CIRCUIT EXPLANATORY
FOR
DIAGRAM 94550/SW
50 LINE P A.X.
LINE CONNECTOR AND REGISTER CIRCUITS

1. GENERAL

The diagram shows the following circuits of a private automatic exchange catering for 50 extensions:-

Line Circuit (Fig. 1)
Connector Circuit (Fig. 2A)
Line Finder (Fig. 2B)
Connector Switch (Fig. 2C)
Common Start Relay (Fig. 3)
Register (Fig. 4)
Register Switch (Fig. 4A)
Tens Switch (Fig. 4B)
Unit Switch (Fig. 4C)
Test Line Jack (Fig. 5)
Battery Test Jack (Fig. 6)

This diagram should be considered in conjunction with the following circuits or their equivalents:-

Dgm.	94551/SW	50	Line	P.A.X.	Ringing & Tones Circuit
"	94560/SW	"	"	"	Tie Line with Preference Access and Preference Discrimination
"	94561/SW	"	"	"	Direct Access Circuit
"	94562/SW	"	"	"	Direct Call Circuit
"	94566/SW	"	"	"	Staff Call Audible Code Circuit for 15 Lines
"	94567/SW	"	"	"	Staff Call Circuit
"	94569/SW	"	"	"	2 - Party Line

2. FACILITY SCHEDULE

(1) Automatic intercommunication between extensions

(2) Dial, busy, intrusion, and ring tones.

(3) Automatic or optional preference for extensions to intrude into existing connections.

(4) Access to tie lines and staff call equipment by dialling special codes.

(5) Barring selected extensions from access to staff call equipment.

(6) Two party line working.

(7) Either extension to free itself independently from a connection, busy tone to be transmitted to the last extension to clear.

(8) Transfer of the calling line to line No. 11 when the register is held for more than a specified time due to a P.G. condition or when a spare code is dialled as a tens digit. Busy tone is returned to the calling line in this case.

(9) Using line No. 11 as a test number by the faults man.

3. CIRCUIT DESCRIPTION

The functions of the various relays are as follows:-

Line Circuit (Fig. 1)

Relay LR operates when the extension lifts the receiver to originate a call, and causes the operation of the common start relay AS (Fig. 5). It further marks the calling line on the line finder bank by the extension of battery via relay K.

Relay K operates in series with relay RF (Fig. 4) when the line finder switch tests-in, disconnects relay LR and earth from the line, and disconnects earth from relay AS (Fig. 3) which releases if not held by another call.

Common Start Relay (Fig. 3)

Relay AS operates when a call is originated and releases when relay K operates via the line finder testing-in circuit. It operates relay RS of a free register, provided that a free connector is available.

Register (Fig. 4)

Relay RS is the register start relay. It operates when a start earth is extended by relay AS (Fig. 3), provided that a free connector is available (B21-22 normal). Relay RS disconnects the start relay of the other register to prevent simultaneous operation of both registers, completes the self drive circuit of the register switch (Fig. 4A) and extends earth via relay RT to wiper RS1 to prepare the test-in circuit of the register switch to the first free connector met on its run and marked by a 100 ohm resistance battery on the RS1 bank. Relay RS energizes relay TH.

Relay RT is the register test-in relay and operates when the register switch tests-in on a free connector. It disconnects the register switch drive and completes a self drive circuit of the Line Finder (Fig. 2B) to search for the calling line marked by battery via relay K on the line finder P bank outlet. Relay RT extends earth via both windings of relay RF to the line finder P wiper to prepare the test-in circuit. It also completes the dial tone start circuit.

Relay RF is the line finder test-in relay and operates in series with relay K (Fig. 1) when the line finder reaches for the calling line. Relay RF cuts the line finder drive and allows the operation of relay RN.

Relay RN operates after the linefinder has tested-in on the calling line (relay RF operating). It connects relay RA to the calling line, disconnects relay RS and extends earth to the T3 wiper to prepare the operation of relay RH. It prevents the operation of the RH relay of the other register.

Relay RA is the impulsing relay for the tens and units switches of the register. It is controlled by the calling party's dial. Operates relay RB.

Relay RB is operated by relay RA and holds due to its slow release feature (slug) during the impulsing period. Operates relay BA, and also retains RJ operated.

Relay RC operates on the first release of relay RA and holds due to its slow release feature (slug and shunt) during the impulsing period of the 'tens' and 'units' drive magnets.

Relay RC controls the stepping of the 'units' switch from its home position ('0' or '12') to posn. '1' or '13' during the inter digital period. Disconnects the operate circuit of relay RH during 'tens' and 'units' switch stepping periods.

Relay BA is a relief relay on relay RB. It connects dial tone to the tone winding of relay RA, disconnects the homing circuits of the 'tens' and 'units' switches, prepares the impulsing circuit of the register 'tens' and 'units' switches. Operates relay PF if the call is from a preference extension.

Relay RH operates on the conclusion of the register loading period, completes the self drive circuit of the connector switch (Fig. 2C), extends marking battery to the connector M bank via the 'tens' and 'units' switch wipers. Prepares the test-in circuit of relays RJ and T (Fig. 2A) to the marking battery when the connector switch reaches the marked outlet. Extends busying earth to the 250 ohm resistance battery common to prevent simultaneous marking operations.

Relay RJ is the connector switch cut drive relay. It operates in series with relay T when the M bank outlet marked by resistance battery from the register is reached. Releases relay RH.

Relay PF operates on calls from preference extensions and switches the marking battery from the normal to the preference outlet of the connector M bank associated with the tie line.

Relay TB is the staff call barring relay which switches the marking battery from the staff call outlet of the M bank to the MH terminal associated with outlet '11' of the M bank.

Relay TH is a thermal relay operating with a delay of 25 to 40 secs. and releasing with a lag of about 10 secs. It operates relay RZ to force the release of the register under P.G. conditions.

Relay RZ operates on the release of the register and when relay TH is operated due to a P.G. condition.
If a P.G. condition exists, relay RZ extends marking battery via the MH terminal to the M bank contact 11 and operates relay RH. This routes the faulty line to line '11' and releases subsequently the register. Relay RZ releases when relay TH restores, thus ensuring that the thermal contact is normal.
The register cannot be reseized while relay RZ is operated.

Connector (Fig. 2A)

Relay T operates in series with relay RJ when the connector switch tests in on the line marked by the register on the connector M bank. It releases relay RA (Fig. 4) and passes the calling loop forward to relay A and the transmission bridge.

Relay H is the connector test relay. It operates when the called line is free to battery via relay K in the called party's line circuit and guards the called line.

Relay A operates to the calling loop.
Provides intrusion facility (optional) on calls from preference extensions by operating relay PR and consequently relay D when the calling preference party dials '1'.

Relay B — is operated by Relay A. Holds preceding equipment and guards the connector. Holds relay T. Busies the connector on the register RS1 bank.

Relay F — is the ring trip relay. It operates when the called party answers and extends relay D to the called line. Short circuits relay H forcing it to release. Guards the called line.

Relay D — operates to the current feeding the called extension's telephone. Provides intrusion facility for preference parties on calls to busy extensions and prepares the test circuit of relay H when the existing connection is cleared down.

Relay PG — operates when the called line is free and disconnects relay PR. It releases relay S (Dgm. 94569/SW) on calls from Two Party Line extensions.

Relay PR — operates on calls from preference extensions to busy extensions. It operates either automatically or when the calling party dials '1' on optional preference working. Operates relay D to provide the intrusion facility.

DETAIL OF CIRCUIT OPERATION

Note:- Contacts not mentioned are ineffective at the particular stage.

3.1 Seizure of the Connector

When an extension originates a call.

Relay LR — (Fig. 1) operates via the calling party's instrument loop to earth at K22.

LR1-2 — operates relay AS and prepares a hold circuit for relay LR.

LR4-5 — busies the line on the connector P bank by disconnecting relay K - battery from the connector P bank contact common, and marks the calling line on the line finder P bank contact by relay K - battery.

Relay AS — (Fig. 3) operates to earth at LR1.

AS1 — extends earth from B22 to the RS relays of both registers, if free.

All free connectors are marked by a 100 ohm resistance (R2) battery potential on the RS1 banks of all registers in accordance with Table 7 on Dgm. If all connectors are engaged (all B relays operated) there is no earth on contact B21 so that no start condition will be relayed to the registers i.e. to relays RS.

The RS relays of both registers (if both are free) will attempt to operate, but one will operate first and disconnect the operate circuit of the other RS relay at RS1-2.

Relay RS — (Fig. 4) operating via earth, B21-22, AS1-2, RS1-2 of the other register, RS winding, RN23-24, RZ3-4, T1 wiper on contact '0' or '11' Tdm, T magnet to battery.

RS1-2 — disconnects the operate circuit of the other register's RS relay.

RS4-5 — prepares the test in circuit of relay RT to the first free connector, marked on the RS1 bank by R2 - battery.

RS21-22 — completes the self drive circuit of the register switch RS.

RS24-25 — energizes the thermal relay TH (see Note 3 on Dgm.).

When the hunting register switch reaches the first free connector marked by resistance (R2) - battery on the RS1 bank.

Relay RT	(Fig. 4) operates on its 10 ohm winding.
RT1-2	prepares the test in circuit of relay RF and the operate circuit of relay K (Line Circuit).
RT4-5	disconnects the self drive circuit of the RS switch and prepares the connection of busying earth to the RS1 bank contact to busy the connector when relay RS releases.
RT21-22	completes the self drive circuit of the Line Finder (Fig. 2B)
RT23-24	starts the ringing and tones equipment.
	The line finder searches for the calling line marked by battery via relay K (Fig. 1) on the line finder P bank.
	When the marked outlet is reached.
Relay RF	(Fig. 4) operates with both windings in series to battery via relay K (Fig. 1)
RF4-6	extends earth via the 15 ohm winding of relay RF to the P bank outlet to busy the calling line on the line finder bank, and disconnects the self drive circuit of the line finder. Removes the short circuit from relay RN which operates.
Relay K	(Fig. 1) operates in series with relay RF.
K21-22)	disconnect earth and relay LR battery respectively from
K23-24)	the line.
K26-27	releases relay AS (Fig. 3) and retains relay LR.
Relay RN	(Fig. 4) operating, to battery via the LF magnet.
RN1-2) RN21-22)	extend the calling loop to relay RA which operates.
RN3-4	on calls from extensions barred from 'staff call' operates relay TB to earth in Fig. 1B on the M lead.
RN6-7	prevents simultaneous marking by register No. 2 and prepares the operate circuit of relay RH.
RN23-24	releases relay RS.
RN25-26	no function at this stage.
	If the call is from a 'staff call barred' extension,
Relay TB	(Fig. 4) operates to earth connected to the M lead in all line circuits of extensions which are barred from access to the 'staff call' equipment.
TB2-3	changes the connection of the TB terminal (Fig. 4B) associated with the staff call digit ('7') from the staff call circuit lead to the MH terminal lead so that outlet '11' of the M bank of the connector is marked.
TB21-22	retains relay TB.
Relay AS	(Fig. 3) releases, if not held by another call.
Relay RA	(Fig. 4) operates to the calling loop
RA22-23	operates relay RB.
Relay RB	(Fig. 4) operating,
RB1-2	operates relay BA.
RB4-5	prepares an alternative hold circuit of relay TH.
RB21-22	retains relay RT.
Relay RS	(Fig. 4) releasing at RN23-24,
RS1-2	allows the operation of the other registers RS relay.
RS3-5	retains busying earth (from RT4-5) on the RS1 bank contact.
RS21-22	further disconnects the register switch drive circuit.
RS23-24	ineffective due to the subsequent operation of BA21-22.

Relay BA (Fig. 4) operating,

BA1-2 prepares the impulse repetition circuit to the register 'T' and 'U' switches and an operate circuit of relay RC.

BA4-5 disconnects the homing circuit of the 'Tens' switch.

BA7-8 operates PF to battery on lead M in Fig. 1A if the call is from a preference extension.

BA21-22 retains relay TH.

BA23-24 extends the dial tone lead from the Ringing and Tones Set to the tone winding of relay RA. Dial tone is transmitted to the caller by the transformer action of the relay RA windings.

BA27-28 disconnects the homing circuit of the 'Unit' switch.

If the call is from a preference subscriber

Relay PF (Fig. 4) operates to resistance battery on lead M in the preference extension's line circuit (Fig. 1A).

PF2-3) Switch the markings of tie line groups 1 and 2 on the M bank from the
PF22-23) 'normal' to the 'preference' outlets.

Dial tone is returned at this stage to the caller.
Relays operated at this stage are:-

BA, K, LR, RA, RB, RF, RN and RT.

Relay TB is operated when the call is from 'staff call barred' extension.
Relay PF is operated when the call is from a 'preference' extension.

3.2 Dialling the 'Tens' Digit

The numbering scheme is 10 to 59.
Number 11 is the test number utilized by the faults man when plugging into the test jack on the P.A.X. for testing purposes. It should not be used for ordinary service since it is also used as a holding circuit for faulty lines (P.G. condition) and for inadvertently dialled spare codes ('6' to '0').
Codes '6' to '0' are spare or may be used for tie-line or special services (Staff Call, etc.) working.

Dialling a first digit '1' to '5'

Relay RA follows the impulses of the calling party's dial and repeats them to the 'tens' (T) magnet via:- earth, RA21-23, BA1-2, RC winding, U2 wiper on home contact, T magnet, battery.

On the first release of RA21-23 relay RC operates and holds during the impulsing period due to its slow release feature (slug and shunt). Relay RB is disconnected during the release periods of relay RA but holds due to its slug.

Relay RC (Fig. 4) operating in series with the T magnet.

RC1-2 energizes the U1-magnet via earth, U1 wiper on home contact, BA4-5, RC1-2, U magnet battery.

RC3-4 disconnects the tone coil of relay RA during impulsing to prevent interference with impulse transmission.

RC21-22 disconnects the operate circuit of relay RH during dialling.

On the re-operation of relay RA the T magnet is disconnected and steps its wipers to the next contact (reverse drive action).

At the conclusion of the 'tens' impulse train the T switch wipers will have taken the same number of steps as the impulse dialled and relay RA will re-operate and remain held to the calling loop.

Relay RA (Fig. 4) re-operating,
RA22-23 holds relay RB and disconnects the T magnet and relay RC in series.

The T switch wipers take the last step and rest now on the contact associated with the digit dialled.

Relay RC (Fig. 4) releasing,
RC1-2 disconnects the U - magnet which steps its wiper from the home position to contacts '1' (or '13').
RC21-22 operates relay RH if the first digit dialled discriminates for a special service or tie line call, or is a spare digit.

The register now awaits the dialling of the 'units' digit.
Relays BA, K, LR, RA, RB, RF, RN, RT, PF (on calls from preference extensions) and JB (on calls from 'staff call barred' extensions) are operated at this stage.
The T switch wipers rest on the contact ('1' to '5') associated with the digit dialled, the U switch wipers are on contacts '1' or '13'.

Dialling a first digit associated with a tie line or special service call
(Digit '7' for Staff Call, Digits '8', '9' or '0' for Tie Line Calls).
The T4 bank contact associated with the Staff Call digit '7' is wired to terminal TB (Fig. 4B). Terminal SC (Fig. 4) is wired via the Staff Call Circuit terminal T7 to the M bank contact associated with staff calls.

The T4 bank terminals associated with Tie Line codes are wired either to terminal PF1 (Tie Line Group No. 1) or to terminal PF2 (Tie Line Group No. 2) Dependent on whether the call originates from a preference party (relay PF operated) or not, the marking condition is extended via the PM or NM lead and the Tie Line Circuit to the M bank contacts allotted to tie lines.

When the last impulse of the digit ('7' for staff calls, '8' or '9' or '0' for tie line calls) has been received, relay RC releases as described previously.

Relay RC (Fig. 4) releasing,
RC1-2 releases the U magnet which steps the wipers to contacts '1' or '13'.
RC21-22 operates relay RH.

Relay RH (Fig. 4) operates via earth, RJ1-2, RN6-7, RZ5-6, wiper T3, bank contacts 6 to 10 and 17 to 21 common, RC21-22, RH (a b) winding, 250 ohm resistance battery common.
RH1-2 retains relay RH to earth at RB1-2, via RJ23-25.
RH3-4 extends earth via relays RJ and T to the M wiper to prepare for the testing in on the marked outlet.
RH5-6 short circuits the (a b) winding of relay RH and extends earth to the 250 ohm resistance battery common to prevent other RH relays from testing and thus to reserve the marking bank M for this call only.
RH21-22 completes the self drive circuit of the connector magnet.
RH23-24 extends a 50 ohm resistance (combined resistance of R1A and R1B) battery via the T4 wiper and bank contact T terminal, strap to TB terminal (staff calls) or strap to PF1 or PF2 (Tie Line Calls), Staff Call or Tie Line Circuit, to the M bank contact allotted to the particular service.

When the connector M wiper reaches the outlet marked with a 50 ohm resistance battery by the register, relays T and RJ operate.

Relay RJ	(Fig. 4) operates in series with relay T to resistance battery on the M bank contact.
RJ2-3	extends earth to U point 24 of the next register to prepare the operation of its RH relay.
RJ5-6	prepares the operation of relay D.
RJ21-22	arrests the connector switch drive.
RJ24-25	retains relay RJ to earth at RB1-2 and releases relay RH.
Relay T	(Fig. 2A) operates in series with relay RJ.
T21-22	('X' action) holds relay T to earth at RF4-6 and later to earth at B22-23.
T5-6) T24-25)	disconnect relay RA and extend the calling line to relay A and to the transmission bridge.
T8-9	operates relay D.
T26-27	extends earth via relay H to the P lead to operate the switching relay associated with the P lead in the staff call line circuit.
T28-29	retains the disconnection of the line finder drive circuit, and disconnects relay RN which releases.
Relay D	(Fig. 2A) operates on its (a-b) coil via T8-9, RJ5-6, T2 wiper, bank contact 6 to 10 and 17 to 21 common, T magnet to battery. The T magnet does not operate in series with relay D.
D1-2) D21-22)	extend the calling line to the staff call or tie line equipment. Contact D21-22 also prepares the impulse repetition by relay A to the +ve leg.
D3-4	retains relay D to earth at RF4-6 and later to earth at B22-23.
D6-7	prevents the transmission of busy tone from the connector on tie line or staff calls.
D23-24	retains the switching relay associated with the P lead in the staff call or tie line circuits. Relay H does not operate in series with the switching relay.
D27-28	operates relay PG.
Relay PG	(Fig. 2A) operating,
PG1-2	retains relay PG.
PG4-5	short circuits relay S in the two-party line circuit (Dgm. 94569/SW) if the call originates from a party line extension.
Relay A	(Fig. 2A) operating to the calling loop.
A2-3	operates relay B and repeats the impulses to the +ve leg.
Relay RA	(Fig. 4) releasing,
RA21-23	releases relay RB.
Relay B	(Fig. 2A) operating,
B5-6	disconnects R2 battery from the RSi bank thereby retaining the busy condition of the connector on the register bank contact.
B22-23	holds relay K in the calling party's line circuit and retains relays T, D and PG and releases relay RF by short circuit.
B25-26	see PG4-5.
Relay RH	(Fig. 4) releases when relay RJ operates.
RH1-2	disconnects the (d-e) winding of relay RH.
RH3-4	disconnects the original operate circuit of relays RJ and T.
RH5-6	disconnects busying earth from the 250 ohms resistance battery common to allow the operation of the RH relay of the other register.

RH23-24 disconnects the marking battery from the M bank multiple.

Relay RB (Fig. 4) releasing,
RB1-2 releases relay BA and relay RJ.
RB3-4 disconnects relay TH and operates relay RZ during the release lag of BA21-22.
RB21-22 releases relay RT.

Relay RT (Fig. 4) releasing,
RT23-24 disconnects the dial tone start earth.

Relay RZ (Fig. 4) operating,
RZ1-2 retains relay RZ.
RZ3-4 provides an additional guard period against reseizure of the register.
RZ21-22 prepares the release of relay RZ by short circuit.

Relay RN (Fig. 4) releasing,
RN5-6 prepares the operate chain of the RH relays.
RN23-24 prepares the seizing circuit of the register.
RN25-26 short circuits relay RZ if TH1-3 is normal.
If relay TH is operated at this stage the release of relay RZ, and consequently the reseizure of the register by the next call is prevented.

Relay BA (Fig. 4) releasing,
BA21-22 disconnects the original operate circuit of relay RZ.
BA3-4 completes the self drive homing circuit of the 'tens' switch if the U switch wipers are in the home position ('1' or '12').
BA27-28 completes the self drive homing circuit of the 'unit' switch.

Relay RJ (Fig. 4) releasing,
RJ1-2 prepares the operate circuit of the RH relays.

Relay RZ (Fig. 4) releasing,
RZ3-4 allows the operation of relay RS and consequently allows the reseizure of the register.

The register is now ready for the next call.
Relays K and LR in the Line Circuit, and relays A, B, D, PG and T in the Connector are operated at this stage.
Dial tone is returned from subsequent equipment. Impulse trains are repeated by relay A to the +ve leg to control subsequent equipment.

Dialling a Spare Code.

All T4 bank terminals associated with spare codes are commoned and connected to the M bank outlet '11'.

When the last impulse of the digit has been received relay RC releases.

Relay RC (Fig. 4) releasing,
RC1-2 causes the U switch wipers to step to contact '1' or '13'.
RC21-22 operates relay RH.

Relay RH (Fig. 4) operating via earth, RJ1-2, RN6-7, RZ5-6, T3 wiper and bank contact 6 to 10 and 17 to 21 common, RC21-22, RH (a-b) winding, 250 ohm resistance battery common.
RH23-24 extends 50 ohm resistance (combined resistance of R1A and R1B) battery via wiper T4, T bank terminal common, terminal MH to outlet '1' of the M bank.
The other RH contacts perform the functions described in the preceding paragraph.

When the connector wipers reach line '11' relays RJ and T operate in series to resistance battery extended via RH23-24, RZ23-24 to the MH terminal and thus to the M bank contact '11'.

Relay RJ — operating performs the functions described previously in 'Dialling a first digit associated with a tie line or special service call' (page 6).

Relay T — operating and holding in series with relay RJ performs the functions described previously (page 7) except that

T26-27 — extends earth from B3-4 and D23-24 to the P lead (Fig. 5) to operate the busy hold relay (NA) in the Ringing and Tones Unit.

Relay D — operates and performs the functions described previously (page 7) except that

D1-2)
D21-22) — extend the calling line to line No. 11.

D23-24 — retains the busy hold relay (see T26-27).

Subsequent operations occur as previously described for 'Dialling a first digit associated with a tie-line or special service call' (page 7).

Relays K and LR (calling line circuit) and relays A, B, D and T in the connector are operated. Busy tone is transmitted from the Ringing and Tones Circuit via the busy tone lead (Fig. 5) and the JKA jack to K24 i.e. the B wire of line 11 and consequently to the caller who abandons the call. Relays A, B, D, T, K and LR release and restore the equipment to normal.

It may be noted that the dialling of the staff call digit '7' by a 'staff call barred' extension (relay TB is operated in this case) causes at TB2-3 the switching of the marking battery from terminal SC to terminal MH. The barred extension is thus switched to line '11' and receives busy tone.

3.3 Dialling the Units Digit

(Continued from para. 3.1 'Dialling a first digit '1' to '5').

Relays K and LR in the line circuit, relays BA, RA, RB, RF, RN, RT, PP (on calls from preference extensions) and TB (on calls from 'staff call barred' extensions) are operated prior to the dialling of the 'units' digit.

The 'T' switch wipers are on contact 1 to 5 dependent on the 'tens' digit dialled, the 'U' switch wipers are on contacts '1' or '13'.

Relay RA follows the impulses of the calling party's dial and repeats them at RA21-23 to the U switch magnet.

On the first release of relay RA relay RC operates in series with the U - magnet.

Relay RA — (Fig. 4) releasing,

RA21-23 — extends earth via BA1-2, RC winding, U2 wiper on contact '1' or '13' to the U magnet which operates.

Relay RC — (Fig. 4) operates and holds during impulsing.

RC1-2 — provides the impulsing circuit of the U magnet when the U2 wiper leaves contact '1'.

RC21-22 — disconnects relay RH during the U switch stepping period.

Relay RA — (Fig. 4) re-operating when the dial springs re-make,

RA22-23 — disconnects relay RC and the U-magnet, and re-energizes relay RB.

The U-magnet releases and steps the wipers to the next contact.

As the remaining impulses of the 'units' train are received, relay RC and the U-magnet are energized at each release period of relay RA, and disconnected at each operate period of relay RA. The U-magnet steps its wipers forward at each operate period of relay RA (reverse drive action).
Relays RB and RC both hold throughout the train of impulses due to their slow release features (slug on relay RB, slug and shunt on relay RC).

On the conclusion of dialling relay RA re-operates and remains held to the calling loop. The U switch takes the final step and relay RC releases.

Relay RC (Fig. 4) releasing,
RC1-2 prevents further stepping of the U switch.
RC21-22 operates relay RH if no short circuiting earth is extended to the 250 ohm resistance battery common by the RH relay of register No. 2.

3.4 Unloading of the Register

Relay RH (Fig. 4) operates in circuit:- earth on U point 24, RJ1-2, RN6-7, RZ5-6, T3 wiper on bank contact 1 to 5 or 12 to 16, U3 wiper on bank contacts 2 to 11 or 14 to 23, T3 bank contact 6 to 10 and 17 to 21 common, RC21-22, RH (a-b) winding, 250 ohm resistance battery.
RH1-2 retains relay RH to earth at RB1-2
RH3-4 prepares the test circuit of relays RJ and T.
RH5-6 extends earth to the resistance battery common (U14) to prevent the RH relay of the other register from operating while this register is un-loading. This reserves the marking bank M for the unloading register thus preventing wrong connections.
RH21-22 completes the self drive circuit of the connector magnet.
RH23-24 extends a 50 ohm resistance (combined resistance of R1A and R1B) battery for marking purposes to the M bank via RZ23-24, T wiper on bank contact 1 to 5 according to the 'tens' digit dialled, U4 to U8 wiper (associated with the T4 bank contact on which the T4 wiper is positioned), U4 to U8 bank contact 2 to 11 according to the 'unit' digit dialled, strapping to M bank contacts 1 to 50.

The connector switch self drives until the line marked on the M bank by the extension of the 50 ohm resistance battery is reached and relays RJ and T operate.

Relay RJ (Fig. 4) operating in series with relay T to battery on the M bank contact.
RJ2-3 extends earth to the U point 24 of the other register.
RJ21-22 cuts the connector switch drive.
RJ24-25 releases relay RH and retains relay RJ independently of RH3-4.

Relay T (Fig. 2A) operating in series with relay RJ.
T21-22 ('X' action) retains relay T to earth at RF4-6 and later to earth at B22-23.
T5-6) disconnect relay RA and extend the calling loop to relay A and the
T24-25) transmission bridge.
T26-27 completes the test circuit for relay H.
T28-29 disconnects the linefinder magnet.

Relay A (Fig. 2A) operating to the calling loop,
A2-3 operates relay B. (Slow operate to allow relay H time to operate via B3-4).
A22-23 controls the operation of relay PR on calls from preference extensions and when optional preference facility is provided.

3.5 Called Extension Free

Relay H (Fig. 2A) operates in circuit:- earth. B3-4, H windings in series, T26-27, P wiper, to battery via relay K in the called extension's line circuit.

H1-2 extends earth to the +ve wire (ring return earth)

H4-5 operates relay PG.

H7-8 prepares a hold circuit for relay F.

H21-22 extends earth via the 20 ohm winding of relay H to the P wire, to busy the line against the operation of other H relays.

H23-24 prepares the ringing circuit.

H26-27 completes the ring tone and start circuit.

Relay PG (Fig. 2A) operating,

PG1-2 retains relay PG.

PG4-5 disconnects relay PR and returns earth on the M lead after relay B has operated.

Relay RA (Fig. 4) releasing,

RA21-23 releases relay RB.

Relay B (Fig. 2A) operating,

B1-2 extends ringing current via relay F to the -ve leg.

B3-4 disconnects the original test earth from relay H.

B5-6 disconnects R2 - battery from the RS1 bank contact to retain the busy condition of the connector on the register bank.

B22-23 retains relays T, PG and F (after its operation) and releases relay RF by short circuit. Holds relay K in the Line Circuit.

B25-26 extends earth from PG4-5 to the M lead to release relay S in the 2-party line circuit if the call originates from a party line subscriber. Releases relay PF if operated.

Relay RF (Fig. 4) releases to the short circuiting earth from B22-23.

Relay RH (Fig. 4) releases when relay RJ operates.

RH1-2 disconnects the (d-e) winding of relay RH.

RH3-4 disconnects the original operate circuit of relays RJ and T.

RH5-6 disconnects earth from the 250 ohm resistance battery common to allow the operation of the RH relay of the other register.

RH23-24 disconnects marking battery from the M bank contact.

Relays RB, RT, BA, RJ and RN release consequently.
Relay RZ operates when RB3-4 restores and releases when RN25-26 and TH1-3 are normal.

The register switches T and U return to their home positions.
The register releases as previously described in para. 3.2 under the heading 'Dialling a first digit associated with a tie-line or special service call'.

Ringing conditions are applied to the called line and ring tone is returned to the caller by the transformer action of the relay A windings.
Relays A, B, H, PG and T in the connector, and relays K and LR in the line circuit of the calling party are operated at this stage.

3.6 Called Extension Busy - Intrusion of Preference Party

(Continued from para. 3.3)

If the called extension is engaged relay H will not operate due to the disconnection of relay K - battery from the P wire (if the called extension

is engaged on an outgoing call) or due to earth encountered on the P wire (if the called extension is engaged on an incoming call).
The register releases as described previously.

Busy tone is extended via T2-3, D5-6, H25-26 to relay A for transmission to the caller.

Relay B	(Fig. 2A) operating,
B1-2	prepares the ringing circuit on calls from preference extensions.
B3-4	disconnects earth from relay H to prevent its operation should the called extension subsequently become free.
B5-6	busies the connector on the register RS1 bank.
B22-23	retains relay T and later relays D and F. Holds relay K in the Line Circuit.
B25-26	prepares the operation of relay PR if optional preference working is provided or operates relay PR on automatic preference working, if the call is from a preference party.

If the call is from an ordinary extension the call will have to be abandoned.

If automatic preference facility is provided and the call is from a preference party

Relay PR	operates via strap U26-U22, PG3-4, B25-26, to R1 - battery (Fig. 1A) on the M lead.
PR21-22	on optional preference working retains relay PR.
PR24-25	disconnects busy tone and prepares the intrusion tone circuit.
PR26-27	operates relay D.
PR28-29	prevents the operation of relay PG.

If optional preference facility is provided the calling extension dials '1' to operate relay PR during the release period of A21-23 (strap U22-U26 is deleted in this case, see Note 11 on Dgm.).

Relay D	operating via R1 battery (Fig. 1A), M lead, B25-26, PG3-4, A22-23, PR26-27, D (a-b) winding, earth.
D1-2) D21-22)	extend the calling line through to the engaged parties.
D3-4	provides an alternative hold circuit of relay D.
D6-7	completes the connection of intrusion tone to relay A tone coil.
D23-24	restores the test circuit of relay H.

The preference party may now speak to the required extension. Should the caller wish a private conversation the wanted party is asked to replace the receiver.

Relay H	operates (when the required party has complied and replaced the receiver) in circuits:- earth D23-24, H windings in series, T26-27, P wiper to battery via relay K in the called party's line circuit.
H1-2	connects earth to the +ve leg (ring return earth).
H4-5	operates relay PG.
H7-8	prepares a hold circuit for relay F and disconnects a hold circuit of relay D.
H21-22	holds relay H and busies the called line.
H23-24	extends ringing to the -ve leg of the line.
H26-27	disconnects intrusion tone and connects ring tone to relay A.

Relay PG	operating to earth at B22-23.
PG1-2	retains relay PG.
PG4-5	releases relays PR and D.

Relay PR releasing, performs no useful functions.

Relay D releasing,
D1-2)
D21-22) open the intrusion path.

Ringing conditions are now applied to the called line and ring tone is transmitted to the caller.
Relays A, B, H, PG and T in the connector, and relays K and LR in the calling party's line circuit are operated at this stage.

3.7 Called Party Answers

(Continued from paragraphs 3.4 or 3.5)

When the called party lifts the receiver

Relay F operates to the d.c. component of the ringing current via the called party's instrument loop.

F21-22 ('X' action) removes the short circuit from the (a-b) winding of relay F which locks to earth at B22-23 and after the release of relay H to earth at D25-26.

F1-2 prevents inadvertent impulsing from affecting line conditions.

F3-4 busies the connector on the register RS1 bank when the calling party clears first i.e. relay B releases.

F6-7)
F24-25) disconnect ringing conditions from, and connect relay D to the called line.

F26-27 connects full earth to the outgoing P lead to busy the called line and releases relay H by short circuit.

F28-29 prevents the establishing of an alternative hold circuit of relay D under control of the calling party.

Relay D operates to the current feeding the called party's telephone.

D1-2)
D21-22) complete the speech path.

D25-26 retains relay F when H6-7 restores.

D27-28 retains relay PG when relay H releases.

Relay H releasing when F26-27 makes,

H26-27 disconnects the ring tone circuit.
The other H contacts prepare the normal condition of the circuit.

Speaking conditions are now established between both parties.
Relays A, B, D, F, PG and T in the connector and relays K and LR in the calling party's line circuit are operated at this stage.

3.8 Release

When the called party clears first,

Relay D releases to the disconnection of the called extension's loop.

D1-2)
D21-22) open the speech path.

D3-4 disconnects relay D prior to the release of F28-29.

D5-6 extends busy tone to relay A for transmission to the calling party.

D23-24 disconnects earth from relay H.

D25-26 releases relay F.

D27-28 disconnects an alternative hold circuit of relay PG.

Relay F releasing,

F26-27 releases the called party's line equipment.

This party may now originate or receive further calls.
The other F contacts prepare the normal condition of the circuit.

The circuit remains in this condition with relays A, B, PG and T in the connector, and relay K and LR in the line circuit of the calling party operated until this party also clears.
Busy tone is transmitted to the calling party as an indication of the called party's clearing.

When the calling party clears,

Relay A releases to the disconnection of the calling loop.
A1-3 releases relay B.

Relay B releasing,
B5-6 re-connects R2 - battery to the RS1 bank to free the connector for seizure by the register.
B21-22 releases relays T and PG in the connector and relay K in the calling party's line circuit.

If the called extension has not cleared at the time when the calling party replaced the receiver, relays D and F remain held and F3-4 retains the busy condition of the connector on the RS1 bank. Contact D6-7 extends busy tone via T1-2 to relay A for transmission to the called party.

3.9 Fault Conditions

Permanent Glow (P.G.) Condition

Relays K, LR (both in the Line Circuit) BA, RA, RB, RF, RN, RT, TB (if the line is associated with a 'staff called barred' extension) and PF (if the line is that of a preference extension) are operated at this stage.

Relay TH (Fig. 4) is a thermal relay and operates within 25 to 40 secs.
TH3-5 operates relay RZ.

Relay RZ operating,
RZ21-22 ('X' action) prepares a short circuit for relay RZ.
RZ1-2 holds relay RZ independently of relay TH.
RZ3-4 renders the re-operation of relay RS that is the seizure of the register dependent on the release of relay RZ.
RZ6-7 operates relay RH.
RZ24-25 prepares the marking circuit of the hold circuit associated with outlet '11'.

Relay RH operates and performs the functions described previously in paragraph 3.2.

Subsequent operations occur as previously described in paragraph 3.2 under 'Dialling a Spare Code'. The connector seizes line '11' and busy tone is transmitted to the faulty line. The register is released. Relays K, LR (line circuit) and A, B, T in the Connector are operated until the PG condition is cleared.