

POST OFFICE ENGINEERING DEPARTMENT

DIAGRAM NOTES SA 8102ASPECIFICATION S 285

SELECTOR SA 8102. CONNECTING CIRCUIT FOR P.A.B.X.s Nos. 1 and 2

GENERAL

1.

The diagram shows the connecting circuit and associated line-finder used at P.A.B.X.s Nos. 1 and 2.

The circuit consists of a 2000 type 100 outlet selector together with a uniselector connected as a line-finder.

On inter-extension calls the connecting circuit performs the function of a final selector, while on exchange, inter-switchboard and '0' level calls it routes the call to the required circuit and is released after the first digit. The call is then completed via an exchange, inter-switchboard or '0' level circuit.

The following diagrams should be considered in conjunction with this diagram:-

- SA 8100 TRUNKING SCHEME FOR P.A.B.X.s NOS. 1 and 2.
- SA 8101 EXTENSION LINE CIRCUIT.
- SA 8103 ENQUIRY CIRCUIT.
- SA 8105 RINGING START AND ALARM CIRCUIT.
- SA 8119 SHT. 1. COMMON SERVICES (EXPLANATORY).
- SA 8121; SA 8137 EXCHANGE LINE CIRCUITS FOR P.A.B.X.s NOS. 1 and 2 (TYPICAL).
- SA 8126; SA 8140 '0' LEVEL CIRCUITS FOR P.A.B.X.s NOS 1 & 2.
- SA 8127; SA 8141 INTER-SWITCHBOARD CIRCUITS FOR P.A.B.X.s NOS. 1 AND 2 (TYPICAL).

2.

FACILITY SCHEDULE

Provision is made for:-

- (1) finding and seizing a calling extension.
- (2) applying an earth to the HF wire to guard the extension against intrusion and to hold the extension line circuit.
- (3) closing the connecting circuit start chain.
- (4) connecting a start condition to the Ringing Start and Alarm circuit.
- (5) returning dial tone to the calling extension.
- (6) stepping the wiper carriage vertically under the control of the first impulse train.
- (7) extending start conditions to exchange, inter-switchboard and '0' level circuits if the first digit dialled is 9, 7 or 0 respectively.

- (8) the release of the connecting circuit when a call is connected via an exchange, inter-switchboard or 'O' level circuit.
- (9) returning N.U. tone under day service conditions or extending a start condition to the calling exchange or inter-switchboard circuit under night service conditions if the first digit dialled is '8'.
- (10) returning busy tone if all exchange or inter-switchboard circuits are engaged.
- (11) the circuit to hold and maintain start conditions extended to the 'O' level circuits if both 'O' level circuits are engaged.
- (12) prohibition of direct access to exchange lines on extensions barred from this facility.
- (13) stepping the wiper carriage horizontally under the control of the second impulse train.
- (14) returning busy tone if the called extension is engaged.
- (15) applying ringing conditions to a free called extension line and returning ring tone to the calling extension.
- (16) returning N.U. tone if a spare level, spare number or extension in the P.G. condition is called.
- (17) first party release on inter-extension calls.
- (18) second party release on enquiry calls.
- (19) forced release of the circuit if held for approximately 60 seconds by a loop due to fault conditions or subscribers misoperation.

CIRCUIT DESCRIPTION

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

Outline

When an extension lifts his receiver, a start signal is extended to the ringing, start and alarm circuit which in turn extends a start condition to the first free connecting circuit. The line-finder associated with the connecting circuit hunts for and seizes the extension which is marked by a battery on the HF bank. The seizure of the extension operates relay CO in the extension line circuit which clears the + and - wires of bridging apparatus. Dial tone is returned from the connecting circuit and the extension may then dial the required number.

If the extension dials the number of an extension, the connecting circuit performs the functions of a final selector.

If the extension requires an exchange, inter-switchboard or 'O' level call and dials the digits 9, 7 or 0, the wiper carriage of the connecting circuit is stepped to the appropriate level and then automatically steps into the bank. A start condition is extended to the group of circuits required and when the line-finder associated with the exchange, inter-switchboard or 'O' level circuit finds the extension, the connecting circuit is released. The circuit is then available for use on further calls.

In the event of the connecting circuit being held by a fault condition or subscriber's misoperation, the circuit is forcibly released after a period of between 30 to 60 seconds to prevent false congestion on the common equipment.

Detail

Inter-Extension call

When an extension lifts his receiver, a start condition is extended from the extension line circuit to the ringing start and alarm circuit (see Diagram Notes SA 8101). In turn the start and alarm circuit extends an earth start condition via the Start Chain to the first free connecting circuit to operate relay A. (See Diagram SA 8119 Sheet 1). At the same time the extension line circuit is marked by the connexion of a 250 ohm battery to the HF wire.

- | | | |
|-----------------|------|---|
| <u>Relay A</u> | (TC) | operating, |
| A1 | (BL) | operates relays B and CD. |
| <u>Relay B</u> | (BL) | operating, |
| B1 | (TL) | completes a self drive circuit for the linefinder and prepares a hold circuit for relay K. |
| B2 | (TF) | prepares a circuit for relay NU. |
| B3 | (BC) | prepares a circuit for relay G. |
| B4 | (BR) | connects an earth to the Ringer Start wire (see Diagram SA 8105). |
| B5 | (TL) | connects earth via R11 and both windings of relay FT to the HF wiper. |
| B6 | (TL) | prepares a circuit for relay AD (see direct access call to public exchange and forced release). |
| <u>Relay CD</u> | (BC) | operating, |
| CD1 | (BC) | prepares a circuit for the rotary magnet. |
| CD2 | (TC) | prepares to return dial tone to the calling extension. |
| CD3 | (BC) | prepares a hold circuit for relay E during the rotary impulse train. |
| CD4 | (BC) | maintains relay G disconnected during impulsing. |
| CD5 | (TR) | maintains earth disconnected from the 7 ohm winding of relay HT during impulsing. |
| CD6 | (BL) | disconnects battery via resistor R6 and prepares a vertical stepping circuit. Relay B holds in series with the vertical magnet. |

The linefinder self drives until it reaches the marked extension when relay FT is operated by the marking battery.

- | | | |
|-----------------|------|---|
| <u>Relay FT</u> | (TL) | operating in series with the HF wire. |
| FT1 | (TL) | cuts the linefinder drive circuit and holds relay FT in series with the HF wire. The connexion of earth to the HF wire via the 50 + 50 ohm windings of relay FT guards the extension line against intrusion and operates relay CO in the extension line circuit. Relay CO disconnects the marking battery and also the bridging apparatus across the + and - wires. |

Meanwhile relay K operates in series with the linefinder driving magnet.

- | | | |
|----------------|------|---|
| <u>Relay K</u> | (TL) | operating, |
| K1 | (BC) | provides an earth for the operation of the vertical and rotary magnets. |
| K2 | (TL) | extend the extension loop to hold relay A and disconnect |
| K3 | (TL) | the start chain. |
| K4 | (BL) | see inter-extension calls via the enquiry circuit. |
| K5 | (TR) | prepares a circuit for relays H and F. |
| K6 | (TC) | operates relay RN. |
| K7 | (TL) | completes an alternative hold circuit for relay FT. |

<u>Relay RN</u>	(TC)	operating,
RN1	(EC)	prepares a rotary release circuit.
RN2	(TL)	connects relay AD to the A Pulse lead (see forced release).
RN3	(TL)	closes the connecting circuit start chain.
RN4	(BL)	connects relay JM to the J wiper (see calls over inter-switchboard lines).
RN5	(TC)	disconnects the line-finder driving magnet and prepares a hold circuit for relay RN.

Dial tone is returned to the calling extension via both 250 ohm windings of relay A.

When the extension dials, relay A releases during each break impulse and A1 repeats the impulses to the vertical magnet from earth at K1 via A1, F1, G7, CD6, the low resistance winding of relay CD, E3 and NR1. The selector steps to the level corresponding to the digit dialled. (The working extension levels are 2 and 3; 2, 3 and 4; 2, 3, 4 and 5; 2, 3, 4, 5 and 6 for sizes of equipments (4 + 15), (5 + 24), (7 + 35) and (10 + 49) respectively).

At the first vertical step the off-normal springs (N) operate.

N1	(BC)	short-circuits the 700 ohm winding of relay CD.
N2	(TC)	holds relay RN.
N3	(TL)	operates relay AD from the earth at FT1 via the BD wire, the extension line circuit and the HF wire (see direct access call to public exchange).
N4	(TL)	disconnects the Z pulse lead.

Relay B is held for the duration of each break impulse by the eddy currents resulting from the short-circuit applied at A1, whilst relay CD is similarly held during the made period between impulses due to the short-circuiting of its 700 ohm winding by N1. At the end of the vertical impulse train relay CD releases.

<u>Relay CD</u>	(BC)	releasing,
CD3	(BC)	completes an operate circuit for relay E in series with the vertical magnet from earth at K1 via the wipers on the vertical marking bank.

<u>Relay E</u>	(BC)	operating,
E1	(TR)	prepares a circuit to test the called extension line.
E2	(BL)	releases relay AD.
E3	(BC)	directs the second train of impulses to the rotary magnet.
E4	(BC)	prepares a hold circuit for relay E.
E5	(BC)	allows relay CD to re-operate.
E6	(TR)	see extension free.
E7	(TC)	maintains tone disconnected until the wipers are positioned on the called extension line circuit.

The units train of impulses is routed to the rotary magnet via CD6 and E3. At the first rotary step the normal rotary springs (NR) operate.

NR1	(BC)	prevents a further operation of the vertical magnet.
NR2	(TL)	ensures that relay AD does not reoperate.
NR3	(TC)	prepares to return supervisory tones to the calling extension.
NR4	(BC)	short-circuits the 700 ohm winding of relay CD.

At the completion of the impulse train relay CD, after a delay period due to the short-circuiting of the 700 ohm winding, releases.

<u>Relay CD</u>	(BC)	releasing,
CD3	(BC)	releases relay E.
CD5	(TR)	connects earth via the 7 ohm winding of relay HT to the H wiper to test the wanted line during the release lag of relay E.

After a delay period relay E releases.

<u>Relay NU</u>	(TR)	operating,
1.U1	(BL)	has no circuit function at this stage.
NU2	(TC)	returns busy tone to the calling extension.
NU3	(TR)	completes a hold circuit for relay NU.

Release

(a) Calling Extension releases

The disconnection of the extension loop releases relay A.

<u>Relay A</u>	(TC)	releasing,
A1	(BL)	releases relay B.

<u>Relay B</u>	(BL)	releasing,
B1	(TC)	releases relay K.

Relay K releases relays F, HT and H. The release earth is connected to the rotary magnet and the wiper carriage drives to the 11th contact to return to normal.

<u>Relay RN</u>	(TC)	releasing when N2 restores.
RN1	(BC)	disconnects the release earth.
RN3	(TL)	opens the start chain and re-connects the start chain IN lead to relay A.

(b) Called Extension releases

The disconnection of the extension loop releases relay D.

<u>Relay D</u>	(TC)	releasing,
D2	(BL)	releases relay B.

The selector then releases as described above.

Direct Access call to Public Exchange

(a) Exchange Line circuit free

The routing digit for direct access calls to the public exchange is '9' and the selector steps to this level on receipt of the first impulse train in a similar manner to that previously described.

The operation of the off-normal springs N3 completes a circuit for relay AD (see page 4).

<u>Relay AD</u>	(TL)	operating,
AD1	(TL)	see forced release.
AD5	(TL)	
AD2	(TC)	prevents busy tone being returned to the calling extension before the call is taken over by the exchange line circuit.
AD3	(TC)	prevents NU tone being returned before the wipers enter the bank.
AD4	(BC)	see CD4 below.
AD6	(BR)	see call to an extension over an inter-switchboard line.

<u>Relay CD</u>	(BL)	releasing, when the wipers reach level 9.
CD4	(BC)	extends the release earth via relay G, JM7, AD4 to the level 9 start lead. Relay G operates in series with relay CS in the Start and Alarm circuit.

<u>Relay G</u>	(BC)	operating,
G1	(BC)	operates relay E.
G2	(TL)	maintains relay AD operated.
G3	(BL)	prepares to connect a marking battery to the J wiper.
G4	(BC)	prepares a circuit for the rotary magnet.
G5	(BC)	completes a hold circuit for relay G.
G6	(BR)	see all exchange line circuits engaged.
G7	(BL)	(see design details).

Relay E (BC) operating,
 E4 (BC) prepares a hold circuit for relay E.
 E5 (BC) allows relay CD to re-operate.
 E7 (TC) maintains tone disconnected.

Relay CD (BC) reoperating,
 CD1 (BC) operates the rotary magnet.

The wipers step into the bank to contact 1 level 9.

The Normal Rotary springs (NR) operate and NR4 releases relay CD as previously described. CD3 (BC) releases relay E and E1 (TR) operates relay NU from earth on the H91 wire (BR).

Relay NU (TR) operating,
 NU1 (BL) connects a marking battery to the J wire of the calling extension.
 NU2 (TC) maintains tone disconnected.
 NU3 (TR) completes a hold circuit for relay NU.

Meanwhile the operation of relay CS in the start and alarm circuit causes the line-finder of a free exchange line circuit to search for the calling extension line. (See Diagram Notes SA 8105 and SA 8121).

When the linefinder reaches the extension an earth is connected to the HF wire to maintain the extension engaged and release relay FT (TL).

Relay FT (TL) releasing,
 FT1 (TL) short-circuits and releases relay K.

The circuit then releases as previously described for an inter-extension call. The extension is connected to the Public Exchange by the exchange line circuit and may originate an outgoing call.

(b) All Exchange line circuits engaged

The circuit operation is similar to that described under paragraph (a) until after the operation of relay NU. In this case earth is connected to contact J91 (BR) via the exchange line circuit busy chain (see diagram SA 8119 sheet 1) and relay ER operates over its 2000 ohm winding in series with the J wiper.

Relay ER (TR) operating,
 ER1 (TR) holds relay ER.
 ER3 (BL) releases relay G (BC) and relay CS in the Start and Alarm circuit.
 ER2 (BL) see inter-extension call via the enquiry circuit.
 ER4 (BL)
 ER5 (TL)

Relay G (BC) releasing,
 G2 (TL) releases relay AD.
 G3 (BL) disconnects the marking battery.

Relay AD (TL) releasing,
 AD2 (TC) returns busy tone to the calling extension.

When the extension replaces the receiver, relay A releases and circuit releases as previously described.

(c) Extensions barred from direct access to the Public Exchange

On extensions not permitted direct access to the Public Exchange the strap between the HL and BD wires is disconnected in the extension line circuit. This prevents the operation of relay AD when the off-normal springs (N) operate. The selector steps vertically to level 9 but relay G does not operate due to the non-operation of AD4. The wipers do not enter the bank and NU tone is returned to the calling extension via AD3 and the Normal-Post springs NP (TC).

Calls over Inter-Switchboard lines

(a) Outgoing calls

Any automatic extension may gain direct access to an inter-switchboard line by dialling '7'. The circuit operation in this event is similar to that described for a call to the Public exchange, paragraphs (a) and (b).

(b) Incoming calls

Inter-switchboard circuits are associated with extension line circuits 21, 22 and 23 to enable exchange calls to be extended over the inter-switchboard line and to provide dialling-in facilities.

When an incoming call is originated over an inter-switchboard line with dialling-in facilities, the associated extension line circuit secures a connecting circuit in the normal manner. A battery is extended from the inter-switchboard circuit on the J wire to operate relay JM (BL). This relay ensures that the call is connected via the inter-switchboard circuit after the dialled impulses have been received.

(i) Call to an extension

<u>Relay JM</u>	(BL)	operating,
JM1	(BR)	prepares a marking battery circuit.
JM4	(BR)	prepares for the connexion of earth to the DS lead (see design details).
JM6	(TR)	prevents ringing being connected to the called extension line.

The selector is stepped to the outlet corresponding to the required extension line as previously described for an inter-extension call. If the extension is engaged busy tone is returned in the normal manner. If free, relays HT and H operate.

<u>Relay H</u>	(TR)	operating,
H1	(BL)	connects battery via resistor R8 in parallel with one winding of relay AD to the BD wire to operate relay JS in the inter-switchboard circuit (see diagram notes for the circuit concerned).
H6	(BR)	connects earth to the DS wire (see design details).
H7	(BR)	prepares to connect a marking battery to the J wire of the called extension.

The operation of relay JS in the inter-switchboard circuit reduces the resistance in series with the BD wire and relay AD operates.

<u>Relay AD</u>	(TL)	operating,
AD6	(BR)	extends the marking battery to the J wire of the called extension.

The linefinder of the inter-switchboard circuit searches for and positions itself on the required extension. The loop holding relay A (TC) is then disconnected and both the connecting circuit and extension line circuit associated with the inter-switchboard circuit release.

The call is then completed via the inter-switchboard circuit.

(ii) Call to the operator

<u>Relay JM</u>	(BL)	operating,
JM2	(BC)	prepare to return earth on the BD wire.
JM3	(BR)	
JM5	(BL)	see design details.
JM7	(BC)	

If the first impulse train from the inter-switchboard circuit steps the selector to level '0', earth is connected to the BD wire to operate relay CR in the inter-switchboard circuit. The line lamp associated with the inter-switchboard line flashes and the connecting circuit and extension line circuit are then released as described in paragraph (i) above.

O level calls

When an extension dials the digit '0', the selector steps to the tenth level and, if an '0' level circuit is available, relay G operates in series with relay BS in the start and Alarm circuit via the '0' level busy chain. The call is then completed via an '0' level circuit in a similar manner to that described for a direct access call over an exchange line circuit.

If both '0' level circuits are in use, relay G does not operate and the calls waits without tone until a circuit becomes free.

Under night service conditions earth is transferred from the HO1 to the JO1 wire and relay N.U. does not operate. NU tone is then returned to the calling extension via NU2 (TC).

Night Service

When the operator leaves the switchboard she throws the night service key causing an alarm to be given at selected points in the building if an incoming exchange or inter-switchboard call occurs.

Any extension may answer this type of call by dialling 8. The selector steps to level 8 and relay G operates in series with relay BS in the start and alarm circuit and the '0' level circuit busy chain. A start signal is extended to the calling circuit which then connects the incoming call to the calling extension in a similar manner to that described for a direct access call to the Public Exchange. The connecting circuit is then released.

If the digit 8 is dialled when the night service key is normal, relay NU does not operate and NU tone is returned to the calling extension (see diagram SA 8119 sheet 1).

Inter Extension calls via the Enquiry circuit

When an extension originates an enquiry call, the linefinder of a connecting circuit positions itself on the extension line circuit (20) associated with the enquiry circuit (see diagram notes SA 8103).

The circuit operation of the connecting circuit until the end of the first impulse train is similar to that described for a normal inter-extension call. Then the operation of E2 (TL) connects the 1000 ohm winding of relay ER in series with the BD wire. Relay ER operates in series with relay SD in the Enquiry circuit.

Relay ER	(TR)	operating,
ER1	(TR)	holds relay ER from earth at K5 (TR).
ER2	(BL)	disconnects earth at D2 to prevent relay B releasing if relay D releases after connexion to the required extension is established.
ER3	(BC)	prevents the operation of relay G should the selector step to a non-extension level.
ER4	(BL)	ensures that relay B is not short-circuited when relay A releases during transfer.
ER5	(TL)	prepares to extend a marking battery to the called extension line.

The second digit is then dialled and the selector functions as for a normal call.

When the called extension answers, relay F operates and F5 (BR) connects the linefinder BD wiper to the selector J wiper to enable marking conditions to be extended to the called extension line should the calling extension wish to transfer the call.

At the conclusion of the enquiry conversation the calling extension may return to the original call by depressing the press button on the telephone which releases both the enquiry and connecting circuits.

By replacing the receiver the calling extension may transfer the exchange or inter-switchboard call to the called extension.

A marking battery is extended from the enquiry circuit BD wire to the J wire of the called extension and the exchange or inter-switchboard circuit then searches for and finds the marked extension. When the transfer is completed an earth is connected to the enquiry circuit HF wire, relay FT releases and the connecting circuit restores.

Forced release

If the connecting circuit is taken into service because of a faulty extension line or by an extension who fails to dial, relay AD is operated by the A pulse after a period of up to approximately 29 seconds.

<u>Relay AD</u>	(TL)	operating,
AD1	(TL)	connects relay K to the Z pulse common.
AD5	(TL)	completes a hold circuit for relay AD.

The Z pulse which follows approximately 28 seconds later short-circuits relay V and the connecting circuit releases. The extension line circuit is forced into the P.G. condition and an alarm is given.

DESIGN DETAILS

4.

Relays are made slow to operate for the following reasons:-

<u>Relay E</u>	(BC)	To ensure a satisfactory operation of relay E at the end of the first train of impulses. The lag ensures the relay being fully fluxed during the time relay CD is released. (If relay E operated quickly, E5 would re-operate relay CD, and CD3 would release relay E before the holding circuit was established at E4). Relay E being fully fluxed, will hold (by virtue of its release lag) during the changeover of CD3, and then lock via E4.
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<u>Relay F</u>	(Th)	to prevent it vibrating to the ringing currents.
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Relays are made slow to release for the following reasons:-

<u>Relay B</u>	(BL)	to enable it to retain during impulsing. The slow-release feature is obtained by short-circuiting the relay by contact A1.
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<u>Relay CD</u>	(BL)	to enable it to retain during impulsing. (It must also release during the inter-digital pause). The slow-release feature is obtained by short-circuiting the 700 ohm winding via E5, N1 and NR4.
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Relays are made high-speed for the following reasons:-

<u>Relay HT</u>	(TR)	to enable the H lead of a called extension or circuit to be tested before relay E releases.
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<u>Relay FT</u>	(TL)	to provide an efficient cut drive circuit for the line-finder.
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Resistors and Relay contacts not fully explained previously

Resistors

R1	(TR)	prevents an earth via the 7 ohm winding of relay HT being applied direct to the H wire of a called extension. If the resistor were not included, an incoming call to an extension engaged on an outgoing call would cause the FT relay in the connecting circuit in use on the outgoing call to release.
R9	(TR)	prevents the battery being short-circuited by contacts F4 and K5.

- R10 (TC) serves to limit the current through the 500 ohm winding of relay A.
- R11 (TL) limits the current through relay FT and prevents a busy condition being applied to the extensions over which the wipers of the line finder pass.
- R12 (BL) prevents the short-circuits applied to the 700 ohm winding of relay CD from affecting the battery and serves to limit the current through relay CD.

Relay contacts

- G7 (BL) is included to prevent relay B being short-circuited by CD1 and G4 when relay CD re-operates on 0, 9, 8, 7 and spare level calls.
- H6 (BR)
JM4 (BR) connect an earth to the DS wire when an incoming call to an extension is made over an inter-switchboard line. If start conditions are not at that moment extended to an exchange, inter-switchboard or O level circuit, relay DS operates in the start and alarm circuit and prevents the extension of any such start condition. The operation of relay DS also allows the operation of relay JS in the inter-switchboard circuit.

This arrangement ensures that other circuits do not switch to the marked extension.

5.

HISTORY

Suffix A

Minor corrections made on diagram and notes amended. Diagram Notes rewritten.

Issue 1

Engineering Department,
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END OF DIAGRAM NOTES