The SE50 Strowger Selector
A New Battery Testing Group Selector

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Freedom from double connexions depends very considerably upon the type of group selector testing circuit. Circuits which have proved excellent in all other respects have failed to prevent the occurence of double switching faults in countries where difficulty is experienced in acquiring skilled labour Consequently, circuits that rely upon a high standard of maintenance are not to be preferred

Group Selector Testing Principles.

Two methods of testing an outlet are available for a group selector viz. *earth testing* and *battery testing* The fundamental difference between the two methods is that a battery testing selector only switches to an outlet which is marked free, whereas an earth testing selector switches to an outlet unless it is marked busy

Earth Testing.

The disadvantage of an earth testing system is that the absence of an earth connection on the marking P wire is not a positive indication that that outlet is free , the absence of an earth may arise from a broken or high resistance P wire, or a dirty bank contact. Furthermore, when a group selector seizes a free outlet, the connexion of a guard earth to the P wire is delayed until either the operation or release of a relay is complete, a period which can be increased by relay contact bounce. It is unfortunate that the shorter the unguarded period, the greater is the risk of switching to a busy outlet during the brief periods of disconnexion which occur when a wiper bounces or overshoots a bank contact. Because of this risk circuit designers are reluctant to use a very high speed relay, consequently the speed of rotary search must be retarded, and there is a risk of the inter-digital pause period being exceeded.

Battery Testing.

In a battery testing system, the risk of double connexions can be made zero by using a testing relay which will not operate in parallel with another similar relay Furthermore, a permanent or momentary disconnexion will not cause the operation of the testing relay

Rotary search can be much faster than for the earth testing selector because there is no risk of faulty switching arising from the operation or release of the testing relay which is liable to occur during wiper bounce or overshoot. This gain in speed is very important in view of the short inter-digital pause period which occurs during fast dialling.

Requirements of a Battery Testing Group Selector.

(*a*) The speed of rotary search should preferably be the unrestricted speed of the switch shaft and wipers.

(*b*) Rotary movement must be arrested reliably when a free outlet is found.

(*c*) The selector must not switch to an outlet being tested by another selector, or alternatively the period during which double switching can take place must be of such brief duration that it can be considered negligible.

(*d*) The selector must not switch to the positive battery potential connected to a P wire during metering.

(*e*) The selector must only switch to an outlet having a " free " potential on the P wire.

(*f*) The selector must not switch to battery via the parallel resistances of all the group selector switching relays and a subscriber's line circuit K relay during the release of a connexion.

(*g*) The testing relay must not have too short an operate time, as otherwise the disconnexion of the circuit of the rotary magnet will be made too soon and the rotary detent may not fall into engagement.

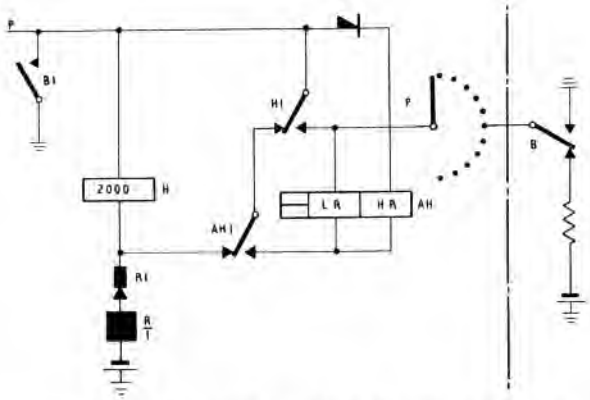

Fig. 1.—Outlet testing circuit for a 10-outlets per level group selector.

Types of Battery Testing Circuit.

Fig. 1 shows an outlet testing circuit of a 10 outlets per level selector, comprising a pair of relays, one functioning as a testing relay, and the other as a switching relay

When the P wiper moves on to the bank contact of a free outlet, relay AH operates with both windings in series, contact AH1 disconnects the rotary magnet circuit and also connects a short-circuit across the rectifier and the high-resistance winding of relay AH. The potential on the P wire is thus lowered preventing the operation of the AH relay in another selector Contact AH1 also disconnects the short-circuit from relay H which then operates and prepares a hold circuit for itself to the earth eventually connected to the P wire by relay B in the subsequent selector The operation of relay H causes the release of relay AH.

This circuit uses one more relay than the combined cut-drive and switching relay of an earth testing selector The question of whether this additional relay is essential will now be examined.

The speed of rotary search of a battery testing selector is approximately 45 steps per second compared with approximately 30 steps per second for an earth testing selector When a selector searches at 45 steps per second, the wipers move on to a bank contact some 2 milli-seconds before the opening of the rotary magnet interrupter springs, consequently the circuit of the testing relay is

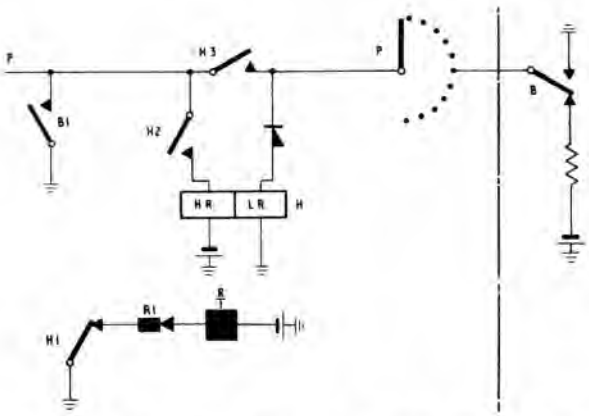

Fig. 2.—Outlet testing circuit for a 10-outlets per level SE50 group selector.

closed 2 milli-seconds before the magnet circuit is disconnected by the interrupter springs. A further period of about 7 milli-seconds then elapses before the interrupter springs re-close upon the return to normal of the magnet armature, consequently there is a period of 9 milli-seconds during which the switching relay can operate before the circuit of the rotary magnet is closed for the next step.

In addition to this period of 9 milli-seconds, there is a further period of about 8 milli-seconds during which the rotary magnet circuit can be closed without any movement of the armature taking place. There is, therefore, a total period of 17 milli-seconds available for the operation of the testing relay That portion of the operation of the relay with which we are concerned is the opening of the contacts which disconnect the rotary magnet circuit , the full operation time of the relay is of little importance.

In Fig. 2 is shown the testing portion of the 10 outlets per level group selector circuit used for the SE50 switch.

Relay H performs the dual functions of a testing and switching relay in an extremely simple circuit. The relay will not operate to the negative battery potential connected to the P wire through the parallel resistances of the selector H relays and relay K in a subscribers line circuit during the release of a connexion. The rectifier in series with relay H prevents the relay operating to the positive battery potential that is connected to the P wire during metering.

When relay H operates on its low-resistance winding, contact H1 disconnects the circuit of the rotary magnet, contact H2 closes a temporary hold circuit for relay H until relay B releases and contact H3 prepares a hold circuit for relay H to the earth eventually connected to the P wire by relay B in the subsequent selector Other contacts of relay H (not shown) extend the calling line to the next selector

This circuit adequately fulfills all the requirements for a battery testing group selector referred to earlier

In the case of a selector of the 20 outlets per level type a further requirement is that when both outlets of a pair are free, the selector must switch to only one of the outlets. Also, it is preferable that a particular one of the pair shall be seized so that the outlets in a graded group are taken into use in a predetermined order

This further requirement is provided, in the preferred form referred to above, by the 20 outlets per level group selector circuit used with the SE50 switch. The testing circuits are shown in Fig. 3.

When both outlets of a pair are free, relays HA and HB operate on their low resistance windings. Contacts HA1 and HB1 disconnect the circuit of the rotary magnet, contact HA2 disconnects the hold circuit of relay HB and closes a hold circuit for relay HA to earth through contact B1 Contact HA3 prepares a hold circuit for relay HA to the earth eventually connected to the P1 wire by relay B in the subsequent selector

Relay C (not shown) is the normal impulse series relay, which in the present instance is also operated by relay HA or HB to perform the function of disconnecting the test windings of relays HA and HB. Contact C1 disconnects earth from the low resistance winding of relay HB , contact C2 prevents the operation of relay HA during the release period of relay B in the event of the P1 outlet becoming free after relay HB has operated to a free P2 outlet.

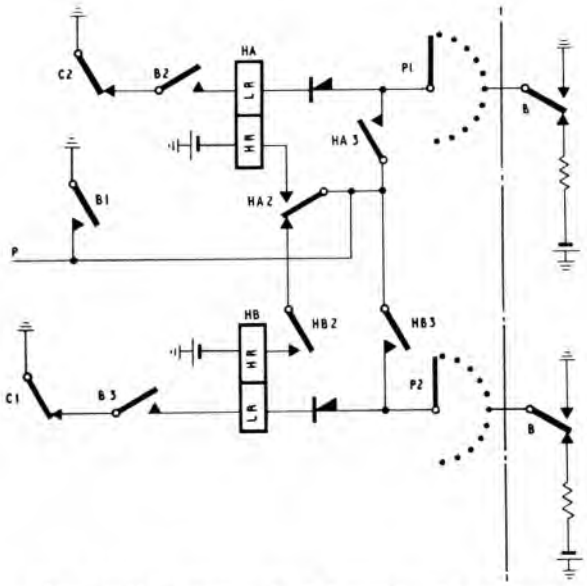

Fig. 3.—Outlet testing circuit for a 20-outlets per level group selector.

10-Outlets per Level Group Selector (Fig. 4).

(*a*) **Selector Seized.**

The switching relay of the preceding selector operates in series with the battery-connected 210 ohm resistance connected to the P wire via off-normal contacts N2, and relay contacts C4, B2 and A1

Relay A operates in series with the calling loop.

Contact A1 connects earth to the P wire to hold the switching relay in the preceding selector or relay K in the subscriber's line circuit, and also closes a circuit for relay B.

Relay B operates in series with the 210 ohm battery connected resistance, its contacts functioning as follows :—

B1 connects an alternative earth to the P wire.

B2 closes an alternative circuit for relay B in series with the 500 ohm resistance and the vertical magnet coil.

B3 closes a circuit for relay C.

B4 further disconnects the circuit of the release magnet (Z).

B5 connects dialling tone to the tone coil of relay A in the case of a local 1st group selector.

Relay C operates, its contacts functioning as follows :—

C1 prepares the vertical magnet impulsing circuit.

C2 and C4 do not perform any function at this time.

C3 further disconnects the rotary magnet circuit.

C5 closes the P.G. alarm lamp circuit.

(*b*) **Impulsing.**

Relay A responds to the dialled impulses and contact A1 operates the vertical magnet a corresponding number of times in series with the 5 ohm winding of relay C.

The vertical off-normal (N) springs operate on the first vertical step, their functions being as follows :—

N1 prepares a circuit for the rotary magnet.

N2 short-circuits the 700 ohm winding of relay C so that it will hold during impulsing.

N3 disconnects the P.G. lamp circuit.

Relay C releases at the end of the train of impulses, its contacts function as follows :—

C1 opens further the vertical magnet impulsing circuit.

C2 prepares an outlet testing circuit for relay H.

C3 closes the rotary magnet circuit.

(*c*) **Rotary Search.**

The rotary magnet operates in series with its interrupter springs.

The rotary off-normal springs (NR) operate on the first rotary step, their functions being as follows :—

NR1 opens further the vertical magnet impulsing circuit.

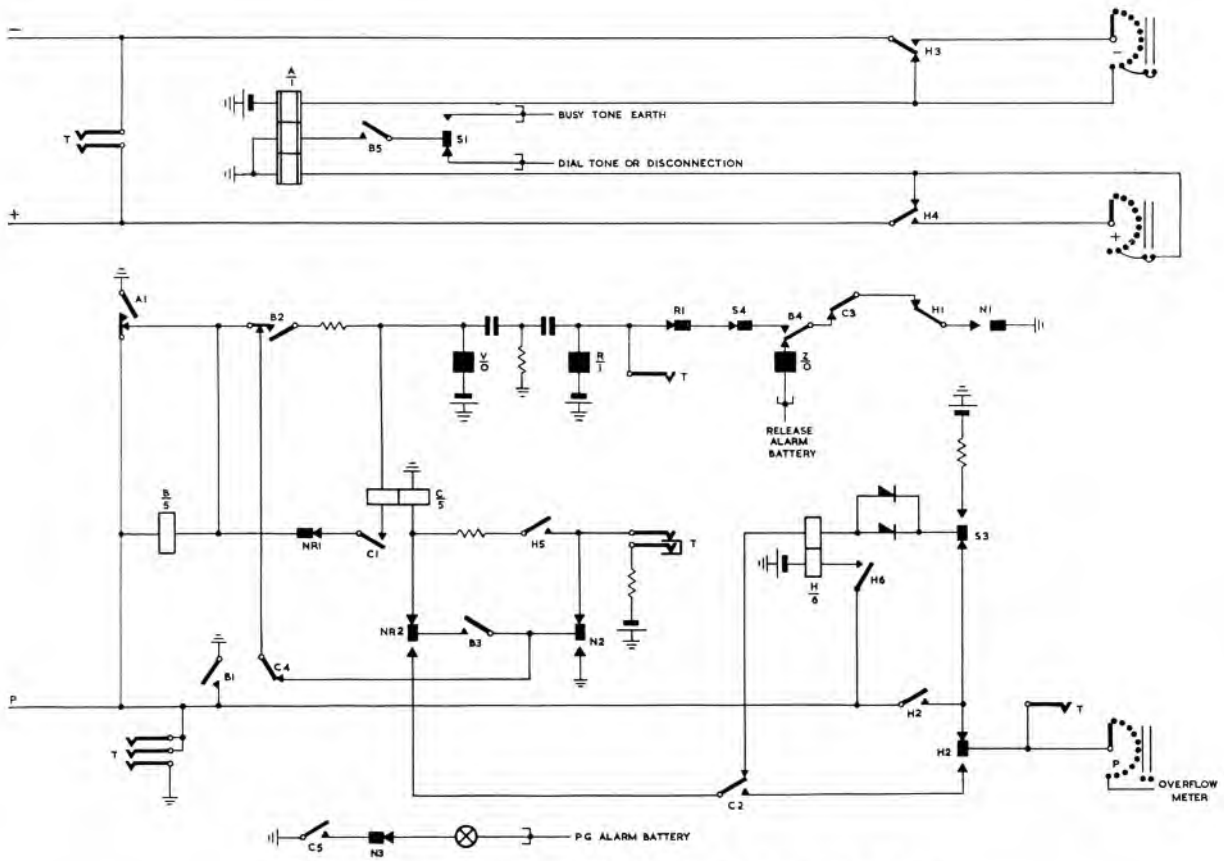

Fig. 4.—100-outlets battery testing group selector circuit. Fast Guard.

NR2 further prepares the testing circuit for relay H and disconnects the short-circuit from relay C. It should be noted that contacts N2 and NR2 are not essential in connexion with the test circuit of relay H , the arrangement shown enables contact B3 to serve a dual purpose and thereby avoids the use of an additional pair of springs on relay B.

When the rotary magnet moves the wipers to the bank contact of the first outlet in the level, the rotary magnet interrupter springs open whereupon the magnet armature releases and in turn restores the interrupter springs to normal thus re-closing the circuit. If the first outlet in the level is engaged, the P wiper will not find battery, consequently relay H will not operate. The rotary magnet re-operates and moves the wipers to the second outlet in the level. This sequence of operations will continue until the P wiper moves on to a bank contact connected to negative battery (i.e. a free outlet).

Relay H operates when a free outlet is found, its contacts functioning as follows :—

H1 disconnects the circuit of the rotary magnet.

H2 connects the earth from contact B1 to the P wiper

H3 and H4 transfer the line wires from relay A to the selector of the next stage.

H5 closes a circuit for relay C.

H6 closes a hold circuit for the 2000 ohm winding of relay H.

Relay C operates and contact C2 disconnects earth from the test winding of relay H, a function necessary on 11th step conditions to prevent the unnecessary energisation of the 24 ohm winding of relay H.

Relay A releases, its contact A1 short circuiting relay B.

(*d*) **Release.**

Relay H releases when the final selector or relay set disconnects earth from the P wire, and contact H5 opens the circuit of relay C.

Relay C releases and of its contacts C3 closes the release magnet circuit and C4 connects a guard earth to the incoming P wire until the switch shaft restores to normal.

(*e*) **All outlets engaged.**

If all outlets are engaged, the wipers will rotate to the 11th step position whereupon the S springs operate as follows :—

S1 connects busy tone to the tone coil of relay A.

S2 prepares a circuit for the overflow meter

S3 connects battery to relay H.

S4 disconnects the rotary magnet circuit.

Relay H operates, its contacts functioning as follows :—

H1 further disconnects the circuit of the rotary magnet.

H2 does not perform any function at this stage.

H3 and H4 close an alternative circuit for relay A in series with the 11th step connexions to the —ve and +ve banks.

H5 connects battery to relay C.

H6 holds relay H to earth at contact B1

Relay C operates and contact C2 allows for the operation of the overflow meter and prevents unnecessary current drain through the 24 ohm coil of relay H.

SE50 type Group Selector—20-Outlets per Level (Fig. 5).

(*a*) **Selector Seized.**

The switching relay (HA or HB) of the preceding group selector operates via its 24 ohm winding in series with the 210 ohm resistance battery connected to the P wire via off-normal contacts N2, and relay contacts C5, B2 and A1

Relay A operates in series with the calling loop. Contact A1 connects earth to the P wire to hold the preceding group selector or subscriber's line circuit cut-off relay, and also removes the short-circuit from the winding of relay B, which then operates over the following circuit :- earth, off-normal spring N1, operated contact A1, winding of relay B, normal contact B2, normal contact C5, off-normal spring N2 to battery via 210 ohm resistance.

Relay B operates, its contacts functioning as follows :—

B1 connects an alternative earth to the P wire.

B2 closes an alternative circuit for relay B which now holds in series with the 500 ohm resistance and the vertical magnet (V).

B3 closes the following circuit for relay C :— earth, 700 ohm winding of relay C, off-normal spring NR2, operated contact B3, off-normal spring N2, 210 ohm resistance to battery

B4 opens further the circuit of the release magnet (Z) and prepares a circuit for the rotary magnet (R).

B5 prepares a circuit for the test winding of relay HA.

B6 connects dialling tone to one coil of relay A.

Relay C operates, its contacts functioning as follows :—

C1 prepares an impulsing circuit for the vertical magnet.

C2 opens further the circuit of the rotary magnet.

C3 closes a circuit for the P.G. alarm lamp, and opens further the circuit of relay HA.

C4 opens further the circuit of relay HB.

C5 does not perform any function at this time.

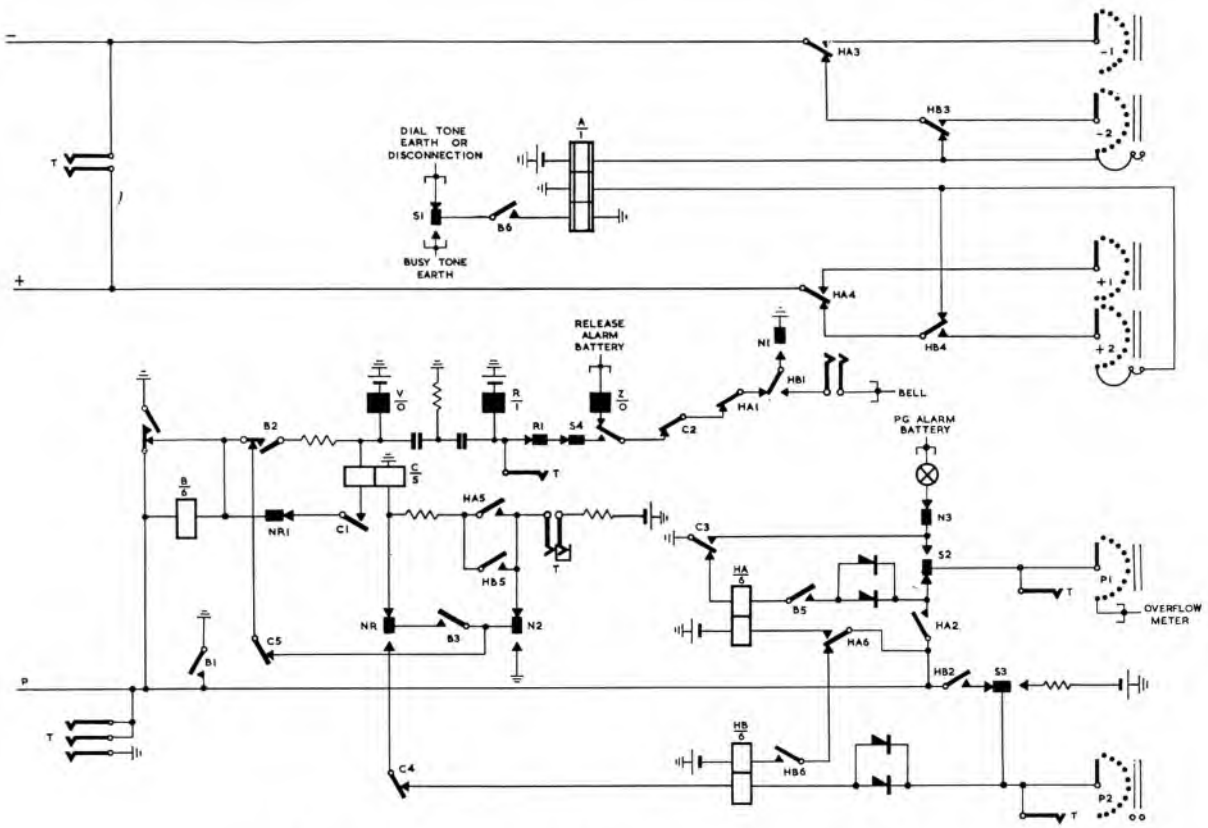

Fig. 5.—200-outlets battery testing SE50 group selector circuit. Fast guard.

(*b*) **Impulsing.**

Relay A responds to the dialled impulses and contact A1 repeats the dialled impulses to the vertical magnet in series with the 5 ohm winding of relay C.

The vertical off-normal (N) springs operate on the first vertical step, their functions being as follows :—

N1 prepares a circuit for the rotary magnet.
N2 disconnects battery from relay C and provides a short-circuit for relay C so that it will hold during impulsing.
N3 disconnects the circuit of the P.G. alarm lamp.

Relay C releases at the end of the train of impulses, contact C2 closing a circuit for the rotary magnet which operates in series with its interrupter springs (R1).

(*c*) **Rotary search.**

The rotary magnet advances the switch wipers to the first set of bank contacts in the level. The interrupter springs open the circuit of the rotary magnet whereupon its armature releases and causes the interrupter springs to re-close and again complete the circuit of the rotary magnet.

The above sequence of operations continues until one or both of the P1 and P2 wipers finds a free outlet (i.e. a P1 or P2 bank contact connected to battery) or the 11th step position is reached.

The rotary off-normal springs (NR) operate on the first rotary step, their functions being as follows :—

NR1 opens further the impulsing circuit.
NR2 closes a circuit for the testing winding of relay HA, but it should be noted that

off-normal springs NR2 and N2 are not essential in this connexion. The circuit of relay HA need only include contacts B3 and C4. This arrangement shown on Fig. 5 enables contact B3 to serve a dual function and thereby avoids the use of an additional pair of springs on relay B.

P1 and P2 outlets free.

When the wipers move on to bank contacts associated with idle P1 and P2 outlets, both relays HA and HB operate. The circuit of relay HA is :— earth, contact C3 normal, 24 ohm winding of relay HA, contact B5 operated, metal rectifiers, off normal spring S2, P1 wiper and bank contact to battery.

The circuit of relay HB is :— earth, off-normal spring N2 operated, contact B3 operated, off-normal spring NR2 operated, contact C4 normal, 24 ohm winding of relay HB, metal rectifiers, P2 wipers and bank contact to battery

Relay HA eventually takes precedence so that the outlets can be engaged in a predetermined order, its contacts functioning as follows :—

HA1 opens the circuit of the rotary magnet.
HA2 closes a hold circuit for the 2000 ohm winding of relay HA to earth at contact B1.
HA3 and HA4 extend the line wires to the selector connected to the P1 outlet and release relay A.
HA5 closes a circuit for relay C.
HA6 disconnects the hold circuit of relay HB.

Relay C operates, its contacts functioning as follows :—

C3 disconnects the test winding of relay HA.
C4 disconnects the test winding of relay HB causing it to release. If relay HB had not operated, contact C4 would have prevented its subsequent operation in the event of the P2 outlet becoming free during the release period of relay B.

Relay A releases, its contact opening the circuit of relay B. Contact B1 disconnects the original hold earth from the P wire, this having now been replaced by earth from the B relay on the selector to which the calling loop is extended.

P1 outlet busy P2 outlet free.

Relay HB operates as already described, its contacts performing the following functions :—

HB1 disconnects the circuit of the rotary magnet and prepares the P2 trunk bell circuit.
HB2 extends the P wire to wiper P2.
HB3 and HB4 extend the calling loop to the next selector, and release relay A.
HB5 operates relay C.
HB6 closes a hold circuit for relay HB to earth at contact B1.

Relay C operates, its contacts functioning as follows :—

C3 disconnects the test winding of relay HA to prevent it operating in the event of the P1 outlet becoming free during the release time of relay B.
C4 disconnects the test winding of relay HB.

Relays A and B release as already described.

All P1 and P2 outlets busy.

When all outlets are busy, the wipers rotate to the 11th step position whereupon the S springs operate as follows :—

S1 connects busy tone to the tone coil of relay A.
S2 prepares a circuit for the overflow meter which can be connected to the 11th step bank contact of wiper P1
S3 prevents the connexion of the earth from contact B1 to wiper P2.

Relay HB operates when wiper P2 moves on to the 11th step contact, its contacts functioning as follows :—

HB1 disconnects the drive circuit of the rotary magnet.
HB3 and HB4 extend the calling loop to the −2 and +2 wipers. The 11th contacts are wired to relay A so that it remains held in series with the calling loop.
HB5 operates relay C.

Relay C operates and contact C3 allows the operation of the overflow meter to take place.