

concerning

DIAGRAM G.B.W. 14690

titled

20, 35 & 49 LINE P.A.B.X. - EXCHANGE LINE CIRCUIT1. GENERAL

This circuit comprises a 50 point Line Finder switch with an associated relay set and is used to terminate bothway lines from the Public Exchange. It is necessary to disconnect permanently, the earth on the 'A' lead of the main exchange line circuit.

2. FACILITY SCHEDULE

Provision is made for:-

1. A transformer type transmission bridge to supply a feed to the calling extension.
2. Bothway working to public exchanges.
3. Direct access to public exchange from extensions.
4. A calling signal to be given on the exchange line lamp on the attendants cabinet when an incoming call occurs.
5. Lamp supervision of incoming calls.
6. The attendant to key the exchange line to the required extension.
7. Automatic ringing of extensions.
8. "Camp on busy" facility.
9. The operator to release a keyed extension if required.
10. Enquiry transfer and operator re-call facility.
11. "Trunk offering".
12. Night Service calls to be answered by any automatic extension.
13. Completion of exchange line start and busy chains when circuit is in use.
14. A visual "circuit engaged" test.
15. Facility for testing the circuit with Routine Test Set GBW.13290.
16. "Mains fail" condition giving access over a selected line to a selected extension.
17. Returning Ring tone to local extension on operator re-call, and, if required to the Public Exchange when the operator extends a call to a free extension.

3. CIRCUIT DESCRIPTION3.1 Outline

When an incoming call occurs, a calling signal is given on the associated line lamp on the attendants cabinet. The operator answers the call by operating the speak key and, after ascertaining the extension required, depresses the digit keys corresponding to the number of the required extension. The exchange line circuit line finder drives to the position corresponding to the extension and if the latter is free, ringing conditions are applied to the line. If the extension is engaged, busy flash is given on the line lamp. In either case the operator may retire from the circuit leaving the call to be automatically connected when the extension becomes free and/or answers.

Any automatic extension, excluding those specifically barred from the facility, may gain direct access to the public exchange by dialling the digit '1'. The Connecting Circuit causes a start condition to be extended from the Ringing, Start and Alarm circuit to the first free Exchange Line circuit which then hunts for, and seizes the extension.

The Connecting circuit is then released, and the extension is connected directly to the exchange line.

The operator may use the circuit to originate an outgoing call which may then be keyed to an extension.

On both outgoing and incoming calls an extension has enquiry, transfer and operator recall facilities. Ring Tone is returned to the caller on operator re-call.

3.2 Detail

3.2.1 Incoming call from Public Automatic Exchange.

Ringling conditions are applied to the line by the automatic equipment at the public exchange and relay AC operates.

Relay AC operating,

AC1 operates relay CR via RG2 to earth at B4.

Relay CR operating,

- CR1 prepares a locking circuit for relay CR, and completes circuit to operate relay BR from earth at B4 via AC1, RG2 & CL3.
- CR2 connects flicker earth to Attendants Cabinet LW lead causing line lamp to flicker.
- CR3 prepares alternative locking circuit for relay CR.
- CR5 connects N/S start earth to ST relay (night service conditions only).
- CR6 earths EC lead to operate EC relay in Misc. circuit to start ringer and sound Attendants buzzer.
- CR7 prepares an alternative hold circuit for relay CL.

Relay BR operating,

- BR1 closes busy chain to next exchange line circuit.
- BR2 applies earth to TJ2 (see GBW.13290).
- BR3 closes start earth to next exchange line circuit.
- BR4 & 5 connects potential divider circuit via relay MH to A line.
- BR6 prepares circuit to light line lamp on "engaged test".

MH operates to earth from the Main exchange via the A line if main exchange ringing is earth return, or to battery if main exchange ringing is battery return.

Relay MH operating,

- MH1 provides alternative hold circuit for relays CR and BR.
- MH2 further prepares alternative hold circuit for relay CL.

It is to be noted that when the immediate busy facility is strapped in relay MH operates to the potential on the A line and operates relay BR via MH1 and CL3. Relays AC and CR then operate as previously described.

In both cases of operation relay AC continues to respond to the ringing until the ringing is tripped.

3.2.2 Attendant Answers.

The attendant answers by operating the speak key associated with the calling exchange line circuit thus operating relay SA to the 250 ohm battery on the OP lead via MR2 and earth on the SK lead.

Relay SA operating,

- SA1 connects attendants OUT +ve lead to main exchange.
- SA2 operates relay CA.
- SA3 connects attendants OUT -ve lead to main exchange.
- SA4 connects D O N lead to CR relay.
- SA5 prepares attendants TO -ve lead.
- SA6 locks relay SA in series with relay SB, and relay S in marker circuit, via S lead. Relay SB operates.
- SA7 prepares attendants TO +ve lead.
- SA8 further disconnects the ST lead to the EB and ER relays.

Relay SB operating,

- SB2 connects attendants IN -ve lead to transmission bridge.
- SB3 connects attendants IN +ve lead to transmission bridge.
- SB4 connects ML lead to M relay.
- SB5 connects Z lead to prepare to hold relays CR or M.
- SB6 prepares to short circuit relay CA if Flash key is operated.
- SB7 applies earth to wiper of M bank of line finder (EF).

Relay CA operating,

- CA2 releases relay AC if operated, and discharges C2 via R2.
- CA3 connects line finder magnet to marker circuit via D lead.
- CA4 operates relay CL from earth at MH1.
- CA5 connects an alternative earth to relay MH potential divider circuit.
- CA6 prepares to connect the Auxiliary Test Pulse (A.T.P.) and Test Pulse (T.P.) to test winding of relay H.
- CA7 partially disconnects original holding circuit of relay MH.

Relay CL operating,

- CL1 provides a hold circuit for relay CR against the release of relay MH.
- CL2 prepares an alternative hold circuit for relay CL via MH2, CR7 and GR1 to earth.
- CL3 locks CL via CA4 to earth and holds relay BR operated.
- CL4 prepares an operating circuit for relay RG.
- CL5 completes the holding loop to the main exchange via the attendants circuit and TR1, thereby tripping exchange ringing.
- CL6 disconnects the hold circuit for relay MH which releases.

The operator can now speak to the main exchange and request the number of the required extension.

3.2.3 Attendant "Keys" number of required extension.

The attendant "keys" the two digits of the required extension number. An earth from the marker circuit via the D lead energises the EF switch via its interrupter contacts EF dm, which drives until the bank contact marked by the marker circuit is reached. Relay M then operates via the ML lead.

Relay M operating,

- M1 prepares to connect ringing to extension's -ve line via ST relay.
- M2 prepares to connect ring return to extension's +ve line.
- M3 locks relay M to earth on the Z lead, via CL1 and SB5, and releases relay CR.
- M4 connects test pulse TP and ATP via H relay to test H lead.
- M5 prepares to connect either busy or earth to line lamp.
- M6 applies earth to Ring Start Lead.
- M7 prepares alternative hold circuit for relay CL.

Relay CR releasing,

- CR1 disconnects original operating circuit of relay BR.
- CR2 disconnects flicker earth to Attendants cabinet (LW lead).
- CR3 further disconnects alternative hold circuit for relay CR.
- CR5 disconnects Night start earth from ST relay.
- CR6 disconnects EC lead thus disconnecting ringer start and attendants buzzer circuits.
- CR7 further disconnects alternative hold circuit for relay CL.

3.2.4 Extension Free.

If the extension is free, the H relay operates to the test pulse, applied by M4.

Relay H operating,

- H1 connects relay ET to J wiper. (No action at this stage).
- H2 prepares an earth on the TR lead via ER2 for subsequent enquiry circuit operation.
- H3) connect ringing and ring return to the extension's lines via
- H4) relay ST, M1 and M2 contacts, thereby ringing the called extension's instrument bell.
- H5 locks relay H via EB7, CR8 and CL1 to earth on Z lead, if attendant is in circuit, or to earth at SB5.
- H6 operates relay RR to earth on Z lead via SB5, CL1 and M3.
- H7 earths the H lead to busy the outlet.
- H8 disconnects D lead to T0 relay in Misc. circuit.

Relay RR operating,

- RR1 connects earth to LW lead thereby giving steady glow on the line lamp.
- RR2 connects ring tone to tone winding of transformer TR1.

3.2.5 Extension Answers.

When the extension answers, relay ST operates to the called extension's loop.

Relay ST operating,

- ST3 releases relay M (only contact effective at this stage).

Relay M releasing,

- M1) release relay ST, disconnect ringing and ring return from the
- M2) extension's lines and connects transmission bridge and relay LS. Relay LS operates to extension's loop.
- M3 disconnects hold circuit for relay M, releases relay RR, and prepares an alternative hold circuit for relay CR.
- M4 disconnects test pulse from relay H.
- M5 extinguishes line lamp.
- M6 disconnects earth from ring start lead.
- M7 further disconnects alternative hold circuit of relay CL.

Relay RR releasing

- RR2 disconnects ring tone from tone winding of transformer TR1.

Relay LS operating,

- LS1 operates relay B.

Relay B operating,

- B1 operates relay RG to earth at CL4.
- B2 prepares an alternative hold circuit for relays CR and OR.
- B3 holds relay H from earth on Z lead or SB5.
- B4 holds relays CA and ER operated.

Relay RG operating

- RG1 locks relay RG to earth at CL4 against release of relay B.
- RG2 prepares an operating circuit for relay GR.
- RG3 earths the ring start lead.
- RG4 holds relay CL to CL2 earth via GR1 and MH2 when the facility of flashing the Public Exchange operator by the extension is required.
- RG5 connects warn tone to the +ve line.
- RG6 connects an alternative earth to MH relay potential divider network.
- RG7 prepares an operating circuit for relays CR or A.

If the attendant has not yet restored the "speak" key she may speak to the extension via the IN leads. When the speak key is restored, relays SA and SB release and the extension is connected to the main exchange caller. It is to be noted that as soon as the extension answers warn tone is connected to the +ve line until the operator releases the speak key. Should the operator enter an existing conversation warn tone is immediately connected to the line.

3.2.6 Extension Busy.

If the extension is busy, a guard earth will be found on the H lead, and relay H will not operate to the test pulse. Busy earth is applied to the exchange line lamp via RR1, M5, CR2 to LW lead. If the attendant does not restore the speak key, the extension's H lead is tested at frequent intervals by the Test Pulse ATP and when the extension becomes free relay H operates and in turn operates relay RR. Call then proceeds as described in para. 3.2.4.

3.2.7 Attendant Trunk Offers.

On the attendant operating the Speak Extension key, the TO relay in the Misc. circuit operates from battery at the EF switch via H8 contact and the D lead. Contacts of the TO relay connect the attendant via the TO leads and contacts SA5, SA7 to the extension's line. The attendant can now speak to the extension without being heard by the main exchange caller. Warn Tone is applied to the line to inform the extension that the attendant has entered the connection. If the extension does not wish to accept the call the attendant restores the Speak Extension key and, if required, can "key" another extension, or cancel the call by operating the cancel key, thus disconnecting the earth from the Z lead and releasing the M relay. The Speak key is then restored, releasing SA and SB relays. Relay SA releases relay CA which restores relay MH to the A line and releases relay CL. MH operates to the exchange line if the caller has not cleared. BR remains operated to earth at MH1 until caller clears, in order to busy the circuit.

If the extension accepts the call, on replacing the receiver relay H operates and in turn operates relay RR. The called extension is re-rung, and ring tone is returned to the Public Exchange caller.

3.2.8 Attendant restores Speak Key leaving Caller "Camped on Busy".

On restoring the speak key relays SA and SB release followed by the release of relay CA. Relay M holds to earth at SB5 via CL1. The line lamp continues to light from Busy Flash.

Relay SA releasing,

- SA1 disconnects attendants OUT +ve lead from main exchange.
- SA2 releases relay CA.
- SA3 disconnects attendants OUT -ve lead from main exchange.
- SA6 releases relay SB (and relay S in marker circuit).

Relay SB releasing,

- SB2 disconnects attendants IN -ve lead from transmission bridge.
- SB3 disconnects attendants IN +ve lead from transmission bridge.
- SB4 disconnects ML lead from M relay.
- SB5 disconnects Z lead, leaving M held from SB5 earth.
- SB7 removes earth from M bank wiper.

Relay CA releasing,

- CA3 disconnects Exchange line finder magnet from Marker Circuit.
- CA4 disconnects operate circuit of relay CL, leaving it held from earth via M7 and MH2.
- CA5 disconnects the earth on the MH potential divider circuit.
- CA6 disconnects ATP from winding of relay H.
- CA7 restores operate circuit for relay MH.

When the exchange line is "camped on busy" and when the engaged extension clears then relay H operates to the test pulse (TP) and rings the extension as previously described in para. 3.2.4.

If the exchange caller decides to clear before the extension has answered a "camped on busy" or normal call and the exchange equipment is such that the earth on the 'A' lead is opened when the exchange caller releases, MH releases. (In cases where MH is not released when the exchange caller releases, the call is maintained until the extension answers and releases.)

Relay MH releasing,

MH2 releases relay CL.

Relay CL releasing,

CL1 releases relay M.
CL2 further disconnects the alternative hold circuit for relay CL and connects an alternative earth to MH relay potential divider network.
CL3 further disconnects the alternative hold circuit for relay CL and releases relay BR.
CL5 disconnects exchange line loop.

Relay M releasing,

M1) further disconnect ringing from +ve and -ve leads.
M2)
M4 disconnects test pulse from relay H.
M6 removes earth from ring start lead.

Relay BR releasing,

BR1 disconnects the busy chain circuit.
BR2 removes earth from TJ2.
BR3 restores start earth to the circuit.
BR4 & 5 disconnect circuit of relay MH to exchange line.
BR6 disconnects the LW lead from the EB lead.

The circuit is now fully released.

3.2.9 Release.

If the extension clears first relay LS releases followed by the release of relay B. LS1 also operates relay A which is held operated until relay RG releases, the loop to the Public Exchange is therefore disconnected.

Relay B releasing,

B4 releases relay CA.

Relay CA releasing

CA4 releases relay CL when the RG4 strap is not connected.
CA7 re-connects relay MH to the A line.

Relay CL releasing

CL1 releases relay H.
CL2 re-connects alternative earth to relay MH potential divider network.
CL3 releases relay BR if the Public Exchange has released.
CL4 releases relay RG.
CL5 further disconnects the loop to the Public Exchange.

Relay RG releasing

RG7 releases relay A.

BR is held operated to earth at MH1 thus busying the circuit as previously explained. The extension is now free to make further calls, but the exchange line circuit is still held. When the main exchange caller clears, relay MH releases which releases relay BR. The circuit is now normal.

When the circuit is strapped for flashing of Public exchange operator by extensions, on the extension clearing relay LS releases, operates A, and releases B as previously described. Relay B releases CA and relay MH is restored to the +ve line. Relay CL is held operated to earth at CL2 via RG4 and MH2.

On the Public exchange operator clearing relay MH releases thereby releasing relay CL which releases relays H, RG and ER, Relay RG releases relay A.

Should a further incoming call be made during the release of the Exchange line circuit relays then on the release of relay CA relay MH is re-connected to the A line and relay AC is connected across the outgoing A and B lines, and relays AC and MH operate to the new ringing conditions. Contact MH1 holds relay ER operated on release of the CL relay, and AC1 operates relay GR.

Relay GR operating

GR1 releases relay CL if RG4 strap is inserted.
GR2 locks GR relay to earth at B4.

Relays CL, H, RG and A release as previously described, RG2 contact operating relay CR which locks to earth at MH1 and releasing the GR relay which prepares to connect the alternative hold circuit for relay CL. Relay CR flashes the line lamp and the AC, CR, MH and ER relays remain operated as for an incoming call.

3.3 Direct Access Outgoing Call.

3.3.1 Extension dials "1".

When an extension dials the digit "1", a start condition is extended by relay AS in the Misc. circuit, to the first free exchange line circuit, to operate relay ST. Relay G in the Connecting circuit applies a 1150 ohm marking battery on the J lead.

Relay ST operating,

ST1 completes driving circuit for the line finder magnet (EF).
ST2 prepares a hold earth for relay H.
ST4 further disconnects the ST lead from the enquiry circuit.
ST5 connects earth to J lead via relay ET for testing.

The switch drives and when the 1150 ohm marking battery on the J lead is found relay ET operates, disconnects the drive circuit and operates relay H.

Relay H operating,

H1 short circuits 100 ohm resistance R3 to hold relay ET and guard against another hunting exchange finder switching to the same marked contact.
H2 prepares an earth on the TR lead for enquiry circuit operation.
H3) connect extension's lines to transmission bridge and LS relay which
H4) operates to the extension's loop. (Relay DR is differentially connected and does not operate).
H5 prepares a part of a holding circuit for relay H.
H7 earths H lead to hold the line circuit CO relay and to release the connecting circuit by short circuiting the connecting circuit FT relay.
H8 further disconnects the drive circuit of the EF switch.

Relay LS operating,

LS1 operates relay B.

Relay B operating,

B1 prepares to operate relay RG.
B2 prepares hold circuit for relay OR (operator re-call).
B3 connects alternative hold circuit for relay H from earth at SB5.
B4 operates relays ER and CA.

Relay BR operating,

- BR1 closes busy chain to next exchange line circuit.
- BR2 applies earth to TJ2 (see GBW.13290).
- BR3 closes start earth to next exchange line circuit.
- BR4 & 5 connect potential divider circuit and relay MH to +ve line.
- BR6 prepares circuit to light lamp on "engaged test".

Relay CA operating,

- CA1 connects calling earth to main exchange B lead.
- CA2 disconnects relay AC and prepares spark quench circuit for A1 contact.
- CA4 prepares to operate relay CL.
- CA7 disconnects alternative operate circuit of relay MH.

The earth applied to the B line by CA1 operates the line relay in the main exchange. When the Selector at the main exchange has found the calling exchange line an earth from the main exchange feed relay on the A line will operate relay MH via CL6 and BR contacts. Relay MH operates relay CL which locks to CL3 earth via CA4.

Relay CL operating,

- CL1 further prepares an operate circuit for relay CR (operator re-call).
- CL2 prepares alternative hold circuit for relay CL.
- CL3 locks relay CL via CA4.
- CL4 operates relay RG.
- CL5 completes a loop to hold main exchange equipment and disconnects the calling earth.
- CL6 disconnects relay MH from A line thereby releasing it.

Relay RG operating,

- RG1 provides a hold circuit for relay RG against release of relay B.
- RG2 prepares an operating circuit for relay GR.
- RG3 prepares to connect earth to ring start lead.
- RG4 holds relay CL to CL2 earth via GR1 and MH2 when the facility of flashing the Public Exchange operator by the extension is required.
- RG5 prepares to connect warn tone to the line.
- RG6 connects an alternative earth to MH relay potential divider network.
- RG7 prepares an operate circuit for relay CR or A.

The extension is now connected to the main exchange via the repeater bridge, and should the operator enter the circuit at any stage of the call from now on the operation of relay SA connects warn tone to the +ve line.

3.3.2 Dialling.

When Dial Tone is received from the main exchange by the calling extension the required number can be dialled. Relay LS responds to the dialled impulses, and impulses the high speed relay A via contacts RG7 and SB1. Relay A repeats the impulses by opening and closing the loop to the main exchange. Relay B holds during impulsing.

3.3.3 Release.

Release is as for an incoming call (para. 3.2.9).

3.4 Outgoing call set up by attendant.

The attendant tests for a free exchange line by operating the Engaged Test key, which causes the line lamps of all busy exchange lines to glow (see para.3.7). A free circuit is selected and the associated Speak key operated, causing relays SA and SB to operate (see para. 3.2.2). Relay SA operates relay CA which extends the calling earth as described in 3.3.1. SA2 operates relay BR. When the Public exchange selector is seized MH operates and in turn operates relay CL which releases relay MH as described in para. 3.3.1.

3.4.1 Attendant dials required number.

The dial off-normal contacts on the attendants dial make contact immediately the dial is moved and extend an earth via the DON lead to operate the CR relay.

CR operates

- CR2 connects flicker earth to the LW lead.
- CR3 locks CR to earth on Z lead via B2, M3, CL1 and SB5.
- CR6 earths the EC lead to Misc. circuit.

The impulse contacts of the dial are connected in the Attendants OUT leads and thus impulse the main exchange equipment direct. If the attendant wishes to retire from the circuit before extending the call to an extension, the flicker earth on the line lamp will remain as long as the exchange subscriber is present, as a reminder that the call has not been extended. Relay CR locks from earth at SB5 via CL1, M3, CR3 and B2, and relay CL locks via CA4 to earth at CL3. If the main exchange subscriber clears, relay MH releases thereby releasing relay CL, which releases relay CR. Relay CR releasing extinguishes the lamp.

3.4.2 Outgoing Operator call extended back to P.A.B.X. extension.

When the attendant wishes to extend the call to an extension, she operates the Speak key (if previously restored) and keys up the required extension's number. The operation is as described for an incoming call (see para. 3.2.4.). The attendant may restore the Speak key, leaving the call connected, no further supervision being required.

3.4.3 Release.

- (1) If the attendant wishes to release the circuit before dialling the main exchange, she can do so by restoring the Speak key, thus releasing relays SA and SB, which release relay CA. Relay CA releases CL and when the Public exchange equipment releases the earth is disconnected from the A line and relay MH, which was previously re-connected by the CA7 contact, releases and in turn releases relay BR and the circuit is then free for further use.
- (2) If the attendant wishes to release the call before keying up the extension, she operates the Release key with the Speak key still operated. Operating the release key removes the earth from the Z lead thereby releasing the CR relay. On restoring the Speak key, relays SA and SB release, followed by relay CA, which releases relay CL. Relays MH and BR release when the main exchange equipment has cleared.
- (3) If the attendant wishes to release the call after having keyed up the extension's number, she operates the Release key with the Speak key operated, thereby releasing relay M which was holding to earth on the Z lead. On restoring the Speak key, relays SA, SB, CA, CL, MH and BR release as in (2).
- (4) If the attendant has keyed up the extension and retired from the circuit and the exchange caller clears before the extension answers, relay MH releases, releasing relay CL. Relay CL releases relays H, M and BR and the circuit returns to normal.
- (5) If the call has been completed, release is effected as for an incoming call (see para. 3.2.9).

3.5 Enquiry Facility.

3.5.1 Enquiry call initiated.

An extension, engaged on an exchange call may make an enquiry call to another extension, and at the same time hold the original call, by a momentary depression of the sub-set button. This connects an earth to the -ve line and unbalances the current through the windings of the DR relay causing it to operate.

Relay DR operating,

- DR1 prepares part of DR lead to enquiry circuit.
- DR2 connects ST lead to relay ER.
- DR3 connects NSK lead to OR relay via ER3.

3.5.2 Enquiry circuit busy.

In this case there is no earth on the ST lead to operate relay ER. During the day there is an earth on the NSK lead which will operate relay OR if relay ER does not operate. Relay OR operates relay CR which causes the attendant to be called by the line lamp flickering, as for a normal incoming call (see para. 3.2.1). Ring tone is returned to the caller.

If there is no earth on the NSK lead, as at night, relay OR will not operate to give the calling signal to the attendant.

3.5.3 Enquiry circuit free.

When the enquiry circuit is free, an earth is connected to the ST lead and relay ER will operate before relay OR operates (OR is slow to operate relay).

Relay ER operating,

- ER1 connects a short circuit across exchange line to hold Main exchange equipment.
- ER2 connects earth from H2 to TR lead.
- ER3 connects relay OR to CR lead.
- ER4 holds relay CL (for transfer).
- ER5 disconnects the H (out) lead chain to the next exchange line circuit and connects the H (in) lead to the EB relay.

The earth at H2 is extended via the TR lead and enquiry circuit to the H "in" lead to prepare to operate relay EB and hold relays EB and ER in series. While the extension holds the button depressed the earth on the ST lead short circuits relay EB thus preventing it from operating. On release of the button relay DR releases, breaking the ST lead at DR2 and thus removing the short circuiting earth on EB and allowing it to operate.

Relay EB operating,

- EB1 prepares to apply earth to the DR lead.
- EB2) disconnects the extension from the main exchange and connects it via
- EB3) the transmission bridge to the enquiry circuit.
- EB4 completes the circuit to operate relay A.
- EB5 prepares to connect the ST relay to TR lead.
- EB6 disconnects the ST lead.
- EB7 prevents earth at SB5 holding relay H.

Dial tone is returned from the enquiry circuit to the extension. On dialling, relay A repeats the dialled impulses to the enquiry circuit, and the extension is connected to the required number.

3.5.4 Reverting to Main Exchange Call.

After completing the enquiry, the extension can revert to the original exchange call by again momentarily depressing the sub-set button. Relay DR operates and extends an earth to the DR lead from EB1, to operate relay Z in the enquiry circuit. Relay Z prepares to release relays ER and EB, but cannot do so until the sub-set button is released since relay DR, held operated by the sub-set button maintains an earth on the DR lead from a contact of relay Z. Relay EB releasing disconnects the extension from the enquiry circuit, which releases, and reconnects it to the main exchange. Relay ER is slow to release in order to maintain the loop on the exchange line to the main exchange until relay EB has released.

3.5.5 Transfer.

If the extension wishes to transfer the exchange call to the enquiry extension, on replacing the receiver, instead of pressing the sub-set button the second time, relay LS releases and operates relay A, which opens the loop and releases the enquiry circuit A relay, at the same time releasing relay B in the exchange line circuit.

Relay B releasing,

- B3 releases relay H.
- B4 releases relay CA.

The release of relay CA prepares the operating circuit of the EF switch at CA3.

Relay H releasing,

- H2 removes earth from TR lead and connects TR lead to ST relay.
- H3) open the +ve and -ve lines to the originating extension.
- H4)
- H7 disconnects earth from the H lead, and releases the line circuit CO relay of the originating extension.
- H8 prepares circuit to operate EF magnet.

The battery on the ST relay operates TR relay in the enquiry circuit, which places a 1050 marking battery on the J lead (via J wiper and bank) of the called extension, and releases relay CD which places a full earth on the TR lead to operate the ST relay.

The operation of the ST relay causes the EF switch to hunt for the marking battery on the J lead as for a normal 'direct access' call (see para. 3.3). When found relays ET, H, LS, B, CA operate as before. Relay A is released when relay LS operates and re-connects the loop to the enquiry circuit operating relays A and Z in the enquiry circuits. Relay Z operating removes the earth from relays EB and ER and they release. As relay EB releases first, it connects the new extension to the main exchange and releases the enquiry circuit. ER releasing disconnects the short circuit across the exchange line A and B leads.

3.5.6 Attendant Re-call.

After momentarily depressing the sub-set button and receiving dial tone from the enquiry circuit, the extension dials the digit '0'. The earth returned via the CR lead from the enquiry circuit, during day time only, operates relay OR.

Relay OR operating

- OR1 operates relay CR to earth on CR lead and locks relay OR to earth at SA2 via OR6.
- OR2 releases relays EB and ER.
- OR3 maintains a short circuit across the exchange line A and B leads against the release of relay ER and disconnects the -ve lead.
- OR4 connects earth to ring start lead.
- OR5 connects ring tone to tone winding of transformer TR1.
- OR6 holds relays OR and CR operated.

Relay CR operating

- CR2 applies flicker earth to line lamp.
- CR6 indirectly sounds the audible alarm on the attendants cabinet.

When the attendant answers relay SA operates and releases relays CR and OR. The attendant after having dealt with the query may retire from the circuit by restoring the speak key, leaving the extension still connected to the main exchange call, or if the extension wishes the attendant to deal with the call, on the extension replacing the receiver relay LS releases and operates relay CR to earth at LS1 via RG7.

Relay CR operating

- CR2 re-connects flicker earth to line lamp.
- CR3 locks relay CR to earth on Z lead.
- CR4 releases relay RG if the extension clears once the operator has entered the circuit.
- CR8 releases relay H, thereby allowing the extension to release.

The attendant may then key up the call to another extension as for a normal incoming call (see para. 3.2.3).

If an attempt to transfer a call to the attendant is made at night, the extension receives "busy" tone and the night bells ring until the call is answered.

If an extension attempts to transfer a call to an extension who has not yet answered, the enquiry circuit extends an earth via the CR lead to operate the OR relay. CR operates to earth at SA2 and locks to SB5. The attendant is called in as described above.

It should be noted that an exchange call cannot be lost by these mis-operations.

3.6 Night Service.

3.6.1 Night Service Key.

When the night service key on the attendant's cabinet is operated, the circuit is modified so that an incoming call causes bells to ring at selected points. The night service start lead is closed and the attendants re-call facility in the enquiry circuit is discontinued.

3.6.2 Incoming Call.

When an incoming call is received, relay AC operates as for a normal call. Relay AC operates relay CR which locks to MH1 earth as before (see para.3.2.1).

3.6.3 Extension dials '2'.

The incoming call may be answered from any extension by dialling the single digit '2'. The connecting circuit seized by the extension extends a start condition to operate relay ST. Circuit operation is similar to that for a direct access outgoing call (see para. 3.3). The extension may use the 'enquiry' or 'transfer' facilities as required, the circuit operation being identical to that described for these facilities in para. 3.5.

3.6.4 Outgoing calls.

Direct access outgoing calls at night take place in the normal way, the operation being as described in para. 3.3.

3.7 Circuit Engaged test.

The attendant is provided with an Engaged Test key which when operated causes all the line lamps of engaged exchange line circuits to glow. When the key is depressed, earth on the key is fed via the EB lead, BR6 operated, M5 back and CR2 back to the LW lead, thus completing the lamp circuit of all engaged exchange line circuits.

3.8 Mains Fail.

Outgoing Calls

In the event of mains failure, relay MF (normally operated) releases. However, a call can still be made to the main exchange from pre-selected extensions.

Relay MF releasing,

- MF1 breaks the operating circuit of the AC relay.
- MF2 connects the B lead of the exchange line to the pre-selected line via the LB relay.
- MF3 prevents battery being connected to the exchange line via MH, should the main fail condition clear during a call.
- MF4 connects 'pre-selected extension' to A lead of the exchange line.

In order to call the main exchange the pre-selected extension depresses the sub-set button till dial tone is received from the main exchange equipment. Relay LB operates in series with the main exchange equipment feed relay to the extension's loop. The extension can now dial the required main exchange number without the prefix digit '1'.

Relay LB operating

LB1 prevents MF from operating should 'mains fail' condition clear while a call is in progress.

Incoming Calls

In the case of an incoming call, the pre-selected extension becomes, in effect, an ordinary subscriber on the main exchange, ringing and feed being supplied from the main exchange in the normal manner.

END