SLEEVE-CONTROL SYSTEM SWITCHBOARD CIRCUITS

CONTENTS

GENERAL

The 'sleeve-control' system is a design of trunk and auto-manual switchboard equipment developed primarily to meet the requirements of modern trunk and junction working. The principle feature of the system is the provision of one type of cord circuit capable of forming a connecting link between all kinds of line circuit, irrespective of the line signalling conditions. This feature is very important, because it enables incoming and outgoing circuits of all types to be multipled, thus spreading the traffic over a large number of operators' positions and allowing the operator who answers an incoming call to set up the required connexion over the outgoing multiple with a minimum of delay.

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THE SWITCHBOARD

The sleeve-control switchboards are made in two heights, 6 ft. 4½ in. and 4 ft. 8½ in. both sizes accommodating seven panels per three positions. Fig. 1 shows a general view of the face equipment of an auto-manual switchboard and Fig. 2 shows the keyshelf layout.

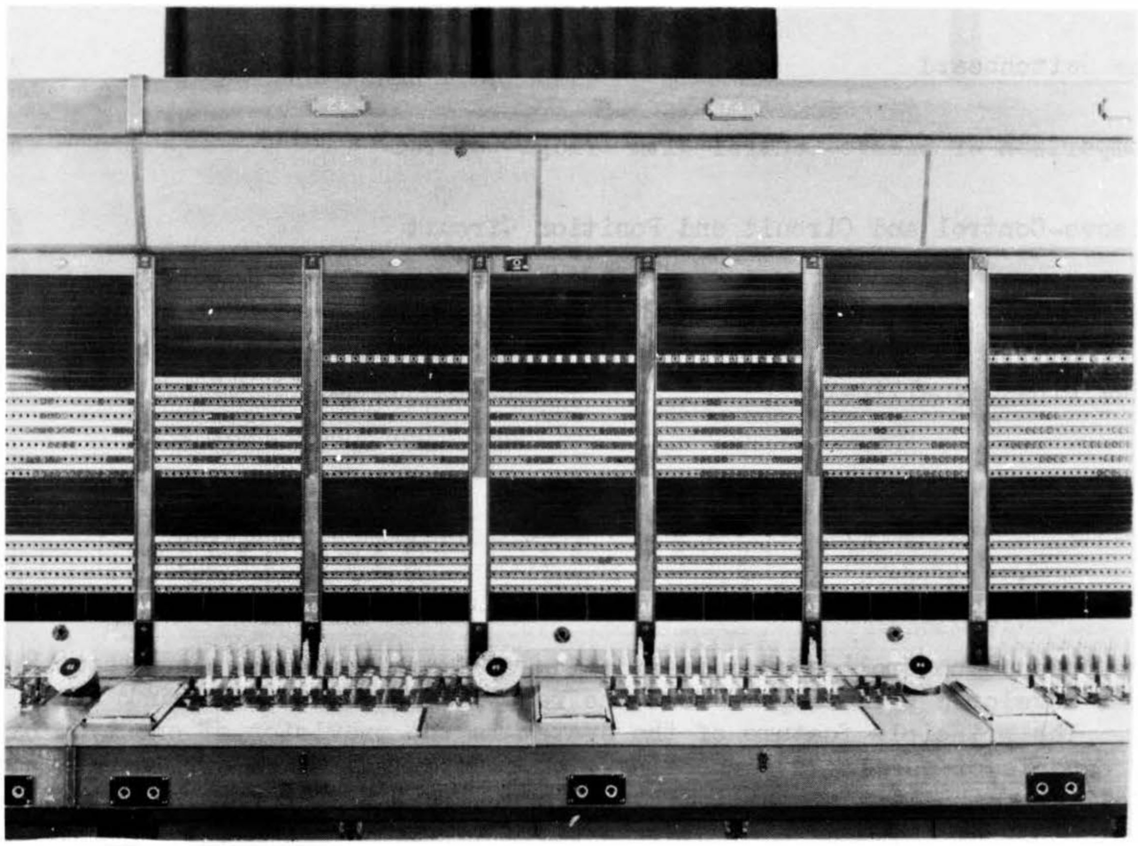

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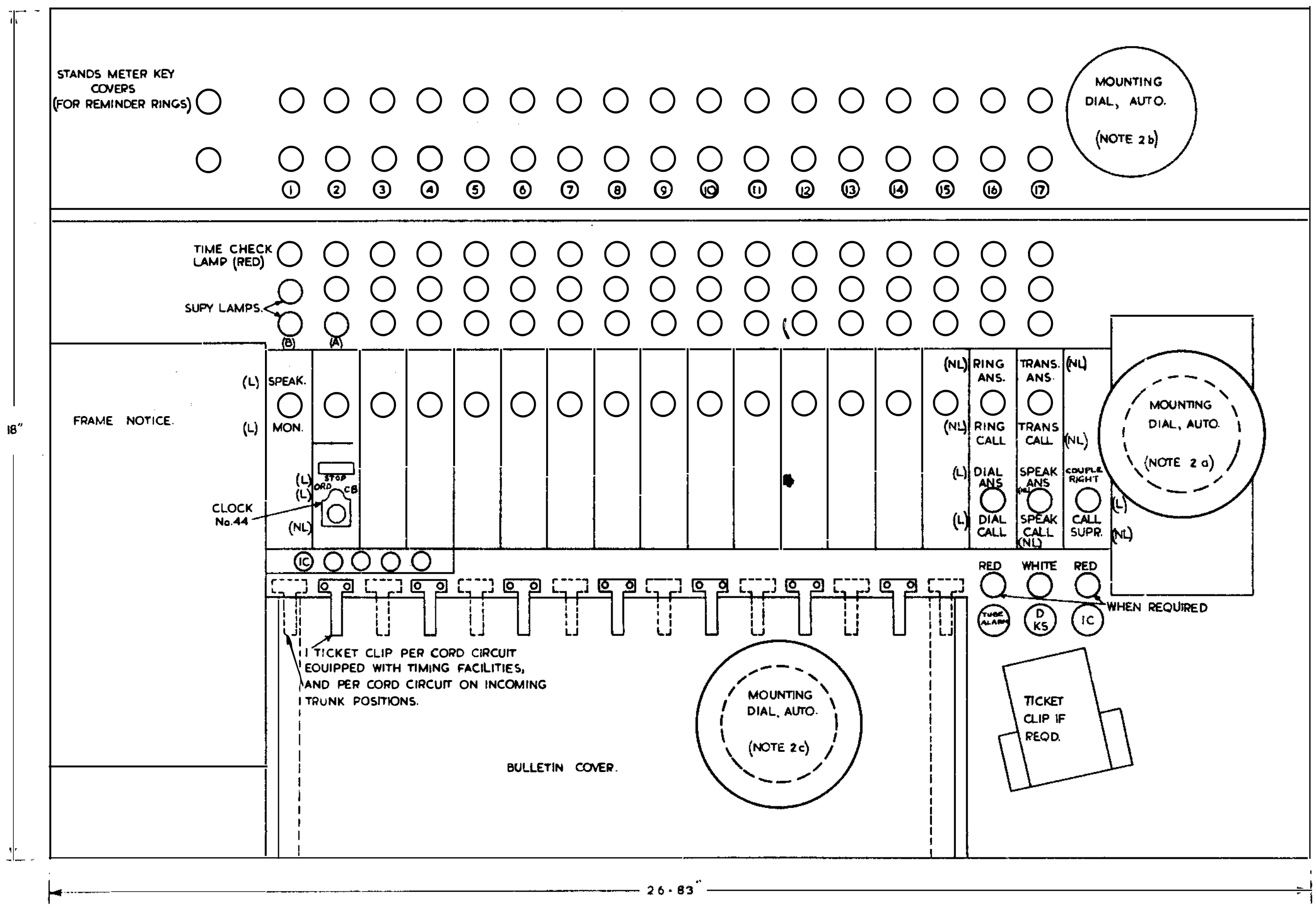
Fig. 1



NOTES:–

1. DIAGRAM SHOWS CAPACITY.
   WHERE EQUIPMENT IS NOT SPECIFIED, BLANKS WILL BE FITTED EXCEPT FOR TUBE INLETS & TUBE ALARM LAMPS, HOLES FOR WHICH WILL ONLY BE CUT WHERE TUBES ARE ULTIMATELY REQUIRED.
2. POSITION OF DIAL
   (a) THE DIAL WILL NORMALLY BE FITTED ON THE DIGIT KEY BLANK.
   (b) WHEN DIGIT KEYS ARE FITTED THE DIAL WILL BE FITTED ON THE PLUG SHELF.
   (c) ON J.E."B" POSITIONS THE BULLETIN COVER WILL BE REPLACED BY A FIBRE-COVERED BLANK AND THE DIAL FITTED AS SHOWN.

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Fig. 2. Keyshelf layout of a sleeve-control switchboard

COMPARISON OF SLEEVE-CONTROL WITH BRIDGE-CONTROL

The primary function of any cord circuit is to provide a connecting link between two line circuits. To enable the operator to exercise control over a completed connexion, supervisory signals controlled by currents in the line are associated with the cord circuit. In the older types of switchboard equipment the apparatus controlling the supervisory signals was included in the cord circuit. Fig. 3 shows a typical example of a bridge-control cord circuit.

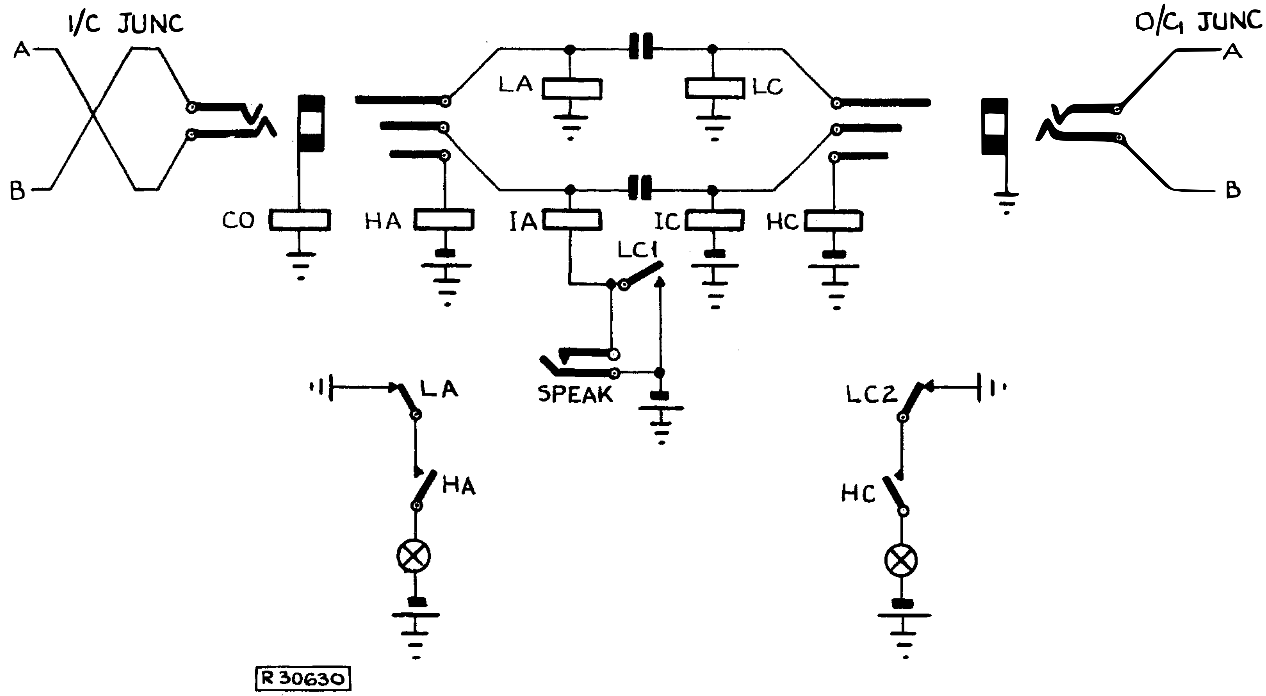


Fig. 3

The signalling relays in this figure respond to the usual C.B. signalling conditions, i.e. relay LA holds to the calling signal (battery on the B-wire of the incoming junction) and relay LC operates to the answering signal (battery on the A-wire of the outgoing junction). The circuits of the supervisory lamps are prepared by the operation of the sleeve relays (HA and HC) and the release of either signalling relay causes the appropriate lamp to glow. It is apparent that different arrangements of the supervisory relays, and consequently different cord circuits, are required for different line signalling conditions. It follows that if a cord circuit is required to be universal in its application to all types of line signalling systems, the signalling relays must be divorced from the cord circuit.

In the sleeve-control system the apparatus controlling the supervisory signals is located in the relay-sets forming the line terminations, and the cord circuit provides an unbroken metallic connexion between the two terminations, as shown in Fig. 4.

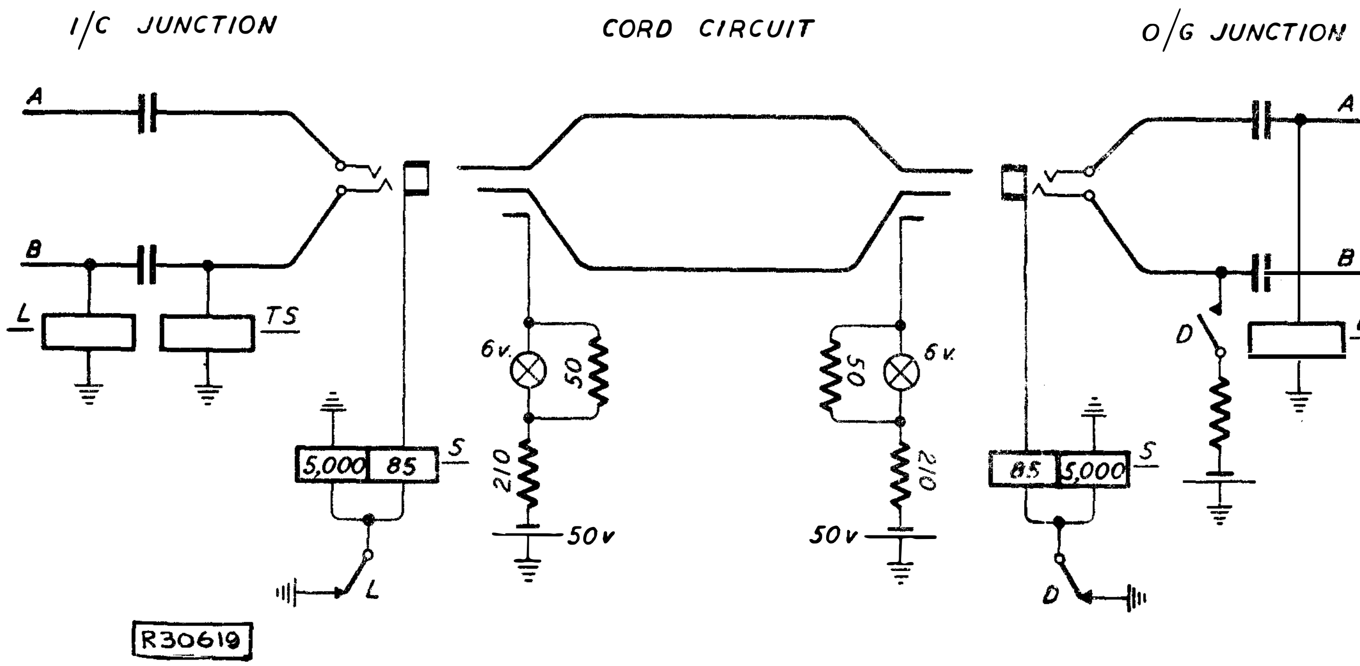


Fig. 4

On the line side of the capacitors the signalling relays are arranged to meet the line conditions, but on the cord circuit side of the capacitors and in the cord circuit itself standardized signalling circuits may be provided. As there are no signalling relays in the cord circuit the supervisory lamps are controlled over the sleeve conductors, hence the expression "sleeve-control". The earlier systems are distinguished by the term "bridge-control", the supervisory relays being bridged across the speaking pair.

It will be seen that each termination has a double relay S connected to the sleeve conductor and when a plug is inserted in a jack the S relay is in series with the supervisory lamp of the cord circuit. The resistance of the components in the lamp circuit is such that the lamp does not glow unless the high resistance coil of the S relay is short-circuited. The lamps therefore glow when their respective supervisory relays (L and D in figure) are normal. As the sleeve relay is normally required to extinguish the calling lamp on incoming circuits or to set up calling conditions on outgoing circuits, it is designed to operate whenever a plug is placed in the line jack irrespective of the condition of the sleeve circuit.

The metallic connexion which the cord circuit provides enables signals to be passed between the two terminations. The principal use made of this feature is for the transmission of the through supervisory signal. This is a standard signal consisting of the application of negative potential to the ring conductor. Thus in Fig. 4, when the supervisory relay D in the outgoing junction termination operates, the signal is transmitted to the incoming junction termination where it causes the operation of relay TS. A contact of relay TS (not shown) then transmits the appropriate signal over the incoming junction.

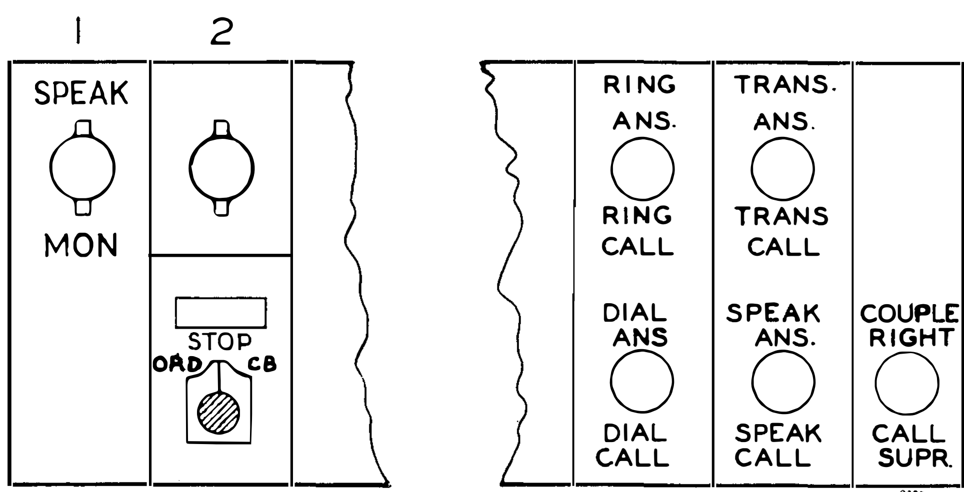
SLEEVE-CONTROL CORD CIRCUIT AND POSITION CIRCUIT

A cord circuit which merely provides a connecting link between the line circuits is, of course, incomplete in itself. Provision must be made for the operator's telephone to be connected to the circuit and for the operator to extend signals (ringing, dialling etc.) to the line circuits. In the sleeve-control system the following items are provided to give the required facilities.

(a) Operator's telephone circuit, including the engaged (click) test circuit.
(b) High impedance monitoring circuit.
(c) Splitting key, for disconnecting either cord from the operator's telephone circuit.
(d) Ring key.
(e) Transfer key.
(f) Dial key.

These components form the "position circuit" which is individual to each operator's position and common to all cord circuits on that position. To connect a cord circuit to the position circuit, each cord circuit has a double throw key, which, when thrown to the forward or SPEAK position connects the cord circuit to items (a), (c), (d), (e) and (f) and when thrown to the backward or MONITOR position, connects the cord circuit to item (b).

The layout of the various keys on the keyshelf of a typical position is indicated in Fig. 5. The position circuit keys are fitted at the extreme right of the keyboard. One additional key is provided for 'coupling' and 'call supervisor' facilities. The cord circuit number 2 is shown fitted with a clock 44 for timing the duration of calls.



1. Without Time Check.
2. With Time Check.

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Fig. 5

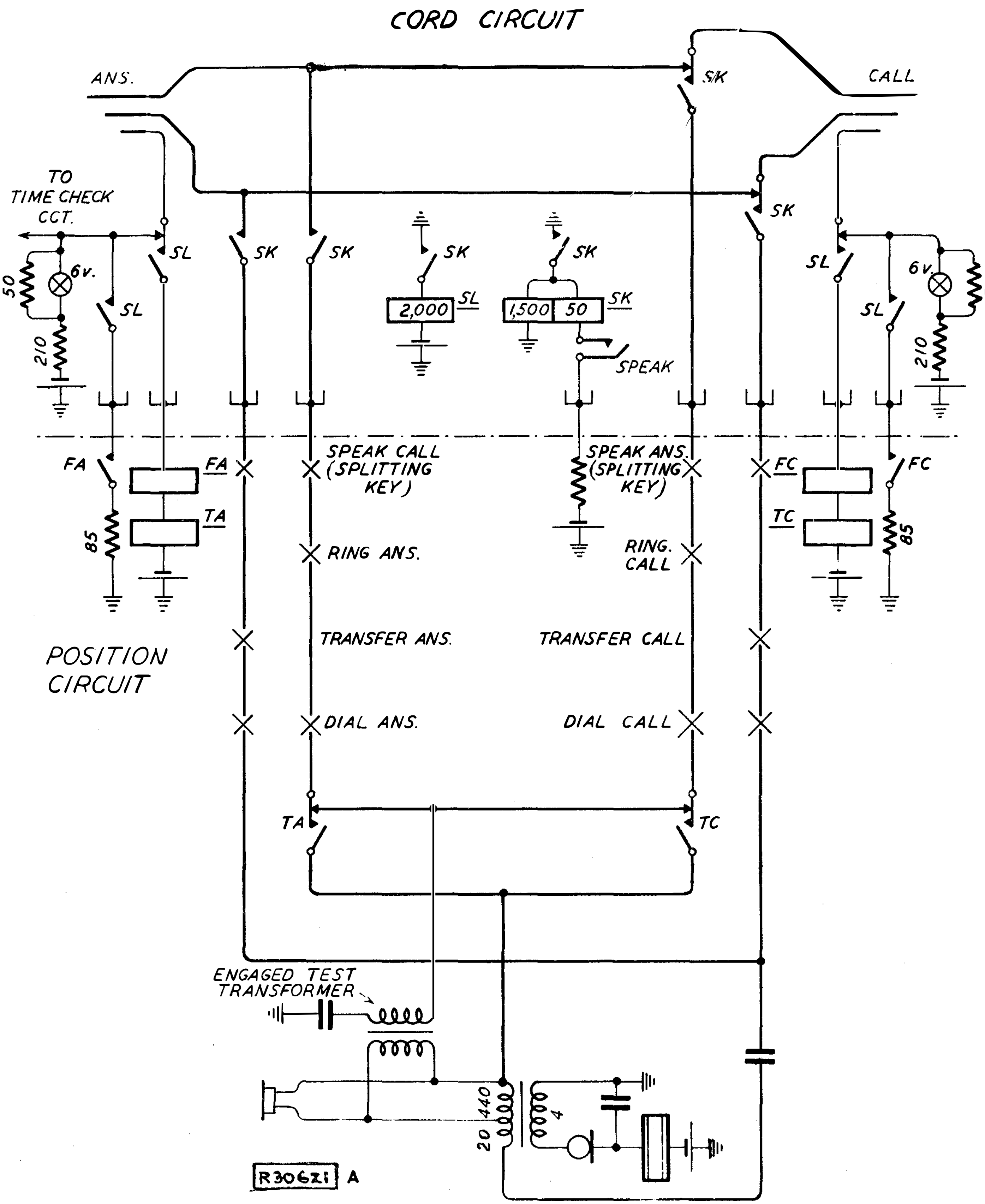
CORD CIRCUIT
ANS.
CALL
SK
TO
TIME CHECK
CCT.
SL
6v.
50
210
2,000
1,500
50
SPEAK
FA
TA
85
SPEAK CALL
(SPLITTING
KEY)
SPEAK ANS.
(SPLITTING
KEY)
RING ANS.
RING.
CALL
FC
TC
POSITION
CIRCUIT
TRANSFER ANS.
TRANSFER CALL
DIAL ANS.
DIAL CALL
ENGAGED TEST
TRANSFORMER
440
20
4
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Fig. 6

The general arrangement of the cord and position circuits is shown in Fig. 6. The cord circuit is connected to the position circuit by contacts of relay SK which operates when the cord circuit SPEAK key is thrown. A contact of SK relay operates its relief relay SL. To prevent more than one cord circuit being connected to the position circuit at any one time, the SK relays of all cord circuits on the position draw their operating current from a common resistance circuit. Each SK relay has two coils, one of 1500 ohms and the other of 50 ohms; the relay operates with both coils in series but when operated it locks via its 50 ohm coil and the 1500 ohm coil is short-circuited. Thus, should another SPEAK key be thrown, the second SK relay is shunted by the low resistance coil of the first and fails to operate.

The operation of relay SK splits the two sides of the cord circuit so that the tip and ring conductors of each side are extended separately to the position circuit. The standard engaged test (click test) facility is provided on all circuits, consequently the tip conductors of each cord must be connected to the engaged test circuit until a connexion has been established over the cord, when they must be switched through to the telephone circuit. The switching of the tip conductors is performed by relays TA and TC which are connected to the sleeves of the answering and calling cords respectively by the operation of SL when SK operates. Relays TA and TC are so designed that they always operate when their respective plugs are inserted in the jacks and the SPEAK key is thrown. When relays TA and TC are both operated the tip and ring conductors are continuous between the two cords, with the operator's telephone bridged across the connexion.

The extension of the sleeve conductors to the position circuit involves the disconnexion of the supervisory lamps from the sleeves of the plugs. In order that the lamps shall respond to supervisory signals when the SPEAK key is thrown it is arranged that the operation of the relay SL places the lamps under the control of relays FA and FC which are joined in series with relays TA and TC respectively, and are so designed that they only operate when the high resistance winding of the sleeve relay in the line termination is short-circuited. (Fig. 7).

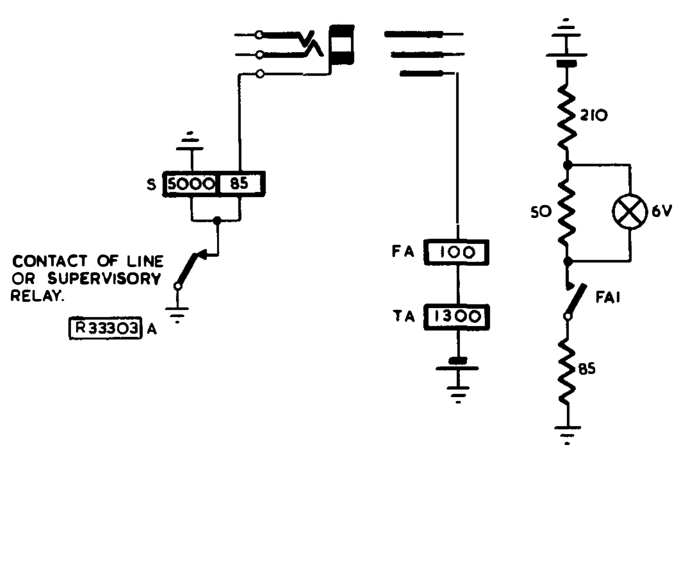

Fig. 7

Monitoring Circuit

The monitoring circuit is provided to enable the operator to supervise a call without appreciably degrading the transmission; the normal telephone circuit is not suitable for this purpose because of its low impedance. The arrangement of the monitoring circuit is shown in Fig. 8. When the monitoring key is thrown, relay M in the position circuit is operated. Contacts of relay M switch the operator's receiver to the secondary winding of a high impedance transformer, the tip and ring conductors being connected by springs of the MONITOR key to the primary winding of the transformer.

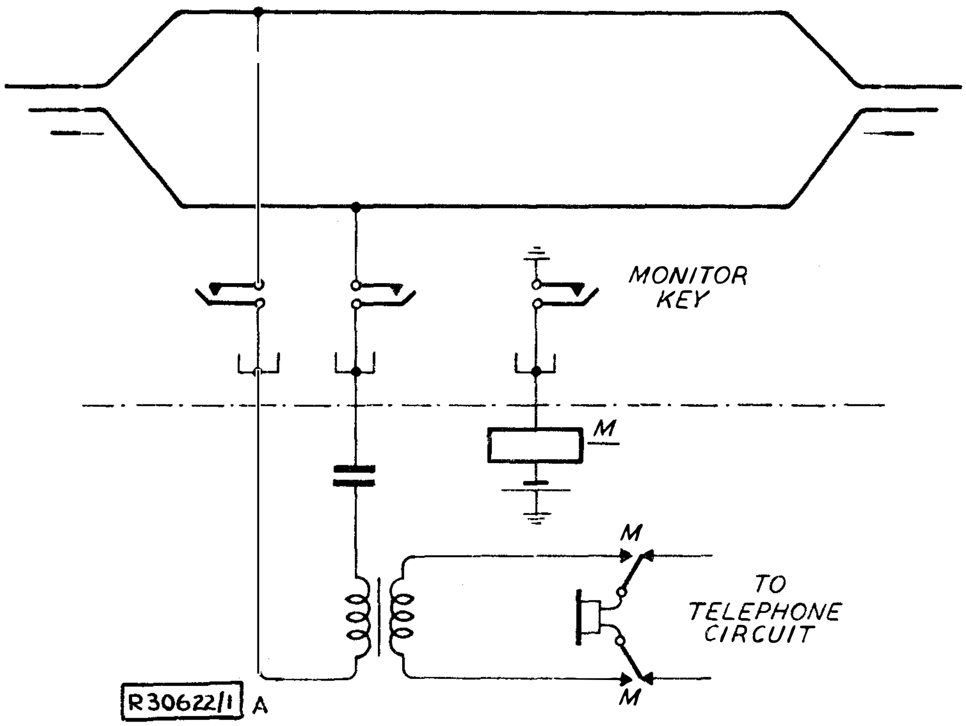

Fig. 8

Splitting Key

As previously explained, when the cord circuit SPEAK key is thrown the operator's telephone circuit is bridged across the answering and calling cords. The SPLITTING key is provided to enable the operator to isolate either cord as required. To isolate the answering cord the key is thrown to the SPEAK CALL position and to isolate the calling cord the key is thrown to the SPEAK ANSWER position (Fig. 9). The isolated cord is not left disconnected, but is switched to a terminating impedance consisting of a 600 ohm non-inductive resistor in series with a 1 µF capacitor. This termination is provided because the cord circuit may be used on any type of line circuit including repeatered trunk lines which may "sing" if they are not terminated by an impedance. When the cord is not isolated the operator's telephone circuit provides the requisite termination.

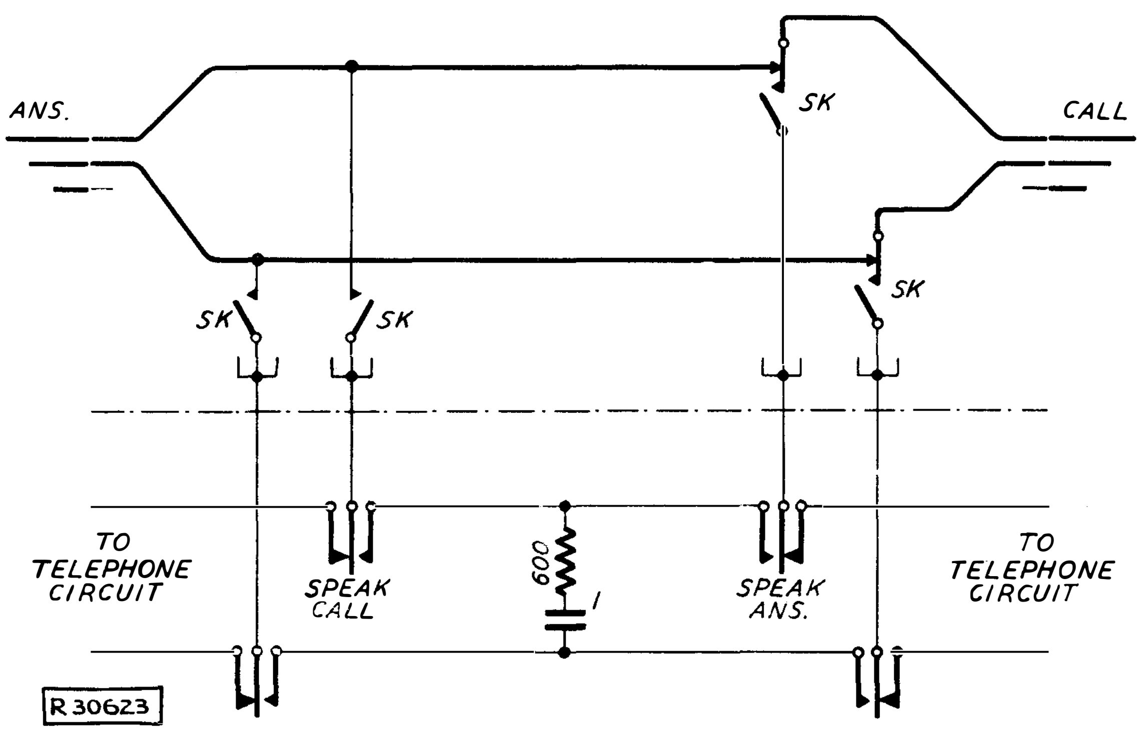

Fig. 9

Ring Key

In bridge-control cord circuits ringing current is extended direct from the RING key, the use of which is restricted to this purpose. In the sleeve-control system, however, the RING key is designated as such for the sake of convenience and is in fact a signalling key, ringing forming only part of its function. The circuit arrangement is shown in Fig. 10. The standard signal from the RING key is negative potential on the tip conductor. In the example shown, the RING key controls a relay RR in a line termination requiring 17 Hz signalling. Other uses of the key will be described in the pamphlet on line terminations E.P. - Draft Series, TELEPHONES 2/7.

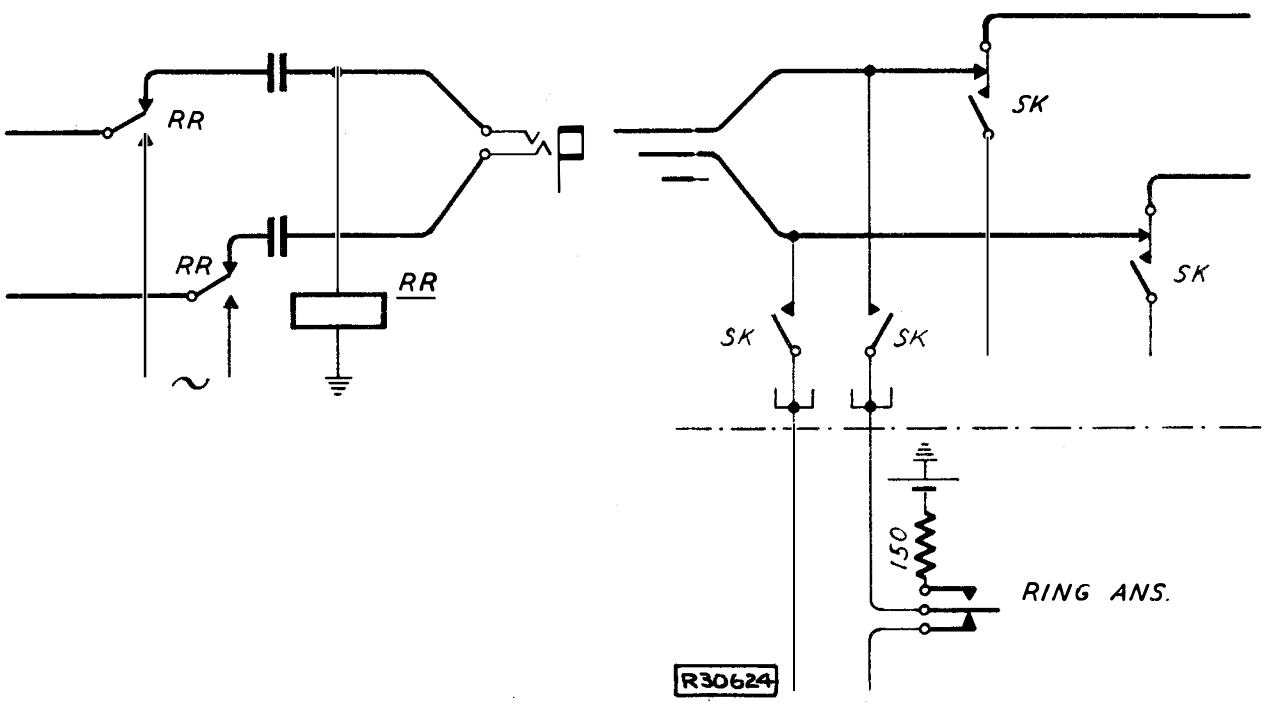

Fig. 10

Transfer Key

The TRANSFER key is peculiar to the sleeve-control system, its principal function being to operate a relay in the line termination to switch calling conditions from one suite of positions to another. The circuit principles are shown in Fig. 11. The calling signal first appears on the normal answering suite and if the call cannot be dealt with there, the operator throws the TRANSFER key, thereby connecting positive potential to the ring conductor to operate relay TR in the line termination. A contact of relay TR causes the calling lamp on the transfer suite to glow. The rectifier in series with relay TR prevents the relay operating to the through supervisory signal (negative potential).

The use of the TRANSFER key, like the RING key, is not necessarily confined to the purpose for which it is primarily intended.

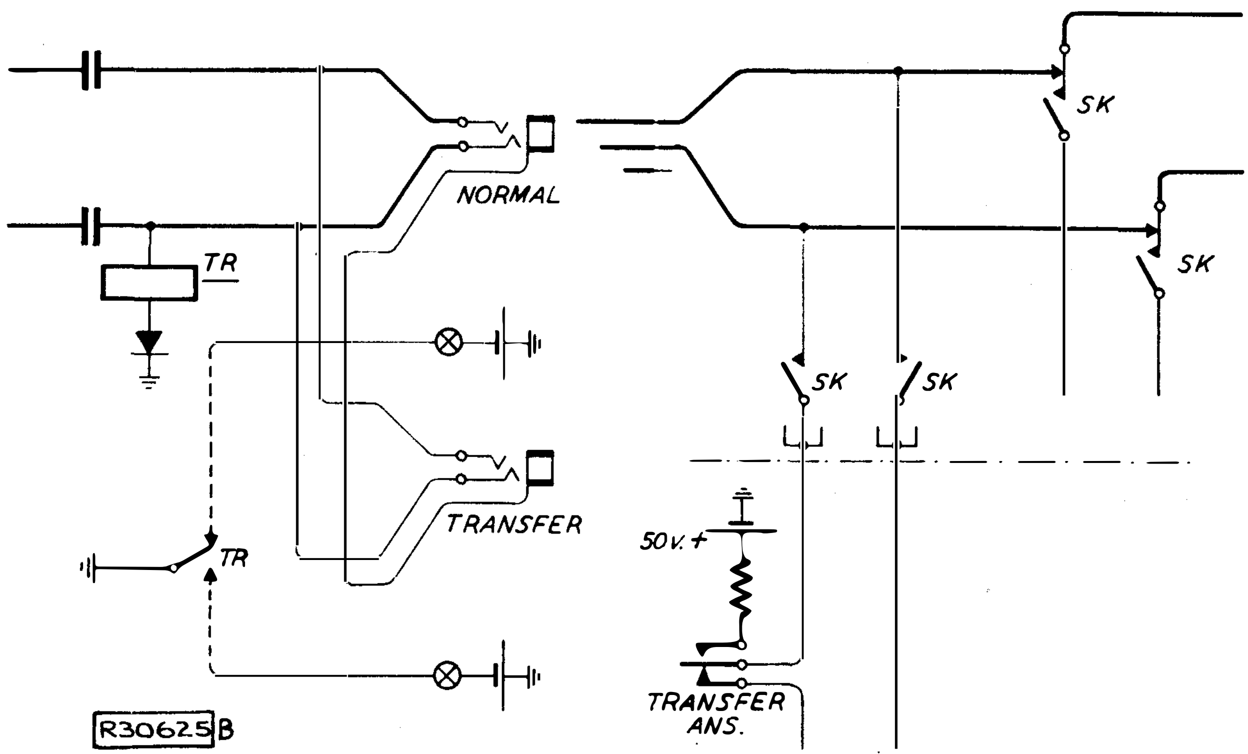

Fig. 11

Dial Key

Although there are different methods of dialling over junction circuits, standard dialling conditions are always transmitted from the sleeve-control position circuit and the line terminations are arranged to transform the pulse signals sent from the position circuit to those required for the particular type of line. Dialling and holding conditions are not always alike; for instance, it is usually desirable to short-circuit the capacitors in the termination during dialling so as to avoid the necessity for pulse repetition, but after dialling these short-circuits are removed and a holding loop applied to the line.

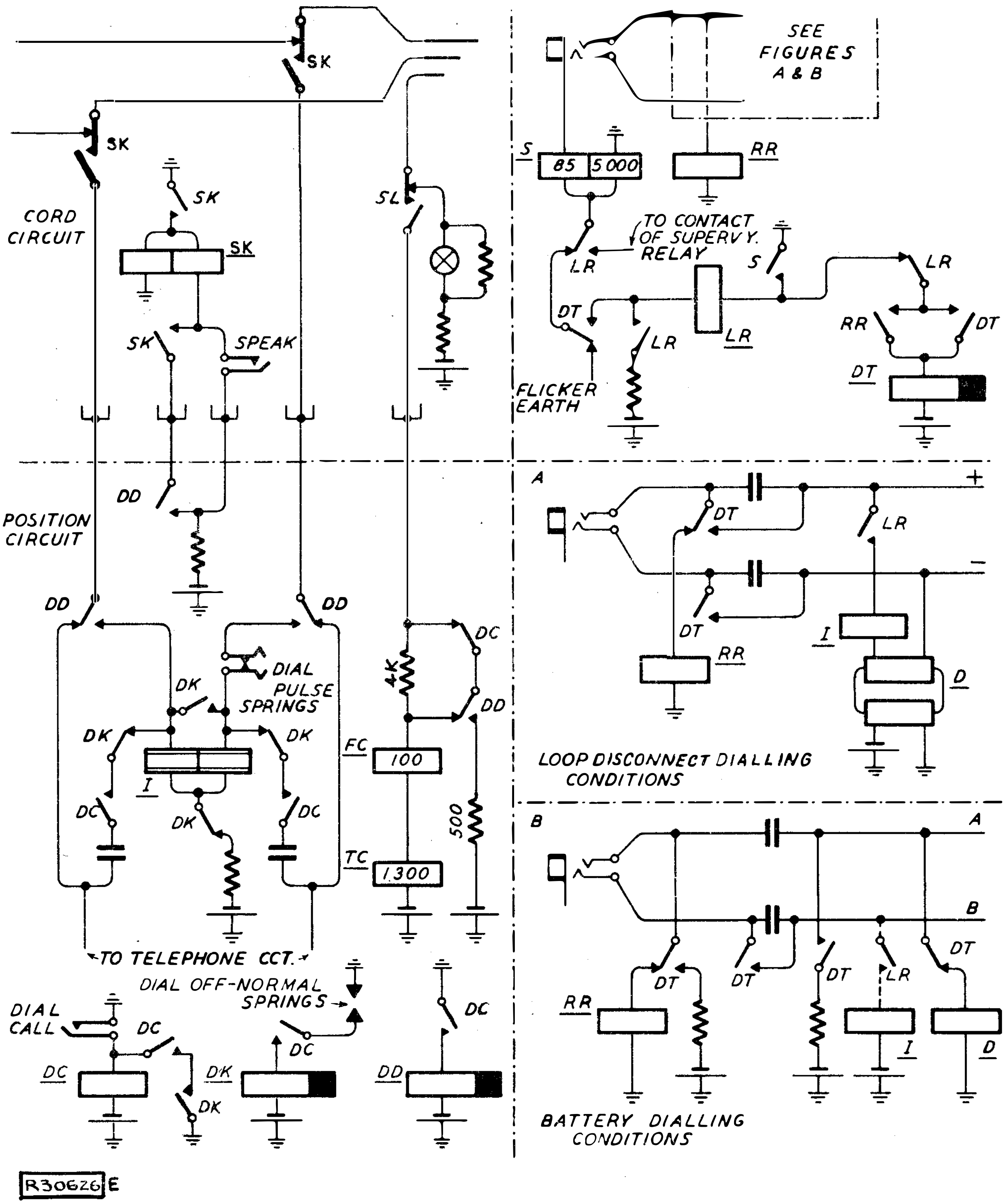
SK
SK
CORD
CIRCUIT
SK
SK
SL
SK
SPEAK
POSITION
CIRCUIT
DD
DD
DD
DK
DIAL
PULSE
SPRINGS
DK
DK
I
DC
DC
DK
DC
DD
4K
FC
100
500
TC
1300
TO TELEPHONE CCT.
DIAL OFF-NORMAL
SPRINGS
DIAL
CALL
DC
DC
DC
DK
DK
DD
DC
SEE
FIGURES
A & B
S
85
5000
RR
TO CONTACT
OF SUPERVY.
RELAY
LR
S
LR
DT
LR
LR
RR
DT
DT
FLICKER
EARTH
A
+
DT
LR
−
DT
RR
I
D
LOOP DISCONNECT DIALLING
CONDITIONS
B
A
B
DT
DT
DT
LR
DT
RR
I
D
BATTERY DIALLING
CONDITIONS
R30626 E

Fig. 12

The circuit arrangements of the position circuit and the controlling relays of a dialling termination are shown in Fig. 12. The required facilities are obtained as follows:-

(a) When the plug is inserted in the line jack, flicker earth connected to the sleeve conductor causes the supervisory lamp to flash. This flashing signal is to remind the operator of the nature of the circuit. It is fitted to all dialling circuits except "manual board first code selectors" in the director areas for which dialling tone must be received before dialling can commence.

(b) When the DIAL key is thrown relays DC and DD operate, connecting balanced battery via the impedance coil I to the tip and ring conductors. Relay RR in the termination operates to the battery signal and operates relay DT which sets up dialling conditions. Relay DD in operating disconnects the normal path to the operator's telephone circuit, but a secondary path is provided to allow the operator to hear dialling tone. The operation of relay DC also causes the resistance of the sleeve circuit to be increased by 4000 ohms in order to prevent the operation of relay LR in the termination, LR being connected in series with the sleeve conductor by a contact of relay DT.

(c) Immediately the dial is rotated off-normal relay DK operates and remains held until the dial returns to its normal position. Contacts of relay DK disconnect the listening circuit and the balanced battery and also short-circuit the impedance coil I so that during dialling, loop disconnect pulses are transmitted to the termination. Release of relay DK each time the dial returns to normal re-connects the listening circuit so that the operator can observe the setting up of the connexion. The type of pulse signal sent to line is determined by the arrangement of the contacts of relay DT. In a loop disconnect dialling termination, for example, the line capacitors are short-circuited so that the loop disconnect pulses from the position circuit pass direct to line.

In a battery dialling termination the capacitor in the B leg is short-circuited by a contact of DT. Another contact of DT places a battery on the tip conductor, and this battery is fed back through the pulse springs of the dial so that battery pulsing over the ring conductor is obtained.

(d) When dialling is completed, DK has released, and the DIAL key is restored, relay DC releases, followed a little later by relay DD. A contact of relay DC connects a 500 ohm battery to the sleeve conductor and the increased current causes the operation of relay LR in the termination. Relay LR establishes holding and speaking conditions and releases relay DT. The slow-release features of relays DD and DT ensure that dialling conditions are maintained sufficiently long to cover the slight lag in the set up of the holding circuit. It should be noted that the premature release of the DIAL key or the SPEAK key during the last journey of the dial does not result in lost pulses because relay DK, and hence DC, remain held to the dial off-normal springs. DC holds DD, and DD holds relay SK independently of the SPEAK key.

Control of Time Checks

When a time check is associated with a cord circuit, the connexions are so arranged that the clock mechanism is stopped when the clearing signal is received on the answering supervisory lamp.

The controlling circuit is shown in Fig. 13. The circuit of the timing mechanism is closed by a contact of relay SY, which is connected to the sleeve of the answering cord when the START key is operated. Relay SY is connected in parallel with the S relay in the termination, and it can only operate when the high-resistance winding of S relay is not short-circuited. When the called subscriber answers, the START key is operated and the clock is stepped at 6 second intervals by an earth pulse obtained from the master clock via a time pulse relay. The earth pulses are repeated to the clock drive magnet by relay SY which is operated from battery via the cord circuit supervisory lamp. When the clearing signal is received, the value of the shunt across relay SY is reduced to 85 ohms and the relay releases.

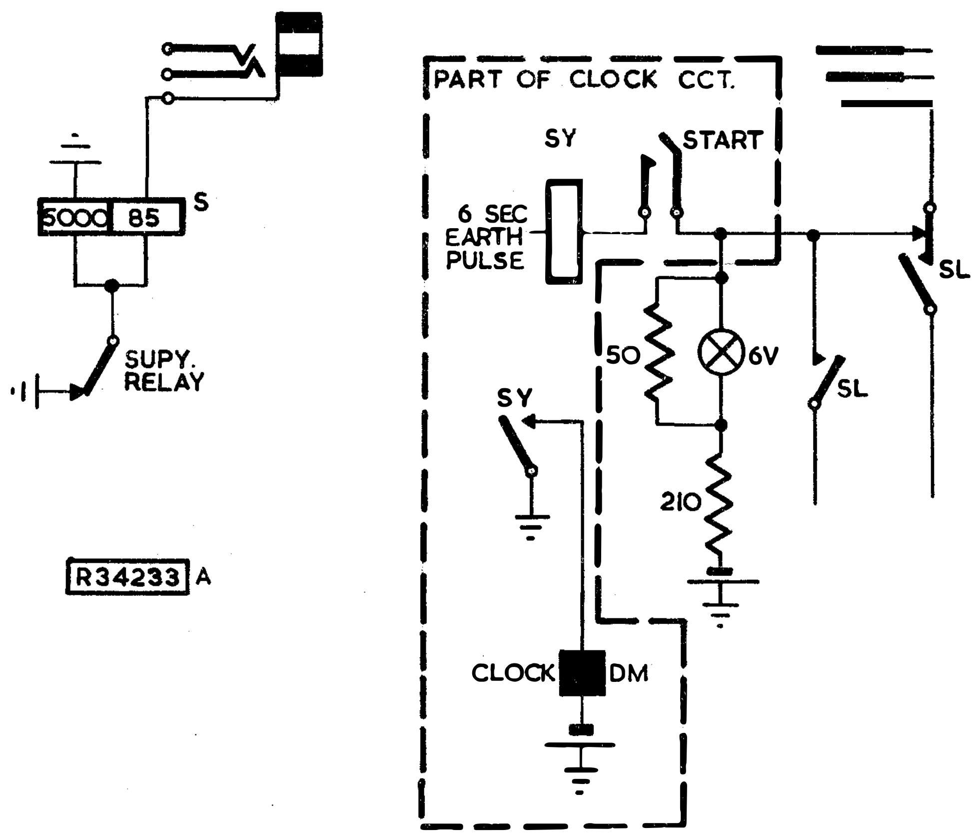

Fig. 13

Automatic Start Facility

This facility is provided by the inclusion of a 'delay circuit' which is connected to the calling cord sleeve circuit. The delay circuit is a transistor controlled slow operate relay device which detects the called subscriber answer signal by the change in potential on the sleeve wire; after a delay period of 130-150 ms the delay circuit relay operates to complete the clock drive circuit, see Fig. 14.

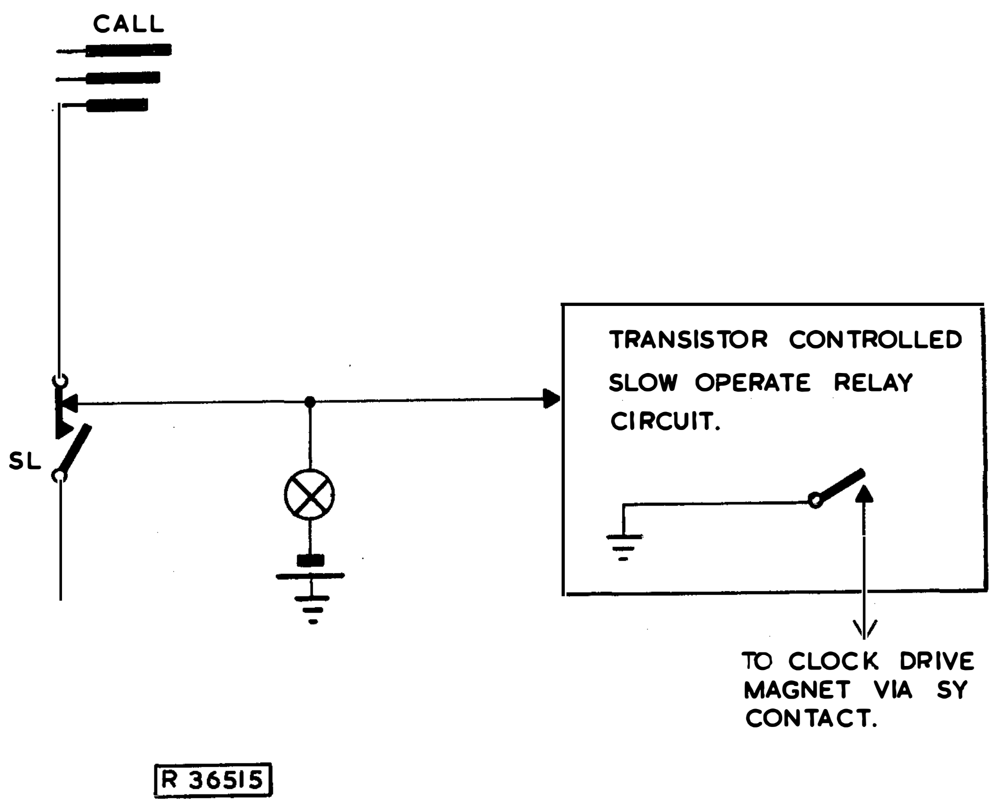

Fig. 14

When the automatic start facility is included in the time check circuit the START key is operated on the receipt of ring tone. When the called party answers the delay circuit operates and the clock starts automatically.

CALLING SIGNAL LOCK-OUT

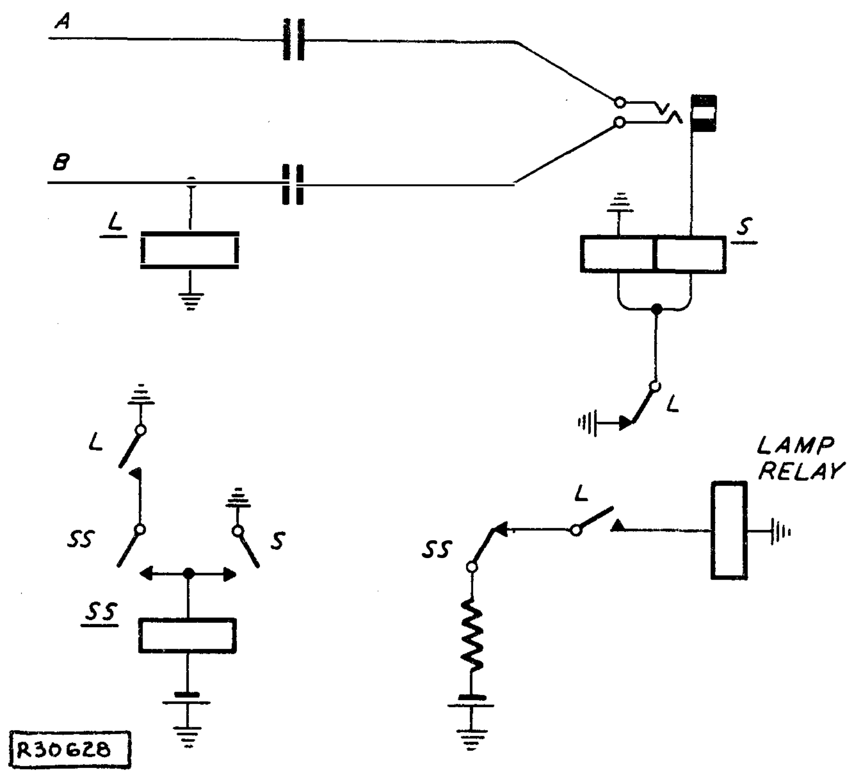

Fig. 15

The calling signal lock-out facility is necessitated by the use of multipled answering jacks. The facility provides that once an incoming signal has been answered, the calling lamp shall not glow again as a result of that call even though the answering operator removes the plug from the answering jack. The facility is provided on all sleeve control terminations. The circuit principles are shown in Fig. 15. The line relay (L) operating to the calling signal operates the lamp relay, which causes the multipled answering lamps to glow. When a plug is inserted in the answering jack, relay S operates followed by SS. A contact of SS disconnects the calling lamp and relay SS remains held until both L and S restore, thus ensuring that the lamp relay cannot operate again during the call.

USE OF A.C. MAINS FOR LIGHTING CALLING LAMPS

In modern practice the current for lighting the lamps associated with line jacks is obtained where possible from a.c. supply mains, the normal supply voltage being stepped down to 6 volts for this purpose. Arrangements are made whereby in the event of a failure of the supply mains the lamps are lit from the exchange battery. Now where a 6 volt supply is required to light a number of multipled lamps only a very small voltage drop can be tolerated and therefore the transformers used for stepping down the voltage are located near the switchboard so that long supply leads are eliminated. To avoid restrictions regarding the position of the terminating relay-sets due to this feature, the lamps are controlled by relays mounted on the transformer racks and these relays are in turn controlled from the terminations.

The circuit arrangements of the multipled lamps, together with the lamp relay and the a.c. and d.c. supplies, are shown in Fig. 16. In order to limit the extent of a breakdown, two 6 volt a.c. supplies are used and when the lamp relay (LC) operates, alternate calling lamps are lit from each supply.

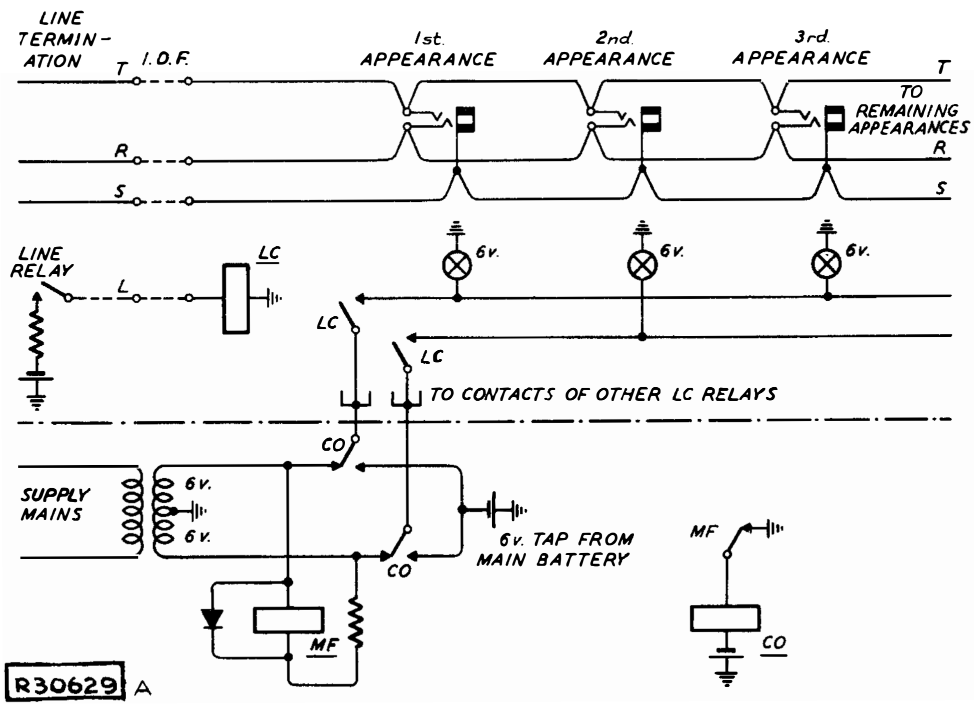

Fig. 16

Relay MF is provided to effect the change-over to a 6 volt tapping on the exchange battery in the event of failure of the supply mains. The relay remains operated until a failure occurs, when it releases and operates relay CO which switches the contacts of the lamp relays to the d.c. supply. (The circuit arrangement shown in the figure is equally applicable to bridge-controlled switchboards).

FREE LINE SIGNALLING

The method of operating outgoing junction circuits from a sleeve-control switchboard necessitates the selection of a free circuit by the operator and, in order to reduce operating time to a minimum, means must be adopted whereby the operator can readily find a free circuit in a large group of outgoing circuits. The normal engaged test is too slow in the case of large junction groups during busy periods and the modern method provides a visual indication of the first free circuit in a group. This system is termed Free Line Signalling.

The free line signalling lamps are fitted behind pinholes in the designation strip, and are connected to the equipment so that the first free junction within a group of junction circuits is shown by the glowing of the lamp.

The circuit arrangement is shown in Fig. 17.

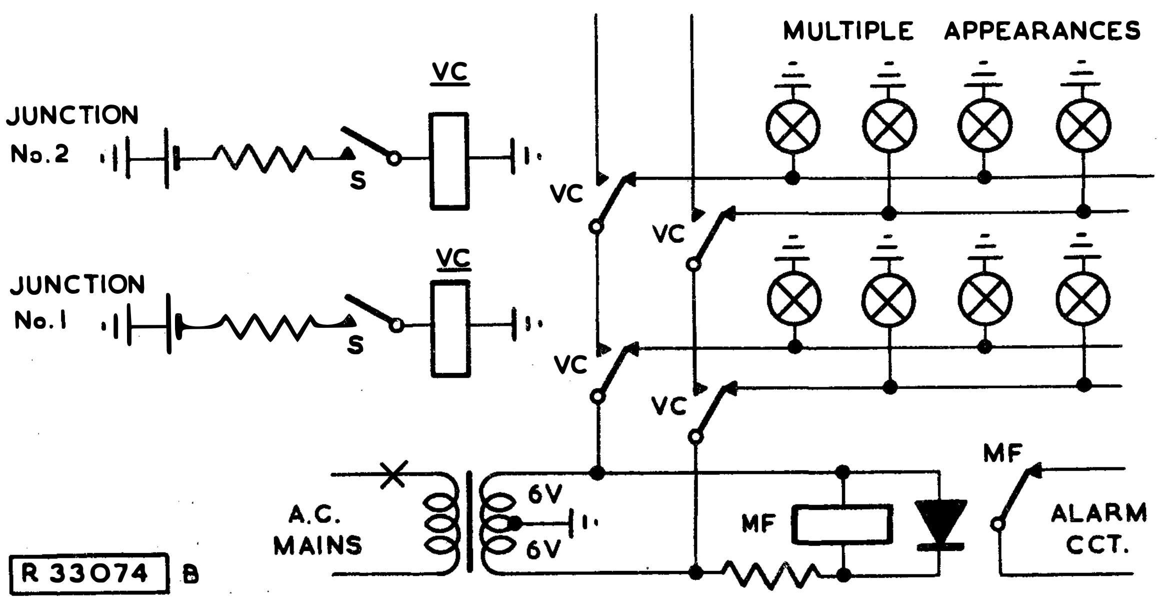

Fig. 17

When a plug is inserted into a junction jack the relay VC is operated by a contact of the sleeve relay and completes a circuit via the VC contact of other engaged circuits to cause the lamp on the next free junction to glow.

If the multiple is very large, the VC relay has several spring sets, each of which completes the circuit of 20 lamps joined in parallel.

A 6 volt a.c. supply is used for the free line signalling lamps and is obtained from the a.c. mains via a step-down transformer. A key is provided so that the lamps can be switched off at night when there is little traffic. The normal engaged test is then used.

Unlike the multipled answering-lamp supply a standby d.c. supply is not usually provided. In the event of a mains failure MF relay acts as an alarm relay and the normal engaged test is used until the circuit is restored.

END

References

E.P. - Draft Series, TELEPHONES 2/7