ORDINARY FINAL SELECTORS

CONTENTS

INTRODUCTION

The final selector, as its name implies, is the last of the selectors taken into use in routing a call from a subscriber on one exchange to another subscriber on the same or any other exchange.

The final selector, when seized, applies a holding condition to the private wire so as to hold the group selector circuit and subscriber's uniselector circuit. It receives the last two trains of pulses from the calling subscriber's dial and tests the called subscriber's line for the engaged condition. If the called subscriber's line is free, intermittent ringing current will be connected to the line to ring the subscriber's bell; ring tone will be returned to the calling subscriber to indicate the final selector has switched to, and ringing current is being fed to, the wanted subscriber's line.

When the called subscriber answers, the ringing current is "tripped" and the calling subscriber is switched to the called subscriber. A metering pulse is connected to the private wire to operate the calling subscriber's meter if the called subscriber is connected to the same exchange as the calling subscriber. The polarity of the +ve and -ve wires is also reversed for supervisory purposes or to effect metering if the two subscribers are connected to different exchanges.

If the called subscriber's line is engaged, the final selector will not switch but will transmit busy tone to the calling subscriber.

Issue 2.1, 9/62
(8/68)

Transmission Bridge

In standard automatic systems, a transmission bridge is normally included in the final selector circuit.

As the efficiency of a subscriber's transmitter depends on the direct current flowing through it, it is desirable to keep the strength of this current as constant as possible over lines which have different resistance values. This condition is obtained by using, as part of the transmission bridge, a ballast resistor which is inserted on the 'called' side of the transmission bridge as shown in Fig. 1.

The calling side of the bridge in the final selector does not require a ballast resistor, as on all calls other than local calls provision of this equipment is made in other apparatus. In the case of local calls the grade of transmission is comparatively high and the loss caused by this exception can be tolerated.

The ballast resistor is about 3 inches long and 1 inch in diameter and consists of a hydrogen-filled bulb containing two tungsten filaments brought out to separate terminals. Its characteristic property is that the resistance of the filament increases with the current passing through it, and thus tends, within certain limits, to keep the current at a constant value.

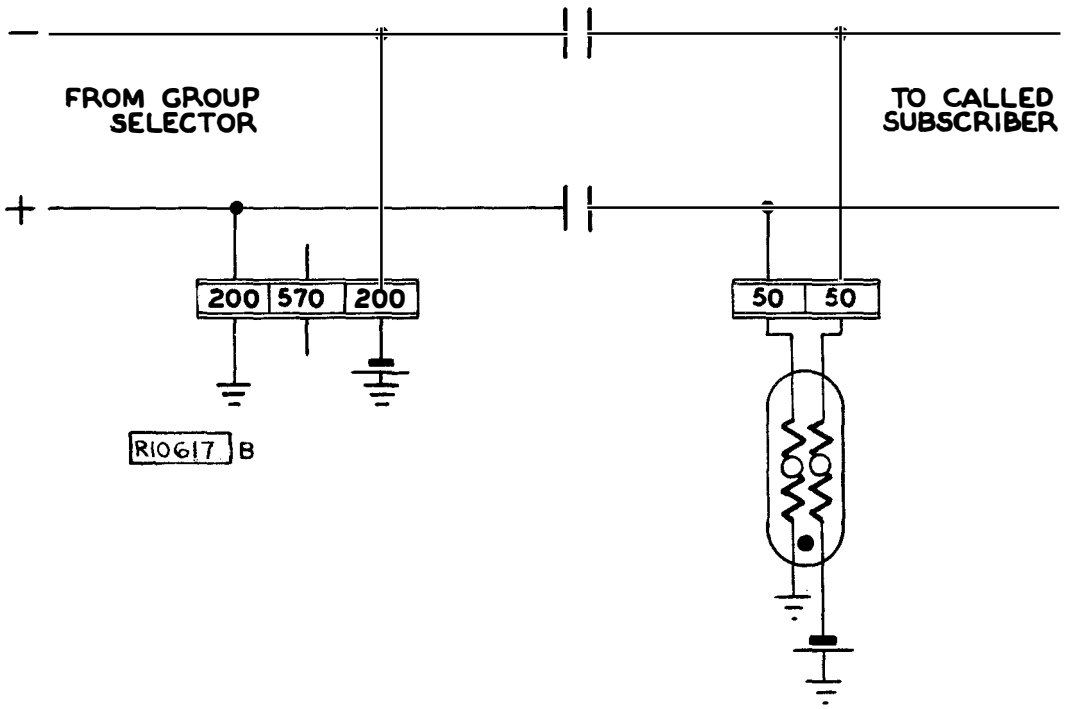

Fig. 1

Fig. 2 shows a photograph of a ballast resistor.

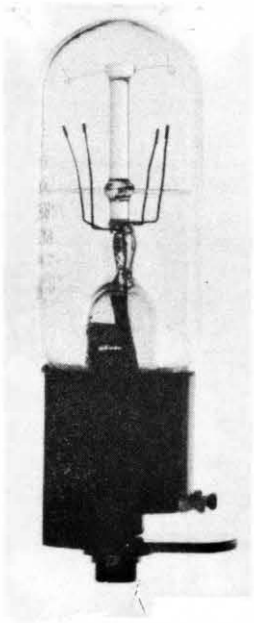

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Fig. 2

The ballast resistor has been developed to limit the effect of line resistance on the value of the feeding current, and to permit the employment of a feeding relay of lower resistance (50 ohms + 50 ohms) than the previous standard (200 ohms + 200 ohms). Under high-resistance line conditions the reduced resistance of the feeding relay results in an appreciable net gain in transmitter current, since in these circumstances the resistance of the ballast resistor is small. Under low-resistance line conditions the ballast resistor, by increasing its resistance, limits the current.

100 LINE FINAL SELECTOR, 2000-TYPE

Seizure of Final Selector

The pulsing circuit of the selector is shown in Fig. 3.

The absence of an earth on the P-wire to the final selector allows it to be seized by the preceding selector and the calling subscriber's loop is extended to operate relay A.

Contact A1 removes the short-circuit from relay B which operates:-

Earth - contact CD2 (normal) - spring N3 (normal) - contact A1 (operated) - relay B - rectifier MR2 (see design details later) - resistor R2 - battery.

Contact B2 connects earth to the incoming private wire (P) to guard against the final selector being seized by another group selector and to hold in operation relays H in the group selector circuits and relay K in the subscriber's uniselector circuit.

Contact B4 prepares a circuit for the operation of the vertical magnet, (VM).

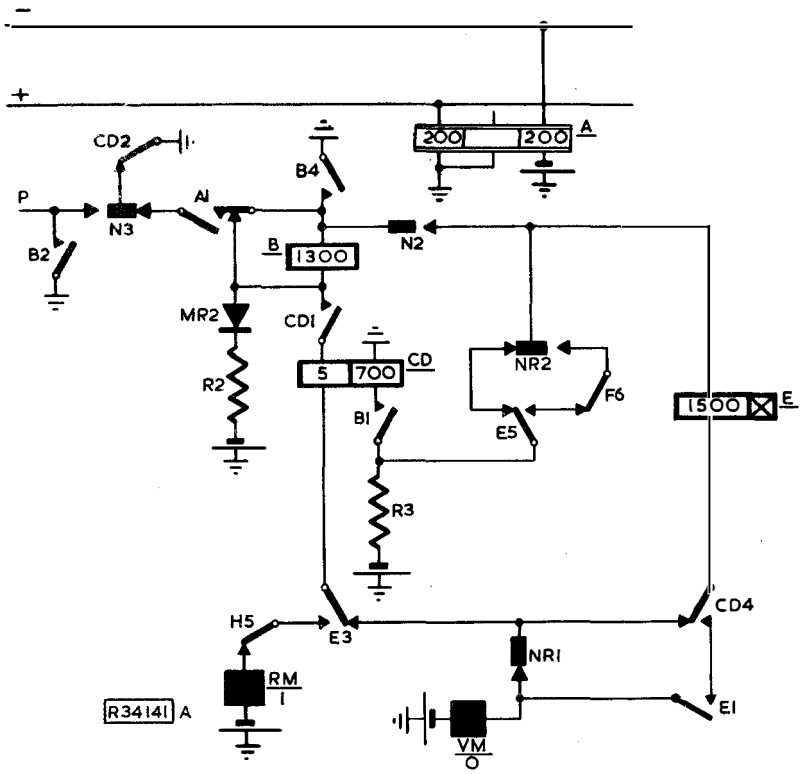


Fig. 3

Contact B1 completes the circuit for the operation of relay CD:-

Earth - relay CD (700 ohm winding) - contact B1 (operated) - resistor R3 - battery.

Relay CD operates.

Contact CD1 prepares the pulsing circuit for the vertical magnet VM.

Contact CD2 disconnects earth from the pulsing circuit (earth being now supplied at contact B4, operated).

Contact CD4 disconnects the operating circuit of relay E.

At this stage, current flows from earth-contact B4 (operated) - relay B - contact CD1 (operated) - relay CD (5 ohm winding) - contact E3 (normal) - spring NR1 (normal) - vertical magnet (VM) - battery, but owing to the resistance in the circuit the vertical magnet VM does not operate.

Vertical Stepping

The final selector is now ready to receive the tens digit of the called subscriber's number. If this number is 3, the line will be disconnected and re-connected three times.

Relay A will release when the dial springs break, and will be re-operated when the dial springs make.

When relay A releases, the operate circuit for the vertical magnet VM is completed at contact A1 (normal):-

Earth - contact B4 (operated) - contact A1 (normal) - contact CD1 (operated) - relay CD (5 ohm winding) - contact E3 (normal) - spring NR1 (normal) - vertical magnet VM - battery.

The vertical magnet is operated and lifts the wiper carriage to the first level.

When relay A re-operates, the circuit for the vertical magnet VM is disconnected and the vertical magnet releases.

This operation is repeated for each pulse until the wiper carriage is lifted to level 3, and relay A remains operated to the calling subscriber's loop.

During the pulsing of relay A, contact A1, on release, places a short-circuit across the coil of relay B. This causes relay B to be slow-to-release and to hold during pulsing.

The off-normal springs N operate as soon as the wiper carriage is raised from its normal position.

Spring N2 prepares the circuit for the operation of relay E and places a short-circuit across the 700 ohm winding of relay CD as follows:-

Earth - contact B4 (operated) - spring N2 (operated) - spring NR2 (normal) - contact E5 (normal) - contact B1 (operated) - relay CD (700 ohm winding) - earth.

Spring N3 prepares the guarding circuit for the incoming private wire during the release of the selector.

The short-circuit across the 700 ohm winding of relay CD makes the relay slow-to-release; the effect of this, combined with the small current that flows through the 5 ohm winding while contact A1 is operated, holds relay CD operated during the make periods of the pulses from the calling subscriber's dial. At the end of the pulse train, relay CD releases.

Contact CD1 disconnects the circuit for the vertical magnet VM.

Contact CD4 completes the circuit for the operation of relay E:-

Earth - contact B4 (operated) - spring N2 (operated) -
relay E - contact CD4 (normal) - spring NR1 (normal) -
vertical magnet VM - battery.

Relay E operates but there is insufficient current to operate the vertical magnet VM.

Contact E1 prepares the holding circuit for relay E.

Contact E3 prepares the circuit for the operation of the rotary magnet RM.

Contact E5 disconnects the short-circuit from relay CD, which re-operates via its 700 ohm winding.

Contact CD1 prepares the operating circuit for the rotary magnet RM.

Contact CD4 completes the holding circuit for relay E:-

Earth - contact B4 (operated) - spring N2 (operated) -
relay E - contact CD4 (operated) - contact E1 (operated) -
vertical magnet VM - battery.

At this stage current flows from earth - contact B4 (operated) - relay B - contact CD1 (operated) - relay CD (5 ohm winding) - contact E3 (operated) - contact H5 (normal) - rotary magnet RM - battery, but due to the resistance in the circuit the rotary magnet does not operate.

Rotary Stepping

The final selector is now ready to receive the units digit of the called subscriber's number. Suppose this digit to be 4.

The calling subscriber's line will be disconnected and reconnected four times and each time relay A will release and re-operate.

When relay A releases, contact A1 completes the circuit for the operation of the rotary magnet RM:-

Earth - contact B4 (operated) - contact A1 (normal) -
contact CD1 (operated) - relay CD (5 ohm winding) - contact E3 (operated) -
contact H5 (normal) - rotary magnet RM - battery.

The rotary magnet operates and steps the wipers to contact 1 of level 3 of the bank.

When relay A re-operates at the end of the break period of the first pulse, the operate circuit for the rotary magnet RM is disconnected at contact A1 and the rotary magnet releases.

As the rotary magnet steps the wipers to the first contact on the bank the rotary off-normal springs NR operate.

Spring NR1 disconnects the operating circuit for relay E.

Spring NR2 provides a path for earth to short-circuit the 700 ohm winding of relay CD:-

Earth - contact B4 (operated) - spring N2 (operated) -
Spring NR2 (operated) - contact F6 (normal) - contact E5 (operated) -
contact B1 (operated) - relay CD (700 ohm winding) - earth.

During the break period of each pulse, the full operate current of the rotary magnet will energize the 5 ohm winding of relay CD. During each make period, relay B is inserted in series with this winding, but relay CD remains operated by virtue of the effect of the reduced current combined with the slugging effect of the short-circuited 700 ohm winding.

On the release of relay A for the second pulse, contact A1 re-operates the rotary magnet. The sequence of operations is repeated for the four pulses.

The wipers now stand on the fourth contact of level three of the bank.

At the end of the pulse train, relay CD releases.

Function of Subscriber's Uniselector Circuit on an Incoming Call

Before describing the switching of the final selector to the called subscriber's line, it is necessary to consider the part played by the subscriber's uniselector circuit in this operation.

Fig. 4 shows part of the final selector circuit and part of the called subscriber's uniselector circuit, connected together by cabling and jumpering on the distribution frames.

Relay B in the final selector is operated, and when relay CD releases at the end of the rotary stepping, contact CD3 completes a circuit for relay H:-

Earth - contact CD3 (normal) - contact B3 (operated) -
relay H - private wiper - private bank -
I.D.F. multiple side - I.D.F. local side - homing wiper H (on home contact) -
homing arc - relay K - spring DMdm -
magnet DM - battery.

Relays H and K operate to the battery via the drive-magnet DM, but the latter does not operate.

The contacts of relay H connect the ringing circuit of the final selector to the subscriber's line via the I.D.F. connexion strip.

Relay K contacts disconnect the circuit for the drive magnet DM and the circuit for relay L.

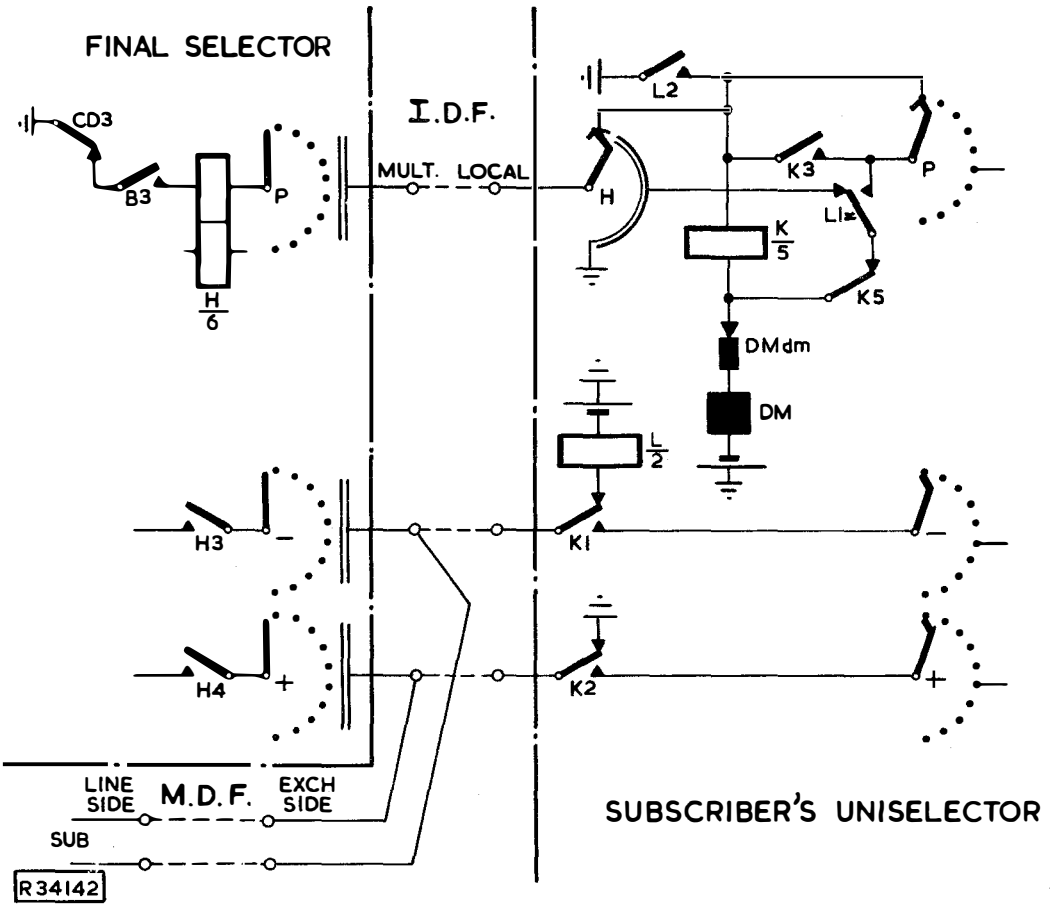


Fig. 4

The uniselector positive and negative wipers are standing on the home contact, which is not multipled and therefore contact with other subscribers is not made.

In the event of the called subscriber being engaged on an outgoing call, when the final selector steps on to the bank contacts of that subscriber, an earth is encountered on the private bank contact. This earth is extended from the homing arc and homing wiper, the latter being off-normal in this case, and relay H does not operate.

Switching

The switching and ringing circuit element of the selector is shown in Fig. 5.

On completion of rotary stepping, relays A and B remain operated and relays CD and E release. (Fig. 3).

If the called subscriber's line is free, the circuit for the operation of relay H is completed:-

Earth - contact CD3 (normal) - contact B3 (operated) - relay H (900 ohm winding) - private wiper - private bank contact - battery (via relay K and drive-magnet DM in subscriber's uniselector circuit).

Relay H operates.

Contact H1 completes a holding circuit for relay H via its 400 ohm winding:-

Earth - contact B4 (operated) - contact H1 (operated) - contact F4 x (normal) - relay H (400 ohm winding) - battery.

Contact H2 connects earth to the private wiper to hold in operation relay K in the subscriber's uniselector circuit, and to guard the line against intrusion by another caller requiring the same number.

Contacts H3 and H4 prepare the circuit for the intermittent ringing current to operate the subscriber's bell.

Contact H6 prepares a circuit for the operation of relay J.

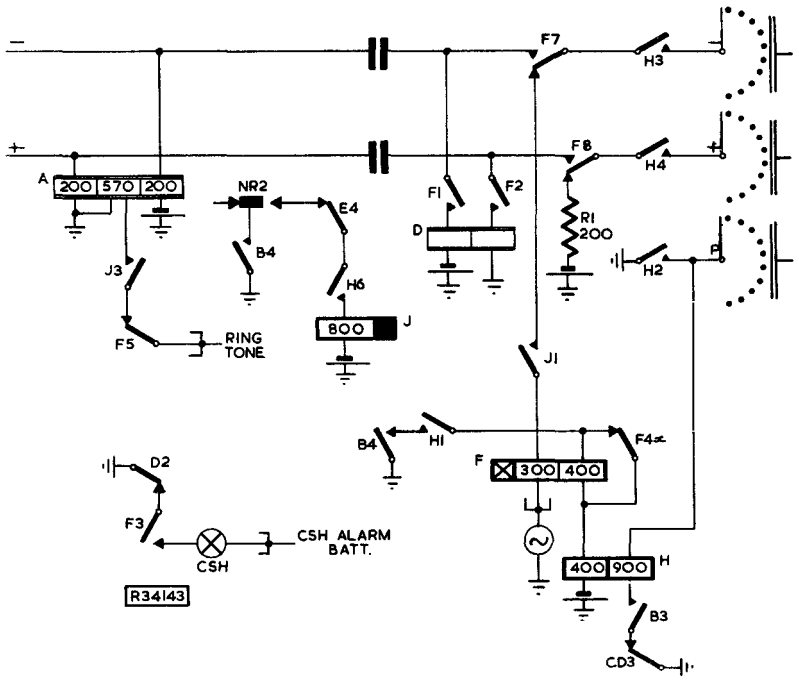


Fig. 5

Transmission of Ringing Current

When relay CD releases, contact CD4 disconnects the holding circuit for relay E, (Fig. 3) which releases slowly (the slow-operate slug also makes the relay slow-to-release).

Contact E1 disconnects the operating circuit for relay E against the re-operation of relay CD.

Contact E5 disconnects the short-circuit across the 700 ohm winding of relay CD and relay CD re-operates.

Contact E4 (Fig. 5) completes the circuit for relay J:-

Earth - contact B4 (operated) - spring NR2 (operated) - contact E4 (normal) - contact H6 (operated) - relay J - battery.

Relay J operates, and contact J1 completes the circuit for ringing the called subscriber's bell:-

Earth via intermittent ringing current - relay F (300 ohm winding) - contact J1 (operated) - contact F7 (normal) - contact H3 (operated) - negative wiper - negative bank contact - I.D.F. - M.D.F. - subscriber's B line - subscriber's bell and capacitor - subscriber's A line - M.D.F. - I.D.F. - positive bank contact - positive wiper - contact H4 (operated) - contact F8 (normal) - resistor R1 - battery via ringing return.

The inclusion of contact J1 in the ringing circuit allows time for the operation of relay K in the subscriber's line circuit before the circuit for relay F is completed. The latter relay cannot then operate prematurely to the battery via the called subscriber's L relay.

Owing to the short-circuited 400 ohm winding and the slow-operate slug on relay F, the relay does not operate to the ringing current.

Contact J3 connects ring tone to relay A:-

Earth - relay A (570 ohm winding) - contact J3 (operated) - contact F5 (normal) - ring tone.

The ring tone current is fed to the 570 ohm winding from the secondary of the ring tone transformer. Since the three windings of the A relay are on the same core, e.m.f's of ring tone frequency will be induced in the 200 ohm windings, and will result in tone current flowing from earth via one 200 ohm winding round the subscriber's loop to the battery connexion on the other 200 ohm winding.

Called Subscriber Answers

When the called subscriber answers, his capacitor and bell are shunted by the transmitter loop. Direct current, together with an increased value of ringing current, will flow through relay F causing it to operate. (The operating circuit is the same as that given for the ringing current).

Contact F4 *x* removes the short-circuit from the 400 ohm winding of relay F to provide a hold circuit for the relay:-

Earth - contact B4 (operated) - spring N2 (operated) (see Fig. 7) - contact H1 (operated) - relay F (400 ohm winding) - relay H (400 ohm winding) - battery.

Contact F7 disconnects ringing from the negative line and connects the negative wiper to the transmission bridge.

Contact F8 disconnects the ringing return battery from the positive line and connects the positive wiper to the transmission bridge.

Contacts F1 and F2 connect the speaking battery and earth via relay D to the called subscriber's negative and positive lines respectively.

Contact F5 disconnects ring tone from relay A.

Contact F6 disconnects the path for short-circuiting relay CD that would otherwise be completed by the operation of relay E. (Fig. 3).

The circuit to operate relay D is completed:-

Earth - relay D coil - contact F2 (operated) - contact F8 (operated) - contact H4 (operated) - positive wiper - positive bank - I.D.F. - M.D.F. - subscriber's loop - M.D.F. - I.D.F. - negative bank - negative wiper - contact H3 (operated) - contact F7 (operated) - contact F1 (operated) - relay D coil - battery.

Relay D operates.

Application of Metering Pulse (positive battery metering)

A description of the circuitry and apparatus involved in the generation of meter pulses is beyond the scope of this pamphlet.

The circuit elements concerned with metering are shown in Fig. 6.

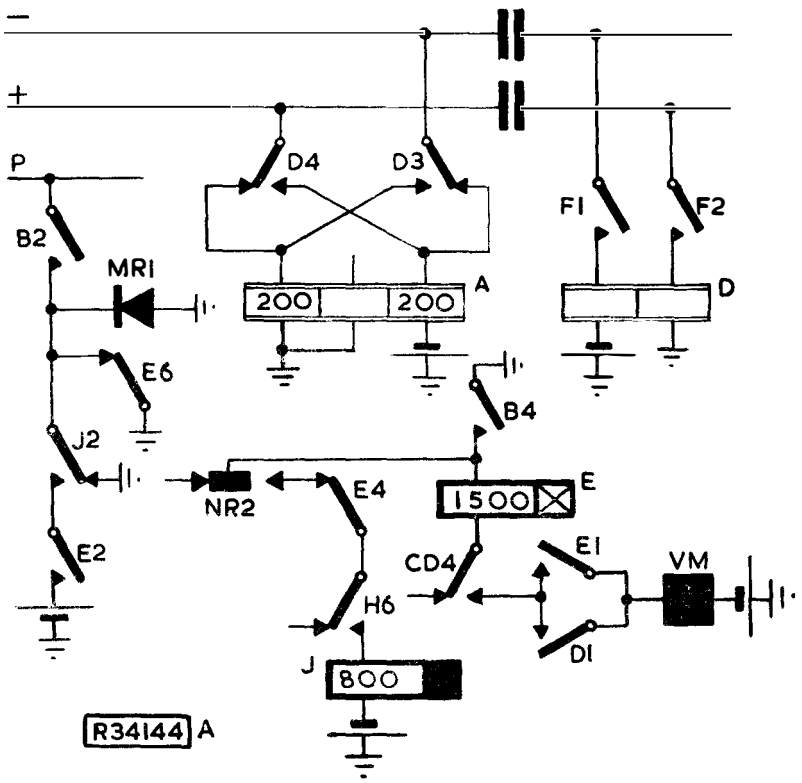


Fig. 6

On the operation of relay D, D1 completes the circuit for the re-operation of relay E:-

Earth - contact B4 (operated) - relay E - contact CD4 (operated) - contact D1 (operated) - vertical magnet VM - battery.

Relay E re-operates.

Contacts D3 and D4 reverse the connexions of relay A to the positive and negative lines to operate supervisory relays on calls from manual exchanges and to give metering conditions on calls incoming from other automatic exchanges. Contact D2 disconnects the circuit for the 'Called Subscriber Held' (C.S.H.) lamp. (Fig. 7).

Contact E2 completes the circuit for the operation of the calling subscriber's meter:-

Positive battery - contact E2 (operated) - contact J2 (operated) - contact B2 (operated) - private wire.

The positive battery is extended through the 2nd selector, 1st selector and uniselector to earth via the meter.

The circuit of relay J is disconnected at contact E4 when relay E operates, but relay J, being slow-to-release, maintains the positive battery on the private wire during the slow-release period.

Contact E6 disconnects earth from the private wire, but the guarding of the private wire is maintained by the earth through rectifier MR1.

When relay J releases, the guarding of the incoming private wire is taken over by earth re-connected at contact J2.

Relays A, B, CD, D, E, F and H are held operated for the duration of the call.

Release of Selector for Matured Call

The release of the various relays and the restoration of the mechanically operated spring-sets can readily be followed from the complete circuit diagram of the final selector - Fig. 7.

The release of the selector is controlled by the calling subscriber.

The calling subscriber, in replacing the handset on the cradle, disconnects the loop holding relay A in operation and relay A releases.

Contact A1 releasing completes a short-circuit across the coil of relay B, which releases.

Contact B1 disconnects the holding circuit for relay CD.

Contact B2 disconnects the holding and guarding earth on the incoming wire to release the preceding selectors.

Relay CD releases.

Contact B3 disconnects the circuit for relay H, to prevent its operation to a disengaged subscriber's line during the rotary release.

Contact B4 disconnects the holding circuit for relays E, F and H.

Relays E, F and H release.

Contact CD2 connects earth via spring N3 (operated) to the incoming private wire, to guard against seizure of the selector during release.

Contact F1 and F2 disconnect the circuit for relay D, which releases.

Contacts B5, E7 and H5 complete the self-drive circuit for the release of the selector:-

Release alrm earth - rotary interrupter spring RM1 (normal) - contact B5 (normal) - spring N1 (operated) - contact E7 (normal) - contact H5 (normal) - rotary magnet RM - battery.

The rotary magnet RM operates and steps the selector wipers to the next bank contact on the level. The rotary magnet circuit is disconnected at the interrupter springs RM1 when the magnet is fully operated, and magnet RM releases. When the rotary magnet circuit is completed, the magnet operates and again the wipers are stepped. This operation is repeated until the wipers take up the 12th position and NR springs release. In this position the wipers are clear of the bank and drop vertically. The wipers and carriage return to the normal position under the control of the restoring spring. N springs restore to normal.

Spring N3 disconnects earth from the incoming private wire to leave the selector free to be taken into use by another call. Spring N1 disconnects the rotary magnet circuit.

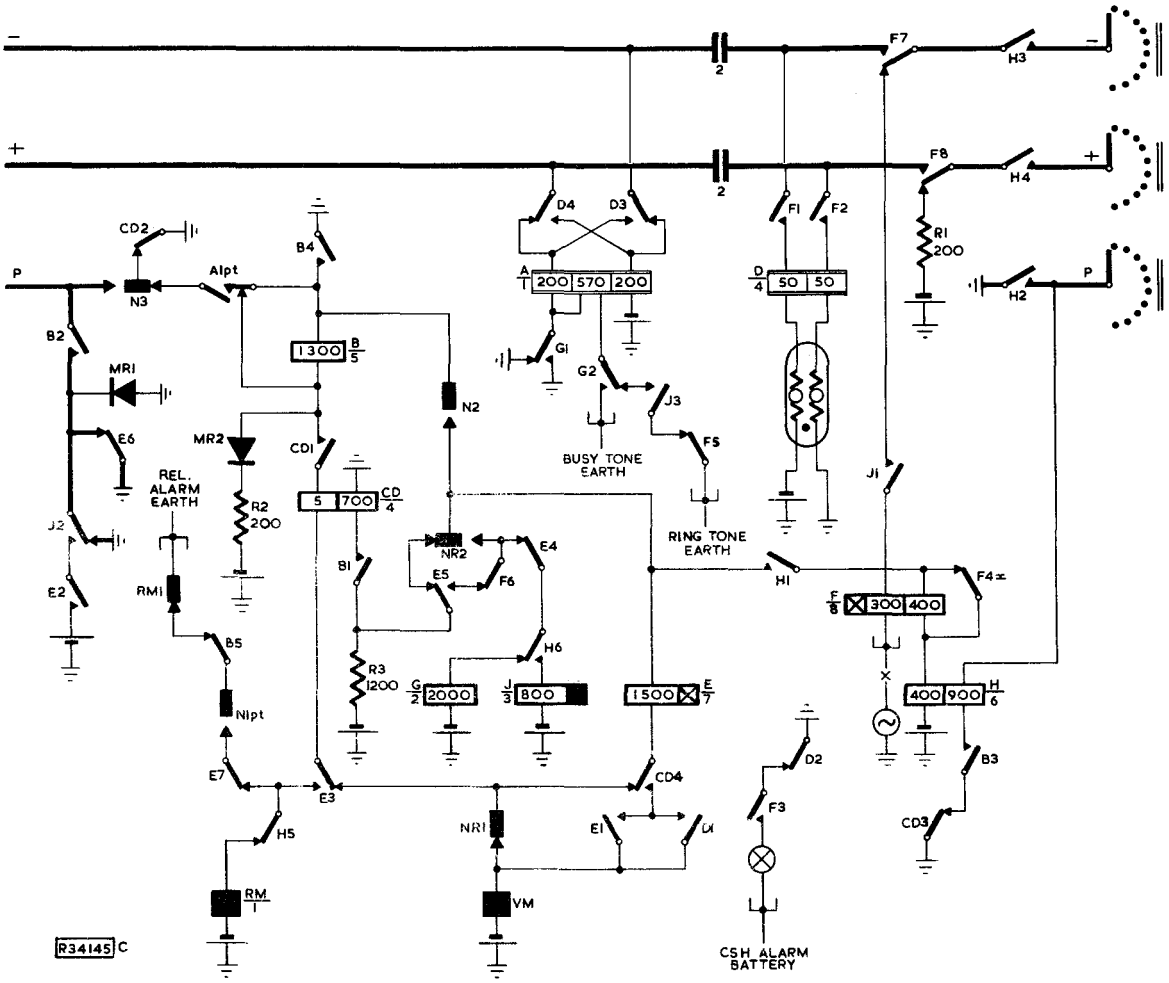


Fig. 7

Called-Subscriber Held Condition

If the called subscriber clears, but the calling subscriber (who controls the release of the selectors) does not clear, the called subscriber's line will test engaged to any other incoming call, and the called subscriber will be unable to originate calls because relay K in his uniselector circuit is held operated.

In order to reduce the time the called subscriber's line is held, provision is made for an alarm to be given to the maintenance staff after three minutes.

When the called subscriber clears the line, relay D releases and completes the circuit for the 'Called Subscriber Held' lamp:-

Earth - contact D2 (released) - contact F3 (operated) -
C.S.H. Lamp - battery via the alarm relays.

This alarm, which may be visual or visual and audible (according to exchange conditions), indicates to the maintenance staff the need for tracing the calling subscriber and releasing the connexion.

Operation of Final Selector when Called Subscriber is Engaged

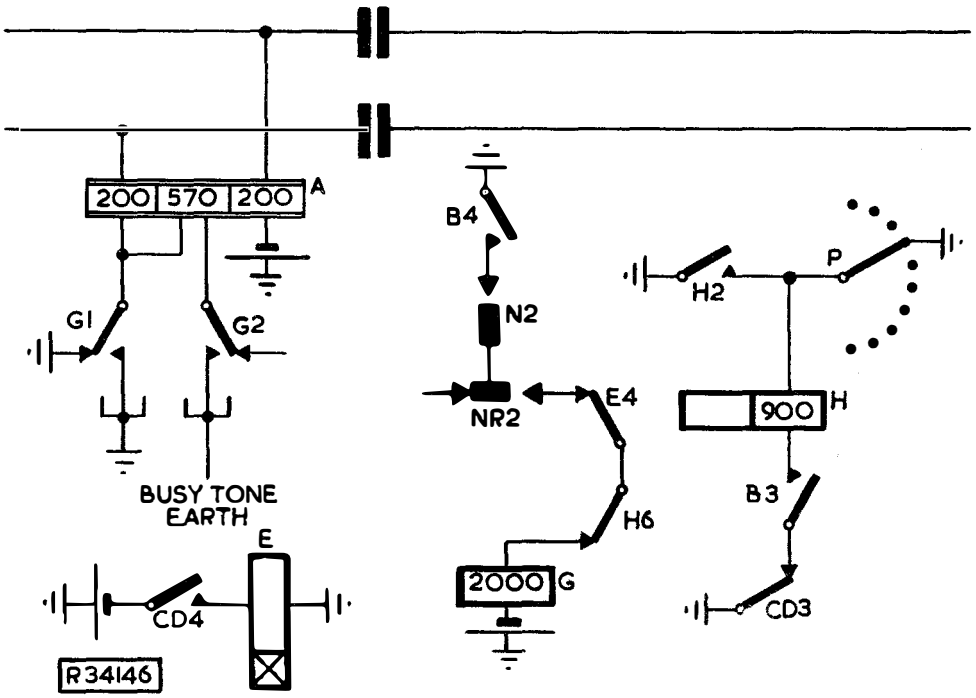


Fig. 8

When a subscriber is engaged on an outgoing or an incoming call, the private wire of his line equipment has an earth connected to it.

At the end of the rotary action of the final selector described previously, relay A re-operates to the calling subscriber's loop and contact A1 removes the

short-circuit from relay B, which becomes re-energized. Contact A1 disconnects the circuit of relay CD (5 ohm winding), which releases.

The wipers are standing on the bank contact associated with the called subscriber's line, and, as the subscriber is engaged, an earth is encountered on the private wire bank contact (Fig. 8); relay H cannot, therefore, operate when contact CD3 becomes normal.

When contact CD4 releases, the holding circuit for relay E is disconnected.

Relay E releases.

Contact E4 completes the circuits for the operation of relay G:-

Earth - contact B4 (operated) - spring N2 (operated) - spring NR2 (operated) - contact E4 (normal) - contact H6 (normal) - relay G - battery.

Relay G operates.

Contact G1 performs no function now that the busy flash facility has been withdrawn. (Before the withdrawal of the busy flash facility, this contact connected intermittent battery and earth to the +ve line via the 200 ohm winding of relay A).

Contact G2 connects busy tone earth to the 570 ohm winding of relay A.

Busy tone is induced in the 200 ohm windings of relay A and transmitted to the calling subscriber in the same way as that described for ring tone.

Contact E5 disconnects the short-circuit across the 700 ohm winding of relay CD and relay CD re-operates.

Contact CD3 disconnects earth from the 900 ohm winding of relay H, preventing the operation of that relay should the called subscriber's line become free.

Relays A, B, CD and G are held in operation during the time the calling subscriber maintains the connexion.

Release of Selectors from Engaged Line

When the calling subscriber replaces the handset on the cradle, the loop which is holding relay A in operation is disconnected and relay A releases.

Contact A1 short-circuits the coil of relay B, which releases.

Contact B1 disconnects the holding circuit for relay CD, which releases.

Contact B2 disconnects earth from the incoming private wire, but earth is reapplied at contact CD2 via spring N3 (operated) to guard against seizure of the selector, during release, by another caller.

Contact B3 disconnects the circuit for relay H, to prevent its operation to a disengaged subscriber's line during the rotary release.

Contact B4 disconnects the circuit for relay G and relay G releases.

Contact B5 completes the self-drive release circuit for the rotary magnet RM.

Contact G2 disconnects the busy tone earth from the 570 ohm winding of relay A.

The rotary magnet RM operates over the completed circuit:-

Release alarm earth - rotary interrupter spring (RM1) (normal) - contact B5 (normal) - spring N1 (operated) - contact E7 (normal) - contact H5 (normal) - rotary magnet RM - battery.

The release of the selector is similar to that described for 'Release of Selector from Matured Call'.

Release Alarm

In the event of a mechanical fault preventing the return of the selector wiper carriage assembly to normal, so that the rotary interrupter springs are not disconnected, a visual and audible alarm is operated to draw the attention of the maintenance staff to the failure.

Release of Selector from a Call where the Called Subscriber has not Answered

In the event of a called subscriber not answering, the calling subscriber abandons the call.

While ringing current is connected to the called subscriber's line, relays A, B, CD, H and J are operated.

The calling subscriber replaces the handset on the cradle and disconnects the loop holding relay A in operation.

Relay A releases.

Contact A1 short-circuits the coil of relay B to release it.

Contact B1 disconnects the circuit for relay CD (700 ohm winding) and relay CD releases.

Contact B4 disconnects the circuit for relays H and J.

Relays H and J release.

Contact B5 prepares the circuit for the self-drive release circuit.

Contact H5 completes the circuit for the self-drive release of the selector.

The selector releases in a similar manner to that described previously.

Design Details

Rectifier MR1. The earth via this rectifier is provided to maintain a guarding earth on the private wire during the transit time of contact J2. An earth connected to the private wire without a rectifier would shunt the positive battery.

Rectifier MR2. This rectifier is included in the circuit of relay B to prevent the battery via 200 ohm resistor R2 shunting the vertical and rotary magnets during pulsing and thus causing faulty operation of these magnets.

Relay J. Slow-to-Release. Relay J is made slow-to-release so that the meter pulse is connected to the private wire during the period of release of relay J, after its circuit has been disconnected.at E4. When the called subscriber answers, the meter pulse is connected to the private wire during the period between the closing of contact E2, when relay E re-operates, and the restoration of contact J2 following the release of relay J at contact E4. The meter pulse is thus applied during the release time of relay J, which is made sufficiently long to ensure correct operation of the subscriber's meter.

Relay E. Slow-to-Operate. Relay E is made slow-to-operate and slow-to-release to avoid the possibility of interaction between relay CD and relay E, which might otherwise occur as follows. After receipt of the first train of pulses, relay CD releases, operating relay E at contact CD4. Contact E5 removes the short-circuit from the 700 ohm winding of relay CD, causing this relay to operate. If relays E and CD operate sufficiently quickly, contact CD4, in operating to hold relay E via contact E1 (operated), will interrupt the circuit for relay E, which in releasing will replace the short-circuit on relay CD at contact E5, and so on. Now relay E cannot operate until the core is fully fluxed, thus ensuring that the slow-release feature shall be completely effective; hence the relay remains operated during the change-over of contact CD4.

Relay F. This is designed so that it does not operate when interrupted ringing current is fed through one of its coils, but is positive and definite in its operation when the called subscriber answers. This is brought about by fitting an armature-end slug to the relay to give it an operate lag of approximately 60 milliseconds. Each half cycle of ringing current is about 30 ms in duration so that the relay remains unoperated until direct current is superimposed on the ringing current, i.e. the called subscriber answers.

Ring Return Battery. It should be noted that the battery connexion required for the ringing return circuit is not taken from the normal battery supply to the selector, but is wired from a separate jack point, to which a battery lead is run as one of a twisted pair, with the ringing lead, from the power board, where the ringing fuses are located. This arrangement is adopted to prevent induced interference in speech conductors due to an isolated conductor carrying ringing current.

Developments

The method of connecting N.U. tone and a switching battery to spare lines at the Intermediate Distribution Frame is wasteful of labour and materials. New final selector circuits have been introduced in which the N.U. tone is applied from the circuit which is based on the following testing principles,

(i) Ring tone is applied to the calling line when the called P-wire is marked with a battery condition.

(ii) Engaged tone is applied when the called P-wire is marked with an earth.

(iii) N.U. tone is applied when the called P-wire is disconnected.

The arrangement of the new testing circuit and tone feeding circuit is shown in Fig. 9. Relay E, not shown, operates during the pause between the vertical and rotary pulse trains, and at contact E7 disconnects the short-circuit on the 700 ohm coil of relay CD and completes an operate circuit for relay G. A hold circuit is completed for relay G by contact G1 to the earth at contact CD3 operated.

At the first rotary step, the NR spring-set operates, and at NR2 completes a short-circuit on the 700 ohm coil of relay CD to the earth at contact B4. Relay CD releases at the end of rotary stepping and contact CD3 extends the operated relay G in series with relay H to the P-wire.

(i) Free line - the P-wire is marked with a battery potential, hence the battery connected G relay releases and at contact G1 extends an earth to operate relays H and K. Subsequently relay E releases and at contact E1 normal and H2 operated completes a circuit to extend ring tone to the calling line.

(ii) Engaged line - the P-wire is at earth potential and relay G is held operated. The current which flows is insufficient to operate relay H. With G relay operated, when relay E releases a circuit is completed to extend busy tone to the calling line - contact E1 normal and G2 operated.

(iii) Spare line - the P-wire is left disconnected, hence H does not operate and relay G releases. When relay E releases, contact E1 normal, G2 normal, H2 normal and the NR contacts operated completes a circuit to extend the N.U. tone to the calling line.

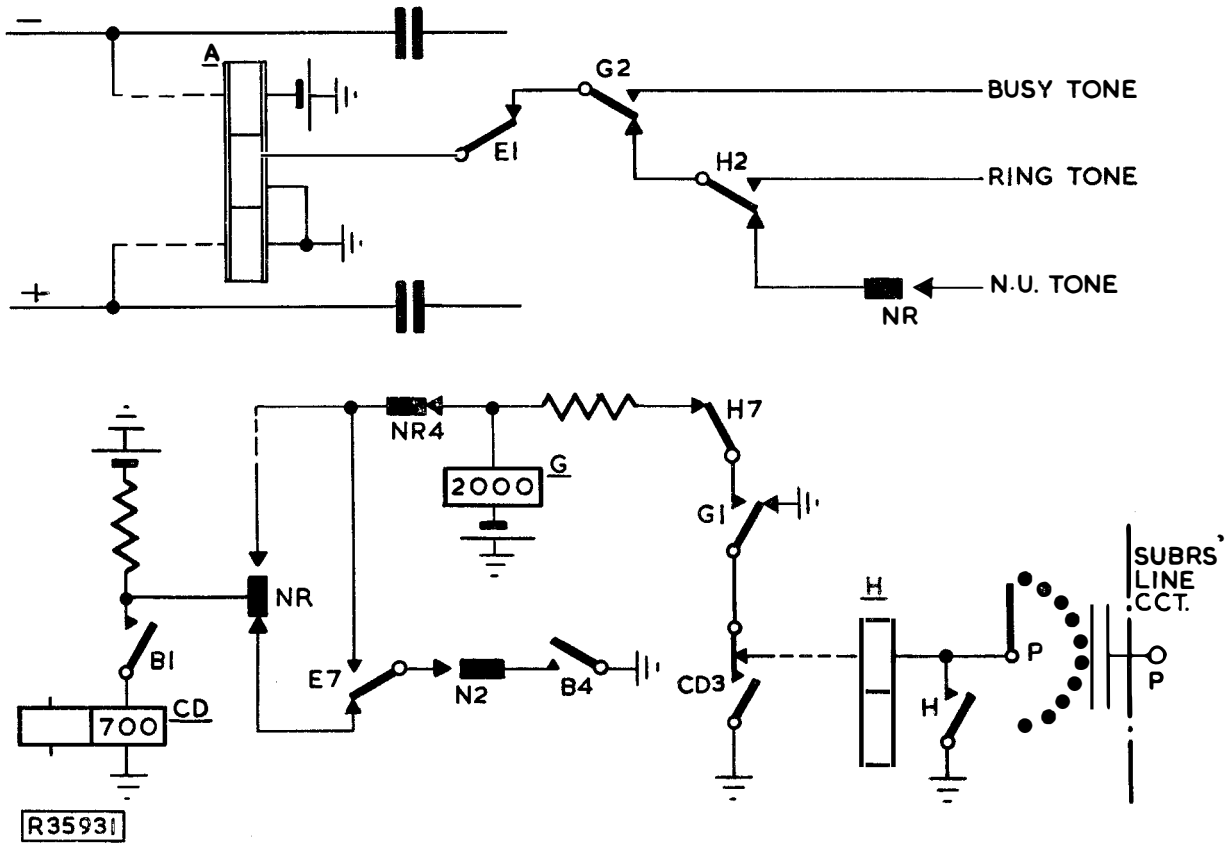


Fig. 9

100 LINE FINAL SELECTOR, PRE-2000 TYPE

Seizure of Selector

The absence of earth on the incoming private of the final selector allows it to be seized by the preceding selector, and the calling subscriber's loop is extended to operate relay A.

Contact A1 operates relay B.

Contact B1 returns an earth on the private to guard the circuit and to hold the preceding apparatus.

Contact B3 feeds earth via NR1 and N1 springs to operate relay C.

Contacts B5 and C3 prepare a circuit for operation of the vertical magnet V.

Contact B4 prepares a circuit for relay H and relay E.

Contact B2 disconnects the circuit of the release magnet Z.

Vertical Stepping

The elements of the vertical and rotary stepping circuits are shown in Fig. 10.

On each release of relay A during the 'tens' pulse train, a circuit is completed to energize the vertical magnet:-

Earth - contact A1 (normal) - contact B5 (operated) - contact C3 (operated) - contact E2 (normal) - vertical magnet V - relay C (3 ohm winding) - battery.

The wipers are thus lifted to the required level.

After the first vertical step the vertical off-normal springs N are operated.

N1 contacts disconnect the operate circuit of relay C, but this relay remains held during vertical stepping owing to the current pulses through its 3 ohm winding in conjunction with its slow-release feature.

N3 contacts prepare an operate circuit for relay E.

Since relays B and C are slow-to-release they both remain held during pulsing. At the end of the 'tens' pulse train, relay A remains operated to the subscriber's loop during the inter-train pause. The circuit for the vertical magnet is thus broken and relay C releases.

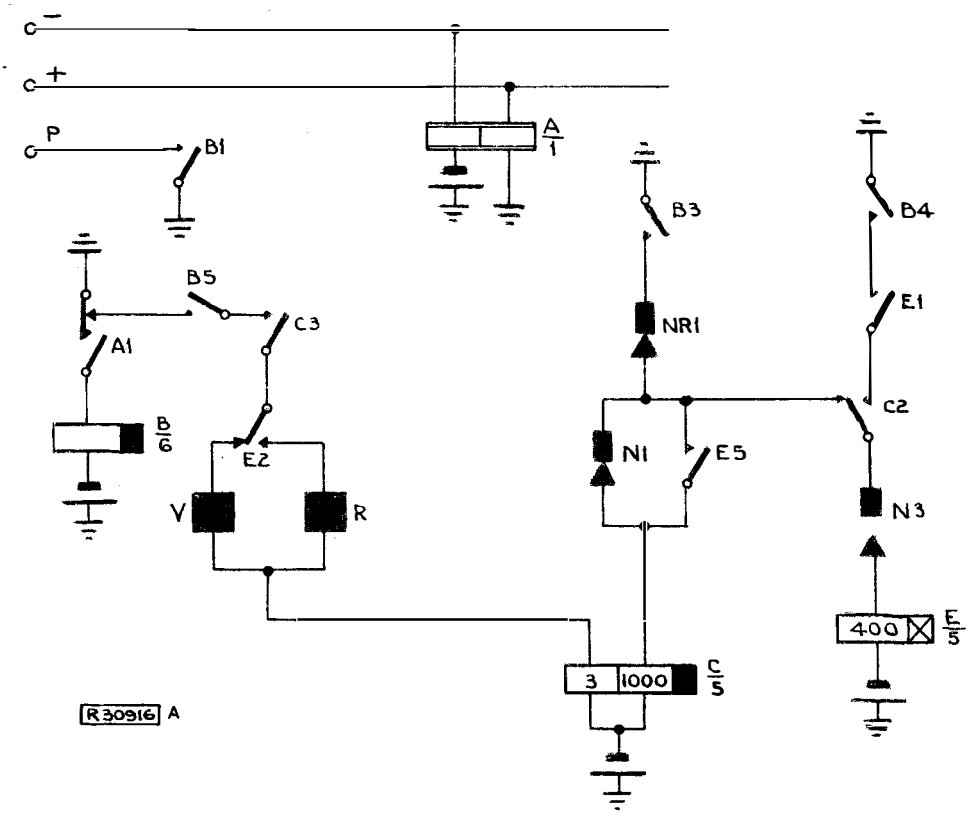


Fig. 10

Rotary Stepping

When relay C releases on completion of vertical stepping, the operate circuit for relay E is completed at contact C2:-

Earth - contact B3 (operated) - rotary off-normal springs NR1 (normal) - contact C2 (normal) - vertical off-normal springs (operated) - relay E - battery.

Contact E5 short-circuits the N1 springs to re-operate relay C.

Contact E1 completes a hold circuit for relay E:-

Earth - contact B4 (operated) - contact E1 (operated) - contact C2 (operated) - springs N3 (operated) - relay E - battery.

Contact E2 prepares a circuit for the operation of the rotary magnet R.

When the 'units' pulse train is received, the rotary magnet R is energized on each release of relay A:-

Earth - contact A1 (normal) - contact B5 (operated) - contact C3 (operated) - contact E2 (operated) - rotary magnet R - battery.

During the first rotary step, the rotary off-normal springs NR are operated.

NR1 springs disconnect the operate circuit of relay E and the operate circuit for relay C.

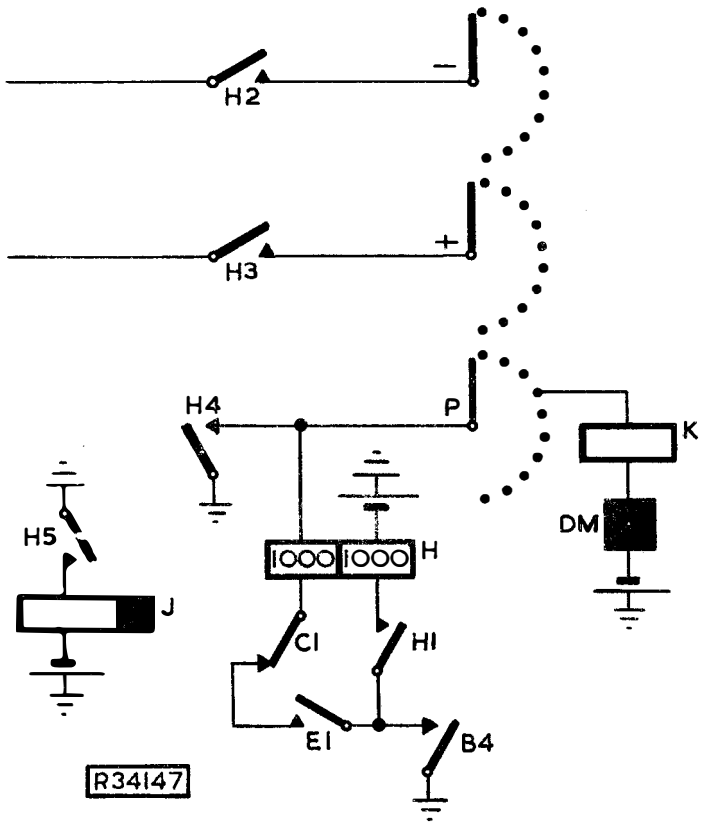
Relay C is energized via its 3 ohm winding during the break portion of each pulse and, in conjunction with its slow-release feature (provided by a heel-end slug), remains held during pulsing. It releases on completion of the pulse train. Contact C2 disconnects the hold circuit for relay E which also releases. As NR1 springs are operated, relays C and E cannot be re-energized and the pulsing circuit thus remains disconnected at C3 contact. Hence any additional pulses received will not affect the connexion.

Switching

The wipers are now standing on the bank contacts of the required subscriber's line and, if this line is free, a circuit will be completed for operation of the switching relay H, (Fig. 11) after the release of C and during the slow-release of relay E:

Earth - contact B4 (operated) - contact E1 (operated) - contact C1 (normal) - relay H - P wiper - battery via called subscriber's K relay.

Relay H operates and also relay K in the called subscriber's uniselector circuit.



Contact H1 holds relay H to the B4 earth.

Contact H4 connects a busying earth to the P-wiper to hold relay K and prevent any other final selector from switching to that particular subscriber's line.

Contacts H2 and H3 switch the negative and positive wipers through to the ringing circuit.

Contact H5 operates relay J.

Fig. 11

Ringing the Called Subscriber

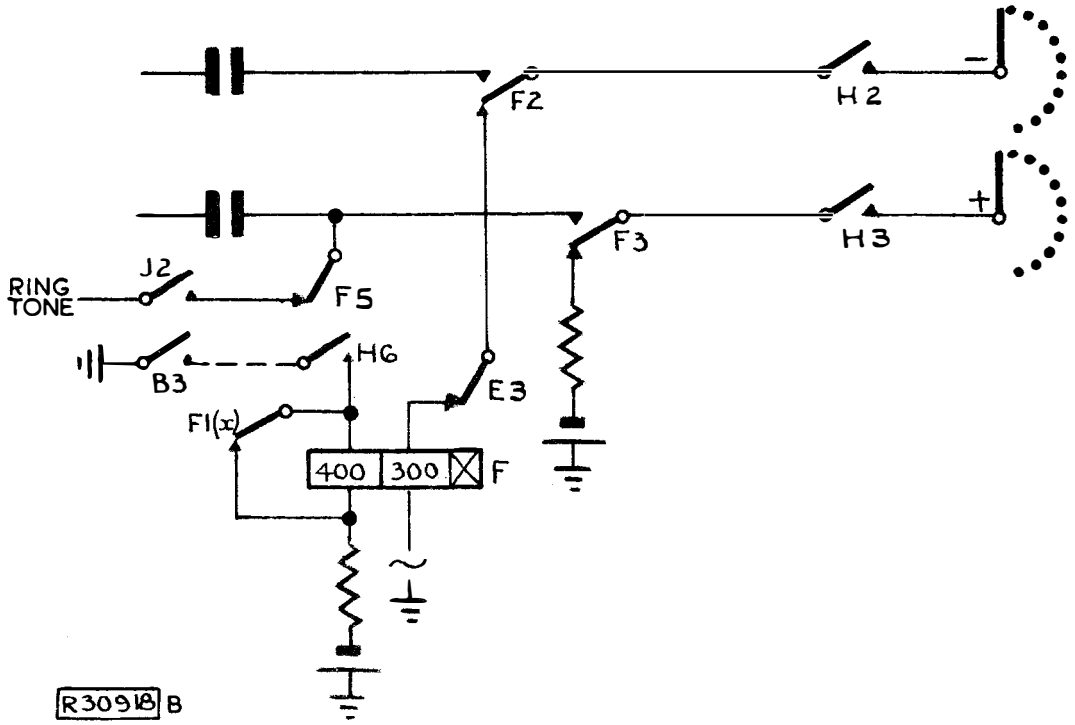


Fig. 12

Ringing current is fed through the 300 ohm winding of relay F and is not applied to the line until contact E3 is normal. This ensures that the subscriber's K relay has removed the earth and battery from the line circuit before ringing current is switched through to the subscriber's line. On the release of E3 ringing current is passed via the negative line, the subscriber's bell and positive line to a ringing return battery fed through a 200 ohm resistance spool connected to contact F3.

Relay F is so designed that it will not operate until a loop is placed across the line. (See Design Details).

Ring tone is returned to the caller via contact J2 (operated), contact F5 (normal) and the transmission bridge capacitors.

Called Subscriber Answers

When the called subscriber answers, his capacitor and bell are shunted by the transmitter loop. Direct current, together with an increased value of ringing current will then flow through relay F, causing it to operate. Contacts F2 and F3 disconnect the operate circuit for this relay, but, since contact F1 (x) is operated, an alternative hold circuit is provided from earth, contact B3 (operated), contact H6 (operated), and the 400 ohm winding of relay F to battery.

The called subscriber's line is now extended to relay D, which operates (Fig. 13).

Contacts D1 and D2 reverse the connexions of the A relay to the incoming negative and positive wires. This provides for supervisory signalling when the call originates from a manual board and for metering when the call is originated by a subscriber on another auto exchange.

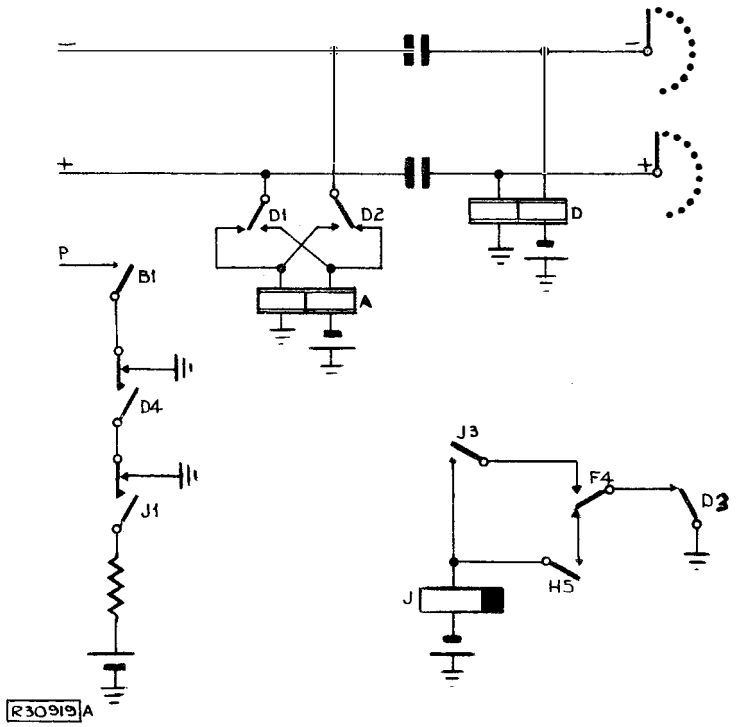


Fig. 13

Metering (positive battery metering)

When relay H operated, contact H5 operated relay J which, at contact J1, connected a 50 volt positive battery to contact D4. (Fig. 13).

When relay F operates, the original circuit for relay J is disconnected and the relay now holds over its own contact J3. This circuit is disconnected on the operation of contact D3.

Relay J is, however, slow-to-release. For a short period, therefore, positive battery is applied to the calling subscriber's meter via the operated contacts J1, D4 and B1. This battery is replaced by earth on the release of contact J1. On the release of contact J3, there is no possible re-operating circuit for relay J as F4 remains operated until release of the selector takes place.

Called Subscriber Engaged

If, at the end of dialling, the wipers come to rest on an engaged contact, the earth on the private will prevent relay H from operating. Relays C and E will release in the normal way and thus, if contact H6 is unoperated on the release of contact E4, relay G will operate. (Fig. 14).

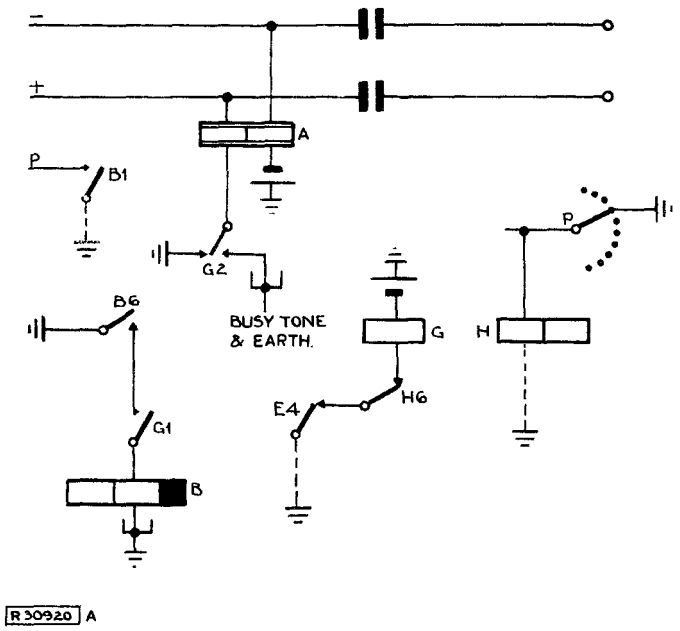


Fig. 14

Contact G2 connects busy tone via the 200 ohm winding of relay A to the positive wire but contact G1 performs no function now that the busy flash facility has been withdrawn.

Release from a Matured Call

The complete circuit diagram of this selector is given in Fig. 15, and the release of the various relays can be followed from this figure.

When the caller replaces his handset on the cradle, relay A releases.

Contact A1 releases relay B.

Contact B1 removes the earth from the private and the preceding selectors restore to normal.

Contact B2 prepares a circuit for the release magnet Z.

Contact B3 releases relay F.

Contact B4 releases relay H.

With the release of relay H, contact H4 removes the earth from the outgoing P-wire so unbusying the called subscriber's line, whether or not the called subscriber has replaced his handset on the cradle.

The circuit for the release magnet is now completed via vertical off-normal springs N2 (operated), contact B2 (normal), contact H4 (normal) to earth. The shaft and wipers are returned to normal and, when the vertical off-normal springs are restored, springs N2 disconnect the operating circuit of release magnet Z.

During release, auxiliary springs (Z1), mounted on the release magnet armature, earth the incoming private wire.

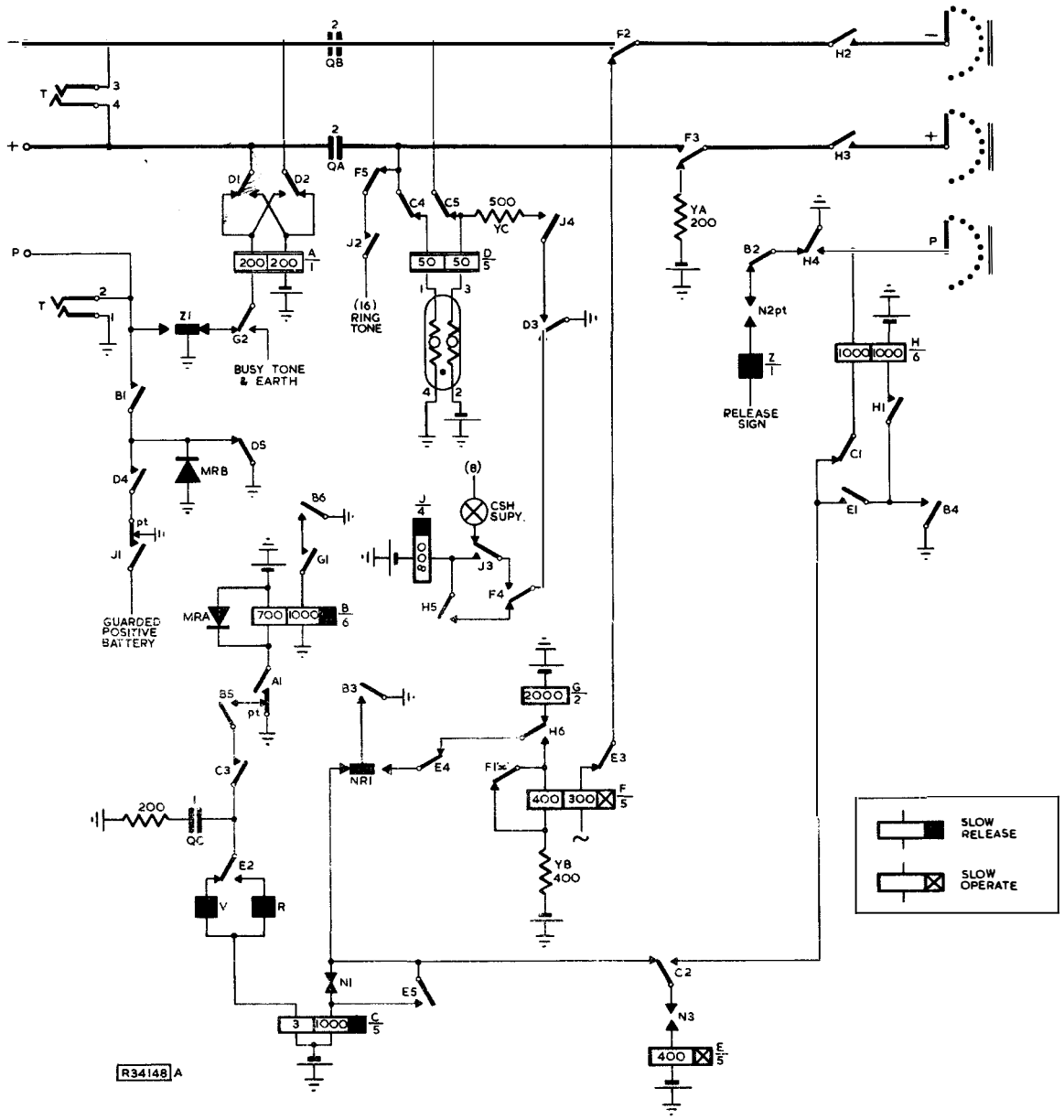


Fig. 15

Release of Selector when Called Subscriber is Engaged

When the calling subscriber replaces the handset on the cradle, the loop is disconnected from relay A which releases.

Contact A1 disconnects the circuit for the 700 ohm winding of relay B and the latter releases.

Contact B1 removes the earth from the private wire and the preceding selectors restore to normal.

Contact B2 completes the circuit for the energization of the release magnet:-

Earth - contact H4 (normal) - contact B2 (normal) - vertical off-normal - N2 springs (operated) - release magnet Z - battery.

Contact B3 releases relay G.

The shaft and wipers are returned to normal and, when the vertical off-normal springs are restored, springs N2 disconnect the release magnet. The incoming private wire is earthed by springs Z1 while the release magnet is energized, to guard against seizure before the switch has fully restored to normal.

Called-Subscriber-Held Condition

If the called subscriber clears, but the calling subscriber (who controls the release of the selector) does not clear, the called subscriber's line will test engaged to any other incoming call, and also the called subscriber will be unable to originate calls because relay K in his uniselector circuit is held operated.

In order to restrict the time for which the called subscriber's line is held, provision is made for an alarm to be given to the maintenance staff after 3 minutes.

When the called subscriber clears the line, relay D releases and completes the circuit for the "Called Subscriber Held" lamp:-

Earth - contact D3 (normal) - contact F4 (operated) - J3 (normal) - C.S.H. lamp - battery via the alarm relays.

This alarm, which may be visual or visual and audible (according to exchange conditions), indicates the maintenance staff the need for tracing the calling subscriber and releasing the connexion.

Design Details

Contacts C4 and C5 disconnect the windings of relay D from the transmission bridge capacitors during dialling in order that the pulsing circuit for relay A may be kept as distortionless as possible.

Rectifier MRA in parallel with the 700 ohm winding of relay B is provided to increase the release lag of the relay under pulsing conditions. The rectifier actually provides a short-circuit in one direction across the winding and thus has a slugging effect on the relay.

Rectifier MRB is provided to maintain an earth on the P-wire to hold the switching relays of the selectors in the event of a faulty metering condition. For example, if the positive battery fuse blows, the preceding switches will be released when the metering condition is applied, because the circuit for maintaining the switching relays operated will be broken. The provision of the rectifier ensures that an earth is provided for the negative battery via the switching relays; but the connexions of the rectifier are such as to provide a high resistance path for the positive battery.

Relay F is of identical design to the relay F in the 2000 type final selector circuit. It does not operate when interrupted ringing current is fed through one of its coils, but is positive and definite in its operation when the called subscriber answers. This is brought about by fitting an armature-end slug to the relay to give it an operate lag of approximately 60 ms. Each half cycle of ringing current is about 30 ms in duration so that the relay remains unoperated until a direct current flows through its operate winding, i.e. when the called subscriber answers.

BACKWARD HOLDING BY FINAL SELECTOR

In the description of the operation of the subscriber's uniselector and group selector circuits, it is stated that the holding of these circuits is taken over by the final selector.

Fig. 16 shows how this is effected in the case of 2000 type equipment. The principles are similar for pre-2000 type equipment.

When a subscriber originates a call, his uniselector steps to find the first free outlet to the first selector. A free outlet having been found, relay K operates due to the absence of an earth on the private wire and switches the subscriber's loop to operate relay A in the first selector. A contact of relay A operates relay B, and a contact of relay B connects earth to the private wire to hold relay K in the uniselector circuit operated.

The subscriber dials the first digit of the required number to step the first selector to the appropriate level. The first selector automatically hunts to find the first free outlet on that level to a 2nd selector, when relay H releases. A contact of relay H re-operates relay CD and contacts of this relay switch the subscriber's loop to operate relay A in the 2nd selector and re-operate relay H. Relay A in the first selector releases.

The operation of the 2nd selector and subsequent selectors, if any, is the same as that of the first selector, and when a final selector is seized, relay A in the 2nd selector releases.

The subscriber's loop operates relay A in the final selector. A contact of relay A operates relay B and a contact of relay B connects earth to the incoming private wire. This earth holds the H relays in the 1st and 2nd selectors and relay K in the uniselector circuit.

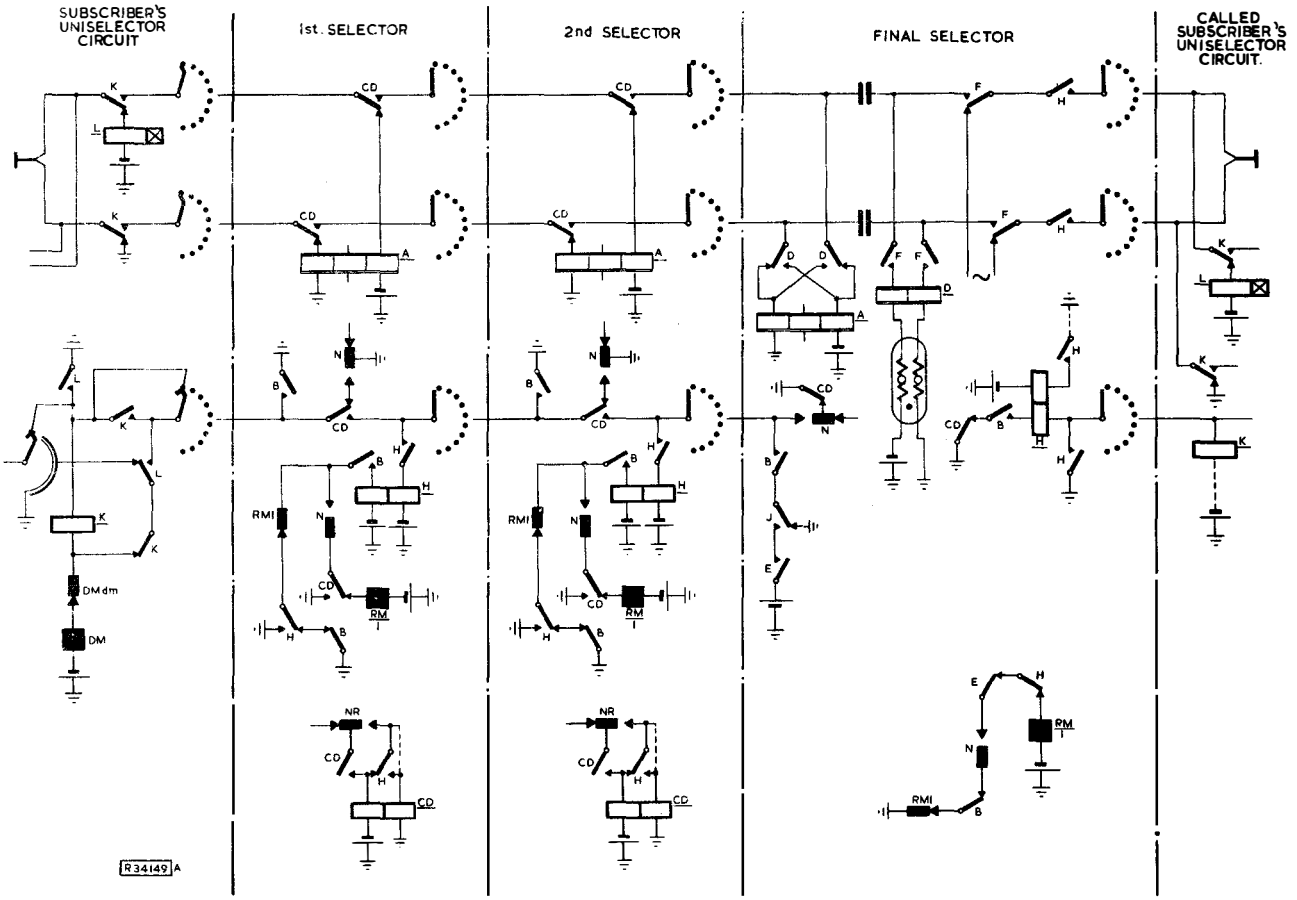


Fig. 16

Release of Connexion

When the calling subscriber clears, the loop to hold relay A in the final selector is disconnected and relay A releases.

Restoration of A relay contact releases relay B which, in turn, allows all other operated relays in the final selector to release. In the interval between the release of relays B and CD, the holding earth is momentarily disconnected from the P-wire to allow the H relays in the first and second selectors and the K relay in the calling subscriber's uniselector circuit to release.

The release circuit of the final selector is completed, and CD and N contacts place a guarding earth on the P-wire until the selector has restored.

Release of the group selector H relay allows the respective CD relays to release. The release circuit is thus completed in each selector and a guarding earth placed on the P-wire as in the case of the final selector.

The release of relay K in the calling subscriber's uniselector circuit completes the drive-magnet circuit. The uniselector is returned to normal and a guarding earth is maintained on the incoming P-wire (from the final selector multiple) by the homing wiper until the uniselector has restored.

200-LINE FINAL SELECTOR

This switch is of the same general construction as the 200-outlet group selector. Its circuit is similar to that of the 100-line final selector except that an additional relay WS is provided, the contacts of which switch the calling subscriber to either bank as required.

Unlike the 200-outlet group selector, the 200-line final selector must carry two incoming trunks - one for each bank of 100 subscribers. In the case of the group selector any one of 20 outlets on a level may be required, whereas in the case of the final selector a certain contact out of 10 on a particular level of one bank is required.

Circuit operation (B.P.O. pre-2000 type)

Fig. 17 shows the elements of the wiper switching circuit of a B.P.O. pre-2000 type 200-line final selector.

If the selector is seized over the incoming trunk associated with No. 1 bank, relays A and B operate and the switch steps and connects the calling line to the required subscriber on No. 1 bank in the normal way.

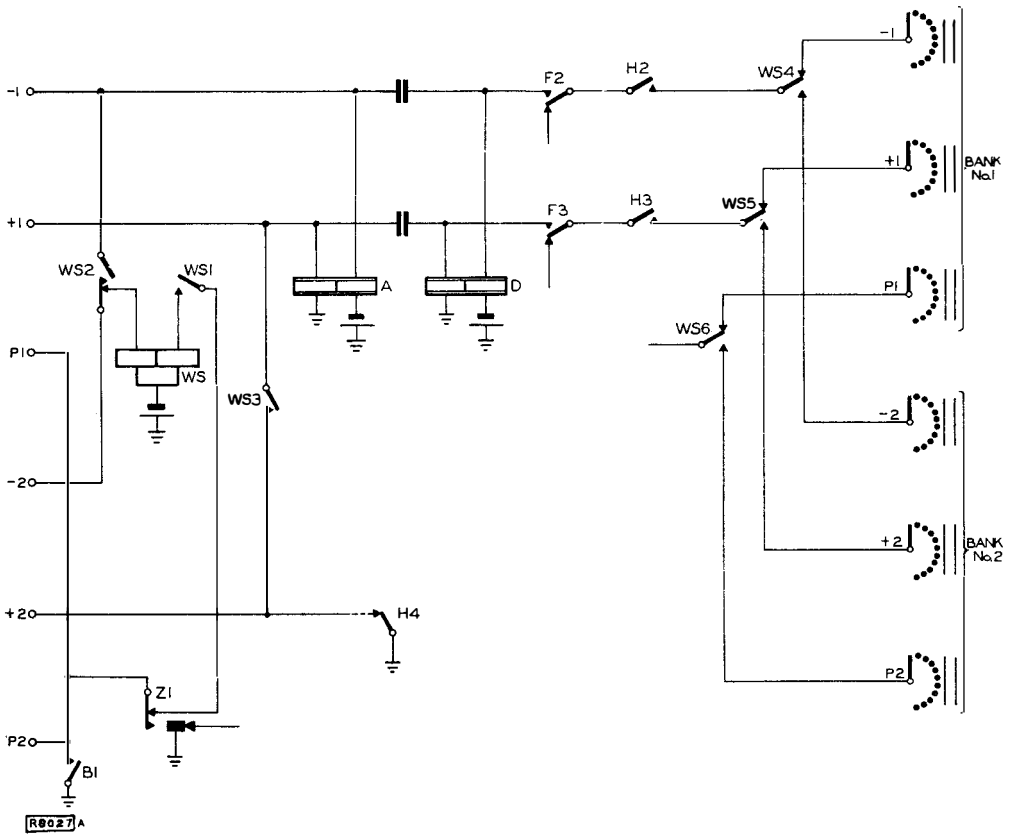


Fig. 17

If, however, it is seized by a call incoming from the trunk associated with No. 2 bank, relay WS operates over the calling loop to earth at contact H4, and holds over its second coil to earth on P2. Contacts WS4, WS5 and WS6 switch the -ve, +ve and P wires of the final selector from No. 1 bank to No. 2 bank and the operation of the selector proceeds as before to connect the caller to the required subscriber on No. 2 bank.

Circuit operation (B.P.O. 2000 type)

Fig. 18 shows the wiper switching circuit of the B.P.O. 2000 type 200-line final selector.

When the selector is seized over the incoming trunk associated with No. 2 bank, relay A operates in the normal way but relay WS is short-circuited at E5. After vertical stepping, relay E operates during the inter-train pause thus allowing the operation of WS over one coil in series with the positive trunk and relay A. WS then holds over its second coil while the NR springs re-apply the short-circuit to the operate coil of WS, to restore balance in the pulsing loop.

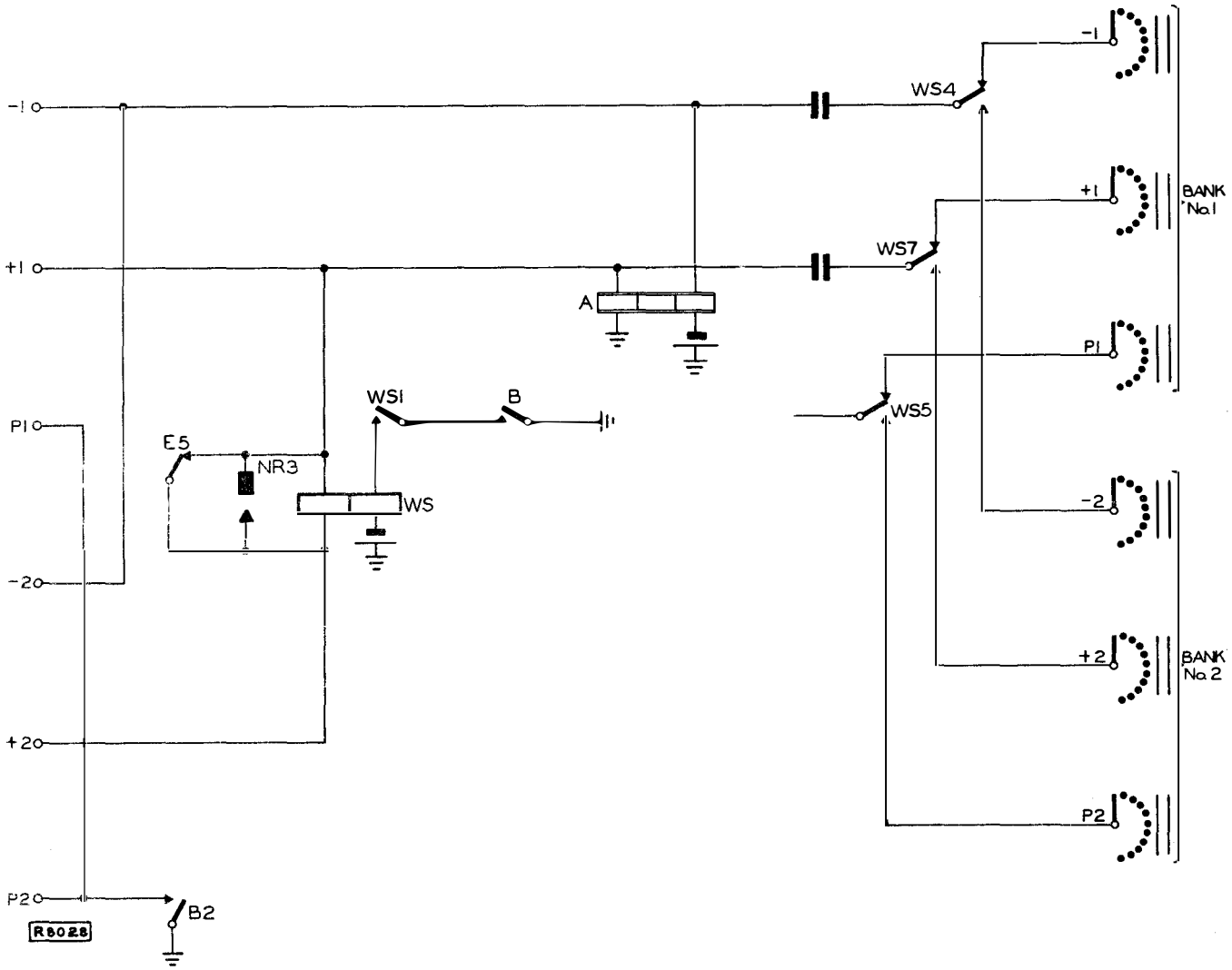


Fig. 18

NON-METERING FINAL SELECTORS

In Director exchanges the meter pulses are applied to the subscriber's meter by the 1st code selector, and thus there is no need to provide circuitry for this purpose in the final selector. In final selectors of this type relay J is not required, and the contacts normally associated with the metering circuit are also omitted.

Figs. 19 and 20 show the Pre-2000 and 2000 type 200-outlet final selectors that are used in a Director exchange. The pulsing, testing, switching and tone circuits are identical to those already described in the previous pages of this pamphlet.

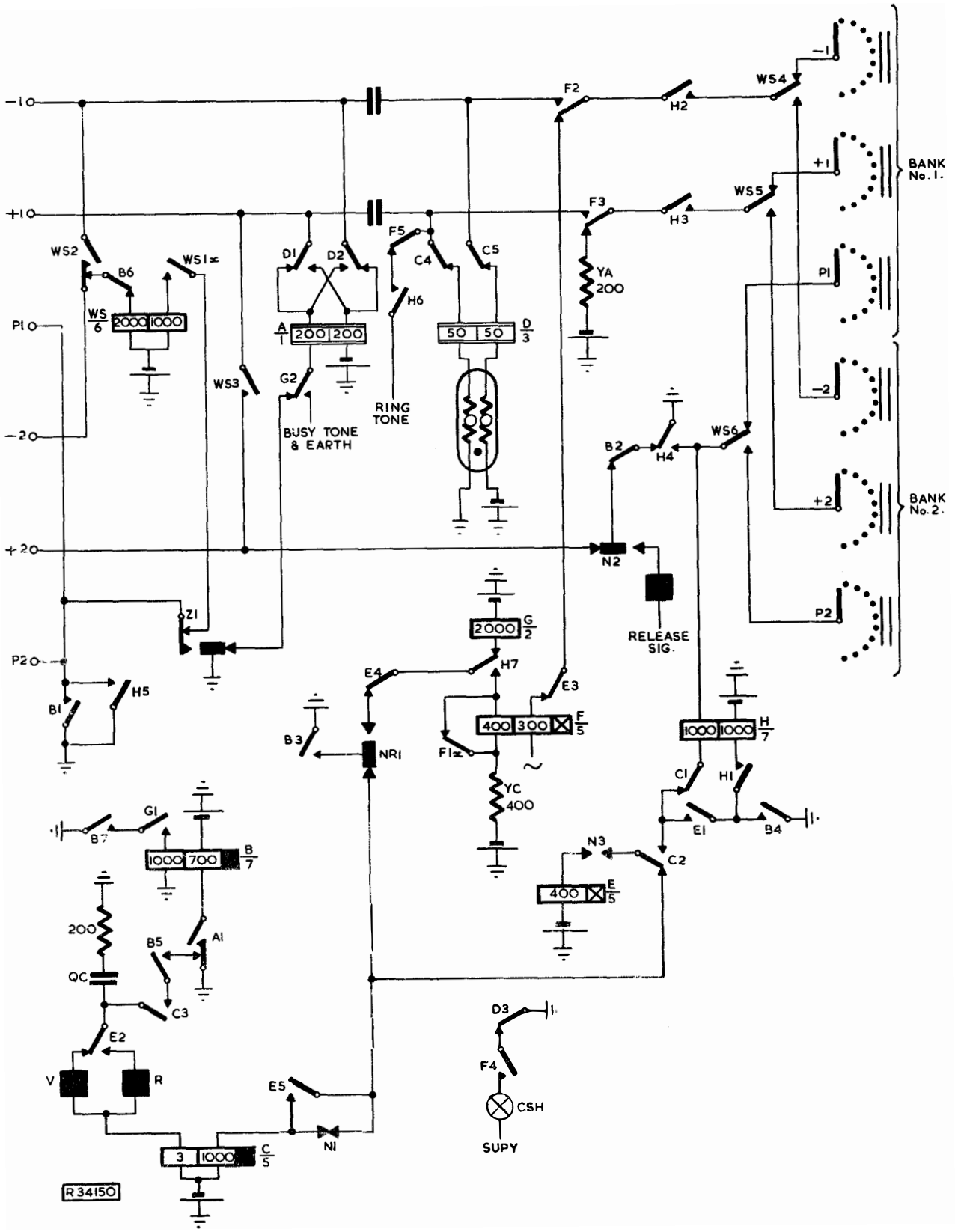

-10
+10
P10
-20
+20
P20
WS2
B6
WS1
WS 6
2000 1000
WS3
D1
D2
A 1
200 200
G2
BUSY TONE & EARTH
RING TONE
F5
C4
H6
C5
50 50
D 3
F2
H2
F3
H3
YA 200
WS4
WS5
WS6
-1
+1
P1
-2
+2
P2
BANK No. 1.
BANK No. 2.
B2
H4
N2
RELEASE SIG.
Z1
B1
H5
2000 G 2
H7
E4
E3
B3
NR1
400 300 F 5
F1
YC 400
1000 1000 H 7
C1
H1
E1
B4
N3
C2
400 E 5
G1
B7
1000 700 B 7
200
QC
B5
A1
C3
E2
V
R
E5
N1
3 1000 C 5
D3
F4
CSH
SUPY
R 34150

Fig. 19

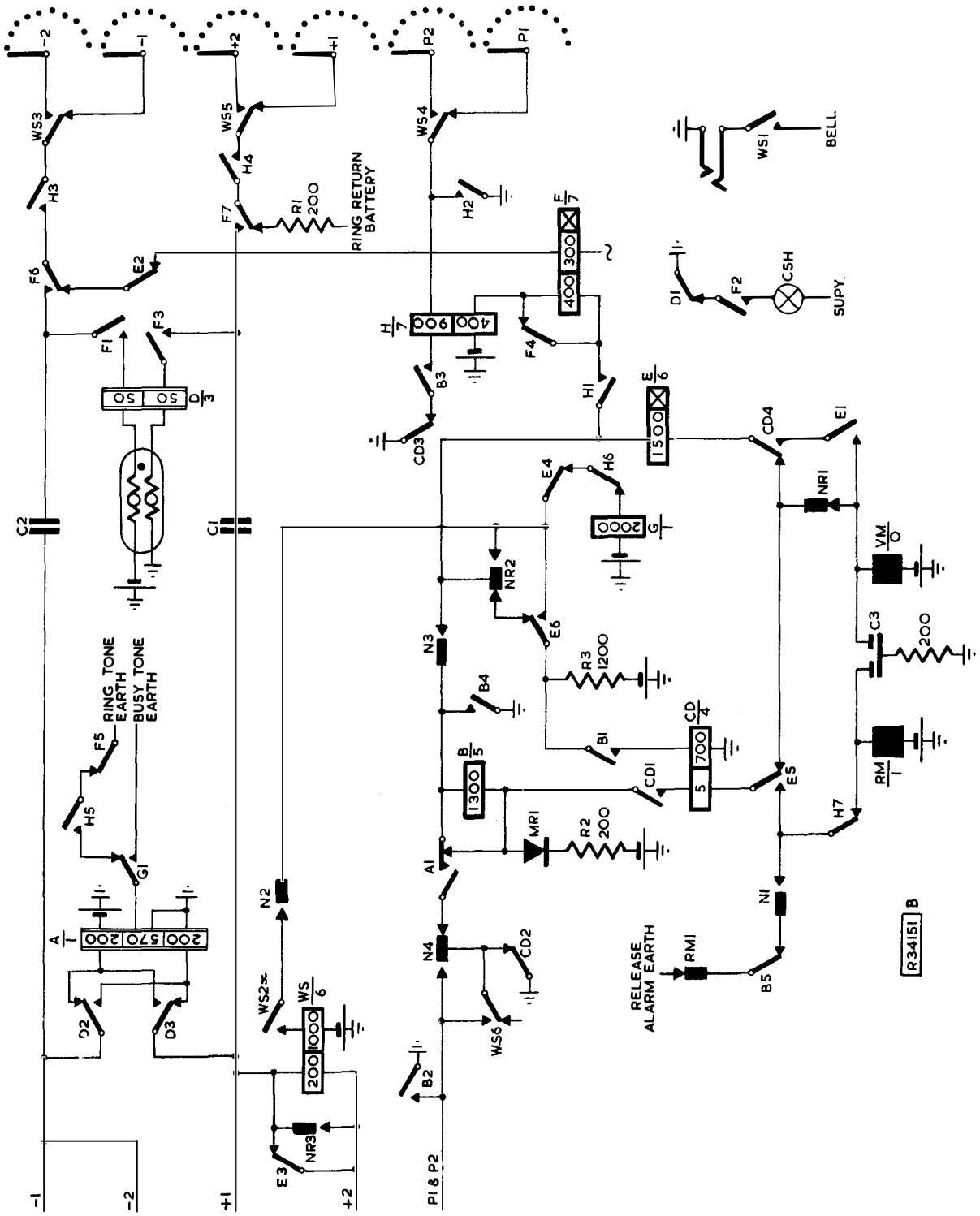


Fig. 20

END

(8/68)