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New Lamp Signalling P.M.B.X. Switchboard

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A new switchboard designed primarily for P.M.B.X. purposes is described. Novel features are the physical construction of the board and the line circuit which dispenses with line and cut-off relays.

Introduction.

THE question of the introduction of a lamp signalling P.M.B.X. was first raised in 1922, but it was considered at that time that the anticipated demand for a switchboard of this type did not justify the work involved. In 1931, however, the question was again raised due to increased demand by the public for a lamp signalling P.M.B.X. and also to the fact that a number of installations outside the capacity of the largest P.M.B.X. switchboard the Post Office had to offer (Sections Switch C.B. Multiple No. 9, ultimate capacity per suite of positions 160 exchange lines, 800 extension lines) were in demand, chiefly for hotels and large establishments in London. An experimental model of a lamp signalling P.M.B.X. was then proceeded with, using the framework of a recovered C.B. No. 1 Section. The whole of the apparatus was accommodated in the rear of the section. This design was abandoned as it proved cumbersome and the layout of the equipment was such that it prevented ready accessibility to the interior of the board.

As a tentative measure demands for lamp signalling P.M.B.X.s were met by the provision of a main exchange switchboard C.B. No. 10. Arrangements were then made to develop, in conjunction with the contractors, a lamp signalling P.M.B.X. The development had practically reached conclusion in September, 1939, but was suspended owing to the outbreak of hostilities. The demands for Sections Switch B.E.C.B. Multiple No. 9 increased with the outbreak of the war to such an extent that a serious shortage in supplies of this board resulted. It was then decided to introduce the lamp signalling P.M.B.X. in a slightly modified form to augment the supply of multiple type P.M.B.X.s. This decision was influenced by the fact that earlier deliveries of the new board could be effected as all the items used were standard apparatus, whereas the Section Switch B.E.C.B. Multiple No. 9 used non-standard jacks which were in limited supply, and were being manufactured by one contractor only. The new lamp signalling switchboard bears the Rate Book description " Section Switch P.M.B.X. No. 1A."

Physical Design

A complete installation consists of a suite of two or more sections, closed at each end by cable-turning sections, and one or more apparatus racks (Equipments P.M.B.X. No. 1 or No. 1/35), together with a suitable power plant. Fig. 1 shows the first installation of this type.

Section Switch P.M.B.X. No. 1A.

The section is of wooden construction, normally of mahogany, the ironwork for mounting apparatus being screwed to and supported by the timber frame in contrast to the main exchange practice of having a metal framework to which the wooden parts of the section are attached. The design is modern in that all panelling and cornices have been omitted, giving the completed suite a clean smooth line. The keyboard and pilot rail are covered with red fibre. The remainder of the external surfaces of the section, with the exception of the back door, are polished to the standard finish for P.M.B.Xs.

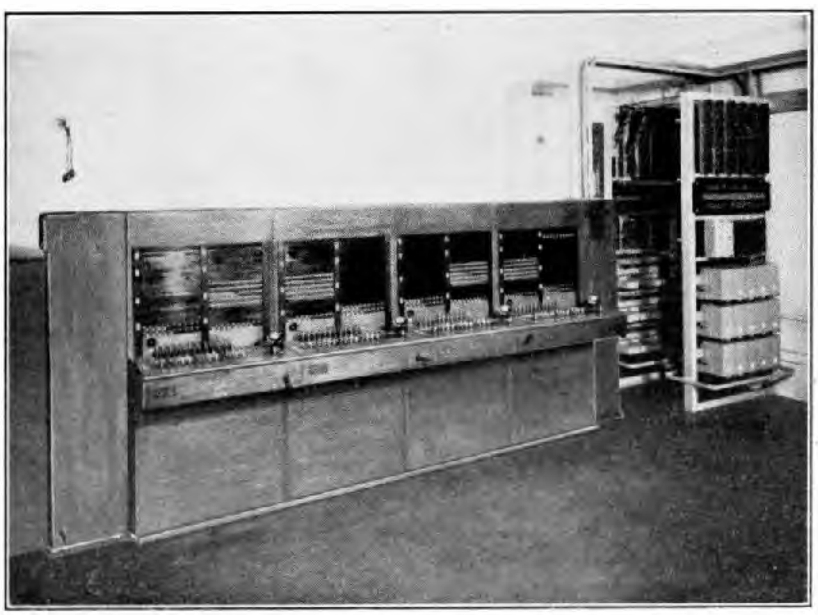

FIG. 1.—TYPICAL INSTALLATION.

The dimensions of the section are: height 4 ft. 6 in., width 2 ft. 2 in., depth over keyshelf 2 ft. 6 in. The height of the keyshelf is 2 ft. 6 in. The dimensions of the B.E.C.B. No. 9 section for comparison are 6 ft. 5 in. × 2 ft. 5 in. × 2 ft. 8 in., height of keyshelf 3ft. The low keyboard and also the low overall height of the P.M.B.X. No. 1A makes the provision of special chairs for the operators unnecessary, a great advantage in subscriber's premises.

The face equipment of the section is divided into two panels, the multiple being complete over two sections, i.e. four panels. Each panel is capable of accommodating 30 strips of jacks. The exchange line multiple occupies the bottom of the panel immediately above the pilot rail and consists of jacks and lamps in strips of 10. The extension multiple occupies the remainder of the panel, 20-way jack and lamp strips being used. The stile casings are engraved 0, 2, 4, 6, 8, to indicate the tens of the extension multiple, removable white celastoid labels being provided for the numbering of the hundreds of the extension multiple and the panel numbers of the exchange line multiple. Interswitchboard lines are accommodated in the exchange line multiple field.

The keyboard is initially equipped with 12 cord circuits and has a capacity for 16. Two supervisory lamps and two keys are provided per cord circuit. The keys allow of ringing and dialling on the calling cord and ring-back on the answering cord; the speaking condition is common to both cords. The facilities provided by the keys, the cords and supervisory lamps are clearly marked by engraved labels countersunk into the keyboard.

The hand generator key which connects the hand generator should the power ringing fail, the position coupling key, and the emergency dial key (only fitted if a keysender is in use) are of the push-button type and are accommodated at the top of the multiple field in the right-hand panel. The functions of these keys are indicated on a designation strip. The removal of these keys from the keyboard simplifies the operation of the switchboard in that only keys concerned with individual cord circuit operations are accommodated on the keyboard. A dial is not fitted on the switchboard as issued, but wiring and facilities for fitting are provided. The dial position is on the right-hand side of the keyshelf immediately in front of the hinge, a sloping mounting being used to facilitate dialling.

A pilot lamp is situated in the pilot rail below the multiple field to the right of the centre stile. The usual cord test jack is fitted in the pilot rail of the left-hand panel.

The apparatus for the cord circuits, operator's circuit, pilot and cord test circuits only, is accommodated in the rear of the section (Fig. 2). The relays, which are all of the 3000 type, are mounted on horizontal mountings which cater for three cord circuits each. Five mountings are provided which will take the 12 cord circuits and miscellaneous circuits. A space is provided for an additional mounting to allow of the cord circuits being extended to the full capacity of 16. All condensers are mounted on a shelf at the top of the section. Ringing feeds, battery feeds, position couplings, etc., are terminated on a connection strip immediately below the relay mountings.

The multiple cabling is supported on pins screwed into vertical iron bars fixed to the woodwork of the section. Each pin carries two layers of four cables (four panel multiple) and can be unscrewed and removed to facilitate maintenance on the multiple field. The usual method of jack fastening is provided.

The back of the section is closed by a plain removable door which is held in recesses at the top and bottom of the section. A feature of this door, which is being introduced for all P.B.X. switchboards, is the omission of projecting lifting handles. Finger slots are provided in lieu. This also applies to the door of the cable turning section and to the kicking panels under the keyboard.

The only unusual feature of the cable turning section, apart from the fact that all panelling has been omitted from its construction, is the provision of a pocket on the inside of the door to hold diagrams, relay cards, etc., for the use of the maintenance staff.

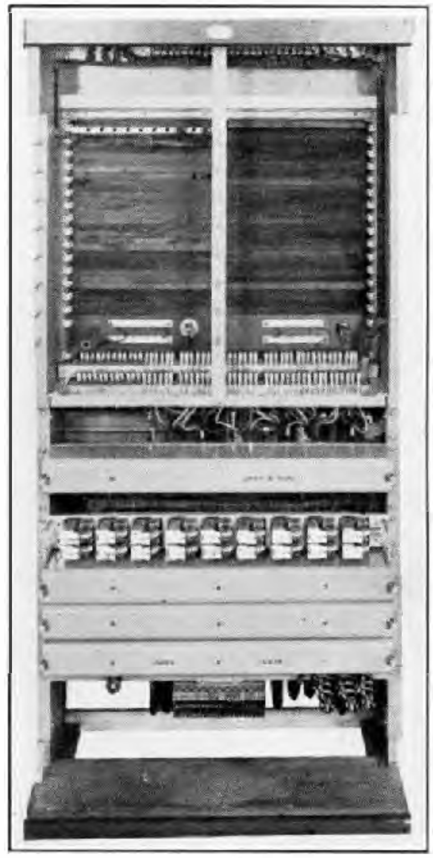

FIG. 2.—REAR VIEW OF SWITCHBOARD.

Auxiliary Apparatus.

All apparatus except that dealt with above is accommodated outside the switchboards on racks. Exchange line and interswitchboard line apparatus is made up in the form of relay sets. As well as the relay sets the apparatus racks carry the rest of the apparatus necessary for an installation. The first of these racks, known as Equipment P.M.B.X. No. 1, consists of an angle-iron framework 7 ft. × 2 ft. 9 in. × 5 ft. (Fig. 3), capable of accommodating the apparatus for five positions, 250 extensions, 30 exchange lines or 15 interswitchboard lines. To this end the rack is built up as follows: 18 connection strips can be accommodated at the top. These are used to terminate the apparatus on the rack and also the cables from the switchboard and M.D.F. Underneath these strips is a fuse mounting taking 96 fuses. This fuse mounting feeds battery to all circuits. Below the fuse mounting 250 resistor coils of 250Ω resistance are fitted in piles of five. These coils form the sleeve resistance for extension circuits. Alongside the mounting for these coils space is provided for a relay mounting for twenty 600 type relays, to allow of the fitting of relays for extensions exceeding 200Ω resistance. The remainder of the rack is taken up by three shelves each accommodating five relay sets of the 2000 type. The jacks on these shelves are so wired that they will take either an exchange line relay set (two circuits per base) or an interswitchboard line relay set (one circuit per base).

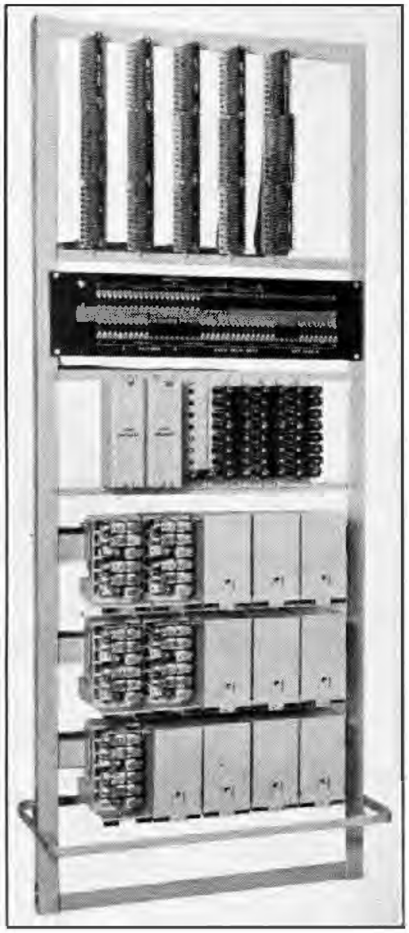

FIG. 3.—APPARATUS RACK (EQUIPMENT P.M.B.X. No. 1).

It will be seen that the maximum of 30 exchange lines per rack is reduced by two for every interswitchboard line fitted.

This rack was originally the only rack provided for housing apparatus associated with P.M.B.X. No. 1A. Owing to wartime demands for large networks of interswitchboard lines, the provision of Equipments P.M.B.X. No. 1 for interswitchboard lines only became uneconomic, and a second rack (Equipment P.M.B.X. No. 1/35) was introduced which caters for 35 interswitchboard line relay sets only. The necessary connection strips for terminating are fitted at the top of the rack and a separate fuse mounting is provided at the side. The dimensions of this rack are the same as the Equipment P.M.B.X. No. 1.

Cabling.

The sections and associated equipment have been designed with a view to reducing to a minimum the amount of work to be carried out locally on an installation. To this end the apparatus racks are used as the junction point of the M.D.F. and switchboard cables. The connection strips serving the exchange and interswitchboard line relay sets are duplicated, the relay set apparatus being terminated on one set and the multiple cables on the other. By jumpering between the two connection strips an I.D.F. facility is obtained. Fig. 4 gives the cabling arrangement for a typical installation.

Points of interest are :—The extension multiple is run in 80-wire cable. This serves both jacks and lamps. The wiring for the lamps is brought out at each multiple appearance, and where no lamp jacks are fitted it is necessary to maintain a through connection on the two wires to the lamp. Initially these wires were soldered together and insulated, but this gives a very bulky form when these wires are laced in. To overcome this difficulty a new method of stripping and forming the 80 wire cable has been evolved which allows of the lamp wires being left uncut where they are not required. It is a variation of the double stripper method, but is slightly more complicated by the fact that in the 80 wire cable the outer layers of wires are twisted in the opposite direction to that of the wires composing the centre core.

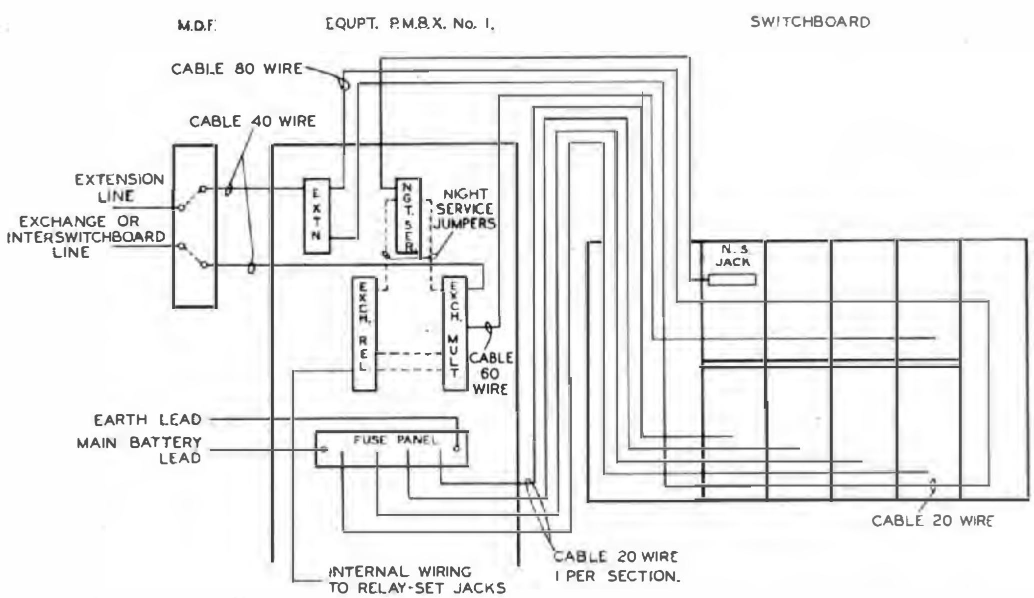

FIG. 4.—CABLING OF TYPICAL INSTALLATION.

The cabling of the extension multiple is so arranged that a long extension line relay can be inserted in any extension circuit. To make this possible the inner spring of the last multiple jack is cabled back to the apparatus rack. This necessitates a 20 wire cable (one wire per circuit) being brought back from the last multiple jacks. This is the reason for the use of two cable turning sections as these 20 wire cables have to be turned and brought along the bottom of the sections.

The night service exchange line interception jacks, usually one strip of 10 jacks is sufficient, are mounted at the top of the multiple field on any convenient section. These jacks are cabled direct to the apparatus rack and terminated on a connection strip. Any exchange line can be given night service facilities by inserting this night service connection strip in the jumper between the two exchange line connection strips on the apparatus rack.

The main battery feed is terminated on the fuse panels and battery is fed to each section by a 20 wire switchboard cable.

Power Supply.

The normal battery supply is a single **24 V** battery floated from A.C. mains by a rectifier (No. 38). If A.C. mains are not available then a double battery scheme would be used. The average load for a reasonably busy installation is 10 ampere hours per section per day. Where a rectifier is used a mains failure alarm is fitted in the cable turning section of the suite. This gives immediate advice that the battery has ceased to charge and the operator can report the trouble to the maintenance staff before the battery has been discharged to any extent. Normally the battery capacity is arranged to give a 24 hour standby on a mains failure.

Facilities and Circuits

Extension Line Circuit.

A special lamp (Lamp No. 2.17) has been introduced to eliminate the usual line relay for extension lines not exceeding **200Ω** (line resistance). The lamp is connected in series with the line on the battery side

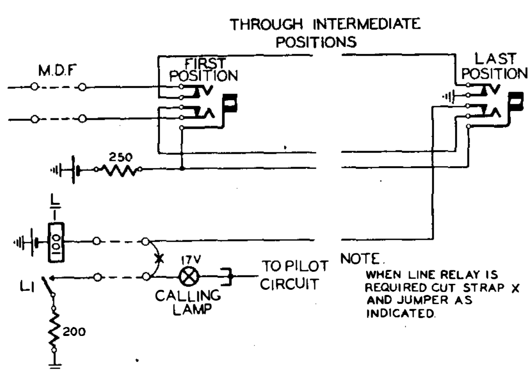

Fig. 5.—Extension Line Circuit.

of the circuit (Fig. 5), and glows when the extension oop is completed by the operation of the telephone gravity switch. Amber lamp caps are fitted to equalise illumination over varying line resistances. Provision is made for the inclusion of line relays for long extension circuits. A break jack series multiple is used for extension circuits to obviate the use of a cut-off relay per extension circuit. The answering lamps are associated with the extension multiple jacks, but only one calling lamp may be fitted for any extension line; thus if the calling lamps for extensions 0 to 19 appear in the first multiple appearance, spacing strips are fitted in lieu of lamp jacks on subsequent appearances.

Flexibility, when required, may be obtained by replacing the spacing strip by a lamp jack at the panel to which it is desired to transfer the calling lamps, and removing the lamps from the existing, and fitting them in the new lamp jack. Distribution for exchange lines may be effected in a similar manner, or if required ancilliary working can be arranged.

Cord Circuit (Fig. **6***).*

Double cords are provided with a supervisory lamp associated with each cord, giving double supervision. For extension-to-extension calls and calls to or from extensions completed via inter-switchboard lines, independent battery feeds are provided to both sides of the cord circuit, and the two supervisory lamps give independent supervision to each side. On extension-to-exchange connections, the cord circuit is a through circuit, and both supervisory lamps are joined in parallel, and are under control of the line relay in the exchange line circuit. In effect, the cord circuit functions as a bridge control circuit on extension-to-extension calls, and as a sleeve control circuit on extension-to-exchange calls.

When either cord is inserted into an extension or interswitchboard extension jack, the associated cord circuit sleeve relay (AS or CS) operates to the **250 Ω** battery on the sleeve of the jack, but when a cord is inserted in an exchange line jack the associated cord circuit sleeve relay does not operate as the sleeve relay is connected to earth via the auxiliary springs of the exchange line jack.

When the operator inserts an answering plug into an extension (or interswitchboard line) jack in response to a calling signal, and the speak key is thrown, relays SK and SKR operate. These two relays connect relays AS and CS to the sleeve wires of the answering and calling cord, and also connect relays LA and LC to the tip and ring wires.

Relay AS operates via battery and **250 Ω** spool on the extension sleeve. Relay AS connects battery and earth via relay LA to the extension instrument. If an extension is required, the calling cord is inserted into the desired jack and relay CS operates; when the called extension answers relay LC operates. With relays AS, CS, LA, and LC operated, a holding circuit is retained for relay SK.

With this relay operated throughout the connection, a divided feed is provided to the extensions. If, however, an exchange call is desired, relay CS does not operate when the calling cord is inserted into the exchange line jack. With relay AS operated, CS normal, LA and LC operated, relay SK will release

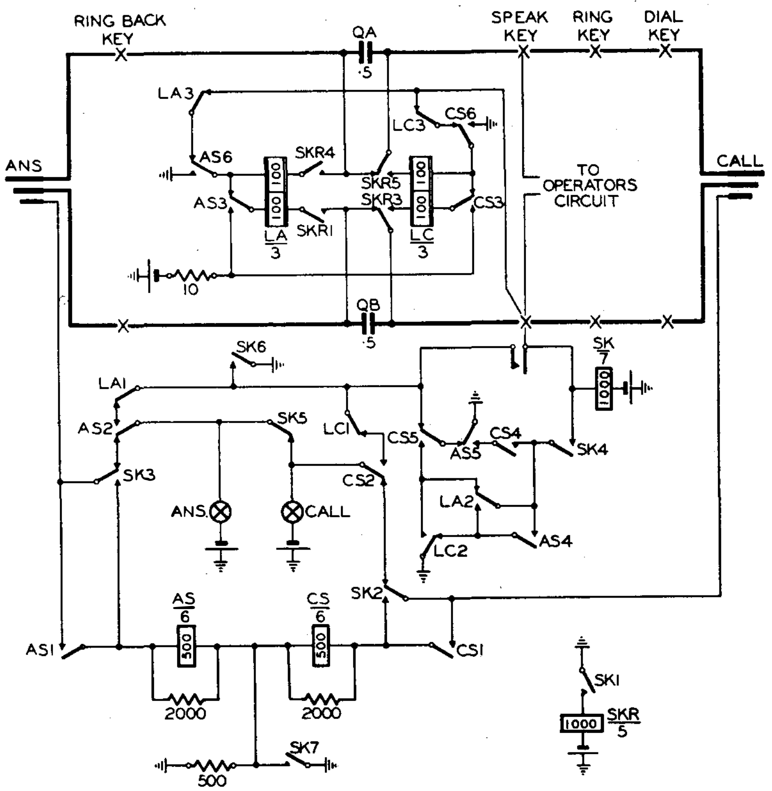

FIG. 6.—CORD CIRCUIT.

ringing and provides a circuit for the operation of relay L.

" L "—The line supervisory relay. This relay removes the short-circuit off the winding of relay LR, the circuit being prepared when the plug was inserted in the jack.

" LR " operates and switches the exchange line to the cord circuit, disconnects relay LG which releases, breaks the holding winding of relay AC, removes the earth on the bush of the jack, replacing it by a 500 Ω resistance connected to earth, thus extinguishing the cord circuit supervisory lamps.

" D " is the operator recall relay ; when operated it connects an earth on the sleeve of the jack, thus lighting the cord circuit supervisory lamps. The relay coil has two 15 Ω windings, one winding in series with each line similar to the L relay, but whereas the L relay responds to current in the loop, the D relay is connected with one winding reversed, and will not operate with loop current, but operates when the current of the two lines is unequal. When the extension is through to the exchange the coils of relays " L " and " D " are in series with the line, and add a further 60 Ω to the resistance of the exchange line; each pair of coils is shunted by a 2 microfarad condenser to by-pass speech currents. The circuit has been designed so that, with a minimum current of 30 milliamperes in the exchange line, relay LR will hold while an extension or operator is dialling.

and, on releasing, completes a direct metallic path from the extension line to the exchange line relay set.

The Position Circuit.

The operator's circuit is connected to the usual four-way double jack with transmitter across the inner, and receiver across the outer, springs, and the circuit follows normal practice except that provision is made for the transmitter current to flow only when the key is in the speak position. A relay and retard are provided for holding exchange calls when the operator re-enters the circuit.

The standard click engaged test is provided.

A position coupling key is provided on each section to connect the operator's circuit to the next position on the right.

The Exchange Line Circuit.

The exchange line circuit is shown in Fig. **7**. There are five relays per circuit whose functions are as follows :—

" AC " for receiving the ringing signal from the main exchange. When this signal is received relay AC operates and locks, lighting the exchange line calling lamps. The insertion of the answering plug into the exchange line jack breaks the locking circuit and the calling lamp circuit.

" LG "—The line guard relay operates when the speaking key is thrown, by current flowing through its windings to a loop on the cord circuit. LG operated places a loop across the exchange line which trips the

Operator Recall.

When the extension user presses the operator recall button at the extension point, an earth is applied to the T line which causes about twice the normal current to flow to earth over the wire connected to the exchange battery, and none over the other wire, which is now connected to earth at both ends. Relay D operates and lights the cord circuit supervisory lamps ; repeated depression of the button flashes the lamps.

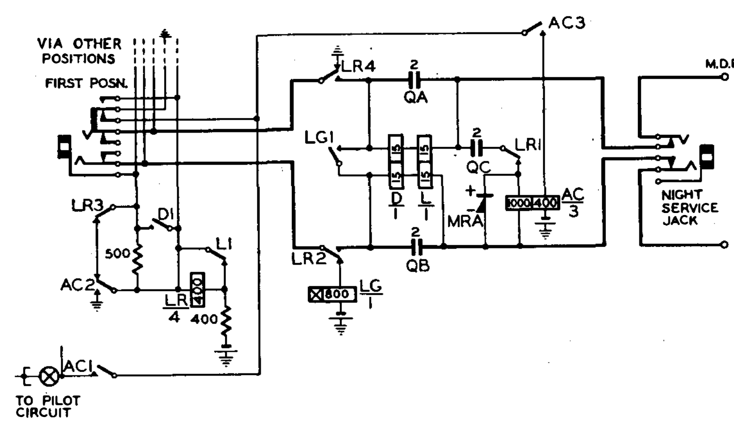

FIG. 7.—EXCHANGE LINE CIRCUIT.

Follow-on-Call Trap.

When the extension has cleared (but not the P.B.X. operator) relays LR, L, LG and AC release, and the cord circuit supervisory lamps light. In this condition an incoming ring operates AC during the ringing period, and extinguishes the lamps which flash to the ringing periods, thus attracting the attention of the operator. The extension bell is not rung as the circuit is broken at the LR relay contacts.

Night Service.

A break jack with the bush disconnected is inserted in each exchange circuit, between the exchange line and the relay set. These jacks are the night service exchange jacks. The insertion of a cord circuit plug into one of the jacks cuts off the exchange calling equipment and the insertion of the associated cord circuit plug into an extension jack joins the exchange line straight through to the extension.

The Interswitchboard Line Circuit.

This is a relay set which will serve both as a termination for an interswitchboard extension and interswitchboard private wire. The relay set serves one circuit only and replaces an exchange relay set which serves two circuits.

When certain " U " points on the jack are strapped it will cater for :—

Generator call and clear.
Generator call and D.C. clear.
D.C. call and clear.
Electrical prohibition of the connection of a private wire to an exchange line.

When an exchange call is extended to a distant P.B.X. the circuit gives through clearing to the exchange from the distant P.B.X. switchboard (but not from the distant extension). The relay set consists of seven 3000 type relays, two retards, two rectifiers and five condensers, together with a transformer.

Conclusion.

Two further developments are in progress. The first is designed to obviate the possibility of a false clear should the operator insert a plug into or withdraw a plug from an interswitchboard line jack while a ringing signal is still being sent from the distant end. The second is the introduction of a simplified interswitchboard line relay set to cater for routes on which D.C. or loop call and D.C. or disconnection clear can be made available at the distant end.

In conclusion, acknowledgments are due to Messrs. Standard Telephones and Cables, Ltd., for the supply of the photographs in this article.