SLEEVE-CONTROL SYSTEM LINE TERMINATIONS

CONTENTS

C.B. SIGNALLING TERMINATIONS

In the C.B. signalling system the calling signal is a negative potential connected to the B-line of the junction and the answering or supervisory signal is a negative potential connected to the A-line. The signals remain on the line during conversation and the clearing signal is the cessation of the calling current.

The signalling arrangements are shown in Fig. 1. At the outgoing end the insertion of a plug in the jack causes the operation of relay M, and contact M1 connects the calling battery to the B-wire of the junction. At the incoming end the calling signal operates relay L; contact L1 operates relay LL and LL1 operates the lamp relay. The lamp relay is disconnected by the operation of relays S, SS and LO when the operator plugs into the answering jack. The answering signal cannot be transmitted immediately a plug is placed in the answering jack because this would prevent the originating operator's supervisory lamp being controlled by the called subscriber. The answering signal is therefore transmitted under the following conditions:-

(a) When the answering operator comes into circuit by throwing the SPEAK key, and

(b) when the through supervisory signal is received after the call has been further extended.

To transmit the signal under condition (a) the sleeve circuit at the incoming end is modified to include one winding of a differentially wound relay DR. The two windings of relay DR are energized through a common resistance circuit and the connexions of the relay are such that when the sleeve winding is energized via the supervisory lamp, the currents in the windings are approximately equal and the relay does not operate. When the SPEAK key is thrown however, the sleeve conductor is switched from the low resistance lamp circuit to the high resistance circuit of relays FA and TA; the currents in the two windings of relay DR are thereby unbalanced and the relay operates. A contact of relay DR operates relay TS, which connects the answering potential to the A-wire of the junction. When the SPEAK key

is restored, relay DR releases and relay TS is then controlled by the through supervisory signal. At the outgoing end the answering signal operates relay D, which sets up local and through supervisory conditions.

Arrangements are made to allow both operators to flash the distant supervisory lamp by the intermittent operation of the RING key. The operation of the RING key causes relay RR to operate and a contact of RR disconnects the calling, or the answering signal as the case may be.

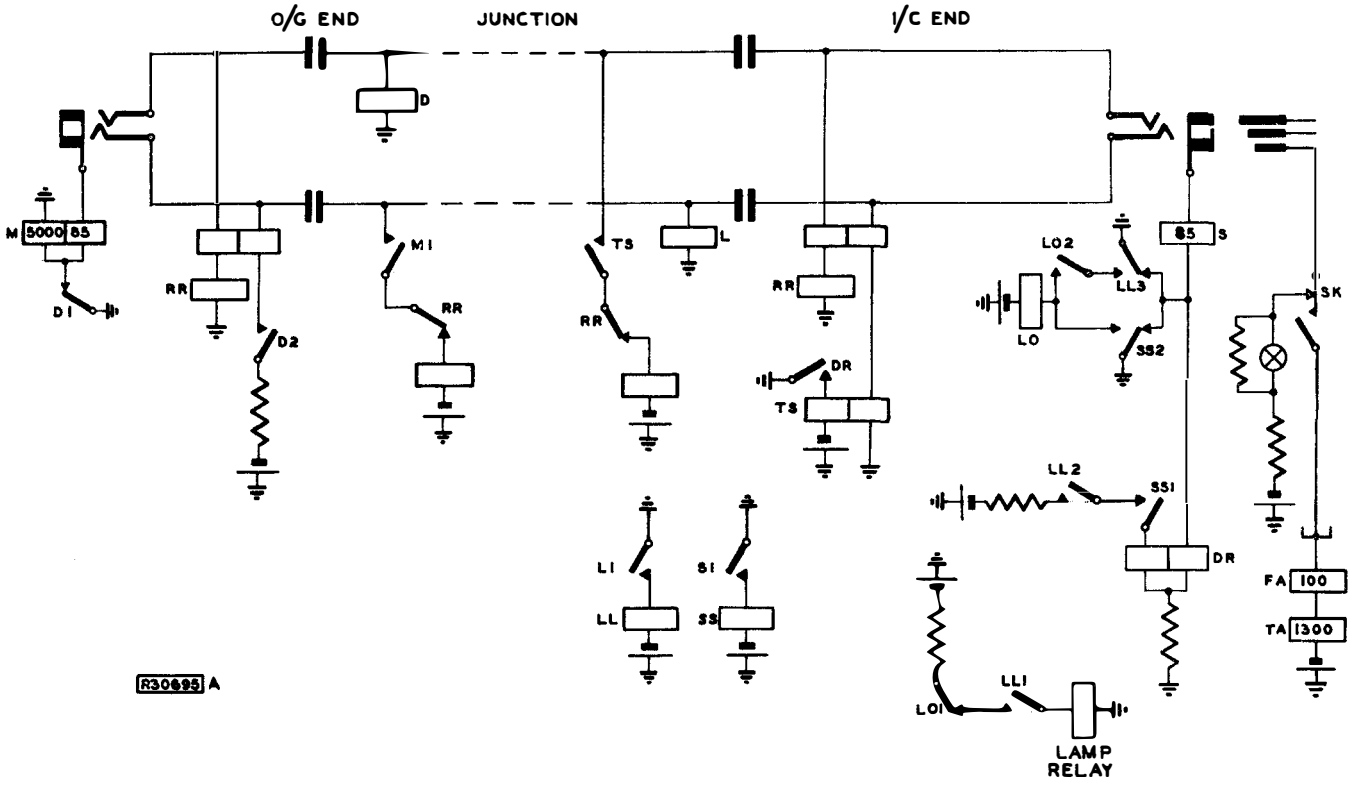

Fig. 1

The flashing, or the cessation of the calling signal results in the release of relays L and LL, and contact LL3 short-circuits the sleeve winding of relay DR thus causing the supervisory lamp to glow. As relay DR would operate under these conditions, its second winding is disconnected by a further contact of relay LL.

Relay LO provides for 'calling signal lock-out' if the operator at the incoming end withdraws the answering cord before the calling signal is disconnected.

Through supervision

A through connexion for a C.B. signalling sleeve-control circuit is shown in Fig..2. The cord circuit is described in E.P. - Draft Series, TELEPHONES 2/6, and a study of this diagram should assist in the understanding of the main feature of sleeve-control working.

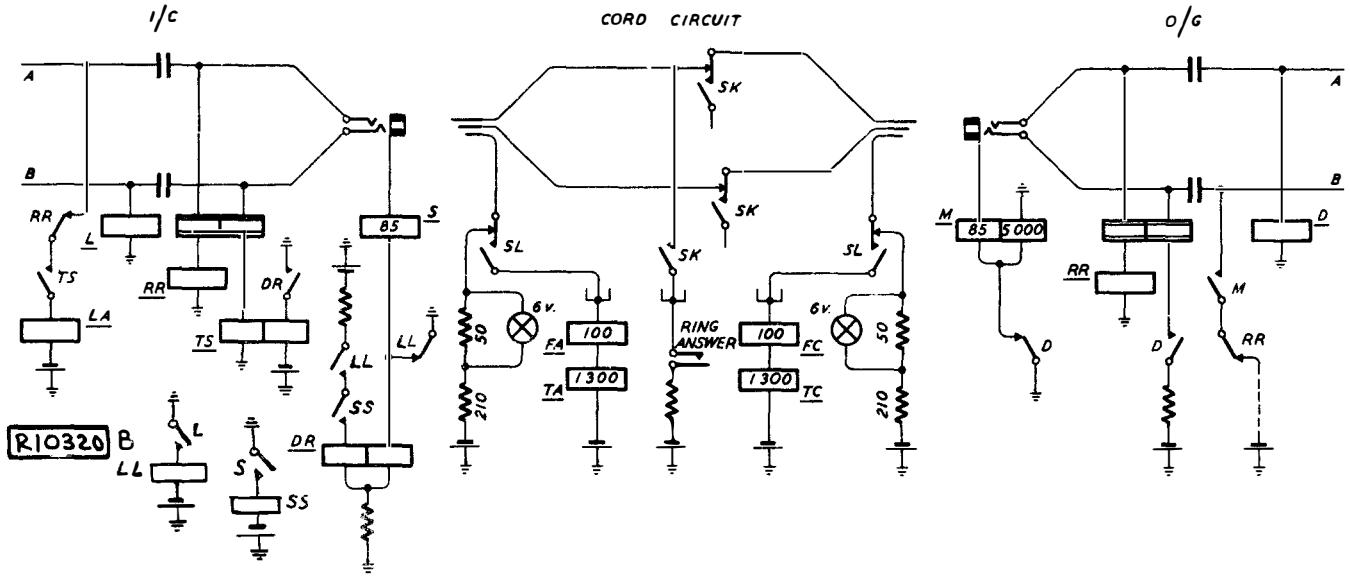

Fig. 2

DIFFERENTIAL SIGNALLING TERMINATIONS

C.B. signalling can only be used when the resistance of the junction circuit is such as to allow a minimum signalling current of 15 milliamperes in each line wire, this being the minimum current which will ensure the correct operation of the signalling relays. Differential signalling circuits are designed to permit d.c. signalling on lines having a resistance which is too high for C.B. signalling. The two line wires are paralleled for signalling purposes, the signals being received by differentially wound relays which are sufficiently sensitive to respond to signalling currents of 10 mA (5 mA per line wire).

Sleeve control terminations for differential signalling are shown in Fig. 3.

The calling signal is a balanced battery and the answering signal is also a balanced battery. For flashing purposes from either end the balanced battery is alternated with balanced earth.

At the outgoing end the insertion of the plug in the jack causes the operation of relay M, which extends the battery calling signal to the junction wires. The direction of the current in the two windings of relay DL at the outgoing end is indicated by arrows and under these conditions the relay does not operate. At the incoming end, however, one coil of relay DL is short-circuited so that the line current flowing through the other winding causes the relay to operate. The relief relay L then operates and completes the circuit for the lamp relay.

When the operator at the incoming end answers, relays S and SS operate and the lamp relay is disconnected. The answering signal is not transmitted until the SPEAK key is thown, when relay DR, which functions as in Fig. 1, operates. A

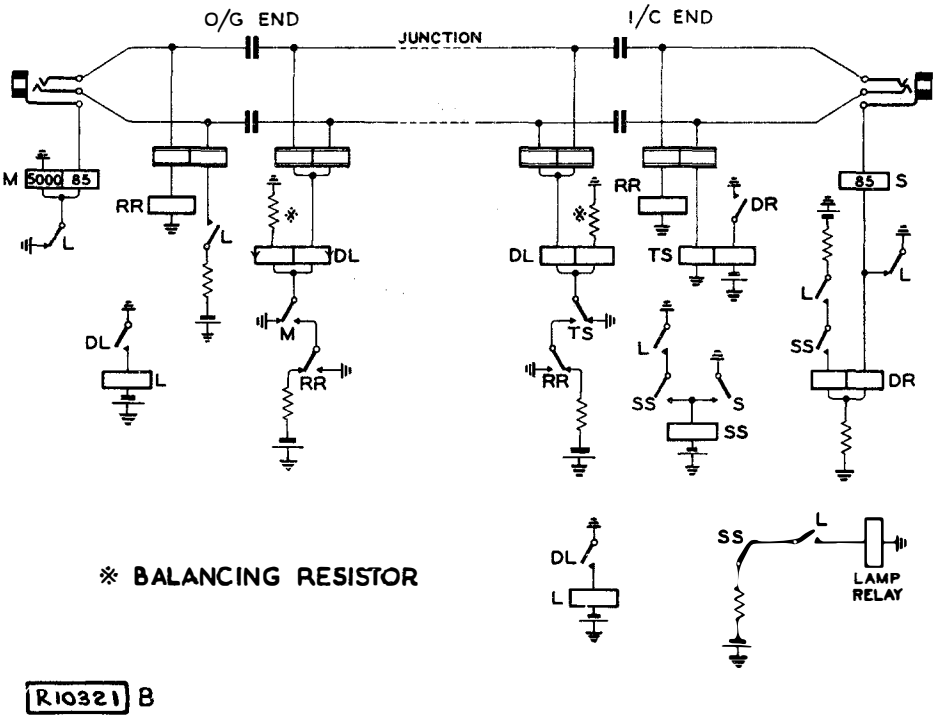

Fig. 3

contact of relay DR operates relay TS which extends the answering signal, that is, balanced battery, to the junction wires. At the outgoing end the reception of the answering signal upsets the balance of relay DL because current ceases to flow in the line winding and the relay therefore operates. The relief relay L also operates and sets up local and through supervisory conditions. It should be noted that relay DL at the incoming end is not affected by the answering signal because although current ceases to flow in the line winding, it still flows in the other winding and thus maintains the unbalanced condition of the relay.

When either operator thows the RING key, earth is connected to the junction wires. This maintains unbalanced conditions on the local DL relay, which remains operated, but balances the distant DL relay which releases and causes the supervisory lamp to glow.

As only the signalling path is required, differential signalling is suitable for use on superposed circuits where four line conductors form three junction circuits. For the purpose of segregating the signals it is necessary to introduce capacitors into the circuit of the line transformers as shown in Fig. 4.

The signals for junction 1 are transmitted over the A-wire of side circuit 1, the signals for junction 2 over the B-wire of side circuit 1 and the signal for junction 3 on the A-wire of side circuit 2.

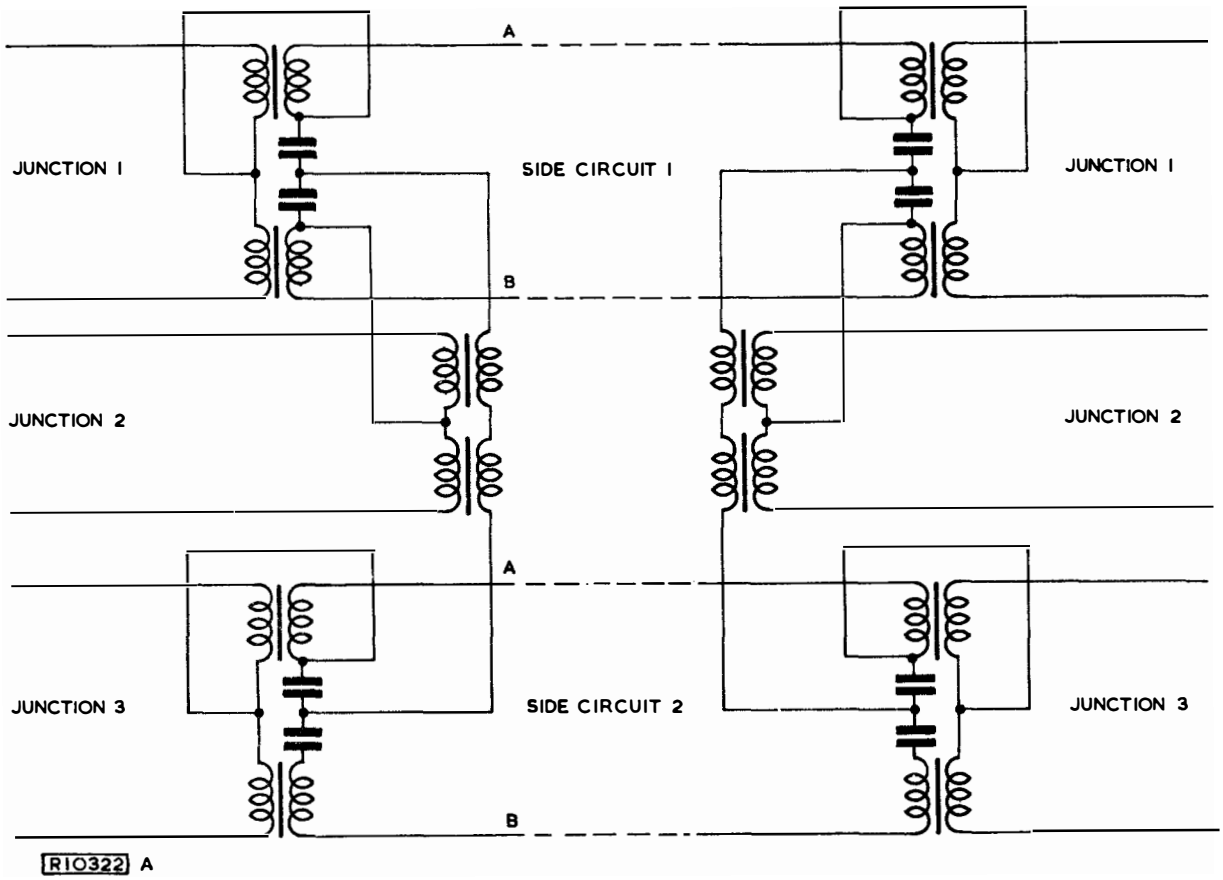

Fig. 4

DIALLING-OUT CIRCUITS

The principles of dialling from a sleeve-control switchboard are dealt with in E.P. - Draft Series, Telephones 2/6. In this pamphlet it is proposed to consider the line circuits in more detail.

Loop Disconnect Dialling Circuit

Loop disconnect dialling is used whenever the loop resistance of the junction falls within the required limits. The circuit elements of the dialling-out relay-set used at a sleeve-control exchange are shown in Fig. 5.

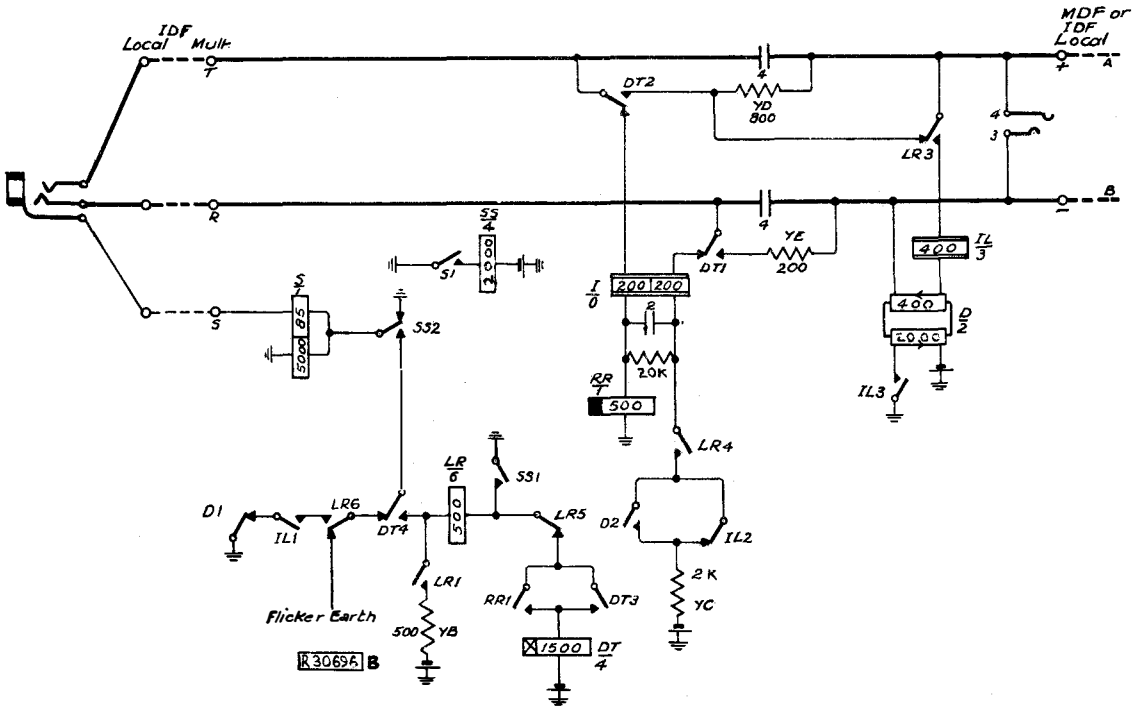

Fig. 5

When a plug is inserted in the jack, relay S operates to battery on the sleeve of the plug. S1 operates the relief relay SS and S remains operated over its 85 ohm coil during the 'on' periods of the flicker earth. When the operator throws her DIAL key relay RR operates to battery on the tip wire. RR1 feeds earth from SS1 to operate DT. DT3 locks DT, DT4 disconnects flicker earth and prepares for the subsequent operation of LR, DT1 and DT2 extend the A and B wires of the line through to the cord circuit so that loop disconnect pulses may be sent from the operator's dial.

When the operator restores her DIAL key on completion of dialling the current in the sleeve circuit is increased sufficiently to operate relay LR (via SS2, DT4 to earth at SS1). LR1 locks LR and LR5 releases DT. LR3 connects a holding loop, via IL and one coil of relay D, across the junction. Relay IL operates. The 5000 ohm winding of relay S is short-circuited by earth fed via D1, IL1, LR6, DT4 and SS2 and the cord circuit supervisory lamp glows. IL3 energizes the polarizing coil of relay D and, when the line current is reversed by the called party answering, this relay operates. Disconnexion of earth at D1 darkens the calling cord supervisory lamp and D2 contact connects battery to the R-wire via LR4, I relay coil and DT1 to provide a through supervisory signal.

On completion of a call the release of relay D provides the clearing signal.

Battery Dialling Circuit

Battery pulsing is used when the loop resistance of the line is too high for loop disconnect pulsing. The battery dialling line circuit used in sleeve-control working is shown in Fig. 6. It is similar in many respects to the loop disconnect dialling relay-set described above.

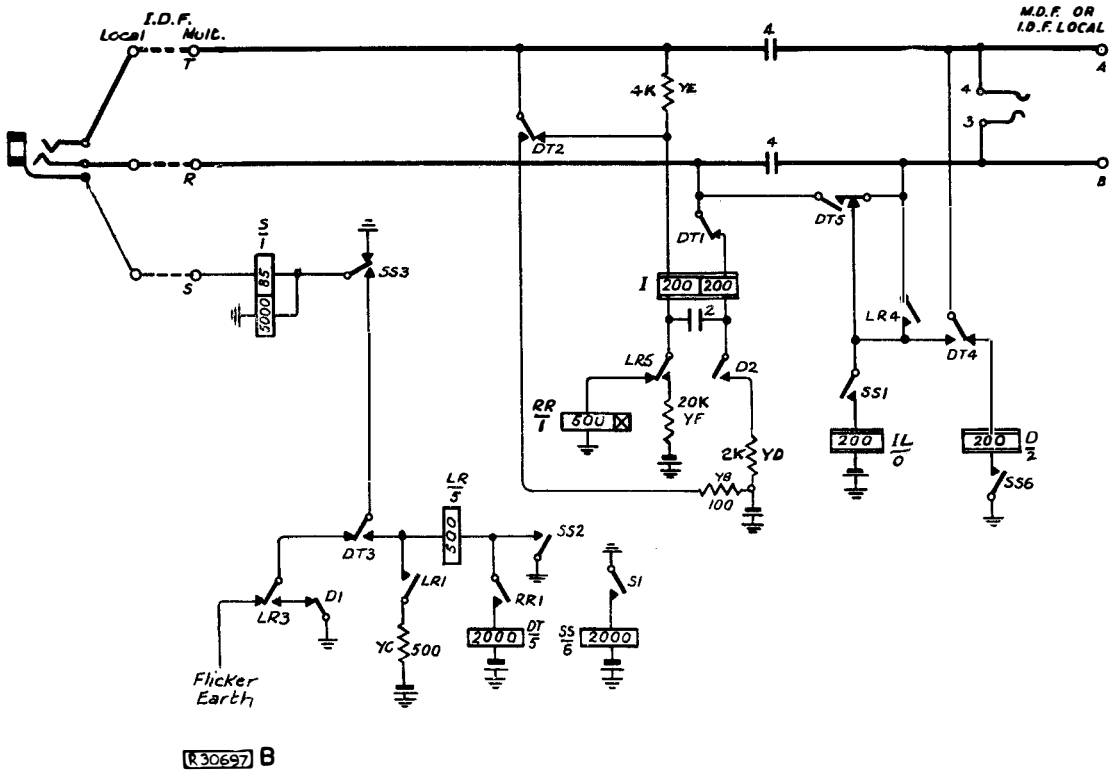

Fig. 6

Relays S, SS, RR and DT operate as already described. Battery is extended to the A-wire of the junction via impedance coil IL, SS1 and DT4, and to the B-wire via DT2, pulsing loop (in the cord circuit), and DT5. When the dial is released battery pulses are sent over the B-wire of the junction. In this circuit relay RR remains held to the battery on the T wire during pulsing and it is therefore unnecessary to lock DT via its own contact.

When the DIAL key is restored relay LR operates as previously described. LR5 releases RR and RR1 releases DT. LR4 connects battery to the B-wire from impedance coil IL to hold the connexion and DT4 connects relay D to the A-wire to receive supervisory signals. Relay D operates to battery returned over the A-wire when the call is answered. Its contacts provide for local and through supervisory signals as in the case of the loop disconnect dialling relay-set.

ASSISTANCE CIRCUITS

Assistance circuits are provided so that a subscriber, by dialling '100', can obtain connexion to an operator at an auto-manual switchboard.

Most calls to the auto-manual board involve special services, such as trunk calls, and as the fees for these are recorded on dockets it is arranged that the caller's meter does not operate. The trunking arrangements for calls to auto-manual switchboards are given in E.P. Draft Series, TELEPHONES 3/7 and 3/11.

For service reasons it is necessary for the auto-manual board operator to control any incoming call of this nature. The 'manual hold' facility is therefore provided so that the operator can hold a connexion should the calling subscriber clear down. The "re-ring" facility which was originally incorporated with "manual hold" has since been abandoned and the associated circuit elements recovered from all equipment.

Circuit for non-director main exchange

When a subscriber makes a call to the auto-manual board in a non-director main exchange, the negative, positive and private wires of the subscriber's line circuit are extended through to an assistance circuit without passing through a transmission bridge, and therefore an earth applied to the private wire by the assistance circuit will hold a connexion when the subscriber clears.

The circuit arrangement is shown in Fig. 7.

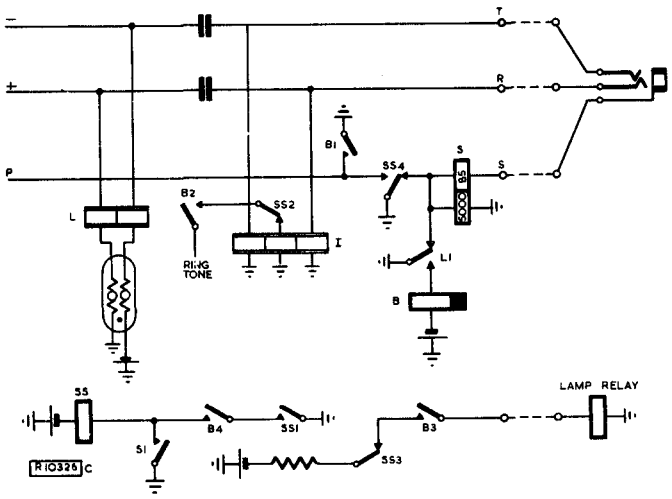

Fig. 7

Relay L operates to the calling subscriber's loop and L1 operates relay B. B1 connects a holding earth to the private wire and B2 connects ring tone to the third winding of relay I, so causing ring tone to be passed inductively to the caller. Contact B3 connects battery to the lamp relay.

The lamp relay is not part of the assistance circuit but is associated with the answering jacks and lamps, to which the relay-set is connected by means of jumpers. When a relay-set is seized, battery is passed from the relay-set to the lamp relay, which in turn connects 6V alternating current to light the lamp.

The ballast resistor in the transmission bridge is provided so that advantage may be taken of the resulting increase in transmission efficiency for calls extended by an operator over a junction to a distant exchange.

Supervisory and manual-hold facility

When the operator answers, the battery from the sleeve of the cord circuit operates relay S and S1 operates relay SS. Relay SS locks via B4 and SS1, disconnecting ring tone at SS2 and the lamp relay at SS3, the supervisory lamp of the cord circuit being dimmed by the removal of the short-circuit from the high-resistance winding of S by SS4. Should the subscriber clear, relay L releases and the high-resistance winding of S is short-circuited by L1, so causing the cord circuit supervisory lamp to be lit, but, so long as the plug of the cord circuit is left in the jack, relay SS holds over S1 (B being released by L1), and the earth at SS4 to the private wire holds the connexion through to the subscriber's line. The circuit arrangement whereby SS is locked via B4 and SS1 is provided so that the calling lamp will not be relit if the operator withdraws the plug from the answering jack whilst the subscriber is on the line.

Circuits for director or satellite exchanges

In director and discriminator working satellite exchanges a transmission bridge is incorporated in the first switching stage. For normal calls, this transmission bridge is used to hold the switching relays of the train of switches set up by a calling subscriber within the calling subscriber's exchange. The switching relays of stages other than the first are, therefore, held by an earth applied to the private wire at the first switching stage. When calls are passed to the auto-manual board, however, it is necessary to provide for the manual hold condition, and, as in such cases a connexion cannot be held by the simple expedient of applying an earth to the private wire, a special circuit arrangement is provided in the assistance circuit and the first switching stage.

The absence of a private wire between an assistance circuit and the switching stages necessitates the passing of a signal over the line from the assistance circuit to the first selector when the manual-hold facility is required. This signal is in the form of a negative battery returned over the +ve wire.

Transmission bridge and supervisory circuit

This is illustrated in Fig. 8.

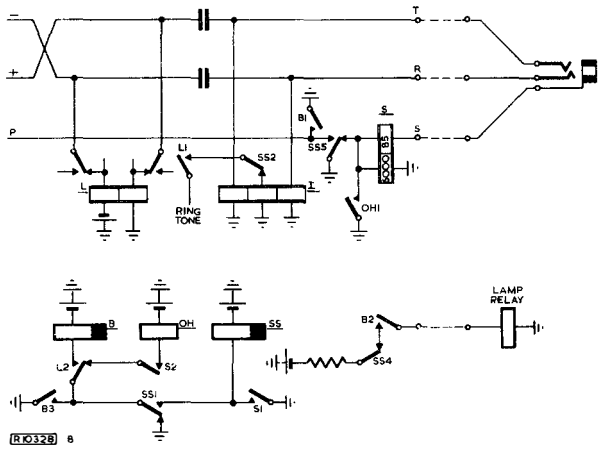

Fig. 8

A ballast resistor is not incorporated in this circuit as speaking current for the subscriber's transmitter is not supplied from this bridge. Relay L operates to the loop from the distant transmission bridge when the assistance circuit is seized, L1 connecting ring tone to the third winding of I and L2 operating B via SS1. Relay B returns a guarding earth to the private wire at B1 and completes the circuit of the lamp relay at B2. When the operator answers, relay S is operated and completes the circuit of SS via S1. Relay SS locks via SS1 and B3 against the operator withdrawing the plug whilst the subscriber is on the line; SS2 disconnects ring tone

SS4 disconnects the lamp relay and SS5 causes the cord-circuit supervisory lamp to be dimmed and a guarding earth to be returned under the control of the operator.

When the calling subscriber clears, relay L is released and OH operates via S2, L2, SS1 and S1 and, by short-circuiting the high-resistance winding of S at OH1, causes a clearing signal to be given by the cord-circuit supervisory lamp.

Manual-hold facility

Fig. 9 shows a typical circuit arrangement by means of which the manual-hold facility is obtained, the circuit element on the left of the figure being incorporated in the first code selector circuit in a director exchange and that on the right in the assistance circuit. The loop of the subscriber's instrument normally holds relay L, and the loop provided in turn by the D and I relays holds relay L of the assistance circuit. Should the subscriber clear, however, the D and I loop is broken at LR2, thus allowing relay L in the assistance circuit to release. L2 restoring causes relay OH to operate to the earth via S2 and also releases relay B; OH1 causes the supervisory lamp to glow and OH2 applied battery to the positive wire, relay MH being connected to the negative wire by OH3.

The battery connected to the positive wire at OH2 operates relay MH (1st code selector) via LR2 (released), DA3, MH coil, DB2, D1, to earth. MH1 holds relay B to the earth at B1. B2 holds relay BB and holding earth is maintained on the P-wire as long as the operator leaves her plug in the jack.

Should a subscriber lift the receiver whilst a connexion is held from the auto-manual board, the restoration of the loop across the negative and positive wires at LR2 operates relay MH (assistance circuit) from the battery at OH2. Relay MH connects a locking circuit for itself at MH2 and a loop across the L relay of the assistance circuit at MH1. When L re-operates, L2 disconnects relay OH and operates relay B, and the connexion of relay L to the negative and positive wires is restored by OH2 and OH3, while OH1 causes the supervisory lamp to be dimmed. Relay MH is released by the closure of the B4 contacts, the short-circuit causing MH to release slowly. The slow release of relay MH is provided to ensure that the relay will hold during the transit time of contacts OH2 and OH3 following the application of manual-hold conditions. When a subscriber clears, the short-circuit at B4 also prevents relay MH being operated by capacitor surges which may occur during the time that OH is operated by the release of L.

The discharge of the capacitors when the operator withdraws the plug to clear the connexion, following the application of manual-hold conditions, may also cause relay L to flick. To prevent the re-operation of B under this condition, relay SS is a slow-release relay and, therefore, SS1 does not provide a circuit for B until sufficient time has elapsed for the capacitors to discharge.

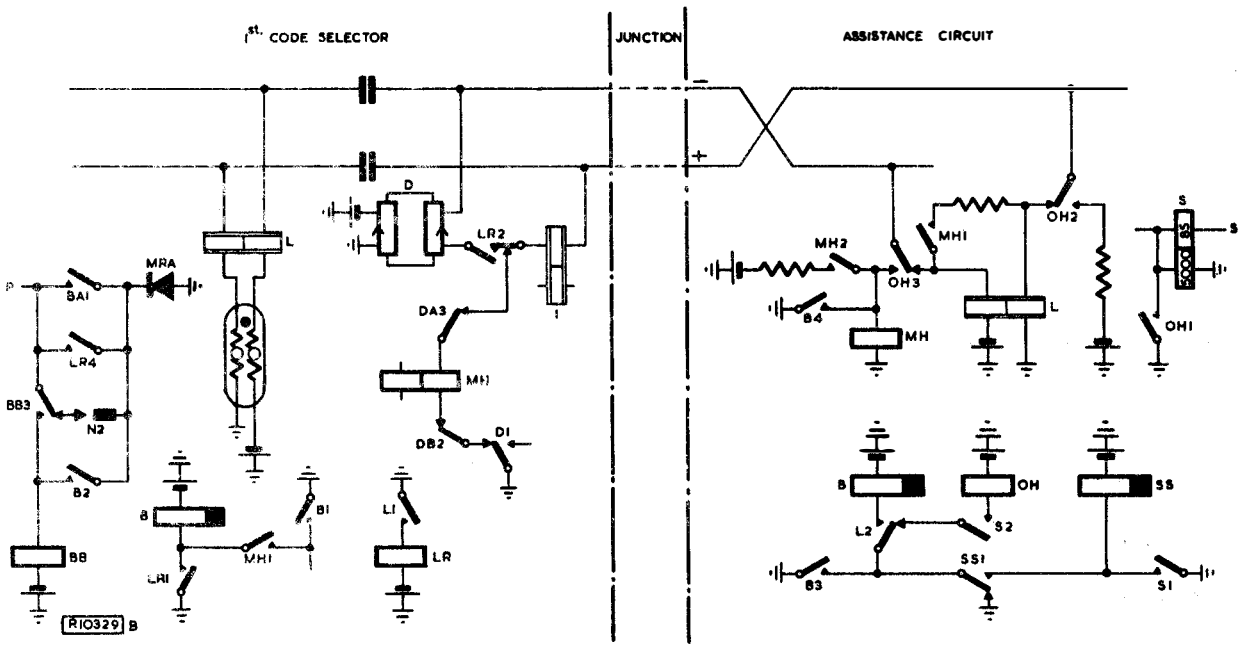

Fig. 9

ASSISTANCE CIRCUIT WITH C.F.C. CONTROL

This circuit gives the usual facilities of an assistance circuit, but in addition provides for coin and fee check control in conjunction with the coin and fee check equipment. Where pay on answer coin box subscribers share the same assistance level circuits with ordinary subscribers, it is necessary to give some form of indication to the answering operator, that the call has originated from a coin box telephone. This discrimination is accomplished by arranging that on answering the call, a positive battery pulse is connected to the positive wire of the circuit, which is detected in the coin and fee check (C.F.C.) equipment and pay tone is returned to the operator. Further positive battery pulses are connected to the positive wire in the assistance circuit by momentary operation of the position RING key, and these are again detected by the C.F.C. equipment. The first such operation causes the discriminating tone to be disconnected. The second operation of the RING key causes the coin slot in the pay on answer coin box to be unlocked. Further operations of the RING key initiate the audit operation within the C.F.C. equipment, i.e. transmission to the operator of pulses of tone corresponding to the number of coins inserted into the coin box. When a fraudulent coin pulse signal is detected by the C.F.C. equipment, number unobtainable tone is returned to the operator, and this tone is also disconnected by operation of the position RING key.

The arrangement for this type of assistance circuit is shown in Fig. 10

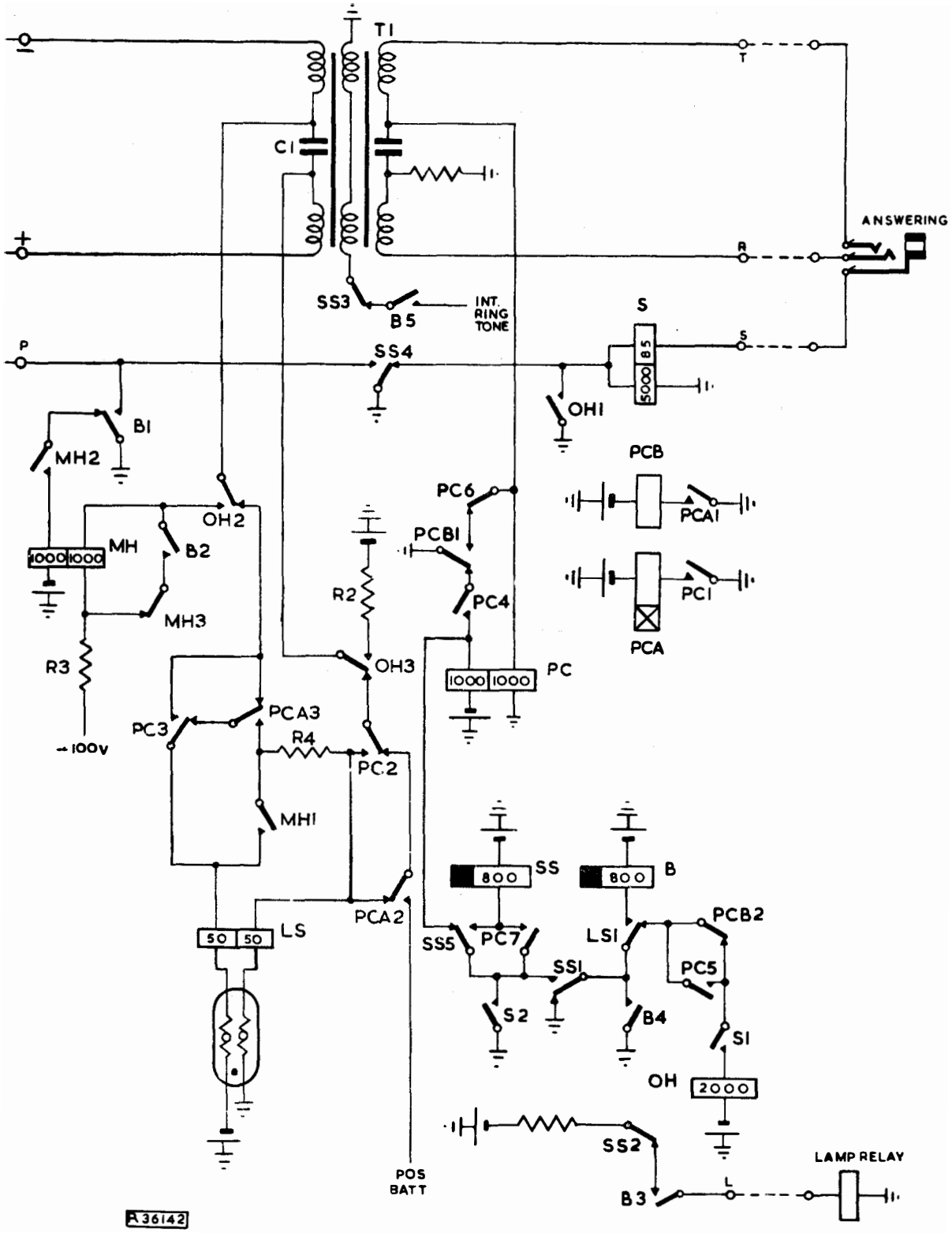
T1
C1
T
R
ANSWERING
S
INT. RING TONE
SS3
B5
SS4
OH1
B1
MH2
PCB
PCA1
PC6
PCB1
OH2
MH
B2
1000 1000
MH3
R2
PC4
PC1
PCA
R3
OH3
PC
1000 1000
PCA3
PC3
R4
PC2
-100V
MH1
SS
800
B
800
PCB2
PCA2
SS5
PC7
LS1
50 50
LS
SS1
PC5
S2
B4
S1
OH
2000
SS2
LAMP RELAY
POS BATT
B3
A36142

Fig. 10

Relay LS operates to the loop condition extended from the previous equipment.

Contact LS1 operates Relay B.

Contact B1 connects the holding and guarding earth to the P wire, Contact B3 operates the lamp relay, and Contact B5 connects intermittent ring tone to the tone winding of the transformer T1.

Supervisory and C.F.C. signals

When the operator answers the battery connected on the sleeve of the cord circuit operates relay S, as before.

Contact S2 operates PC relay.

Contact PC1 operates PCA relay.

Contacts PC2 and PC3 provide an alternative circuit for LS relay.

Contact PC7 operates relay SS.

Contact SS1 provides a hold circuit for relay SS, Contact SS2 disconnects the lamp relay, Contact SS3 disconnects the ring tone, and Contact SS4 disconnects the short circuit on the 5000 ohm coil of the S relay, which increases the resistance in the sleeve circuit, and darkens the cord circuit supervisory lamp.

Relay PCA in operating, prepares the circuit for the discrimination signal at Contact PCA2.

Contact PCA1 operates relay PCB.

Contact PCB1 releases relay PC.

Contact PC3 disconnects the negative wire during the release of relay PCA. Contact PC6 places a short circuit across the operate winding of PC to prevent its re-operation during transmission of the positive battery pulse.

Contact PC1 disconnects relay PCA, and during its release positive battery is connected to the positive wire, by Contact PC2. Relay PCA has a release lag of 200-300 ms, so that a pulse duration in this order of magnitude is sent to the C.F.C. equipment. When relay PCA releases, contacts PCA2 and PCA3 restore the normal battery and earth condition to the LS relay.

Contact PCA1 releases relay PCB, and contact PCB1 removes the short circuit from the operate coil of PC relay.

A similar sequence is followed by PC, PCA and PCB relays every time the position RING key is operated, resulting in a positive battery signal being transmitted to the C.F.C. equipment.

Supervisory and Manual-Hold

When the calling subscriber clears, the disconnection of the loop condition causes relay LS to release.

Contact LS1 operates relay OH, and releases relay B.

Contact OH1 places a short circuit across the 5000 ohm coil of S relay to light the cord circuit supervisory lamp. Contacts OH2 and OH3 disconnect LS relay, and connect -100V and -50V batteries respectively to the line, via resistors R3 and R2. When relay B releases contact B2 removes the short circuit from the operate coil of relay MH, and contact B1 prepres a hold circuit for MH.

When the subscriber recalls, the difference in potential between the -100 Volt battery on the negative line, and the -50 Volt battery on the positive line operates relay MH. The use of the -100 Volt battery is to avoid altering the charge potential across capacitor C1, when the line conditions are varied by the OH contacts.

Contact MH1 operates relay LS via resistor R4.

Contact LS1 releases relay OH, and operates relay B. LS relay is reconnected to the line, and normal line conditions are restored by contacts OH2 and OH3, while contact OH1 removes the short-circuit from the 5000 ohm winding of relay S to extinguish the cord circuit supervisory lamp.

Contact B1 releases relay MH.

Contact MH1 disconnects R4 from the LS relay, and normal call answered conditions are restored.

END

Reference E.P. - Draft Issue TELEPHONES 2/6, 3/7 and 3/11.