions.

The –50-volt and earth potentials which operate relay LS in Fig. 4 when the extension user seizes the extension-line circuit are derived from the common-services circuit, which disconnects the supply under congestion conditions, i.e. when all connecting circuits are engaged. In Fig. 4 those terminals marked x and z are allocated to designated extensions; terminals marked y are allocated to non-designated extensions.

Extension-to-Extension Calls

Calls between extensions are unrestricted and are set up in the usual way. The first party to replace the handset releases the connexion.

When the handset of a calling extension is lifted the extension line is marked on the connecting-circuit linefinder multiple, and a start signal is applied to the

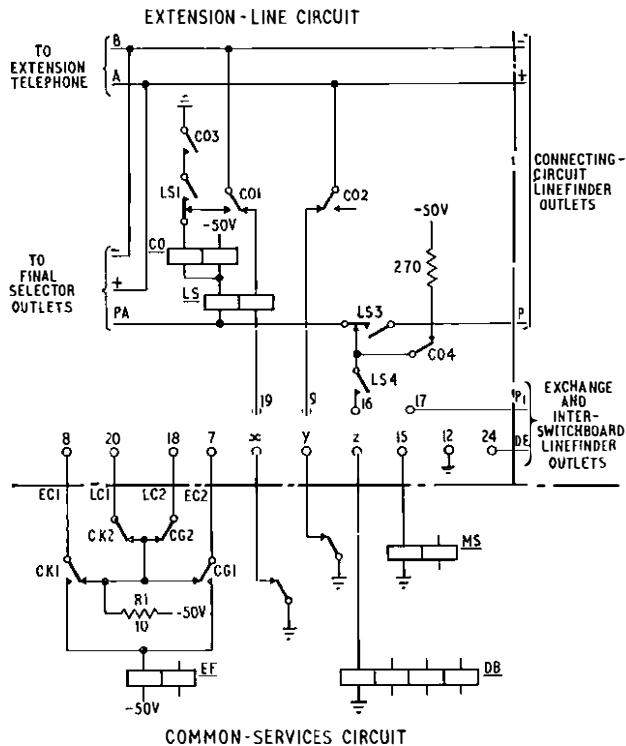


FIG. 4--EXTENSION-LINE CIRCUIT ASSOCIATED WITH COMMON-SERVICES CIRCUIT

The required extension number is now dialled. If the number is in the range 21-20 the connecting-circuit final selector is stepped directly by the dialled pulses and the wipers are positioned accordingly. If the number is in the range 31-30, then, during the inter-digital pause following the initial digit 3, the final selector is driven past the contacts used for extensions 21-20 and the switch subsequently responds to the second digit dialled. From the foregoing it will be seen that outlets 0, 1, 2, 13 and 24 are not used for extension numbers.

If the called extension is free the connecting circuit applies ringing current, and ring tone is returned to the caller; if the called extension is engaged, busy tone is returned. If the called extension number is spare or is in the handset-off-rest (P.G.) condition, number-unobtainable tone is returned. If the calling extension should delay dialling either the first or the second digit for a period of 25-50 seconds, forcible release is applied under the control of the common-services equipment. The connecting circuit is then made available for further use while the extension-line circuit is held in the P.G. lock-out condition. A connecting circuit is held for the duration of an extension-to-extension call and supplies transmitter-feed current to both extensions from its transmission bridge.

Incoming Exchange-Line Call

When a call is received from the public exchange the exchange-line-circuit calling relay detects the ringing current and causes the common calling bells to ring. The first designated extension user to lift his handset is then automatically connected to the incoming call in the following manner (see Fig. 5).

The exchange-line-circuit relay LA operates to ringing current. Contact LA7 operates relay MH, which holds to the exchange-line ringing-return condition, and relay LA is disconnected from the line. Rectifier MR1 terminal 18 is strapped either to terminal 16 or 17 to suit the type of ringing-return condition at the main exchange. Rectifier MR1 ensures that the flux in both coils of relay MH is always series-aiding.

Relay LR, in conjunction with relay DA in the common-services circuit, disconnects the S1 and S2 leads of all the connecting circuits to prevent a connecting-circuit linefinder hunting when the handset is lifted at a designated extension under these conditions.

The designated-extension circuit connects -50 volts via a 270-ohm resistor to give a marking signal on the linefinder P1 outlet. A start condition is extended to the common-services circuit to operate relay DA. Relay ST operates in the exchange-line circuit, causing the linefinder to drive to the marked outlet; relay FK then operates to cut the drive and the designated extension is switched through to the exchange line.

The answering extension then connects the call to the required extension by means of the inquiry and transfer facility. This is only possible if the required extension is not barred incoming exchange-line calls. The answering extension is then free to make or receive other calls.

Outgoing Exchange-Line Call

Any extension, designated or otherwise, can be allowed outgoing exchange calls. When the handset is lifted from an extension telephone, calling conditions are set up as for an extension-to-extension call. To obtain access to the public exchange the telephone instrument

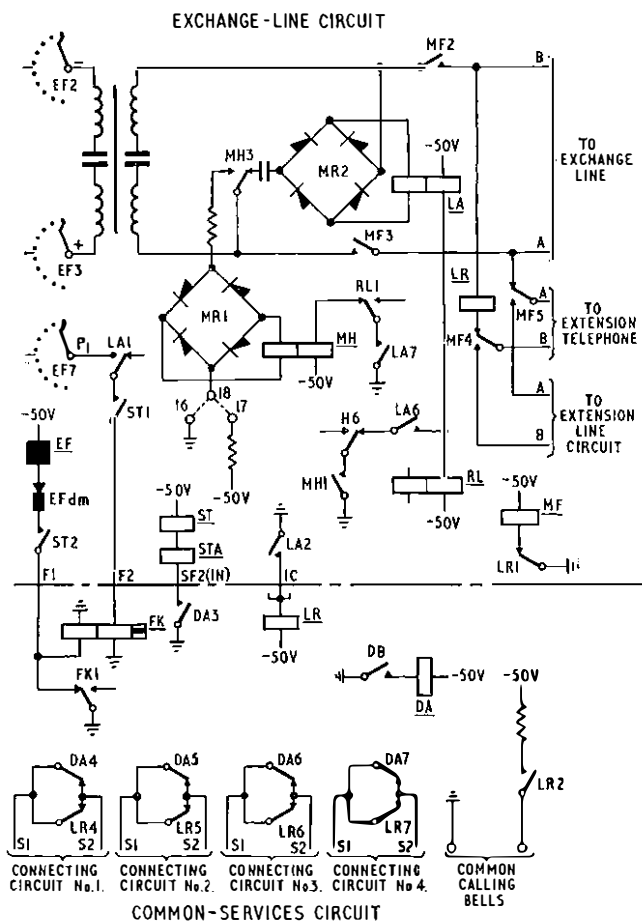
TABLE 1
Extension-Line Circuit Strapping for Designated Extensions

Terminals Always Strapped	Additional Terminals Strapped to	
	Allow Outgoing Exchange Calls	Bar Outgoing Exchange Calls
9-x 16-z 16-17 12-24	19-8	19-20

TABLE 2
Extension-Line Circuit Strapping for Non-Designated Extensions

Terminals Always Strapped	Additional Terminals Strapped to	
	Allow Outgoing Exchange Calls	Bar Outgoing Exchange Calls
9-y 16-15	19-7	19-18

common-services circuit to allocate a free connecting circuit. The extension marking signal is a -50-volt potential on the P lead via windings of relays LS and CO in series, and, if the calling extension is designated, the start condition is a -50-volt potential via a 270-ohm resistor on the z terminal to operate relay DB. A similar start signal on terminal 15 operates relay MS if the calling extension is non-designated (Fig. 4). A free connecting circuit is allocated via a start chain controlled by the common-services switch (not shown in Fig. 4). The linefinder hunts for and switches to the marked outlet and dial tone is returned to the caller.



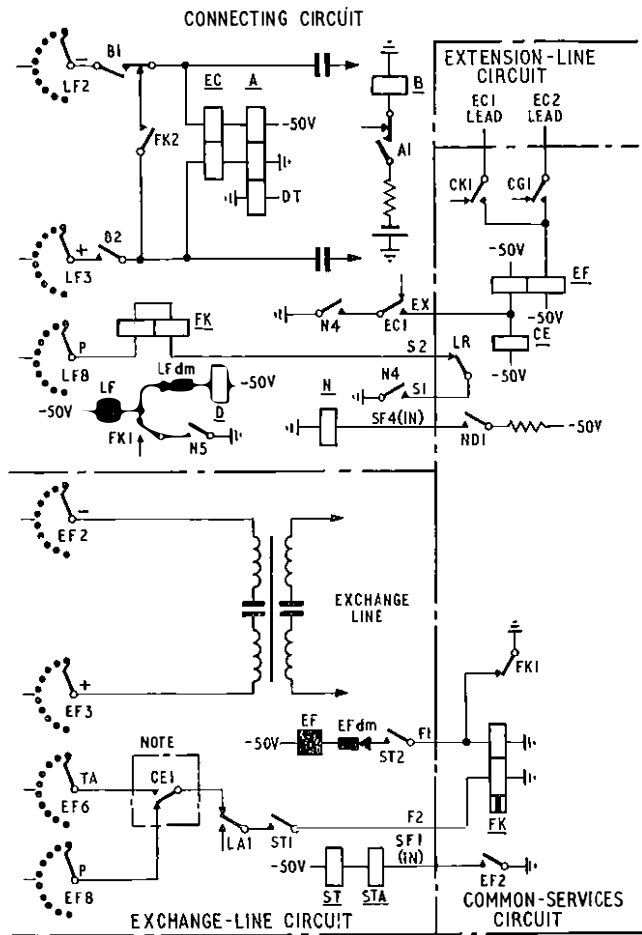
EF—Linefinder associated with exchange-line circuit.
 FIG. 5—CIRCUIT ELEMENTS FOR INCOMING EXCHANGE-LINE CALL

button is pressed and, provided that the extension is allowed outgoing exchange calls, the connecting circuit detects this condition and marks the outlet on the multiple of the exchange-line-circuit linefinder corresponding to the calling extension. The linefinder hunts and finds the marked extension, which is then switched through to the public exchange and the connecting circuit is released. The exchange-line circuit then automatically sends a calling signal to line. If the public exchange is automatic, dial tone is returned and the P.A.B.X. extension can dial into the public network.

If, when an extension originates a call, all connecting circuits are engaged, it is still possible to gain access to a free exchange line. The telephone-instrument button is pressed in the usual way and operates relay EF in the common-services circuit (see Fig. 4). This causes a linefinder associated with a free exchange line to hunt for the calling extension.

Fig. 6 shows the elements of a connecting circuit and an exchange-line circuit associated with the common-services circuit for the purpose of setting up an outgoing call.

When the handset is lifted the extension-line circuit connects a marking potential to the P lead of the connecting-circuit linefinder multiple and at the same time connects -50 volts from the common-services circuit via contact NDI to operate relay N in a free connecting



LF—Linefinder associated with connecting circuits,
 EF—Linefinder associated with exchange-line circuit.
 Note: Part of common-services circuit.
 FIG. 6—CIRCUIT ELEMENTS FOR SETTING UP OUTGOING EXCHANGE-LINE CALL

circuit. The connecting-circuit linefinder hunts for and switches to the marking condition. When the marked extension is found, relay FK operates. Contact FK1 cuts the linefinder drive and FK2 operates relay A, which in turn operates relay B, and dial tone is returned. When the telephone-instrument button is pressed, relay EC in the connecting circuit operates; relay EC in turn operates relays CE and EF in the common-services circuit. A free exchange-line-circuit linefinder hunts for the extension, which has now been marked by -50 volts on the TA arc.

If all connecting circuits are engaged when the extension user originates the call the congestion relay, CG, will be operated so that when the extension user presses the telephone-instrument button, relay EF only will operate. A free exchange line is seized over the SF1 (IN) lead and the linefinder hunts for the extension, which is now marked by -50 volts on the P arc, as described above.

Inquiry and Transfer

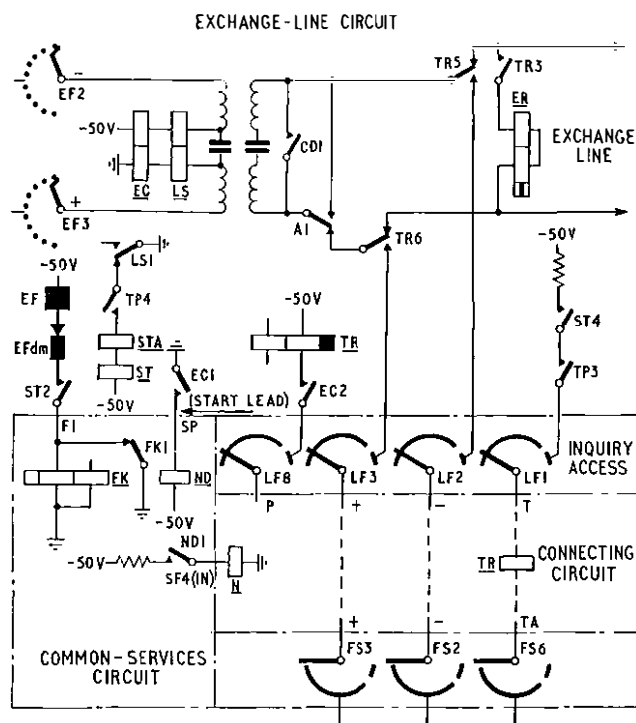
In the absence of an operator it is a fundamental requirement than an extension which has answered an incoming exchange call should be able to hold it while an inquiry is made of another extension, and the first exten-

sion should be able to transfer the call if necessary. Inquiry access is open to all extensions (including barred extensions), or to an extension or operator over an inter-switchboard circuit. To make an inquiry call the telephone-instrument button is depressed and the appropriate extension or inter-switchboard-line number is dialed. A holding condition is applied to the exchange line during the period of the inquiry. The original extension can return to the exchange line at the conclusion of the inquiry by depressing the button again.

If, during an inquiry, an incoming exchange-line caller should clear, the exchange line is re-seized in order to busy the line at the public exchange, the inquiry call remaining uninterrupted. At the conclusion of the inquiry, when the extension returns to the exchange line forcible-release is applied and the extension reverts to the P.G. condition.

Having made an inquiry call to a second extension, an exchange call may be transferred to the second extension simply by asking the second extension to hold on while the handset is replaced at the original extension, without the telephone button being depressed. Transfer will not take place if the inquiry has been made to an extension which is barred incoming exchange calls, or to an extension or operator over an inter-switchboard private circuit. If, for any reason, transfer does not take place the original extension will be re-rung automatically from the exchange-line circuit.

Fig. 7 shows the basic circuit elements necessary for setting up an inquiry call and subsequent transfer.



EF—Linefinder associated with exchange-line circuit.
LF—Linefinder associated with connecting circuit.

FIG. 7—CIRCUIT ELEMENTS FOR SETTING UP INQUIRY CALL

When the instrument button is depressed, relay EC operates (relay EC is differentially connected). An earth is connected to the start lead (SP) to operate relay ND in the common-services circuit. A marking potential via

relay TR is connected to the inquiry access-path (P) lead. A connecting-circuit linefinder hunts for the marked outlet, which, when found, returns dial tone to the extension, and relay TR in the exchange-line circuit operates. Dial pulses from the extension are repeated by the exchange-line circuit relay A, and a holding loop is applied to the exchange line via relay ER. The connecting-circuit final selector is positioned on the required extension outlet.

To transfer the call the originating extension replaces the handset and relay LS releases; provided that the extension or inter-switchboard circuit is permitted transferred calls, relay TP will be operated and a marking potential connected to the T lead, which is extended by the connecting circuit to the TA outlet on the final-selector multiple corresponding to the called-extension outlet, or extended by the inter-switchboard-line circuit to the TA outlet on the inquiry portion of the multiple on which the inter-switchboard-circuit linefinder is standing. The linefinder associated with the exchange-line circuit is driven to find the marking potential, and the call is switched through to the called extension.

Trunk Offering

If, in attempting to transfer a call, the second extension is found to be busy, intrusion is possible by dialling a further digit 1, which overrides the busy condition. A speech path is then established in the connecting circuit and the call may be offered. While the intrusion is occurring warn tone is connected. The designated extension can return to the exchange line by pressing the telephone-instrument button again.

The trunk-offering facility is only available to designated extensions.

Ring-When-Free

If a designated extension makes an inquiry call to a busy extension with the intention of transferring it, the call can be trunk offered as already described. The designated extension receiver may then be replaced, and the call will be "parked" on the required extension, which will be re-rung as soon as the call in progress is terminated. This facility has the obvious advantage, in an unattended installation, of reducing to a minimum the time required by designated extensions for the supervision of incoming calls.

Outgoing Inter-Switchboard-Circuit Call

When an outgoing inter-switchboard call is initiated a connecting circuit is seized in the same way as for an extension-to-extension call. To obtain access to the inter-switchboard circuit the code digit 7 is dialed, so stepping the final selector to the corresponding outlet. An earth is extended over the seizure-and-inquiry marking path (see Fig. 3) to a free inter-switchboard line. A marking signal is returned from the inter-switchboard-line circuit on the TA lead, which is connected through to the T lead to mark the outlet on the extension multiple. The inter-switchboard-circuit linefinder hunts for this marking condition and, when it has found the marked outlet, the extension is switched through directly to the inter-switchboard-line circuit and the connecting circuit is released. If the inter-switchboard circuit is to a P.M.B.X. a calling signal now appears on the distant switchboard; if it is to a P.A.B.X. then dial tone will be

returned and the P.A.B.X. No. 6 extension can dial the required number.

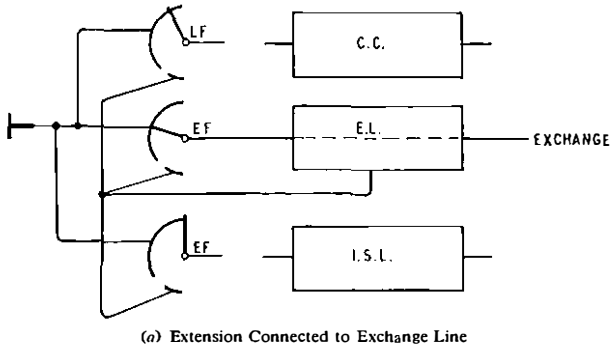
Incoming Inter-Switchboard-Circuit Call

When the circuit is seized by the distant P.B.X., dial tone is returned and the number of the required P.A.B.X. extension can be dialed. The inter-switchboard-circuit linefinder acts as a final selector and, responding to the dialled pulses, steps to the required extension outlet. Ringing current is applied by the inter-switchboard circuit. Supervisory tones—ringing, dial, busy or number unobtainable—are returned to the distant end from the inter-switchboard circuit, as required.

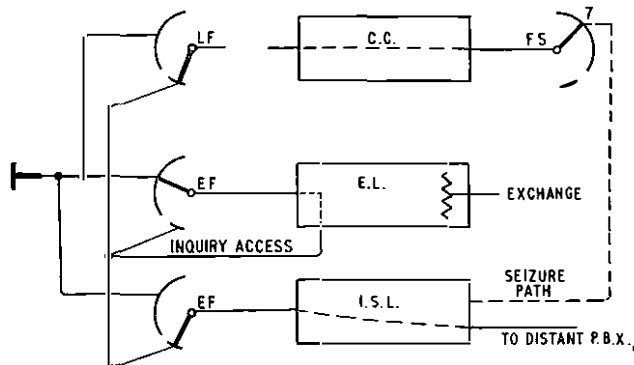
Inquiry and Transfer to an Inter-Switchboard Circuit

The following sequence of events takes place during inquiry and transfer to an inter-switchboard line.

(a) An extension user already speaking to a caller on an exchange line wishes to make an inquiry call to an inter-switchboard line (Fig. 8(a)) and, accordingly, presses the telephone-instrument button.



(a) Extension Connected to Exchange Line



Sequence:
 (i) Final selector steps to outlet 7.
 (ii) Seizure signal applied to inter-switchboard relay-set.
 (iii) Inter-switchboard-line linefinder hunts for marked inquiry outlet and connecting circuit is released. Line to distant P.B.X. seized.
 (c) Extension Dials Inter-Switchboard-Line Code (7).

LF—Linefinder associated with connecting circuit. EF—Linefinder associated with exchange line or inter-switchboard line. C.C.—Connecting circuit. E.L.—Exchange-line relay-set. I.S.L.—Inter-switchboard-line relay-set. C.S.C.—Common-services circuit. FS—Final selector.

FIG. 8—SIMPLIFIED TRUNKING DIAGRAMS SHOWING SEQUENCE OF OPERATIONS FOR AN INQUIRY CALL INVOLVING TRANSFER TO AN INTER-SWITCHBOARD LINE

(b) A connecting circuit is seized and a hold condition is applied to the exchange line.

(c) The connecting-circuit linefinder switches to the inquiry outlet corresponding to the particular exchange line (Fig. 8(b)).

(d) The extension dials the routing digit, say 7.

(e) The final selector is stepped to outlet 7.

(f) Start conditions are applied to the inter-switchboard-line circuit, whose linefinder hunts for the marked inquiry outlet.

(g) When the inquiry outlet is found by the inter-switchboard-circuit linefinder the connecting circuit is released and the inter-switchboard-line relay-set is held by the exchange-line relay-set over the inquiry outlet multiple (Fig. 8(c)).

(h) To transfer the call the extension handset is replaced.

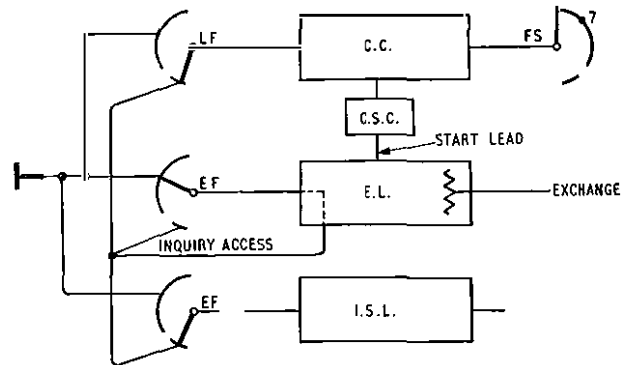
(i) The exchange-line-circuit linefinder hunts for its own marking condition on the TA arc.

The connexion from the exchange line to the inter-switchboard line is thus established via the linefinders of both circuits switched to the inquiry outlet corresponding to the exchange line in use (Fig. 8(d)).

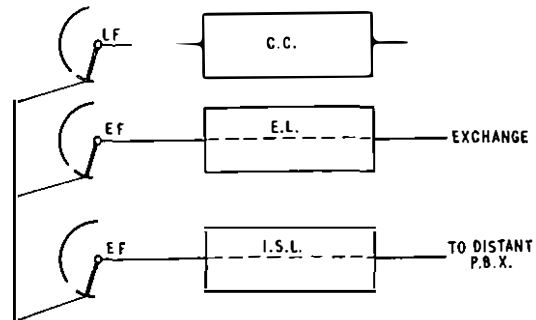
The facility of subsequent transfer is not provided.

Night Service

The concept of night service on an unattended



Sequence:
 (i) Exchange line held.
 (ii) Inquiry outlet marked.
 (iii) Connecting circuit seized.
 (iv) Connecting-circuit linefinder switches to inquiry outlet.
 (b) Extension Instrument Button Pressed to Set Up Inquiry Condition



Sequence:
 (i) Extension handset replaced.
 (ii) Exchange-line circuit linefinder hunts for its own inquiry outlet.
 (d) Exchange Line Transferred to Inter-Switchboard Line

P.A.B.X. is different from that for other P.A.B.X.s. Night service on the P.A.B.X. No. 6 is essentially a method of altering the classification of extensions to suit the night-staffing arrangements.

By operating the night-service key provided on an allocated designated extension the normal extension

conditions may be altered, e.g. extensions which are designated by day can be made non-designated by night, or vice-versa. Similarly, extensions which are barred exchange calls during the day can be given the facility for the night, or vice-versa. It is also possible under night-service conditions to arrange for additional, or different, call bells to be operated on incoming calls.

Night-service relays can be fitted, as required, to provide the appropriate facilities for each particular installation. Four relays can be mounted on spaces reserved on each extension-line-circuit mounting plate.

Additional Facilities

Attendant's Telephone. It is, perhaps, anomalous to provide a special attendant's telephone at an unattended P.A.B.X., but it has been realized that on many installations it will inevitably be necessary for a typist/secretary to answer the bulk of incoming exchange calls. To cater for this requirement a special instrument has been designed, based upon the N 625 plinth² (Fig. 9). The

with incoming traffic without the need for two designated extension instruments on the desk.

Metering. Metering units and cyclometer meters for recording S.T.D. calls can be fitted, and exchange line and extension metering provided as required.

Connexion to Magneto or Central Battery Signalling (C.B.S.) Exchanges. A separate exchange-line relay-set is required for working to magneto or C.B.S. exchanges.

OPERATION DURING MAINS FAILURE

If the mains supply fails relay MF (Fig. 5) releases and each exchange line is diverted to a pre-determined extension which then functions as an exchange line. Any call in progress at the time of failure is lost, but on restoration of the power supply any call in progress is maintained until the call is completed.

ACKNOWLEDGEMENTS

The P.A.B.X. No. 6 was developed by the General



FIG. 9—ATTENDANT'S TELEPHONE

telephone concentrates two designated extensions at one station and provides facilities for holding a call on either line. During busy periods, therefore, the user can deal

²AKESTER, K. M. A Switching Unit for Use with 700-Type Telephones—Plan Set N 625. *P.O.E.E.J.*, Vol. 53, p. 242, Jan. 1961.

Electric Co., Ltd. (G.E.C.), for the Post Office under the British Telephone Technical Development Committee procedure.

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