PRIVATE AUTOMATIC BRANCH EXCHANGE NO. 3

CONTENTS

Introduction

The Private Automatic Branch Exchange (PABX) No. 3 is usually bought by the customer from a Post Office approved contractor who will design and install the equipment to meet the specific requirements of the customer. The incoming cable terminations, the wiring and fitting of the telephones, the power plant, and the general maintenance of the installation are the responsibility of the Post Office.

The PABX No. 3 is designed to meet the needs of business organisations and is capable of expansion from time to time as required. Initially it can provide up to 800 extensions but may be extended to accommodate up to 1200 extensions. By using a different type of switchboard it can be further extended up to a maximum of 4000 extensions.

Outline of Equipment

The PABX No. 3 employs 50-point uniselectors as linefinders, with 2000 type group selectors and final selectors. The relay sets are generally standard "jack-in" type and all equipment is mounted upon open type racks. The layout of the equipment varies somewhat between manufacturers, but generally an installation consists of three types of rack;

(a) Line and Final Selector rack,

(b) Group Selector rack,

(c) Relay Set rack.

However, it is usual for small installations to have the group selectors and relay sets combined on the same rack. The equipment is mounted on single-sided open type racks using the following apparatus:

2000 or 4000 type, 100 outlet, two motion selectors

PO type 2 uniselectors used as linefinders

600 type relays for extension line circuits

3000 type relays for general use and in relay sets

High speed relays used in testing circuits.

The mounting of equipment on racks is such that the installation may easily be extended in multiples of 50 extension lines.

Main Facilities

The following facilities can be provided at a PABX No. 3 installation:

(1) Automatic connexion of dialled extension to extension calls.

(2) First party release. If, once an extension to extension call is established, either party replaces the receiver the call will clear down.

(3) Direct access to the public exchange, ususally obtained by dialling 9. This facility can be withdrawn from an extension if required, (barred access).

(4) Direct access to another PBX, usually obtained by dialling 7 or 8.

(5) All incoming exchange calls are received at the switchboard and may be extended by means of cord circuits to the required extension.

(6) Enquiry. Whilst engaged on an exchange line or inter-PBX call an extension can:-

(a) hold the call, dial another extension to make an enquiry and later return to the original call, or

(b) call the operator into the circuit. Automatic transfer facilities are not allowed on a PABX No. 3 but calls may be transferred by the operator.

(7) Trunk offering. The operator can, by using special trunk offering cords, interrupt a busy extension to offer another call.

(8) Direct access to the operator is obtained by dialling 0.

(9) Satellite working. One or more satellite PBX's may be provided at distant premises, up to 6.5 kilometres away, and are connected to the main installation by special lines (junctions). Extensions at a satellite exchange can call each other using the satellite equipment and can dial extensions in the main installation using the special lines. Incoming exchange calls are received at the main exchange and may be extended to the satellite via the satellite junctions which can be taken from a level of the 1st selector at the main, more than one level being used if more than one satellite is provided. A satellite extension cannot dial an extension on another satellite direct, but must go via the main exchange.

(10) Night service can be provided by connecting individual exchange lines to selected extensions, or by having a separate small night service switchboard.

(11) Manual Extensions. Two types of manual extension circuit may be provided, one where both incoming and outgoing calls are first received by the switchboard, the other where the extension can receive incoming calls directly.

Trunking

Fig. 1 shows the general trunking arrangements of the PABX No. 3.

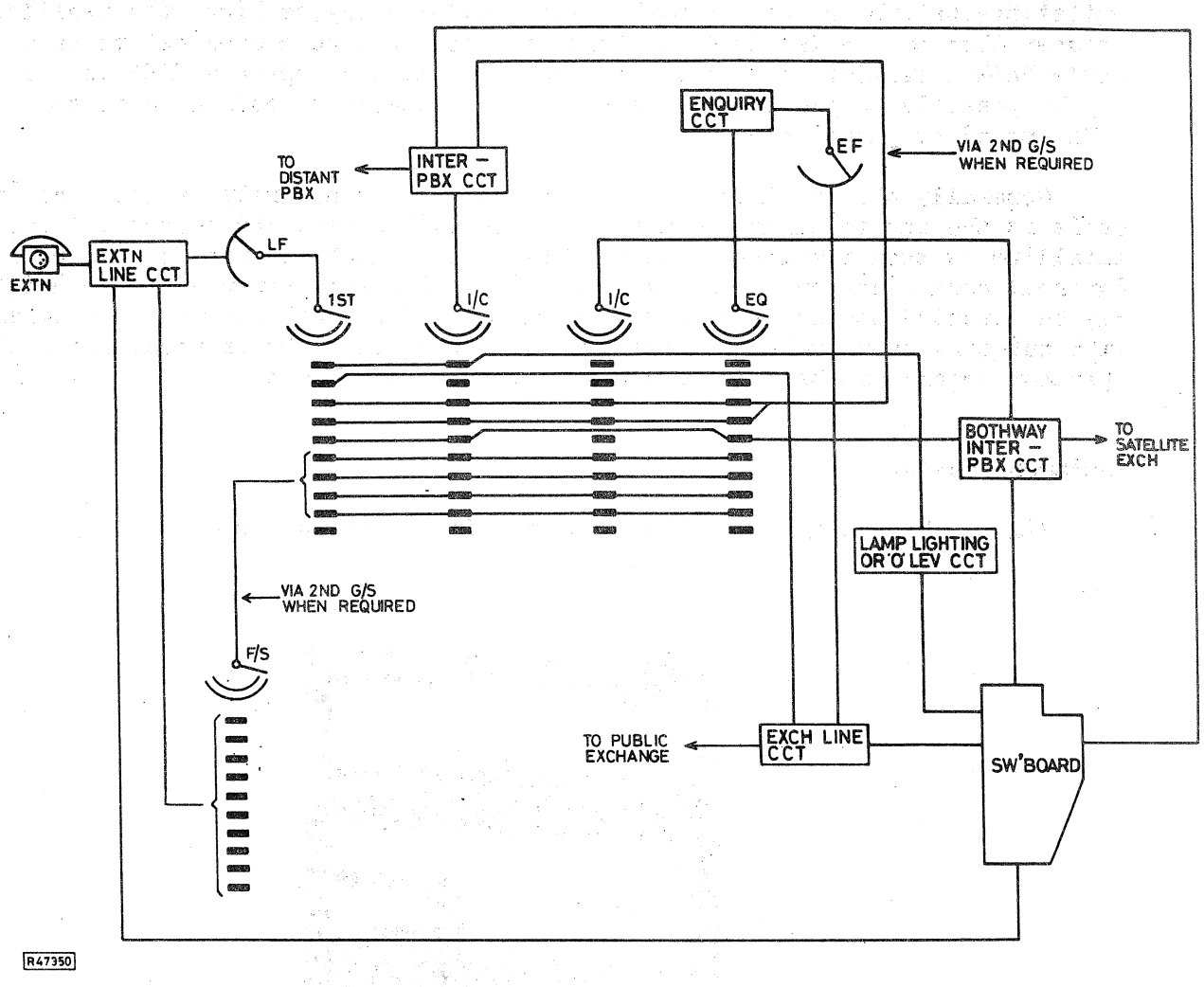

Fig. 1

Depending upon the size and ultimate capacity of the installation either a three-digit, a four-digit, or a mixed three- and four-digit numbering scheme can be provided. Fig. 1 shows a three-digit scheme. The selector levels of the first group selector are allocated as follows:

Level	Allocation
0	PABX operator
9	Exchange lines
8	Inter PBX circuits, direct or via 2nd G/S's
7	
6	Satellite extensions
5	Extensions
4	
3	
2	
1	Spare

Satellite Working

The customer's premises may spread geographically over a wide area, e.g. the office building may be several kilometres from the factory site, so that whilst the telephone traffic within each building may be high, the traffic between them may be fairly low. Since it would not be economical to have the whole PABX installation in one building or to have a separate PABX in each, it may be possible to provide a dependent PABX (satellite) connected to the parent PABX (main) by junction routes.

Generally the building which is to receive the majority of the incoming calls is the one in which the main PABX and switchboard are housed and the satellite is then installed with sufficient equipment to provide for its own internal communication needs. All incoming calls are answered at the main and may be extended to the satellite if required. The satellite may be provided with outgoing only exchange lines but no enquiry facility is permitted although operator recall can be made on a call via the switchboard.

Equipment Layout

Fig. 2 shows a typical PABX3 line and final selector rack.

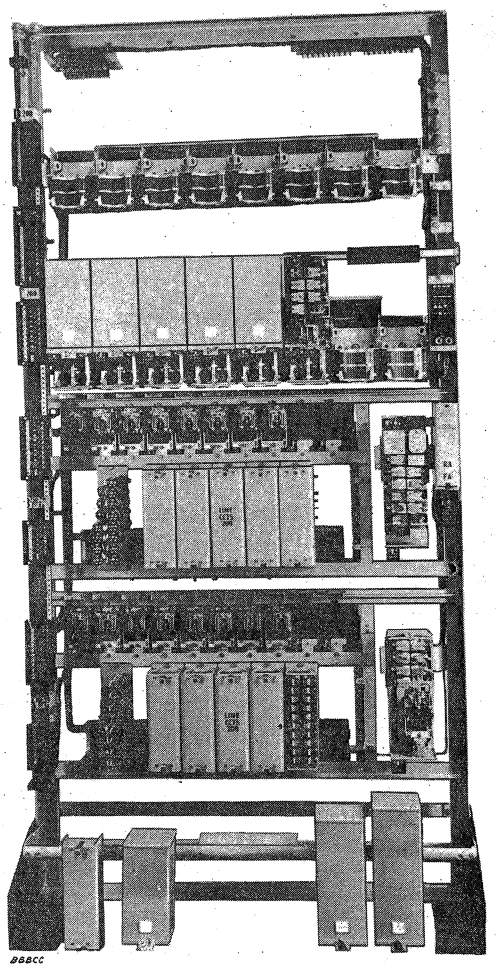

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Fig. 2

The extension line circuits are arranged in groups of 50 to form linefinder groups, each group having up to ten 50-point linefinders. Two linefinder groups are mounted on the lower shelves of each line and final selector rack; the upper shelves accommodate up to sixteen 100-line final selectors that provide access to the extensions on that rack. The final selectors may be of the PBX2-10 type if automatic hunting over a group of extensions is required.

Two line and final selector racks share the same common equipment (consisting of two relay sets mounted on one of the racks as shown in Fig. 2 with covers off) to form a 200 extension line unit.

Each linefinder is connected to a local first group selector mounted on a separate group selector rack. The selectors serving a particular linefinder group are all mounted on one shelf, which may accommodate up to ten selectors, and the group selector rack has five such shelves. Incoming first selectors and enquiry selectors may be mounted either in unequipped positions on local first selector shelves or on separate shelves.

Relay sets such as exchange line circuits, inter-PBX circuits, etc. may be mounted on separate racks or may be mounted on racks containing other equipment, the actual arrangements depending upon the number of relay sets to be provided and also upon the number of spare positions on a rack.

The Switchboard

Fig. 3 shows a typical PABX No. 3 manual suite.

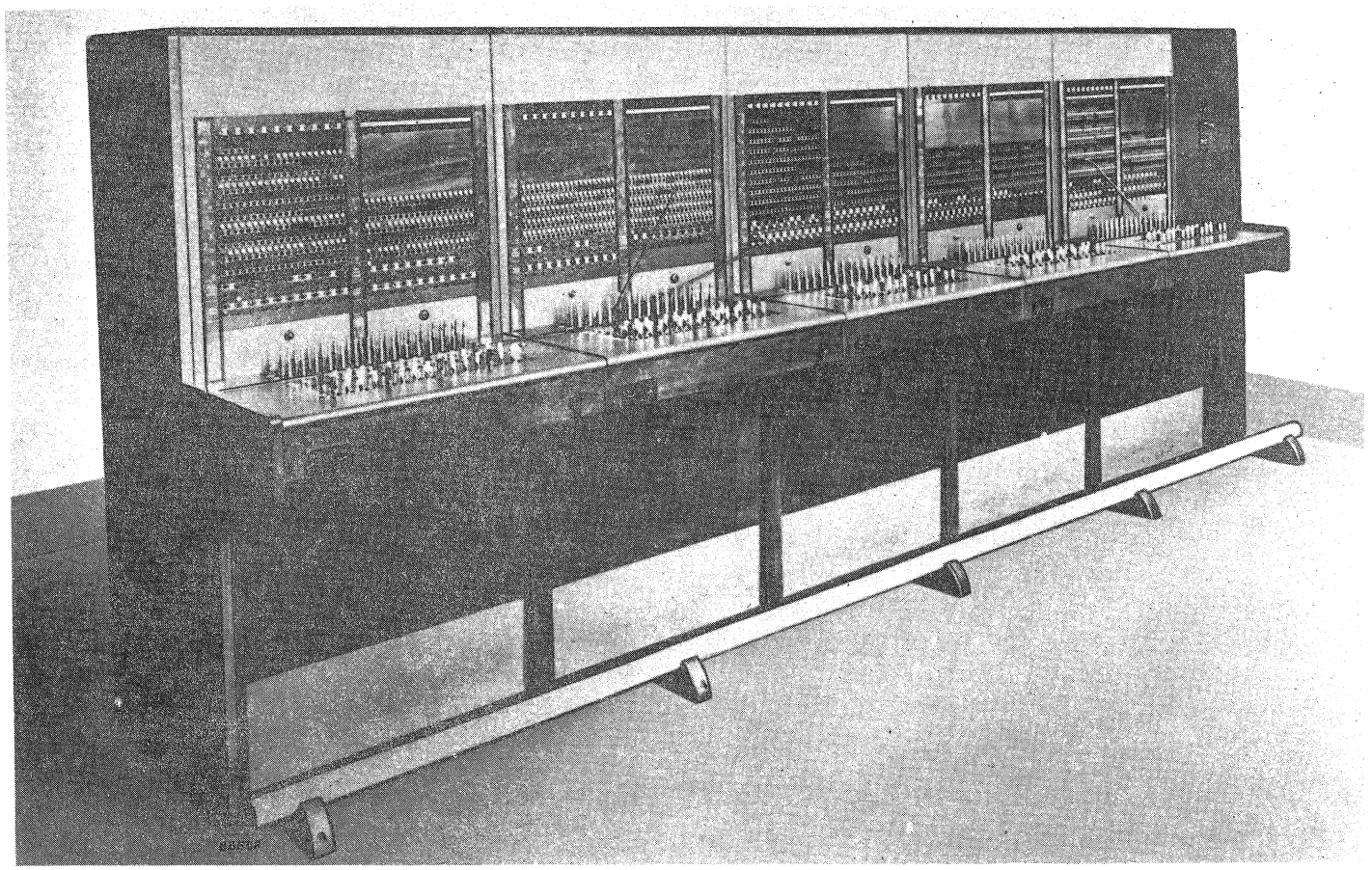


Fig. 3

R47369

The cord type switchboard is assembled in sections the number of which is etermined by the size of the installation. A section consists of two panels ach having a capacity of 40 exchange lines and 200 extensions. A four-panel ultiple is adopted, i.e. an extension's line jack is repeated after every fourth anel, so that 160 exchange lines and 800 extensions can be accommodated on four anels.

For installations with an ultimate capacity not exceeding 1200 extension he multiple is arranged in one of two ways. In the first, where there are not ore than 800 extensions, each extension has an individual calling lamp and jack lamp per line working). The lamp is lit by a lamp lighting circuit when the xtension calls the operator. In the second, where 800 extensions are exceeded, he whole multiple space is used for extension line jacks only and strips of lamps nd jacks are fitted separately and exclusively for 0 level calls. This increases he multiple range up to 1200 extensions using the standard type board; however by ncreasing the height of the board a multiple of up to 200 extensions may be rovided. Above this number, the ultimate capacity being around 3000 extensions, he switchboard is specially constructed and is similar to the sleeve control anual board found in a public exchange.

he Cord Circuit

The cord circuit is of the universal type, i.e. it is designed to become ither bridge control or sleeve control automatically, according to the type of ircuit to which it is connected. Fig. 4 (appended) shows the outline details f the cord circuit.

Under BRIDGE control, i.e. on local extension-to-extension and extension-to- nter-PBX calls, it is the cord circuit that provides the transmission current, he battery and earth supplies being fed via supervisory relays bridged across he tip and ring conductors of the cord circuit. These relays operate independently s each extension's telephone loop is applied to the answering or calling cord, nd they control the answer and calling supervisory lamps.

Under SLEEVE control, i.e. on exchange line calls, the transmission current s supplied by the public exchange and through clearing is required. Once the all is established a through metallic connexion is provided by the tip and ring onductors, whilst the supervisory lamps are connected to the sleeve conductor of he cord circuit and are controlled by conditions returned from the exchange line ircuit.

Bridge Control

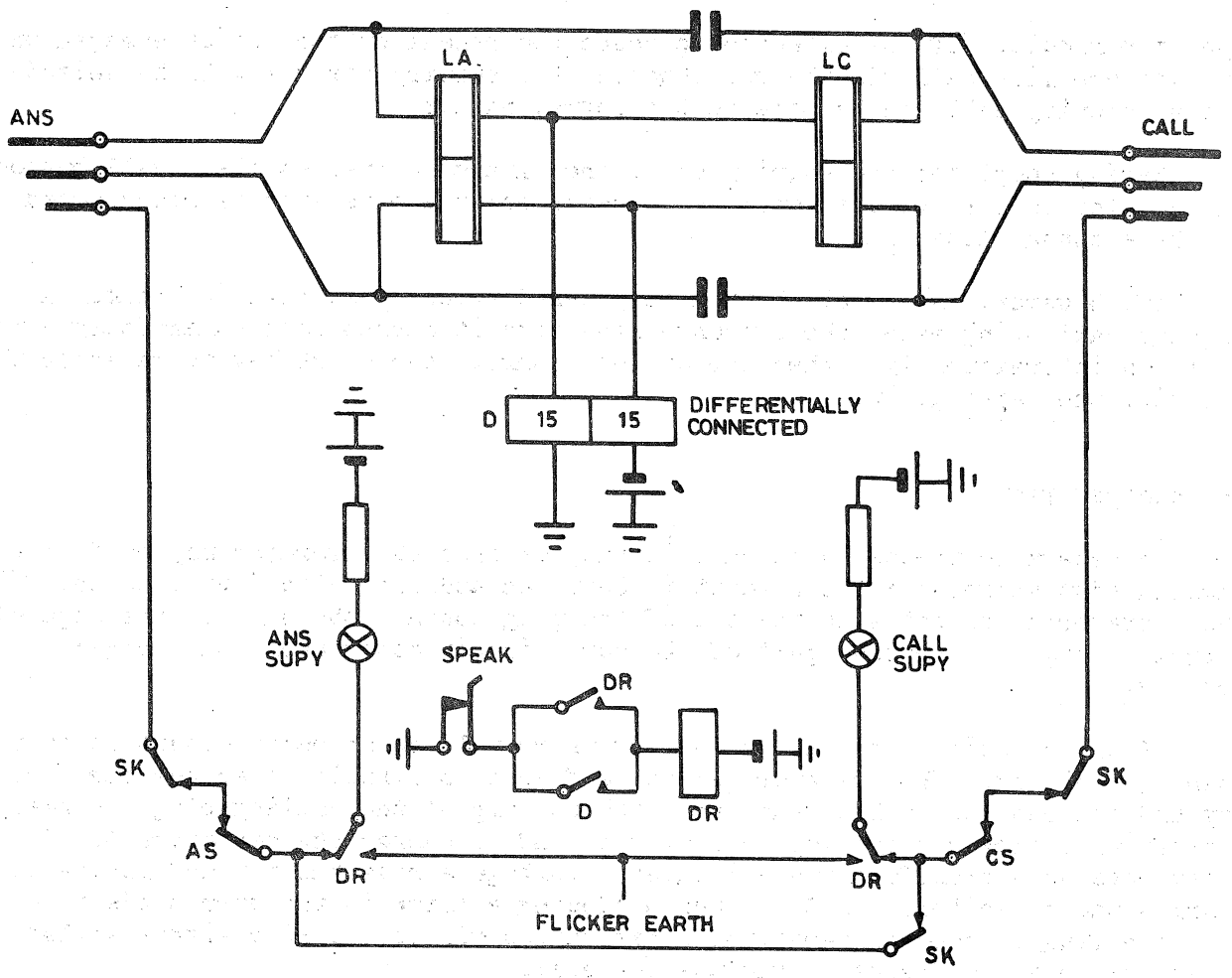
When answering a calling extension the operator will throw the speak key of a free cord circuit; relays SK and SR both operate. As the answer cord is plugged into the extension's line jack relay AS operates to the 250 ohm battery conditon on the bush of the jack. Relay LA operates to the extension's telephone loop and prevents the answer supervisory lamp from glowing. The operator can now speak to the caller.

If the call is to be extended to another extension the operator performs an engaged test on the required circuit and if it is free, the calling plug is inserted; relay CS operates and the calling supervisory lamp glows. The cord circuit is now under BRIDGE control.

The operator will manually ring the extension using the ring key; when the extension answers relay LC operates and the calling supervisory lamp goes out. By restoring the speak key the operator can withdraw from the circuit leaving the supervisory lamps under the control of relays LA and LC. The lamps will glow as each extension subsequently clears.

Operator recall. Should either extension press the recall button on the telephone both cord circuit supervisory lamps will start to flash intermittently to recall the operator. When the operator throws the speak key to enter the circuit the lamps darken.

The transmission current from the cord circuit is fed via a differentially connected relay, Fig. 5, which under normal conditions does not operate. However, when the recall button is pressed the telephone loop is earthed and the relay operates causing relay DR also to operate and hold. DR contacts connect both supervisory lamps to the flicker earth supply causing them to flash. When the speak key is thrown to answer the call relay DR releases and the lamps darken.



CORD CIRCUIT

R 47351

Fig. 5

Sleeve Control

Referring to Fig. 4 (appended), when the operator plugs into a calling extension's jack, relays SK, SR, AS and LA will be operated as described under bridge control. Should the extension request an exchange call the operator will plug the calling cord into a free exchange line jack.

Relay LC operates to battery and earth conditions from the exchange line circuit but there is no condition on the sleeve conductor to operate relay CS. An LC contact releases relay SR which in turn releases relays LA and LC. The cord circuit is now under SLEEVE control.

Upon the return of dial tone the operator may either dial on behalf of the extension or restore the speak key to allow the extension to complete the call When the speak key is restored relay SK releases and both supervisory lamps are connected, in parallel, to the sleeve conductor. The lamps do not glow, however, since relay Z in the exchange line circuit operates upon the seizure of the public exchange equipment and a Z contact changes the condition on the bush of the jack from a full earth to a 2000 ohm earth.

Operator recall. If the extension presses the recall button whilst engaged on an exchange line call via the switchboard, the enquiry circuit will be seized and an enquiry call can be made in the normal manner.

Having completed the enquiry call, the extension presses the recall button again. The enquiry circuit will be released and the extension is reconnected to the exchange line call.

If, however, the recall button is pressed twice in succession without an enquiry call being made, the exchange line circuit causes both supervisory lamps to flash intermittently. When the operator throws the speak key to re-enter the circuit, the lamps go out.

The Engaged Test

To determine whether a circuit is busy or free the operator may perform an engaged test whereby if the circuit is busy, an audible "click" will be heard in the operator's headset when the tip of the plug touches the bush of the engaged circuit. Fig. 6 shows that part of the cord circuit concerned with engaged testing.

If the circuit to be tested is busy there will be an earth condition on the bush of the jack. The operator selects a free cord circuit, operates the speak key and touches the bush of the jack with the tip of the calling plug. A small current will flow via the top coil of relay LC to charge the capacitor A. The relay acts as a transformer and induces a voltage across the tip and ring which charges the capacitors B and C, thus producing a click in the operator's telephone. When the plug is removed capacitor A discharges via the 22 kΩ resistor whilst capacitors B and C discharge via the LC relay.

If the circuit to be tested is free there will be either a disconnexion or a battery condition on the bush, neither of which will allow capacitor A to be charged and no click will be produced.

ENGAGED TEST CCT

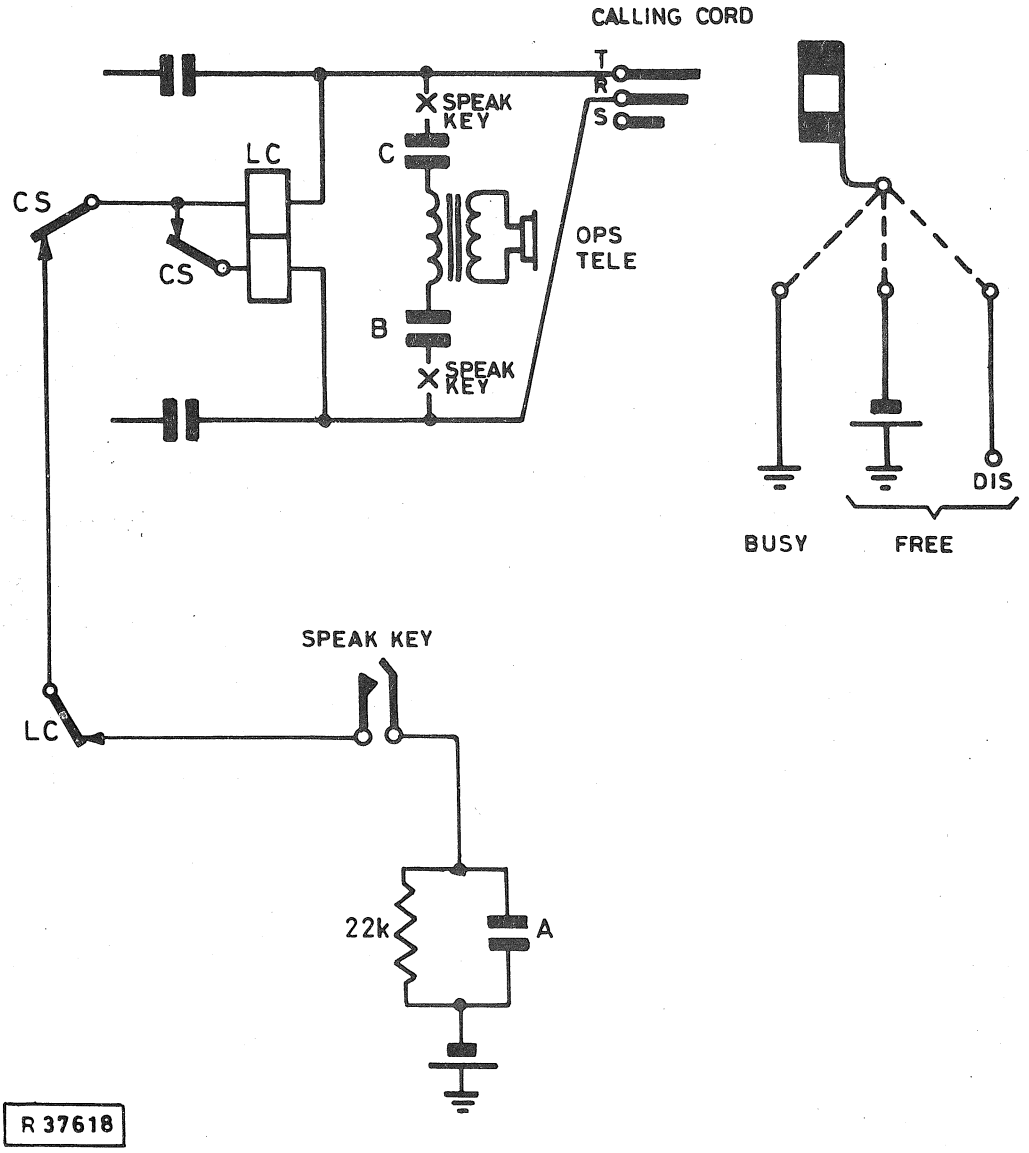


Fig. 6

Local Calls

The Start Chain

To ensure an even distribution of the calling traffic the 'In' and 'Out' leads of the ten 1st selectors in each group are wired to arcs of the PS uniselector which acts as a start signal distributor. Fig. 7 shows one of the uniselector arcs.

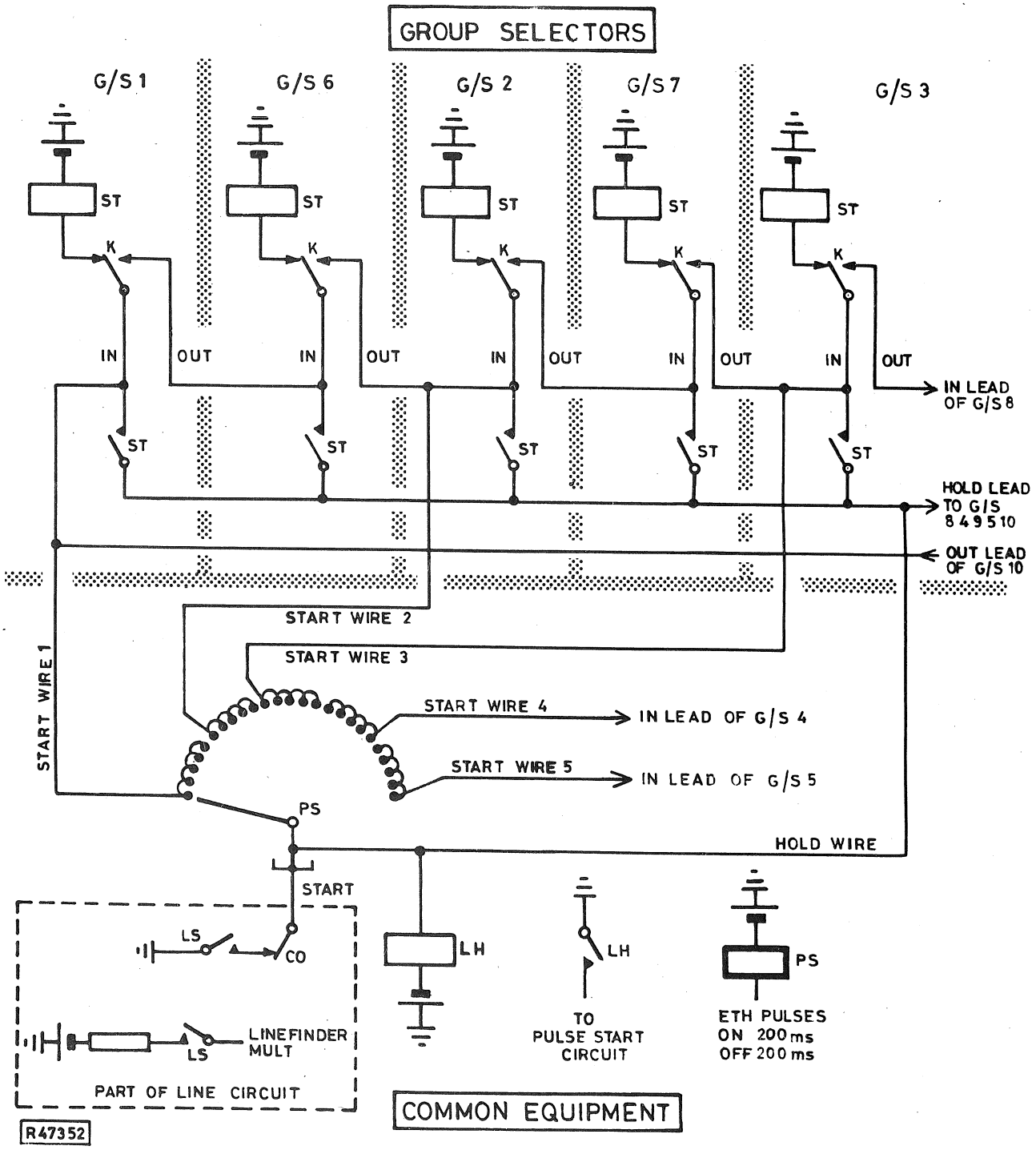


Fig. 7

The arc is connected to a start chain by five start wires, each of which enters the start chain at a different point to spread the traffic evenly.

The start chain is wired in the selector order 1, 6, 2, 7, 3, 8, 4, 9, 5 and 10 so that as the PS uniselector steps, the next selector to be seized depends on:

(i) the outlet on which the PS wipers are standing, and

(ii) the state of the selector connected to that outlet, and if the selector is busy,

(iii) the state of the next and subsequent selectors in the start chain.

When an extension calls, relay LS in the line circuit operates to the telephone loop. An LS contact marks the extension's position in the linefinder multiple with a 250 ohm marking battery, whilst another LS contact extends an earth to the common equipment to operate relay LH. This same earth is connected to a PS wiper and the hold wire of the 10 group selectors available to the extension. Relay LH in operating causes the pulse circuit to step the PS uniselector once every 400 milliseconds.

If the PS wipers are in the position shown in Fig. 7, the calling earth is extended to the 'In' lead of group selector No. 1; if the selector is free, relay ST will operate and hold via one of its contacts to the earth on the hold wire. If the selector is busy, relay K will be operated and the start condition will then be extended via the 'Out' lead to the next selector in the chain, and so on until a free selector can be found. Once a selector is found, its ST relay will operate and hold to the earth on the hold wire. Later, when relay K operates the extension is switched through to the selector, the start chain is closed to release relay ST, whilst the CO relay in the line circuit operates and disconnects the start condition.

The Group Selector

Fig. 8 (appended) shows the outline details of the extension line circuit and the connecting circuit.

Seizure. When an extension lifts the receiver the telephone loop operates relay LS in the line circuit. An LS contact connects a 250 ohm marking battery to the linefinder multiple whilst another LS contact extends an earth via the start lead and common equipment to the 'In' lead of a free group selector to operate relay ST. ST holds to the earth on the hold lead and an ST contact extends a 250 ohm battery to operate relay A. The A contact operates relay B and an earth is extended via a B contact to start the LF linefinder driving.

When the FT wiper finds the marking battery relay FT operates over its 7 ohm coil. The FT contact disconnects the linefinder drive circuit and operates relay K in series with the 3 ohm coil of relay FT to the marking battery. K contacts close the start chain, release relay ST, and switch the extension's loop through to hold relay A operated. When relay ST releases, an earth from a B contact holds relay K via one of its own contacts in series with relays LS and CO in the line circuit. CO operates and disconnects the start condition and the marking battery. Dial tone is returned to the caller via the tone coil of relay A.

Dialling. When the extension dials relay A responds to the impulsing and the A contact steps the vertical magnet VM. During the first dial break period relay A releases and the A contact extends an earth via a B contact and relay CD to energise the vertical magnet which causes the line wipers to step and the N springs to operate. Relay CD operates and will remain held for the duration of the pulse train. Relay B starts to slowly release being short circuited by the A contact, but will not in fact release since its release time is greater than the break period. At the start of the dial make period relay A re-operates and relay B is re-energised. The vertical magnet is released and relay CD starts to release slowly being short circuited by the A contact, but again CD will not fully release since its release time is greater than the make period.

During the inter-digital pause relay CD rleases and a CD contact completes a self-interrupted drive circuit for the rotary magnet RM via an FT contact. As the line wipers rotate the NR springs operate and relay FT, which is connected to the H line wiper, operates when a free outlet is found (a 250 ohm battery from the next selector). The FT contact disconnects the rotary drive circuit and operates relay H in series with the 3 ohm coil of relay FT to the battery condition on the H wiper. The extension's loop is switched through to seize the next selector and an H contact connects relay H in parallel with relays LS and CO, all three relays now holding in series with relay K to the earth on the H wiper from the next selector. An H contact extends an earth from a B contact to short circuit and release relay FT, and as the loop is switched through to the next selector relays A and B release leaving only relays H and K operated.

The Final Selector

Fig. 9 (appended) shows the basic circuit of the PABX3 final selector. As the extension's loop is extended to the final selector, relay A operates and the A contact operates relay B which connects an earth to the incoming H wire to hold the preceding equipment.

When the extension dials, the A contact steps the vertical magnet VM. During the first dial break period relay A releases and the A contact extends an earth via a B contact and relay CD to energise the vertical magnet causing the wipers to step and the N springs to operate. Relay B starts to release slowly and relay CD operates and will remain held for the duration of the pulse train. At the start of the dial make period relay A re-operates and relay B is re-energised. The vertical magnet is released and relay CD starts to release slowly but is re-energised during the next break period.

During the inter-digital pause relay CD releases and a CD contact completes a circuit for relay E to operate in series with the NR springs and the vertical magnet. An E contact changes over the pulsing circuit so that when the next digit is dialled the wipers will be positioned onto the required line by the rotary magnet RM.

The A contact, in pulsing, operates relay CD in series with the rotary magnet and as the wipers rotate the NR springs operate. Relay E now holds via a CD contact in series with an E contact and the vertical magnet battery. At the end of the pulse train relay CD releases and causes relay E to release slowly, during which time relay HT tests the called extension's line. Depending upon the state of the line the H wire will exhibit one of the following conditions; free - a 250 ohm battery, busy - an earth, spare - a disconnexion, PG fault - a 940 ohm battery.

Note PG (permanent glow) is a term used to describe a fault on a line which would cause a permanent calling signal

Called extension free. At the end of dialling when relay CD releases and starts the slow release of relay E, a 400 ohm earth is connected via a CD contact to the lower coil of relay HT which operates to the 250 ohm battery condition on the H wiper. The HT contact completes a circuit to operate relay H in series with the upper coil of HT; relay H then holds over its second coil. An H contact connects an earth to the H wiper to busy the line and to operate relays LS and CO in the line circuit.

At the end of the testing period when relay E releases, an E contact connects ringing current to the line via the F relay, whilst another E contact connects ring tone to the caller via the A relay.

When the called extension answers, relay F operates and disconnects the ringing current and ring tone. Relay HT is released, whilst transmission current is fed to the called extension via relay D which operates. D contacts reverse the polarity of the incoming + and - wires for supervisory purposes.

Called extension busy. If the called extension is busy the earth on the H wire will prevent relay HT from operating during the slow release period of relay E. When E has fully released a 250 ohm battery is connected via a CD contact to the lower coil of relay HT which operates to the busy earth condition on the H wiper. The HT contact completes a circuit to operate relay F which then holds over its second coil. An F contact connects busy tone to the caller via the A relay, and relay HT releases.

Called extension spare or PG. Under PG conditions relay LS in the line circuit is released but relay CO remains held, and a 940 ohm battery is connected to the H wire. If the called extension is spare the H wire is disconnected. During the testing period neither of these conditions will operate relay HT and when E has fully released number unobtainable tone is returned to the caller via the A relay tone coil.

First party release. To minimise the unnecessary holding of equipment it is arranged that as soon as <u>either</u> extension replaces the handset on a local call, the selector train will release and clear down, causing the other extension to go into a PG fault condition until that handset is also replaced.

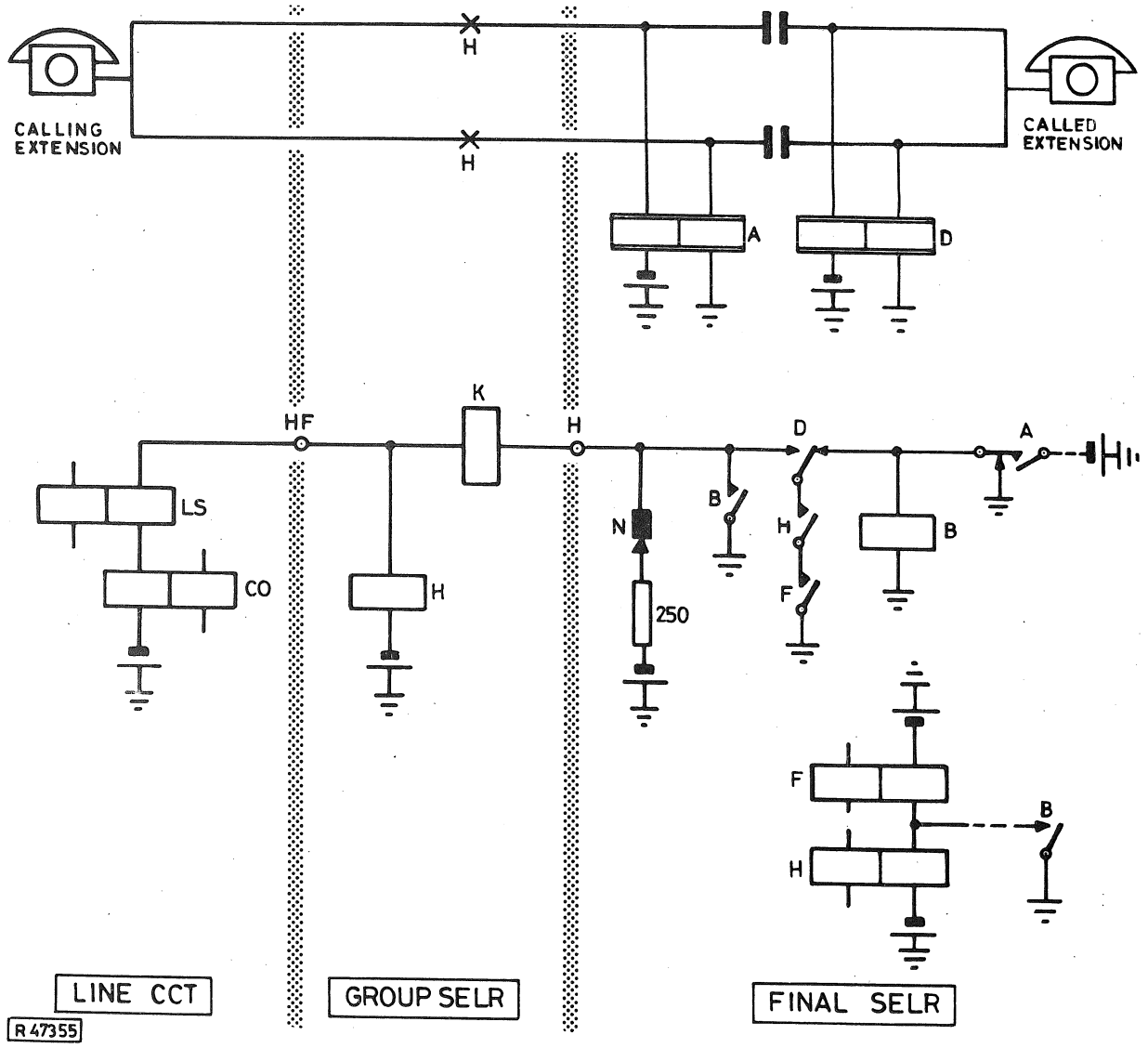


Fig. 10

It can be seen from Fig. 10 that the holding earth on the final selector H wire is supplied by a B contact and also by an F contact (via H and D contacts).

If the calling extension clears first the disconnexion of the loop will release relay A which in turn releases relay B. A contact of B will release relays F and H and the H contact will remove the holding earth from the H wire and the selector train releases.

If the called extension clears first relay D releases and a D contact short circuits and releases relay B. A contact of B removes the holding earth from the H wire and the selector train releases.

Calls to PABX Operator

Lamp Lighting Circuit

At installations having less than 800 extension, each extension has an individual calling lamp which is lit by a lamp lighting circuit (LLC) when the extension calls the PABX operator. This system is known as 'lamp per line working' and the outline circuit operation is shown in Fig. 11.

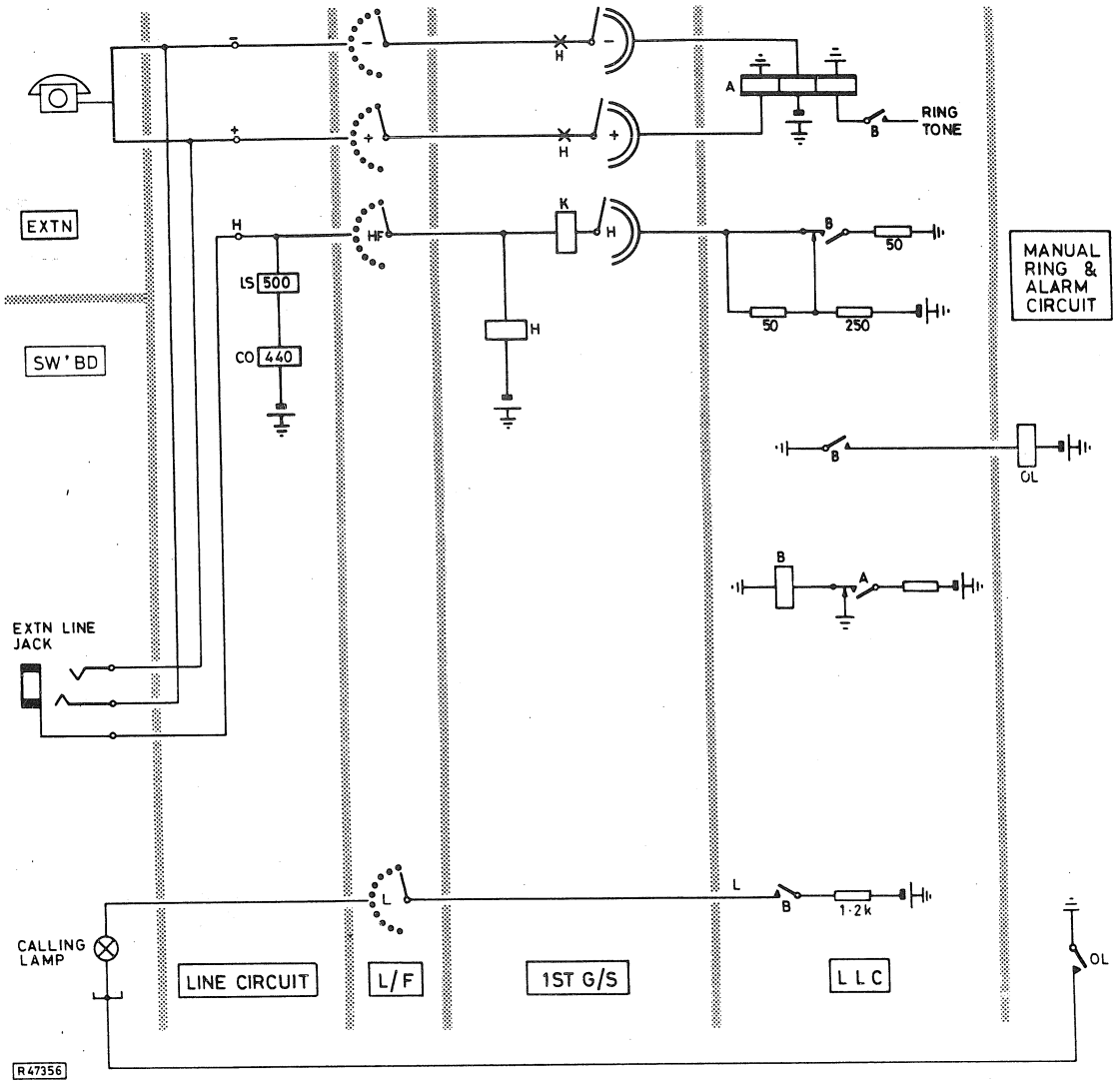


Fig. 11

The group selector wipers are stepped to level 0 and are driven horizontally over the outlets to find a free lamp lighting circuit, the free condition being a 250 ohm battery on the H wire. When the group selector switches, the extension's loop is switched through to the LLC to operate relay A which then operates relay B. Ring tone is now returned to the caller via the tone coil of relay A while an earth is connected to the H wire to hold relays H and K in the group selector and relays LS and CO in the line circuit. An earth is extended to the manual ring and alarm circuit to operate relay OL which connects an earth to the extension's lamp strip on the switchboard. The LLC returns a 1.2 kohm battery on the lamp lead L which completes the circuit to light the calling extension's lamp.

When the operator plugs into the jack to answer the call, the 70 ohm earth on the sleeve of the answering cord short circuits and releases relay K causing the group selector to clear and the LLC to release. The operator can now speak to the caller and may extend the call using the calling cord.

0 Level Circuit

Where an installation has more than 800 extensions there will be insufficient room on the switchboard multiple for 'lamps per line working'. Instead, each extension will have its own multiple jack only, and separate strips of lamps and jacks are provided for the 0 level circuits. Fig. 12 shows the 0 level circuit.

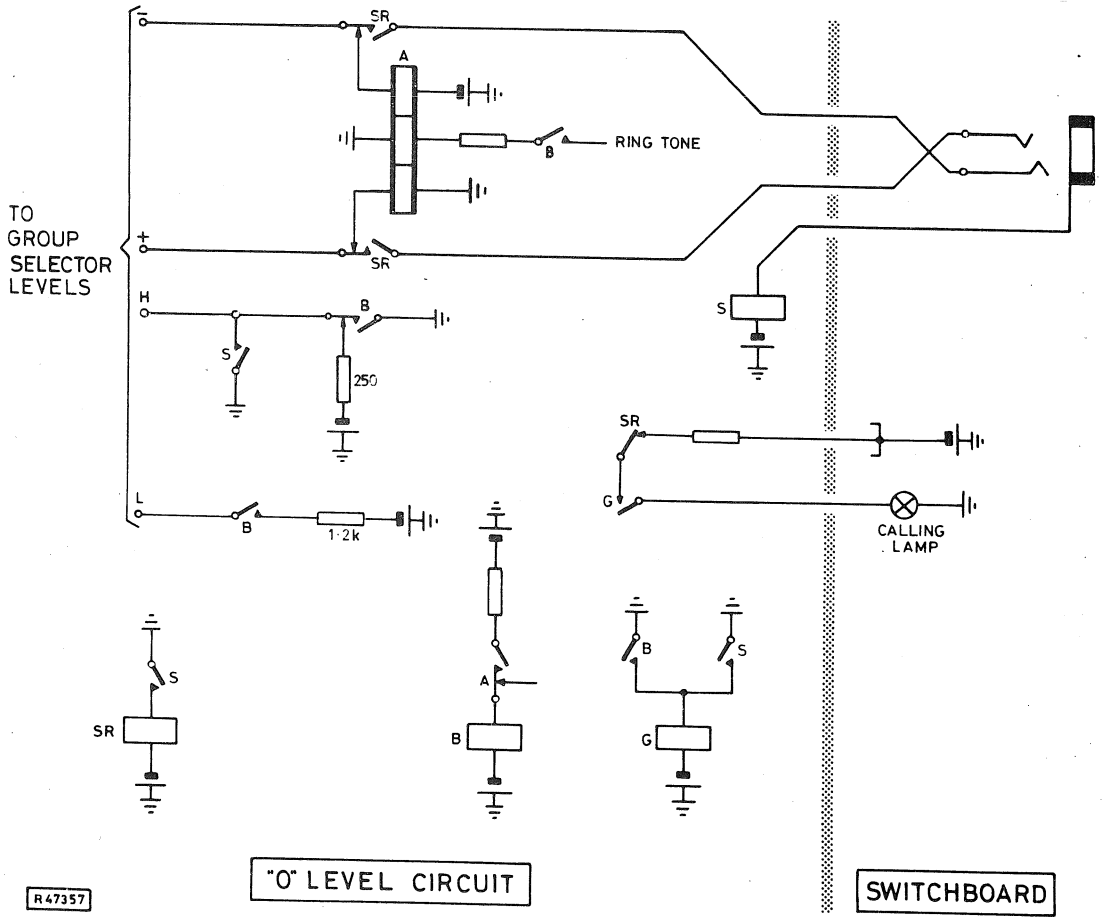


Fig. 12

When the group selector switches to an 0 level circuit the extension's loop is extended to operate relay A, which in turn operates relay B. An earth is connected to the H wire to hold the group selector and the extension's line circuit, while ring tone is returned to the caller via the tone coil of relay A. Relay G operates and a G contact lights the 0 level calling lamp on the switchboard. A 1.2 kohm battery is connected to the L wire but is only used on inter-PBX calls (see later notes).

As the answer cord is plugged into the jack relays S and SR operate, the calling lamp goes out, the extension's loop is switched through to the cord circuit, and relays A and B release. The operator will take particulars of the required call and the calling extension's number. The answering cord is then removed from the jack, causing the group selector and the 0 level circuit to release, and is transferred to the extension's multiple jack so that the call can be completed using the calling cord.

Note Unlike the lamp lighting circuit which releases as soon as the operator answers, the 0 level circuit will remain held until the answering cord is removed.

Public Exchange Calls

Direct Access

To make an exchange call an extension must seize a free group selector and dial 9. The selector wipers are stepped to level 9 and automatically hunt for a free exchange line circuit.

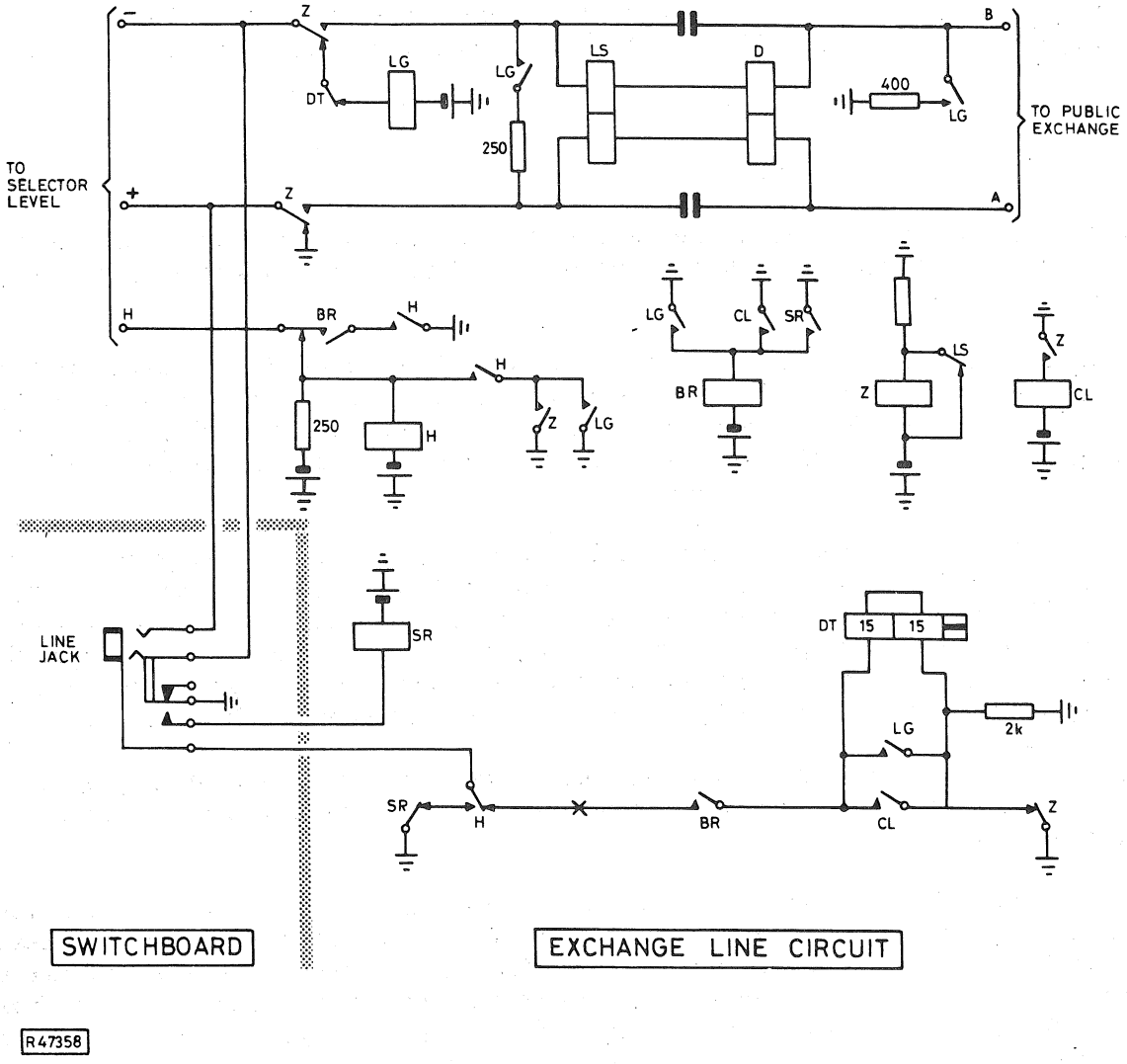


Fig. 13

If the circuit is free a 250 ohm battery in parallel with the H relay is extended to the selector level via the H wire, Fig. 13. As the groups selector switches to the circuit an earth is connected to the H wire to operate relay H. An H contact connects an earth to the bush of the line jack to busy the circuit on the switchboard.

The extension's telephone loop is switched to the circuit and operates relay LG which then operates relay BR. An earth is connected to the H wire to hold the group selector and the line circuit whilst relay H is held operated by an LG contact. Other LG contacts extend an earthed loop to the public exchange to seize a first selector. Relay LS operates to the battery and earth conditions from the first selector and the LS contact removes the short circuit from across relay Z allowing it to operate.

The extension is switched through to the exchange line and relay LG releases. A Z contact operates relay CL and a CL contact holds relay BR operated. Another Z contact holds relay H operated. Dial tone is returned from the public exchange and the required call may be dialled.

The relays operated in the exchange line circuit during the call are H, CL, BR, LS, and Z.

When the extension clears, disconnexion of the telephone loop releases the exchange call and relay LS. The LS contact short circuits and releases relay Z, so causing relays CL, H, and BR to release and the group selector and line circuit to cleardown.

Outgoing Call via Switchboard

The operator may select a free exchange line circuit by performing an engaged test on the bush of the line jack or by means of free line signalling where this is fitted.

When the calling plug is inserted into the jack relay SR operates and an SR contact operates relay BR. A BR contact busies the circuit to the selector level by disconnecting the 250 ohm battery from the H wire. Relay H will not be operated on this type of call but an earth is connected to the bush of the jack from a Z contact via relay DT and a BR contact.

The cord circuit loop operates relay LG and the exchange equipment is seized as before with relays LS, Z, and CL operating once the public exchange first selector is seized. A Z contact removes the full earth from the bush of the jack and replaces it with a 2000 ohm earth; this prevents the cord circuit supervisory lamp from glowing. Other Z contacts switch the operator through to the exchange dial tone, so releasing relay LG, and the required number can be dialled.

The call can be extended to an extension by means of the answer plug and when the operator retires from the circuit the extensions telephone loop will control the call.

Cleardown. When the extension clears, the disconnexion of the loop will release the exchange equipment and relay LS. The LS contact short circuits and releases relay Z which in turn releases relay CL. A CL contact removes the short circuit from across relay DT and a Z contact connects an earth via relay DT to the bush of the jack causing the cord circuit supervisory lamps to glow. Relay DT operates and its contact disconnects the operate path for relay LG, so preventing the re-seizure of the exchange equipment by the extension whilst the cords are still plugged into the circuit. When the cords are removed relays SR, DT, and BR will release and the free condition will be restored to the H wire.

Incoming Exchange Call

On an incoming call ringing current from the public exchange will operate relay AC which is bridged across the line, Fig. 14. AC operates relay CR which then holds over one of its own contacts to an earth via the line jack springs. CR operates relay ST and an ST contact operates relay BR which busies the circuit by disconnecting the 250 ohm battery from the H wire.

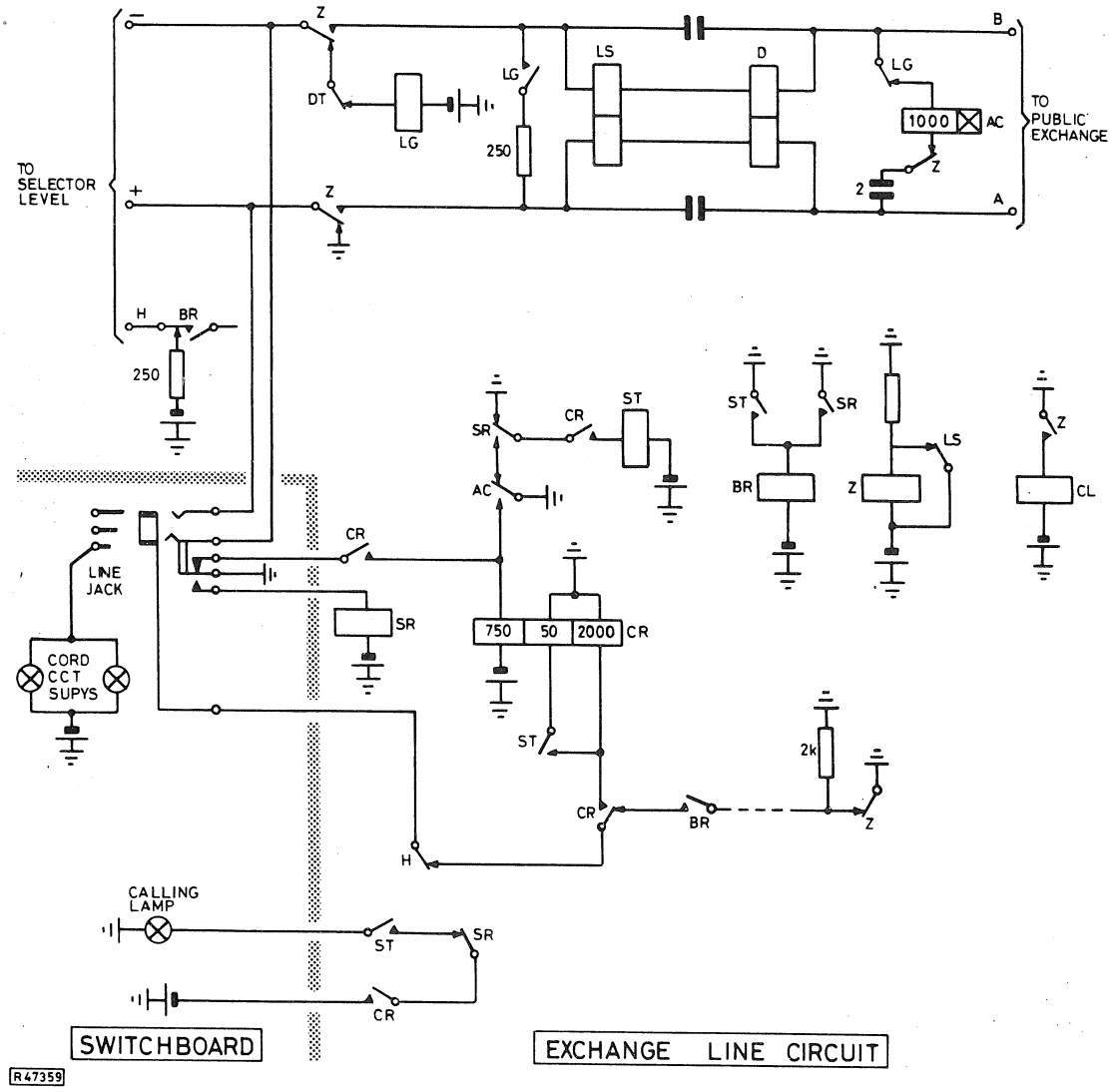


Fig. 14

Another ST contact completes a circuit to light the exchange line calling lamp on the switchboard.

When the operator answers the call the line jack springs, in operating, operate relay SR. This causes the calling lamp to go out and relay ST to release. The cord circuit loop is extended via the tip and ring wires and operates relay LG which releases relay AC. An LG contact connects a 250 ohm resistor across the line to trip the ringing and to operate relay LS to the line conditions. The LS contact removes the short circuit from across relay Z which operates; the Z contacts release relay LG, switch the operator through to the caller, and operate relay CL.

If the operator extends the call to an extension the cord circuit switches to sleeve control when the extension answers, and the telephone loop terminates the connexion when the operator retires from the circuit.

At the end of the call when the extension and/or the caller clears, relays LS and Z release and a Z contact connects a full earth to the bush of the line jack which causes the cord circuit supervisory lamps to glow. The circuit remains busied until the cords are removed from the jacks and relays SR and BR release.

Follow-on-Call

If the operator does not clear down the connexion quickly enough then although relays SR, DT, and BR are still operated from the previous call, it is possible for a further incoming call to arrive causing relay AC to operate to the ringing current.

The AC contact, in operating, operates relay CR which then holds in series with the cord circuit supervisory lamps via the bush of the jack. In releasing, the AC contact operates relay ST via a CR contact. ST continues operating and releasing via the AC contact at inverted ringing rate. An ST contact varies the resistance of the earth on the sleeve conductor between 50 and 2000 ohms by connecting the coils of relay CR in parallel. This causes the cord circuit supervisory lamps to flash at inverted ringing rate indicating to the operator that a follow-on call has arrived.

The operator can either answer the call by throwing the speak key which trips the ringing, or withdraw the cords which causes the exchange line calling lamp to glow and the call can then be answered in the normal way.

If the extension should lift the receiver as a follow-on call arrives the ringing will be tripped and the extension may talk to the caller. The call can be connected to another extension by recalling the operator who can then transfer the cord to the required extension.

Enquiry Call

An extension can only make an enquiry call whilst engaged on an exchange call. Fig. 15 (appended) shows the circuit elements of the enquiry call.

When the extension presses the recall button the earthed telephone loop operates the differentially connected D relay in the exchange line circuit. The D contact operates relay ER and an ER contact connects a 250 ohm marking battery to the T lead whilst another ER contact extends an earth via the ST lead to operate relay ST in the enquiry circuit (to the free battery condition on the H lead of the enquiry group selector).

An ST contact starts the enquiry linefinder ER driving whilst another ST contact connects the FT relay to the T wiper. When the marked outlet is found relay FT operates and its contact operates relay K and cuts the linefinder drive. The earthed loop is switched through to seize the enquiry group selector by K contacts via relay DR which operates. A K contact releases relay ST, which in turn releases relay FT, and holds relay K to the earth returned on the H lead from the group selector.

An ST contact in releasing extends an earth via the HF lead to operate relay RH in the exchange line circuit. RH contacts disconnect the extension from the exchange call and terminate the exchange line with a 250 ohm holding loop. Another RH contact releases relay ER and an ER contact extends an earth via a Z contact to the T lead.

Dial tone is returned from the enquiry selector and the extension can now release the recall button so causing relays D and DR to release. A DR contact removes the short circuit from across relay X allowing it to operate, and an X contact operates relay H.

As the extension dials the enquiry selector is stepped vertically; the NR springs operate upon the first rotary step and remove the short circuit from across the AN and BN leads. This allows relay N to operate and hold in the enquiry circuit. An N contact disconnects the hold path for relay K from the enquiry selector H wire and leaves it dependent on the exchange line circuit T wire. At this point then the relays operated in the enquiry circuit are X, K, H and N, and the extension is connected to a second extension via the enquiry circuit with the exchange line held.

To return to the exchange call the extension will press the recall button once more and relay DR again operates. Relay Y operates and leaves relay K dependent on a DR contact. When the recall button is released relays DR, K and Y all release. The extension's loop is disconnected from the enquiry selector and the enquiry call clears down. K releases relays N and X in the enquiry circuit and relay RH in the exchange line circuit. RH contacts remove the holding loop from across the exchange line and reconnect the extension to the exchange call.

Operator Recall

An extension engaged on an exchange line call via level 9 of the group selector may call the operator into the circuit by pressing the recall button twice in succession without dialling. The first depression of the button will cause the enquiry circuit and enquiry group selector to be seized as described earlier; the relays operated in the enquiry circuit are X, K, and H (but since dialling has not taken place relay N will not be operated) and relays RH and H in the exchange line circuit.

The second depression of the recall button will again operate relay DR in the enquiry circuit. A DR contact extends an earth to operate relay Y, and to operate relay CR in the exchange line circuit via the C lead, Fig. 16.

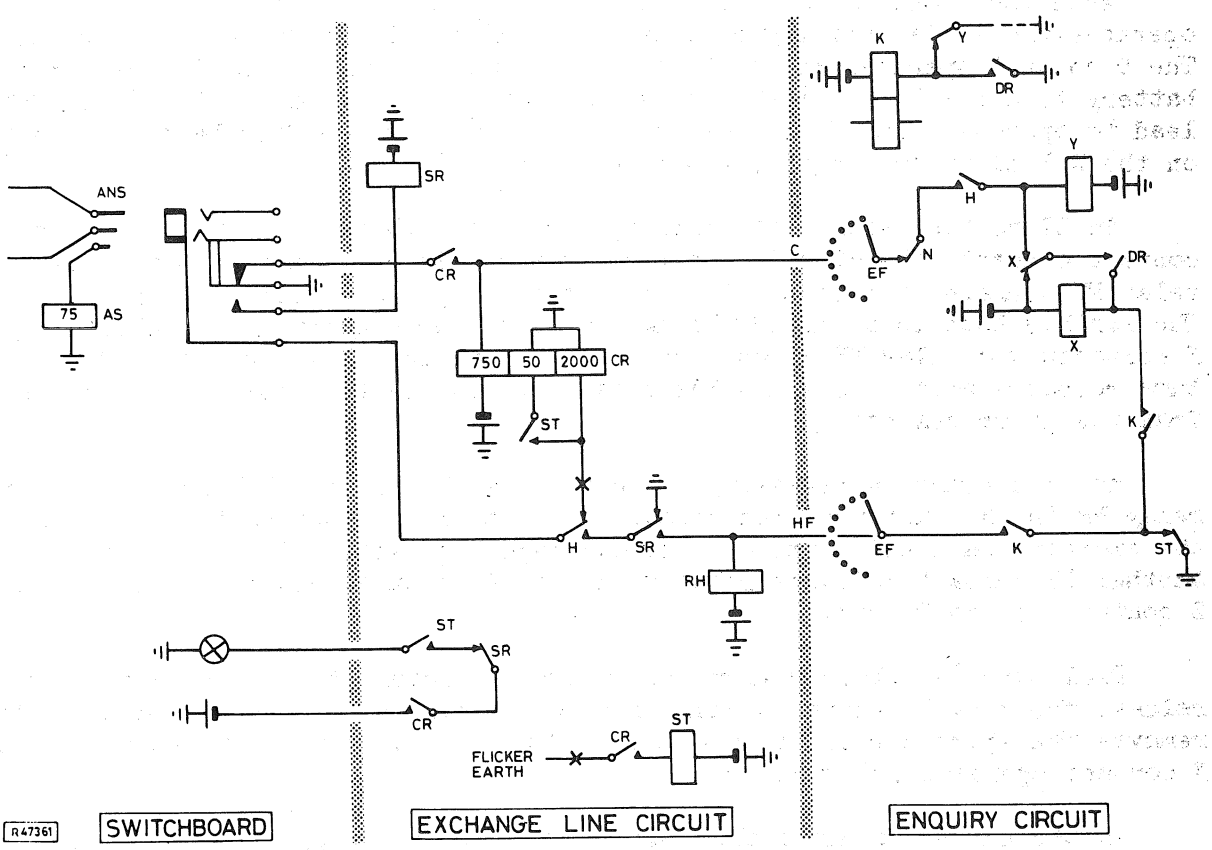


Fig. 16

Relays CR and Y then hold via a CR contact to an earth from the exchange line jack springs. Relay ST in the exchange line circuit is connected to the flicker earth supply via a CR contact and an ST contact causes the exchange line calling lamp to flash at flicker earth rate.

With relay Y operated relay K is left dependent upon a DR contact so that when the recall button is released relays DR and K both release. K in releasing causes the enquiry circuit and group selector to cleardown as before while relay RH in the exchange line circuit releases and reconnects the extension to the exchange line.

Since the exchange line calling lamp is flashing the operator will know that this is a recall. When the answering plug is inserted into the jack relay SR operates, relay CR releases and the calling lamp goes out. Relay RH again operates, this time in series with relay AS in the cord circuit via the bush of the jack, and the exchange line is again held secret while the operator speaks to the extension.

When the extension clears relay H releases causing relay RH to release also, and the exchange line is connected back to the operator who may then extend the call to another extension.

If the exchange call is set up via the switchboard and the extension presses the recall button twice for the operator the foregoing sequence is similar. This time, however, relay H in the exchange line circuit is not operated when relay ST operates at flicker earth rate, an ST contact will vary the earth resistance on the sleeve conductor between 50 and 2000 ohms (via the CR relay coils) causing both supervisory lamps to flash at flicker earth rate. Since relay H is not operated there is no operate path for relay RH and the exchange line is not held secret.

Inter-PBX Calls

An inter-PBX circuit may connect one installation to another and may either terminate on a switchboard, be connected to the automatic equipment, or simply terminate on a telephone at the distant end. Access to the circuit may be gained directly by the extensions or may be restricted to the switchboard.

At smaller installations the incoming section of the circuit may terminate on the linefinder bank contacts. Extension line circuits 30-34 and 80-84 may be modified for inter-PBX working and are provided with extra sets of tags to facilitate the necessary alterations. For inter-PBX working the extension line circuit is disconnected from the linefinder bank contacts and the inter-PBX circuit is wired to them instead.

At larger installations where traffic is sufficiently high the inter-PBX circuit may be directly connected to an incoming group selector whose levels are partly common with those of the ordinary 1st group selectors.

There are several types of inter-PBX circuit each having a different signalling system (loop dialling, earth dialling, generator and balanced battery dialling, etc). This EP will consider an auto-to-auto bothway loop-dialling circuit connected to the linefinder bank contact.

In order to simplify the circuit design two jacks are associated with each inter-PBX circuit on the switchboard. The call and answer jack is the one via which an established call is conducted, and which is used to answer incoming calls if the distant end dials 0. The dial jack is used in conjunction with the dial and TKO cords to enable the operator to dial out over the circuit when setting up an outgoing call. This jack is only used during the actual setting up of the call, the dial cord being removed when dialling is completed.

Outgoing Call from Switchboard

Fig. 17 shows the circuit elements of the inter-PBX-concerned with an outgoing call.

When the operator plugs into the "call and answer" jack, the jack springs operate relay SR whilst an earth on the sleeve (via the cord circuit CS relay) operates relay S. An ST contact operates relay OG (not shown) which prepares the LA relay for an outgoing call, and an S contact operates relay A which in turn operates relay B. Relay BR operates and busies the circuit by disconnecting the free condition from the H wire to the selector levels. An A contact extends a calling loop to the distant PBX via relay LA which operates, but B contacts prevent the rectified relay LD from operating at this stage.

Upon the seizure of the distant equipment dial tone is returned and the operator will now plug a dial cord into the "dial" jack, operate the associated dial key, and dial the required number. The dial off-normal springs operate relay DR and the dial impulsing springs are then connected across the A relay. One A contact repeats the dialled pulses to the distant PBX while the other A contact operates relay CD on the first break pulse; relay CD will hold for the duration of the impulse train. A CD contact short circuits the transmission bridge, so releasing relay LA, and provides a zero resistance pulsing loop; a second CD contact operates relay CC which provides a two-stage dropback facility.

At the end of each impulse train the dial off-normal springs restore and relay DR releases. Relay A remains held and relay CD slowly releases (due to the short circuit applied by the A contact) causing the slow release of relay CC. In releasing, the CD contact removes the zero resistance loop and provides a 400 ohm holding loop across the line via a CC contact, which allows relay LA to operate without releasing the distant equipment. When relay CC has fully released the holding loop is disconnected from across the line. The dial cord is removed from the "dial" jack when the complete number has been dialled.

A reversal is applied to the line by the distant equipment when the extension answers the call. This allows the rectified relay LD to operate and the LD contact operates relay G; the I relay is connected across the tip and ring wires and, since the cord circuit is in bridge control, causes the cord circuit supervisory lamp to go out.

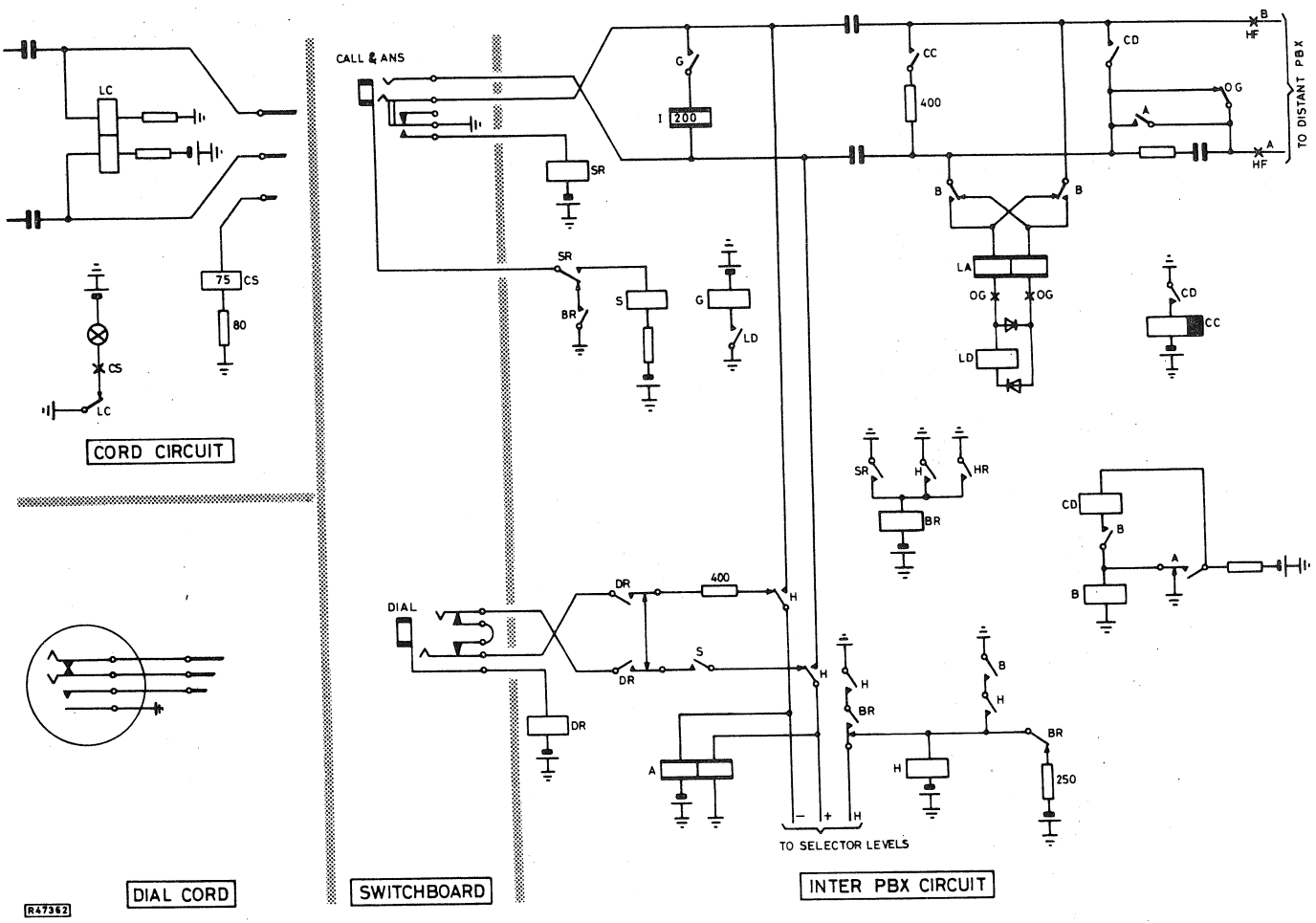


Fig. 17

Outgoing Call from an Extension

An outgoing call made direct by an extension is very similar in operation to that made by the operator. To gain access to the distant PBX an extension will seize a 1st group selector and dial an appropriate code (say 7). The selector will step to this level and automatically hunt for a free inter-PBX circuit. As the selector switches to the circuit it extends an earth via the H wiper to operate relay H; the calling extension's loop is extended via the +ve and -ve wipers to operate relay A which in turn operates relay B. Relay BR operates to busy the circuit and to provide a holding earth on the H wire, while relay OG (not shown) operates and extends a calling loop to the distant PBX via relay LA which also operates. Dial tone is returned from the distant end and the caller may dial the required number.

ıcoming Calls

Fig. 18 shows the incoming section of the inter-PBX circuit.

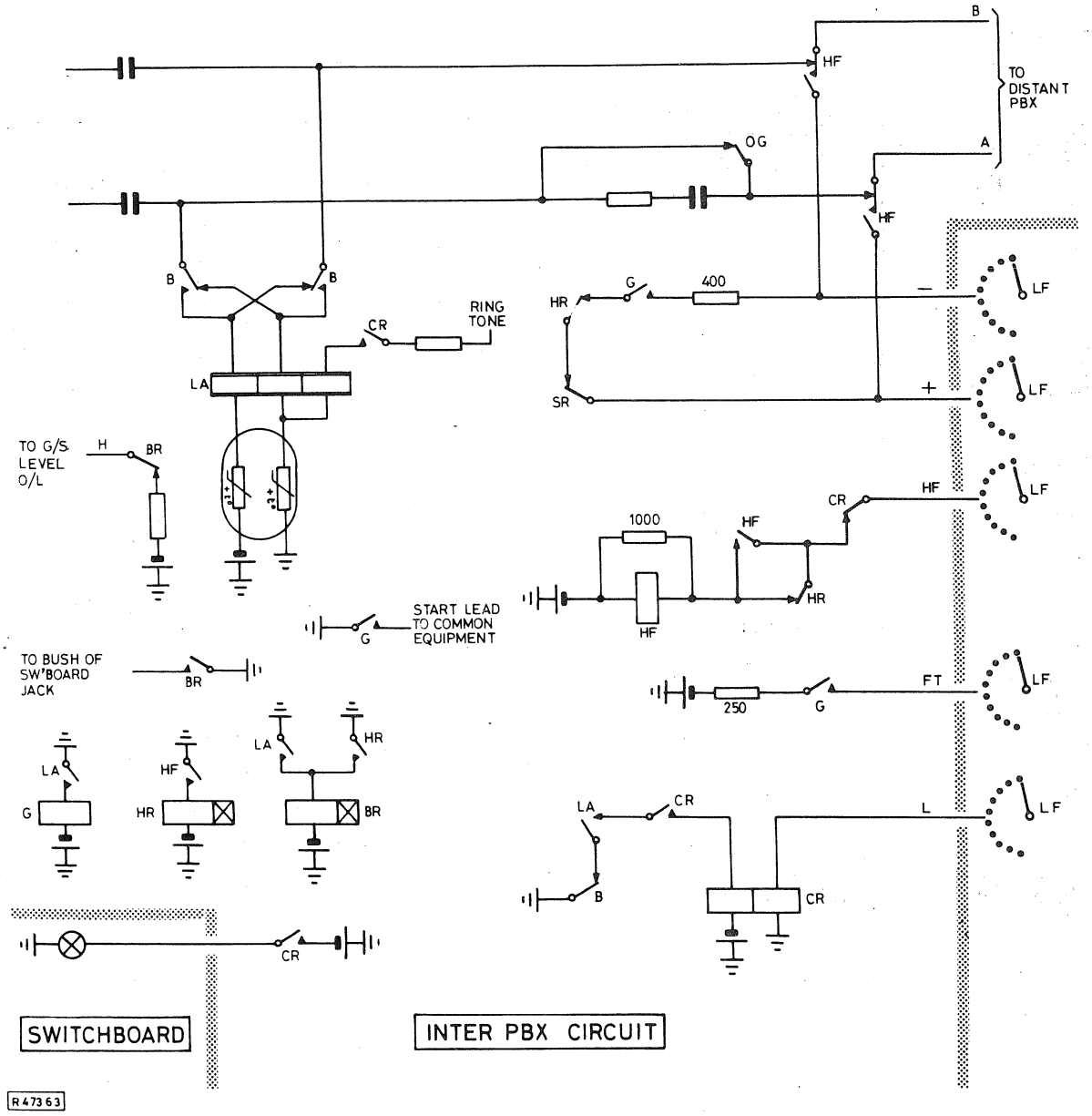


Fig. 18

A loop extended from the distant PBX via the A and B wires will operate relay LA. An LA contact operates relay BR which busies the circuit. Another LA contact operates relay G which connects an earth to the common equipment start lead and a marking battery to the linefinder multiple via the FT lead. A group selector will be seized in the normal way and its linefinder will drive to the marked outlet. Relay HF operates to an earth extended from the group selector via the HF lead, and operates relay HR. The distant caller is switched through to the group selector via HF contacts and relay LA releases. An HR contact maintains the hold circuit for relay BR, but relay G releases and disconnects the start and marking conditions. Dial tone is returned from the group selector and the caller may now dial the required number; when the called extension answers a reversal from the final selector is returned to the distant end for supervisory purposes.

When the distant caller clears, the disconnexion of the loop starts the cleardown of the local selectors. The earth is disconnected from the HF lead and relay HF releases slowly, due to effect of a 1000 ohm resistor shunted across the coil, and in turn relay HR releases slowly. Once relay HR has released relay BR releases slowly and the circuit becomes free. Thus a junction guard is provided to prevent the re-seizure of the distant relay set until all of its relays have fully released.

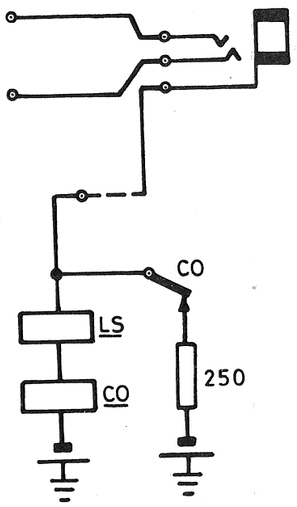
Should the local extension clear first, the local selectors cleardown and the earth is disconnected from the HF lead. Relay HF releases and connects relay LA back across the line; LA re-operates to the distant loop and maintains a hold circuit for relay BR which keeps the circuit busied until the distant caller clears.

Caller dials 0. If instead of dialling an extension number the distant caller dials 0 for the operator, the group selector is stepped to level 0 and searches for a free lamp lighting circuit or 0 level circuit which, when seized, returns a battery via the L wire to operate relay CR. A CR contact releases relay HF and the caller's loop is switched back to the LA relay causing the group selector to cleardown, which leaves relay CR holding to an earth via a B contact. Ring tone is connected to the tone coil of relay LA and a CR contact lights the calling lamp on the switchboard.

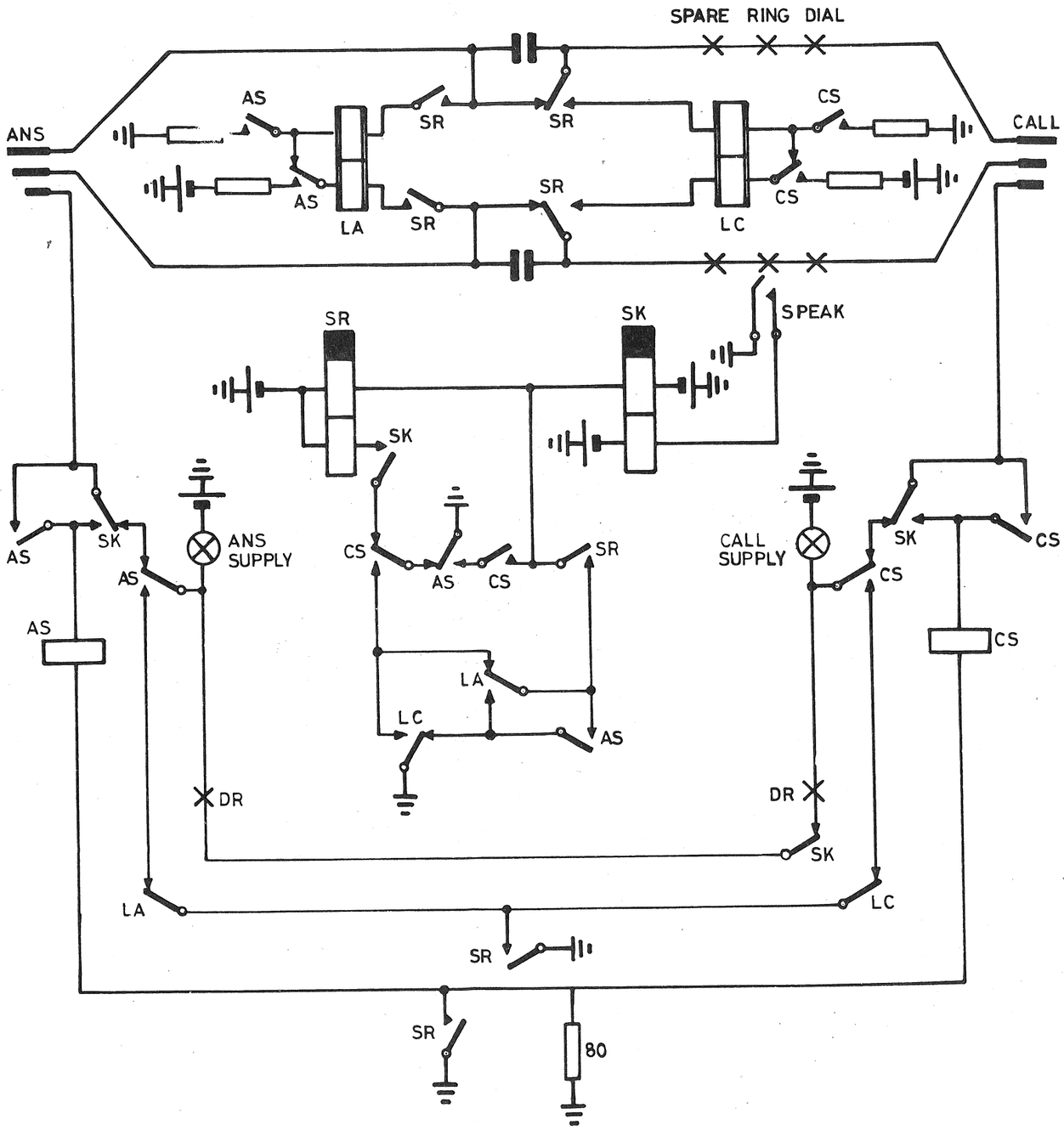
When the operator inserts an answer cord relays SR and S operate as seen in Fig. 17; an S contact operates relay A which in turn operates relay B; a B contact releases relay CR (Fig. 18) and CR contacts disconnect the ring tone and extinguish the calling lamp. A reversal is sent back to the distant end for supervisory purposes as B contacts, in operating, change the direction of the transmission current.

END

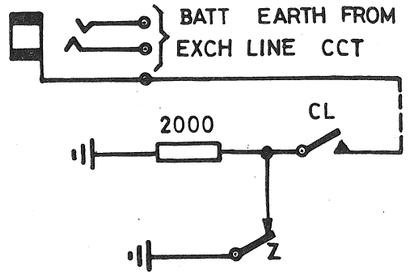
EXCH LINE CIRCUIT



CORD CIRCUIT

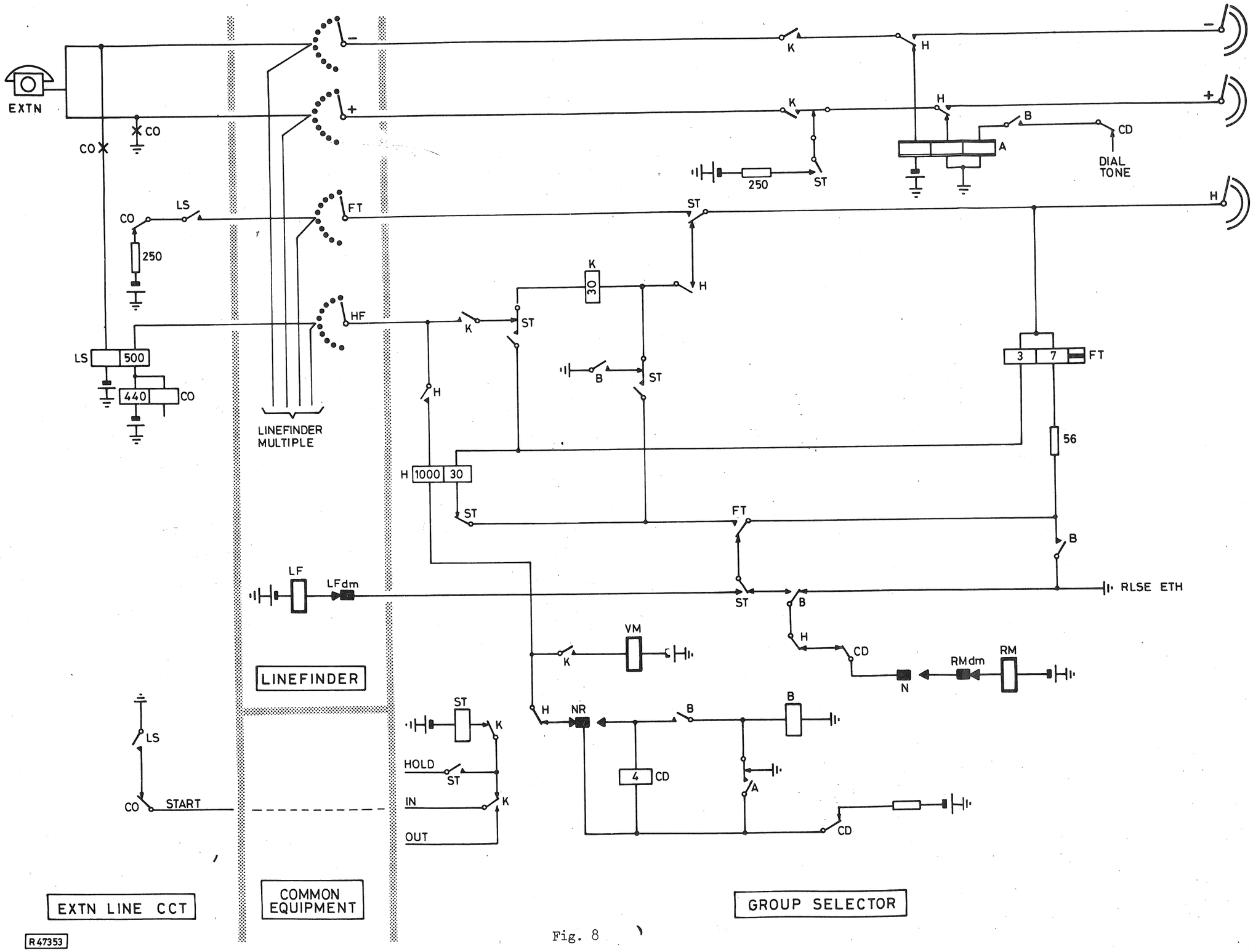


EXCH LINE CIRCUIT



R37617 A

Fig. 4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CO
CO
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CO
250
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FT
HF
LINEFINDER MULTIPLE
K
ST
H
K
30
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A
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CD
DIAL TONE
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3
7
FT
56
B
RLSE ETH
LF
LFdm
ST
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VM
K
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CD
N
RMdm
RM
H
NR
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CD
A
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LINEFINDER
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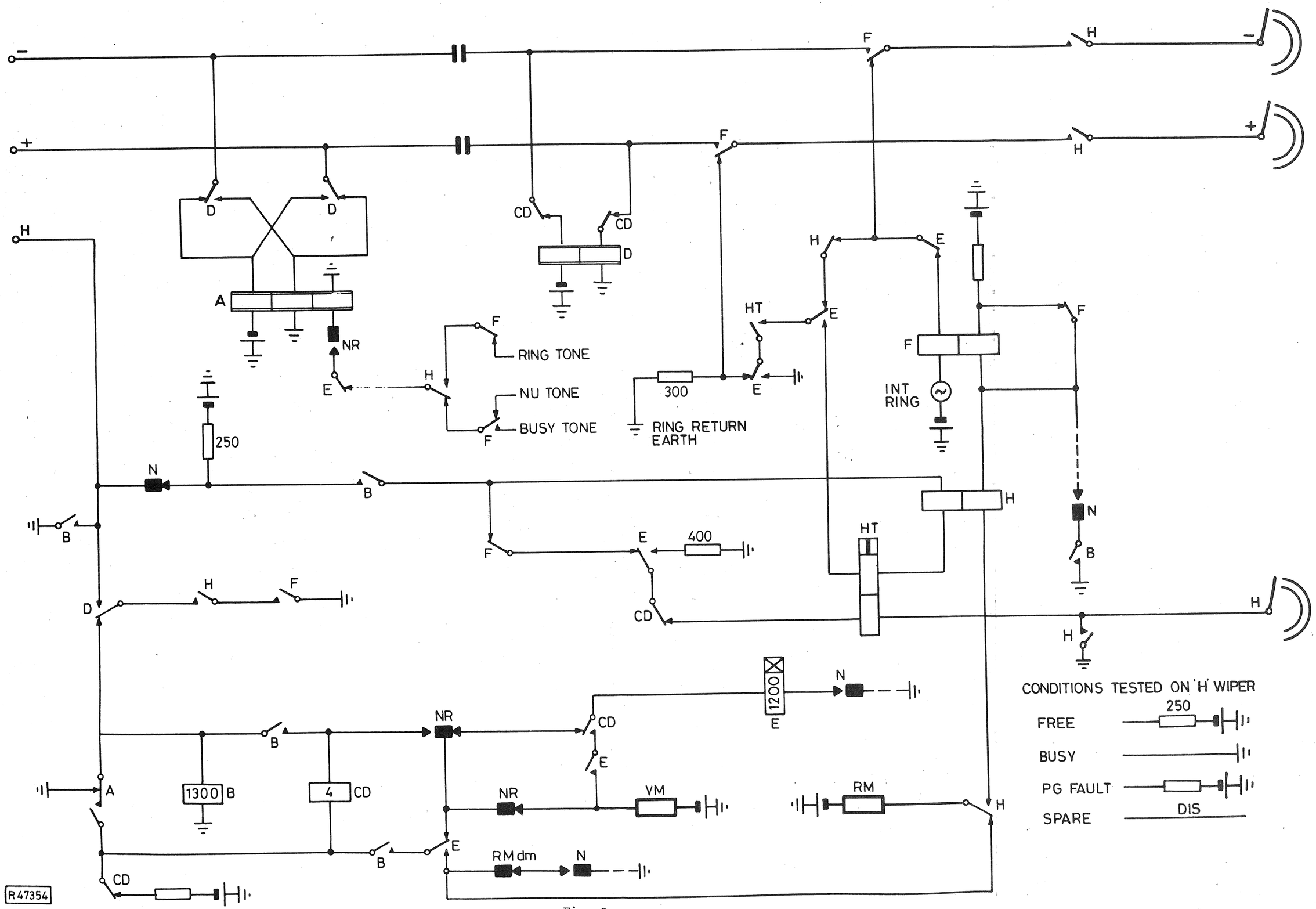
CO
START
EXTN LINE CCT
COMMON EQUIPMENT
GROUP SELECTOR
R47353

Fig. 8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HT
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RING RETURN EARTH
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INT RING
250
N
B
400
1200
1300 B
4 CD
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VM
RM
RM dm
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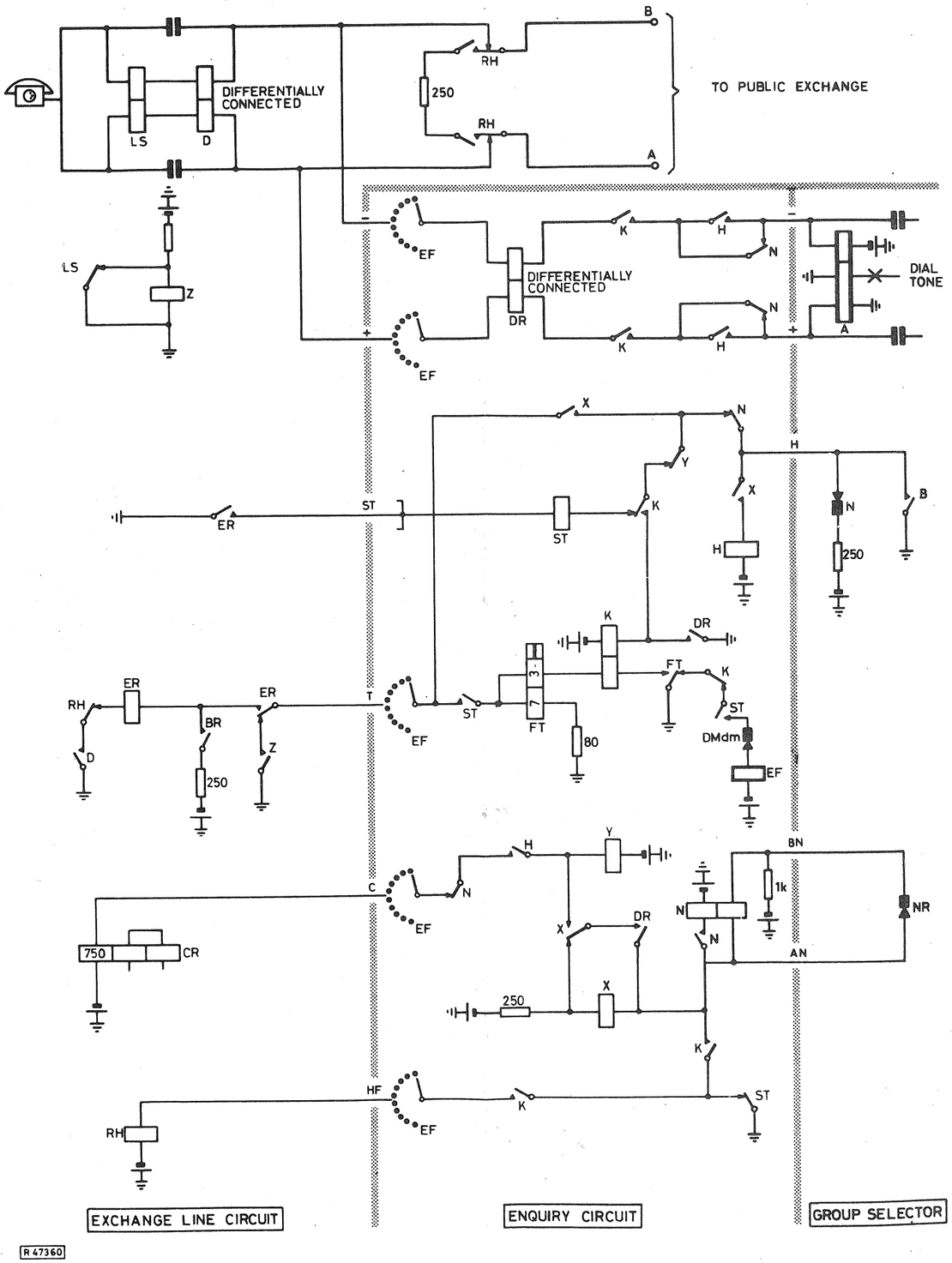
BUSY
PG FAULT
SPARE
DIS
R47354

Fig. 9


B
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RH
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HF
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RH
EF
EXCHANGE LINE CIRCUIT
ENQUIRY CIRCUIT
GROUP SELECTOR
R 47360

Fig. 15