POST OFFICE TELECOMMUNICATIONS HEADQUARTERS

DIAGRAM NOTES AT 60110A

SPECIFICATION T 60110

FINAL SELECTOR. 2-10 TYPE

WITH TEST SELECTOR ACCESS

UAX NO. 13

(AT 60085 MODIFIED)

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1. GENERAL

The diagram shows the circuit of a 100 outlet final selector with PBX groups of 2-10 lines, and Subscriber Trunk Dialling and/or Change Number and Service Interception working, provided at a UAX No. 13 as modified for test selector working.

The following typical diagrams, or their equivalents, should be considered in conjunction with this diagram:-

AT 3721 UNIT AUTO NO. 13. SUBSCRIBER'S LINE, LINEFINDER AND CONTROL RELAY SET.

AT 60068 GROUP SELECTOR. UNIT AUTO NO. 13.

AT 60109 TEST SELECTOR. UAX NO. 13.

2. FACILITY SCHEDULE

Provision is made for:-

2.1 Access to a total multiple of 100 lines including 2-10 PBX groups.

2.2 Holding the preceding equipment in the chain of connexions.

2.3 Vertical stepping under the control of the first train of pulses received by the selector.

2.4 Rotary stepping under the control of the second train of pulses received by the selector.

2.5 Testing the first line of a PBX group and, should it be busy automatic rotary hunting for a free line over the remainder of the group.

2.6 The transmission of busy tone to the caller if the particular number dialled is busy, or if all the lines in a PBX group are busy.

2.7 Applying ringing current to the called subscriber's line and returning ring tone to the caller.

2.8 The return of metering or supervisory signals when the called subscriber answers.

2.9 Night service facilities on any line of a PBX group other than the first.

2.10 Guarding the circuit against intrusion during the progress and release of a call.

2.11 A transmission and current feeding bridge for the calling and called subscriber's lines.

2.12 Trunk offering on calls incoming from an operator.

2.13 The forced release of the circuit:-

(a) under the control of the time pulse circuit when 'Called Subscriber Held' conditions are encountered,

and (b) when the call originates via a faulty junction, ie with an earth or battery fault on the junction.

2.14 Prevention of the forced release condition being applied when a non-meter answer signal is encountered.

2.15 Automatic busying of the selector:-

(a) if the wiper carriage remains off-normal during release,

or (b) if the battery is disconnected by a blown fuse.

2.16 Release alarm conditions, should the selector fail to release due to a mechanical fault.

2.17 The selector to be used as a test final selector when required.

3. CIRCUIT DESCRIPTION

3.1 Location

It should be imagined that this diagram is divided into six equal sections which will be referred to as follows:-

Top Left	(TL)	Top Centre	(TC)	Top Right	(TR)
Bottom Left	(BL)	Bottom Centre	(BC)	Bottom Right	(BR)

Each relay coil and contact is immediately followed by an indication of its location in an abbreviated form as shown in the brackets above.

3.2 Outline

The selector is seized by a loop extended via the group selector bank multiple, and relay A operates. The wiper carriage is stepped vertically under the control of the 'tens' digit to the level corresponding to that digit. After the inter-train pause the wipers are rotated under the control of the 'units' digit to the bank contacts appropriate to that digit. The called subscriber's line is tested, and if it is free, ringing current is applied to the line while ring tone is returned to the caller. When the called subscriber answers the ringing is tripped and supervisory and metering conditions are returned to the caller. If busy conditions are encountered, busy tone is returned to the originating end.

On a call made to a PBX group, the first line being free, the circuit operation is as already described; but if the first line is busy, rotary hunting takes place until either a free line is found, or the last line of the group is reached. If this last line is also busy further rotary stepping is prevented and busy tone is returned to the caller.

In the case of an operator controlled call, a positive battery via the M-wire operates relay TO, the contacts of which remove a short-circuit from the windings of relay OC. If the called subscriber is busy, trunk offering is effected by the operator momentarily operating the 'Ring' key, which causes an earth to be applied to the junction loop. This unbalance causes the differentially connected relay OC to operate, and subsequent circuit operation gives access to the required subscriber's line. When this subscriber is released from the original connexion, the operator receives a clear supervisory signal and so re-operates the 'Ring' key. The resultant re-operation of relay CC releases relay F causing ringing to be applied to the subscribers line.

When 'Called Subscriber Held' conditions persist, the circuit is forced released under the control of the time pulse circuit. If a call is made to a service (such a Service Interception) which returns a non-meter answer signal however, the time pulse sequence occurs but forced release is prevented.

When the circuit is to be used as a test final selector, seizure from the test selector outlets operates relay G and a contact of this relay disconnects the release alarm circuit. The selector mechanism only is used and is directly controlled by the test selector.

3.3 General

If, in describing the operation or release any relay or contact is not mentioned, it should be assumed that it performs no useful function at that stage.

The following operational details are described:-

3.4.1 Call from a Local Subscriber or a Non-parent Junction.

3.4.1.1 Seizure.

3.4.1.2 Dialling.

3.4.1.3 Called Subscriber Free.

3.4.1.4 Release on Cleardown from a Complete Call.

3.4.1.5 Called Subscriber Busy.

3.4.1.6 Release on Cleardown from Called Subscriber Busy.

3.4.2 Call to a PBX Group.

3.4.2.1 First Line Free.

3.4.2.2 First Line Busy.

3.4.2.3 All Lines Busy.

3.4.2.4 Night Service.

3.4.3 Incoming Call from the Parent Exchange.

3.4.3.1 Trunk Offering.

3.4.4 Call Encountering a Non-metering Answer Signal.

3.4.5 Forced Release from 'Called Subscriber Held' Conditions.

3.4.6 Faulty Junction from the Parent Exchange.

3.4.7 Release Alarm.

3.4.8 Operation as a Test Final Selector.

3.4 Detail

3.4.1 Call from a Local Subscriber or a Non-parent Junction

3.4.1.1 Seizure

A loop extended on the negative and positive wires operates relay A.

Relay A	(TL)	operating,
A1	(BC)	operates relay B.
Relay B	(BC)	operating,
B1	(TL)	disconnects the testing-in-battery from, and connects a guarding and holding earth to, the incoming P-wire.
B2	(BC)	disconnects the 'Release Alarm Earth' wire.
B3	(TC)	prepares the pulsing and holding earth circuits.
B4	(TC)	operates relay CD.
B5	(BR)	prepares for the operation of relay HS when the first line of a PBX group is dialled.
B6	(BR)	prepares the P1 wire testing circuit.
Relay CD	(BC)	operating,
CD2	(BC)	prepares a pulsing circuit for the vertical magnet VM in series with the low resistance winding of relay CD.

The circuit is now ready for the reception of the first pulse train.

3.4.1.2 Dialling

The following relays are held operated at this stage:-

A, B and CD.

The 'tens' digit train of loop-disconnect pulses is received to pulse relay A.

Relay A	(TL)	pulsing,
A1	(BC)	short-circuits relay B which holds during pulsing, and pulses the vertical magnet VM via the low resistance winding of relay CD.

The vertical magnet VM steps the wipers to the level determined by the digit dialled, and during the first vertical step the off-normal springs N operate.

N Springs		operating,
N3	(BC)	short-circuits the high resistance winding of relay CD to make it slow to release, and prepares operate circuits for relays E and HR.

At the end of the pulse train relay CD releases.

Relay CD	(BC)	releasing slowly,
CD3	(BC)	operates relay E in series with the vertical magnet VM.

Relay E	(BC)	operating slowly,
E2	(BC)	changes over the pulsing circuit from the vertical magnet VM to the rotary magnet RM.
E3	(BC)	prepares a hold circuit for relay E.
E4	(BC)	re-operates relay CD by removing the short-circuit from its high resistance winding.

Relay CD	(BC)	operating,
CD2	(BC)	prepares the rotary magnet RM pulsing circuit.
CD3	(BC)	holds relay E via contact E3.

The selector is now ready for the next pulse train. The 'units' digit train of loop-disconnect pulses is received to the pulse relay A.

Relay A	(TL)	pulsing,
A1	(BC)	short-circuits relay B which holds during pulsing, and pulses the rotary magnet RM.

The rotary magnet RM steps the wipers to the bank contacts corresponding to the digit dialled, and during the first rotary step the rotary off-normal springs NR operate.

NR Springs		operating,
NR1	(BL)	connects earth to the incoming P-wire independently of contacts F1 and D3.
NR3	(BC)	short-circuits the high resistance winding of relay CD to make it slow to release.

At the end of the pulse train relay CD releases.

Relay CD	(BC)	releasing slowly,
CD3	(BC)	releases relay E. (See paras. 3.4.1.3 and 3.4.1.5).
CD5	(BR)	completes the P1 wire testing circuit.

3.4.1.3 Called Subscriber Free

The following relays are held operated at this stage:- A and B.

If the called subscriber's line is not engaged a battery is encountered on the P1 wire which operates relay H.

Relay H	(BR)	operating,
H1	(BC)	disconnects the pulsing circuit from the rotary magnet RM.
H2	(TR)	operates relay HR.
H3	(TC)	connect relay D to the positive and negative wires on
H4	(TC)	the outgoing side of the transmission bridge.
H5	(BR)	holds relay H.
H6	(TR)	connects earth to the P1 wire to seize and guard the called subscriber's line circuit. Also short-circuits the operate winding of relay H which, however, holds on its second winding.

Relay HR	(TR)	operating,
HR2	(BR)	prepares the operate circuit for relay J.
HR3	(TR)	prepares the hold circuit for relay F.
HR4	(TR)	prepares to connect ringing current to the negative wiper.
HR5	(TR)	connects the ring return battery to the positive wiper.

Relay E (BC) releasing slowly at contact CD3,
E4 (BC) removes the short-circuit from the high resistance winding of relay CD and this relay thus re-operates.
E5 (BR) operates relay J.

Relay CD (BC) operating,
CD5 (BR) connects earth to the 'Release Relay' wire.

Relay J (BR) operating at contact E5,
J1 (TC) prepares the M-wire metering circuit.
J2 (TC) connects ring tone to the tone winding of relay A.
J4 (TR) connects ringing current to the called subscriber's line.

When the called subscriber answers, relay F operates to the loop completed via the subscriber's line.

Relay F (TR) operating slowly,
F1 (BL) completes the time pulse start circuit.
F2 (TC) disconnects ring tone from relay A.
F5x (TR) holds relay F.
F6 (TR)) disconnects ringing current from, and connect the trans-
) mission bridge to, the called subscriber's line. Relay D
F7 (TR)) operates to the subscriber's line loop.

Relay D (TC) operating,
D1 (TL)) reverses the potential to the incoming negative and
D2 (TL)) positive wires to provide an answering supervisory signal.
D3 (BL) disconnects the time pulse start circuit.
D4 (BC) re-operates relay E.

Relay E (BC) operating slowly,
E1 (TC) connects battery to the M-wire for meter purposes.
E3 (BC) holds relay E.
E5 (BR) releases relay J.

Relay J (BR) releasing slowly,
J1 (TC) disconnects the metering battery from the M-wire.

The connexion between the calling and called subscribers' line is now complete and conversation can proceed.

3.4.1.4 Release on Cleardown from a Completed Call

The following relays are held operated at this stage:- A, B, CD, D, E, F, H and HR.

When the calling subscriber clears, the loop condition is removed from the incoming negative and positive wires releasing relay A.

Relay A (TL) releasing,
A1 (BC) short-circuits relay B which thus releases.

Relay B (BC) releasing slowly,
B1 (TL) disconnects the earth at springs NR1 from the incoming P-wire to release the preceding equipment.
B2 (BC) prepares the rotary magnet RM self-drive circuit.
B3 (TC) releases relays HR, H, E and F.
B4 (TC) releases relay CD.

Relay HR (TR) releasing,
HR1 (TC) prevents the subsequent re-operation of relay D when contact H3 releases.
HR4 (TR)) disconnects the transmission bridge from the called
HR5 (TR)) subscribers line thus releasing relay D.

Relay H (BR) releasing at contact B3,
H1 (BC) completes the self-drive circuit for the rotary magnet RM, so the selector commences to restore.
H6 (TR) disconnects earth from the P1 wiper to release and remove the busy condition from the called subscribers line circuit.

Relay CD (BC) releasing at contact B4,
CD5 (BR) disconnects earth from the 'Release Relay' wire.

Relay D (TC) releasing at contacts HR4 and HR5,
D1 (TL)) restore the normal potentials to the incoming
D2 (TL)) negative and positive wires.
D3 (BL) completes the time pulse start circuit.

Relay F (TR) releasing slowly at contact B3,
F1 (BL) disconnects the time pulse start circuit.

The wipers are rotated to the 12th rotary position where the rotary off-normal springs NR release. As the rotary magnet RM is energised for the 13th time, the RM1 springs are mechanically prevented from re-operating and the rotary pawl is prevented from engaging with the shaft, while the wiper carriage restores vertically. Restoration of the carriage on the normal level is effected under spring action and on reaching the normal position the off-normal springs N release.

N Springs releasing,
N1 (TL) re-connect the testing-in battery to the incoming P-wire.
N2 (BC) releases the rotary magnet RM.

The selector is now fully released and ready for the next call.

3.4.1.5 Called Subscriber Busy

The following relays are held operated at this stage:- A and B.

If the required line is busy a battery is not encountered on the P-wire and relays H and HR do not operate during the slow release of relay E.

Relay E (BC) releasing slowly at contact CD3,
E4 (BC) re-operates relay CD by removing the short-circuit from its high resistance winding.
E5 (BR) operates relay G.

Relay CD (BC) operating,
CD5 (BR) connects earth to the 'Release Relay' wire.

Relay G (BR) operating,
G2 (TL) connects busy tone to the tone winding of relay A.
G4 (BR) connects earth to the 'Ringing Machine Start' wire and to the 'Release Relay' wire.

The selector is held and busy tone returned until the calling subscriber clears.

3.4.1.6 Release on Cleardown from Called Subscriber Busy

The following relays are held operated at this stage:- A, B, CD and G.

When the called subscriber clears, the loop condition is removed from the incoming negative and positive wires releasing relay A.

Relay A	(TL)	releasing,
A1	(BC)	short-circuits relay B which thus releases.
Relay B	(BC)	releasing slowly,
B1	(TL)	disconnects the earth at springs NR1 from the incoming P-wire, to release the preceding equipment.
B2	(BC)	prepares the rotary magnet RM circuit.
B3	(TC)	releases relay G.
B4	(TC)	releases relay CD.
Relay G	(BR)	releasing,
G1	(BC)	completes the self-drive circuit for the rotary magnet RM, so the selector commences to restore.
G2	(TL)	disconnects busy tone from the tone winding of relay A.
G4	(BR)	disconnects earth from the 'Ringing Machine Start' wire.
Relay CD	(BC)	releasing at contact B4,
CD5	(BR)	disconnects earth from the 'Release Relay' wire.

The subsequent restoration of the selector is as described in par 3.4.1.4.

3.4.2 Call to a PBX Group

A 200 ohm resistance battery is connected to the P2 bank contact corresponding to the first line of the PBX group, and an earth is connected to the P2 bank contact corresponding to the last line of the group. For calls to the first line the operation of the circuit on seizure and during dialling is as described in paras. 3.4.1.1 and 3.4.1.2 except that in addition the final release of contact CD4 (BR) operates relay HS to the 200 ohm resistance battery via the P2 wiper.

The following relays are held operated at this stage:- A and B.

3.4.2.1 First Line Free

The operation of the circuit is as described in para. 3.4.1.3 except that, with contact HS4 (BR) operated contact E5 (BR) releasing is ineffective, but later when contact CD4 (BR) releases relay HS, contact HS4 allows relay J to operate via contact E5 released.

3.4.2.2 First Line Busy

Relay HS	(BR)	operating,
HS1	(BC)	prepares the rotary magnet RM circuit.
HS2	(TC)	prevents the connexion of busy tone to the tone coil of relay A during PBX hunting.
HS3	(BR)	places relay G under the control of the RM1 springs.
HS5	(BR)	holds relay HS during the PBX hunting.

As the first line is busy a battery is not encountered on the P-wire, so relay H does not operate during the slow release of relay E.

Relay E	(BC)	releasing slowly at contact CD3,
E4	(BC)	re-operates relay CD by removing the short-circuit from its high resistance winding.
Relay CD	(BC)	operating,
CD1	(BC)	operates the rotary magnet RM.
CD5	(BR)	removes the short-circuit from relay G. Relays G and H are now in series with the P1 wiper for the subsequent outlet testing.

The rotary magnet RM operating steps the wipers to the second line outlet, and the RM1 springs operate relay G.

Relay G	(BR)	operating,
G1	(BC)	releases the rotary magnet RM.
G3	(BR)	disconnects earth from the holding winding of relay HS which is slow to release.
G4	(BR)	connects earth to the 'Ringing Machine Start' wire.

If the second and subsequent lines are busy, inter-action between relay G and the rotary magnet RM takes place until the P1 wiper encounters a battery condition from a free line circuit when relay H operates to this condition.

Relay H	(BR)	operating,
H1	(BC)	disconnects the circuit for the rotary magnet RM.
H2	(TR)	operates relay HR.
H3	(TC)	connect relay D to the positive and negative wires on
H4	(TC)	the outgoing side of the transmission bridge.
H5	(BR)	holds relay H and HS.
H6	(TR)	connects earth to the P1 wire to seize and guard the called subscribers line circuit. Also short-circuits the operate winding of relay H and the hold winding of relay G. Relay H holds on its second winding and relay G releases.

Relay HR	(TR)	operating,
HR2	(BR)	prepares the operate circuit for relay J.
HR3	(TR)	prepares the hold circuit for relay F.
HR4	(TR)	prepares to connect ringing current to the negative wiper.
HR5	(TR)	connects the ring return battery to the positive wiper.

Relay G	(BR)	releasing slowly at contact H6,
G3	(BR)	releases relay HS (see Design Details).
G4	(BR)	disconnects earth from the 'Ringing Machine Start' wire and from the 'Release Relay' wire.

Relay HS	(BR)	releasing slowly,
HS3	(BR)	operate relay J.
HS4	(BR)	

Relay J	(BR)	operating,
J1	(TC)	prepares the M-wire metering circuit.
J2	(TC)	connects ring tone to the tone winding of relay A.
J4	(TR)	connects ringing current to the called subscriber line.

The subsequent operation of the circuit is as described in par. 3.4.1.3 commencing with the called subscriber answering.

The release of the circuit on cleardown is as described in par. 3.4.1.4.

3.4.2.3 All Lines Busy

If all the lines in the PBX group are busy, interaction between relay G and the rotary magnet RM continues until the last line is reached, when relay G is operated by the RM1 springs and remains held via resistor R5 to the earth on the arc P2 contact.

Relay G (BR) operating,
G1 (BC) releases the rotary magnet RM.
G2 (TL) prepares for the connexion of busy tone to the tone winding of relay A.
G3 (BR) releases relay HS.
G4 (BR) connects earth to the 'Ringing Machine Start' wire and to the 'Release Relay' wire.

Relay HS (BR) releasing slowly,
HS2 (TC) connects busy tone to the tone winding of relay A.
HS3 (BR) transfers the hold of relay G from earth on the arc P2 contact to earth at contact B3.
HS6 (BR) disconnects the outlet testing circuit of relays G and H from the P1 wiper.

The selector is held and busy tone returned until the calling subscriber clears.

The release of the circuit on cleardown is as described in par. 3.4.1.6.

3.4.2.4 Night Service

Since the operation of relay HS to the 200 ohm resistance battery connected to the P2 bank contact can only occur when the first line of a PBX group is dialled, night service facilities can be provided on any PBX line other than the first.

3.4.3 Incoming Call From the Parent Exchange

The operation of the circuit is as described in par. 3.4.1 except that in addition a low resistance positive battery is connected to the incoming M-wire by the junction equipment, to operate relay TO.

Relay TO (TC) operating,
TO1 (TL)) remove the short-circuits from the windings of relay OC
TO2 (TL)) which however, remains unoperated due to its windings being differentially connected and the line conditions being balanced.
TO3y (TC) disconnects the M-wire to prevent a current drain on the positive battery.
TO4 (TC) holds relay TO.

3.4.3.1 Trunk Offering

The following relays are held operated at this stage:- A, B, CD, G and TO.

In order to offer a call to a subscriber who is already engaged on a call, the exchange operator momentarily operates the 'Ring' key which connects earth to the junction loop, and the unbalanced line conditions operate relay OC since the windings of this relay are differentially connected.

Relay OC (TL) operating,
OC1 (TR) operates relay F.

Relay F (TR) operating slowly,
F1 (BL) completes the time pulse start circuit.
F4 (TR) operates relay HR.
F5 (TR) prevents the re-application of a short-circuit to the low resistance winding of relay F.
F6 (TR)) prepare the transmission path to the required
F7 (TR)) subscribers line.

Relay HR (TR) operating,
HR1 (TC) operates relay D.
HR2 (BR) releases relay G and operates relay J.
HR3 (TR) prepares a hold circuit for relay F.
HR4 (TR) completes the transmission path to the required
HR5 (TR) subscribers line.
HR6 (BR) completes the P1 wire testing circuit.

Relay D (TC) operating,
D1 (TL) disconnects relay OC from, and reverse the potentials to,
D2 (TL) the incoming negative and positive wires. Relay OC releases.
D3 (BL) disconnects the time pulse start circuit.

Relay G (BR) releasing at contact HR2,
G2 (TL) disconnects busy tone from the tone winding of relay A.
G4 (BR) disconnects earth from the 'Ringing Machine Start' wire and to the 'Release Relay' wire.

Relay OC (TL) releasing at contacts D1 and D2,
OC1 (TR) transfers the hold of relay F from earth at contact H6 to earth at contact B3.

The distant operator offers the call to the called subscriber, and if it is accepted the subscriber is asked to clear the call already in progress. When cleardown has occurred a circuit is completed via the P1 wiper to battery in the free subscribers line to operate relay H.

Relay H (BR) operating,
H1 (BC) completes an operate circuit for relay E (see relay E in Design Details).
H2 (TR) holds relay HR independently of contact F4.
H3 (TC) releases relay D and connects one winding of this relay to the positive wire.
H4 (TC) connects the second winding of relay D to the negative wire.
H5 (BR) holds relay H.
H6 (TR) connects earth to the P1 wire to hold and guard the called subscribers line circuit. Also short-circuits the operate winding of relay H which however, holds on its second winding.

Relay D (TC) releasing,
D1 (TL) restore the normal potentials to the incoming negative
D2 (TL) and positive wires and reconnect relay OC in series with relay A.
D3 (BL) completes the time pulse start circuit.
D4 (BC) disconnects the operate circuit for relay E.

On receipt of the clearing supervisory signal the distant operator momentarily re-operates the 'Ring' key which reconnects earth to the junction loop and again the unbalanced line conditions operate relay OC.

Relay OC (TL) operating,
OC1 (TR) releases relay F.

Relay F (TR) releasing slowly,
F1 (BL) disconnects the time pulse start circuit.
F2 (TC) connects ring tone to the tone winding of relay A.
F6 (TR) connect ringing current to the called subscribers
F7 (TR) line.

When the 'Ring' key is restored relay OG releases, its contact performing no useful function at this stage.

The called subscriber is being rung, and when the subscriber answers, the operation of the circuit is as described in par. 3.4.1.3 except that metering is prevented by contact TO3y(TC).

The release of the circuit on cleardown is as described in par. 3.4.1.4 except that in addition relay TO is released by contact B4(TC).

3.4.4 Call Encountering a Non-metering Answer Signal

When the service operator answers, conditions are as described under par. 3.4.1.3 except that relay D does not operate, hence relay E remains normal and relay J remains operated. Since contact D3(BL) remains normal with the time pulse start circuit completed at contact F1(BL), after the delay period, a low resistance battery is returned on the 'TP Start' wire to operate relay TM.

Relay TM	(BL)	operating,
TM1	(BL)	holds relay TM to battery via the 'TP Hold' wire.
TM2	(BC)	is prevented from preparing a circuit to short-circuit relay B by contact J3 operated which maintains a hold circuit for this relay via resistor R3.

The circuit remains in this condition until the caller clears.

3.4.5 Forced release from 'Called Subscriber Held' Conditions

The following relays are held operated at this stage:- A, B, CD, D, E, F, H and HR.

When the called subscriber clears first, relay D releases.

Relay D	(TC)	releasing,
D1	(TL)	restore the normal potentials to the incoming negative
D2	(TL)	and positive wires.
D3	(BL)	completes the time pulse start circuit.

After the delay period, a low resistance battery is returned on the 'TP Start' wire to operate relay TM.

Relay TM	(BL)	operating,
TM1	(BL)	holds relay TM to battery via the 'TP Hold' wire.
TM2	(BC)	prepares a circuit to short-circuit relay B.

At the end of the timing period, earth is connected to the 'TP Release' wire to short-circuit relay B which thus releases.

Relay B	(BC)	releasing slowly,
B1	(TL)	disconnects the earth at spring NR1 from the incoming P-wire to release the preceding equipment.
B2	(BC)	prepares the rotary magnet RM self-drive circuit.
B3	(TC)	releases relays HR, H, E and F.
B4	(TC)	releases relay CD.

Relay HR	(TR)	releasing,
HR1	(TC)	prevents the subsequent re-operation of relay D when contact H3 releases.
HR4	(TR)	disconnect the transmission bridge from the called
HR5	(TR)	subscribers line.

Relay H
H1 (BR) releasing at contact B3,
(BC) completes the self-drive circuit for the rotary magnet RM, so the selector commences to restore.
H6 (TR) disconnects earth from the P1 wiper to release and remove the busy condition from the called subscribers line circuit.

Relay CD
CD5 (BC) releasing at contact B4,
(BR) disconnects earth from the 'Release Relay' wire.

The preceding equipment in releasing removes the loop from the incoming negative and positive wires to release relay A, its contact performing no useful function at this stage.

Relay F
F1 (TR) releasing slowly at contact B3,
(BL) disconnects the time pulse circuit and releases relay TM.

The subsequent restoration of the selector is as described in par. 3.4.1.4.

3.4.6 Faulty Junction from the Parent Exchange

If an earth or battery fault exists on either the negative or positive wires of the incoming junction then when the selector is seized as described in par. 3.4.3 relay OC also operates to the unbalanced junction conditions since the windings of this relay are differentially connected.

Relay OC
OC1 (TL) operating,
(TR) operates relay F.

Relay F
F1 (TR) operating,
(BL) prevents a guarding earth being applied to the incoming P-wire, and completes the time pulse start circuit.
F4 (TR) prepares an operate circuit for relay HR.

The preceding equipment releases in the absence of a guarding earth via contact B1, and thus removes the loop from the incoming negative and positive wires to release relays A and OC.

Relay A
A1 (TL) releasing,
(BC) short-circuits relay B which thus releases and operates the vertical magnet VM via the low resistance winding of relay CD.

Relay OC
OC1 (TL) releasing,
(TR) disconnects relay F which is slow to release.

The vertical magnet VM raises the wipers to level 1, and the off-normal springs N operate.

N Springs operating,
N2 (BC) prepares the rotary magnet RM self-drive circuit.
N3 (BC) short-circuits the operate coil of relay CD, and operates relay HR.

Relay HR
HR1 (TR) operating,
(TC) operates relay D.
HR3 (TR) holds relay F.

Relay D
D3 (TC) operating,
(BL) disconnects the time pulse start circuit.

Relay B (BC) releasing slowly at contact A1,
B2 (BC) completes the self-drive circuit for the rotary magnet RM, so the selector commences to restore and during the first rotary step the off-normal springs NR operate.
B3 (TC) releases relays CD, HR and F, and also the vertical magnet VM.

Relay HR (TR) releasing,
HR1 (TC) releases relay D.

The subsequent restoration of the selector is as described in par. 3.4.1.4.

3.4.7 Release Alarm

Should the selector fail to release due to a mechanical or circuit failure the off-normal springs N do not release. Springs N1(TL) disconnect the incoming P-wire testing-in battery to guard the circuit against further seizure, and springs N2(BC) complete the release alarm circuit.

3.4.8 Operation as a Test Final Selector

Earth is connected by the test selector to the incoming P-wire to guard the selector against seizure from the group selector bank multiple and to the G-wire to operate relay G.

Relay G (BR) operating,
G1 (BC) disconnects the release alarm circuit.
G2 (TL) connects busy tone to the tone winding of relay A.
G4 (BR) connects earth to the "Ringing Machine Start" wire and to the 'Release Relay' wire.

A train of pulses, extended on the VM wire from the test selector, pulses the vertical magnet VM, and the wipers are raised to the level corresponding to the digit dialled. A second train of pulses, this time extended on the RM wire, pulses the rotary magnet RM, and the wipers are stepped to the outlet corresponding to the digit dialled. The negative, positive and P1 wires have thus been extended from the test selector to the required subscribers line circuit, and testing may now take place.

4. DESIGN DETAILS

4.1 Relays

The following relays are made slow to operate for the following reasons:-

Relay E (BC) to ensure the relay has sufficient flux to hold for the changeover time of its control contact CD3(BC), since relay CD is immediately re-operated by contact E4(BC). Also, to prevent the relay operating while trunk offering, during the release of relay D following the operation of relay H.

Relay F (TR) to prevent the premature operation, or vibration, of the relay to ringing current via the called subscribers bell circuit.

The following relays are made slow to release for the following reasons:-

Relay B (BC) by means of a short-circuit connected across its coil, to hold during pulsing.

Relay CD (BC) by means of a short-circuit connected across its high resistance winding, to hold during pulsing.

Relay E (BC) to prevent the operation of relay G while relays H and HR are operating, and together with the operate lags of relays HR and J, provides the ringing delay period required to disconnect bridging relays from the called subscribers line.

Relay HS (BR) to cover the periods of disconnexion of the hold circuit at contact G3(BR) operated, during PBX hunting.

Relay J (BR) to provide a meter pulse of sufficient length for the correct operation of the subscriber meter.

To ensure satisfactory operation of the circuit the lags of relays which have timing requirements should be within the limits shown in the table below. All times quoted are in milliseconds.

Relay	Release lag		Operate lag	
	Min	Max	Min	Max
B	150	225		
CD	100	150		
E			45	70
F			60	90
HS	150	225		
J	250	350		

Relay OC (TL) is differently connected to operate to current differences in its windings, that is unbalanced line conditions.

4.2 Contacts

The following contacts, not fully described previously, are provided for the following reasons:-

Contact B5 (BR) prevents the operation of relay HS should the selector wipers pass over the first line of a PBX group during rotary release.

Contact B6 (BR) prevents the operation of relay H when the selector wipers pass over free subscribers' lines during rotary release

Contact CD5 (BR) operated, prevents the operation of relay H when the selector wipers, under the control of the 'units' digit, pass over the subscribers' lines.

Contact E5 (BR) operated, prevents unnecessary operations of relay G during the rotary stepping of the wipers.

Contact E6 (BR) operated, prevents earth and battery conditions via resistor R5 being applied to the P2 wiper, when the selector wipers are being stepped under the control of the 'units' digit.

Contact F3 (BC) prevents a short-circuit of relay CD by contact E4(BC) and the consequent inter-action between relays CD and E, subsequent to the answer signal.

Contact F5x (TR) operated, ensures that the hold circuit of relay F is completed before the operate circuit is disconnected by contacts F6(TR) and F7(TR).

Contact G3 (BR) make contact, ensures the correct sequence of release for relays G and HS respectively, when switching to an intermediate line in a PBX group. Should relay HS release before relay G, busy tone would be transmitted to the calling subscriber.

Contact G4 (BR) operated, connexion earth to the 'Release Relay' wire thus enabling the selector to release.

Contact H3 (TC)) disconnect relay D from the outgoing side of the
Contact H4 (TC)) transmission bridge to prevent the adverse effect of the relay on the selector pulsing performance.

Contact HR6 (BR) operated, (a) completes an operate circuit for relay H under trunk offering conditions, and (b) in conjunction with contact H6(TR) makes relay H slow to release, to ensure relay HR releases first on the release of the circuit. This prevents the reoperation of relay D.

Contact HS6 (BR) operated, holds relay G in series with relay H when switching to a free PBX line, other than the first, to allow contact H1(BC) sufficient time to disconnect the rotary magnet RM circuit.

Contact J4 (TR) in conjunction with contact HR4(TR) and HR5(TR) provides a ringing delay period to allow sufficient time for relay K in the subscribers line circuit to operate and remove relay L from the line, thus preventing premature ring trip.

Springs NR2 (BC) allow relay E to release on the release of contact CD3(BC).

4.3 Resistors

Resistors R5 (BR) prevents earth at contact CD1(BC), via the RM1 springs (BC) operated, during PBX hunting, being connected direct to the P2 wiper, thus avoiding simulation of last line conditions for hunting selectors. At the same time, sufficient current is allowed to flow for relay G to be held operated when the selector hunts to the last line of a PBX group.

4.4 Rectifiers

The following rectifiers have been provided for the following reasons:-

Rectifier MR1 (BC) to prevent an earth from the circuit being applied to the 'TP Release' wire during the operated period of contact TM2(BC).

Rectifier MR2 (BC) to prevent the battery at resistor R2(BC) shunting the vertical magnet VM and the rotary magnet RM, during pulsing.

Rectifier MR3 (TC) to prevent the operation of relay TO to negative battery conditions on the M-wire.

Rectifier MR4 (BC) to prevent the operation of relay E(BC), when the circuit is operating as a test final selector.

Rectifiers MR5 & MR6 (BR) to ensure that a d.c. path does not exist between the 'Release Alarm' wire and the 'Ring Machine' wire.

4.5 Common Services

This circuit has been designed to work in conjunction with the following common services:-

Busy tone earth
Ring tone earth
Interrupted ringing
Ring return battery
} Diagram AT 60131

Time pulse start
Time pulse hold
Time pulse release
} Diagram AT 5406 - Figure 2

Release relay
Release alarm earth
} Diagram AT 4082 - Figure 2

5. HISTORY

Date	Dgm Suffix	D.N. Issue	Details of Amendment
March 1968	Open	1	
January 1978	A	1	MR5 and MR6 added, contact G4 connected to the 'Release Relay' wire.

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END OF DIAGRAM NOTES