

ENGINEERING BULLETIN No. 8

PRIVATE AUTOMATIC EXCHANGE TYPE 4154 30 LINES, 3 CONNECTING CIRCUITS

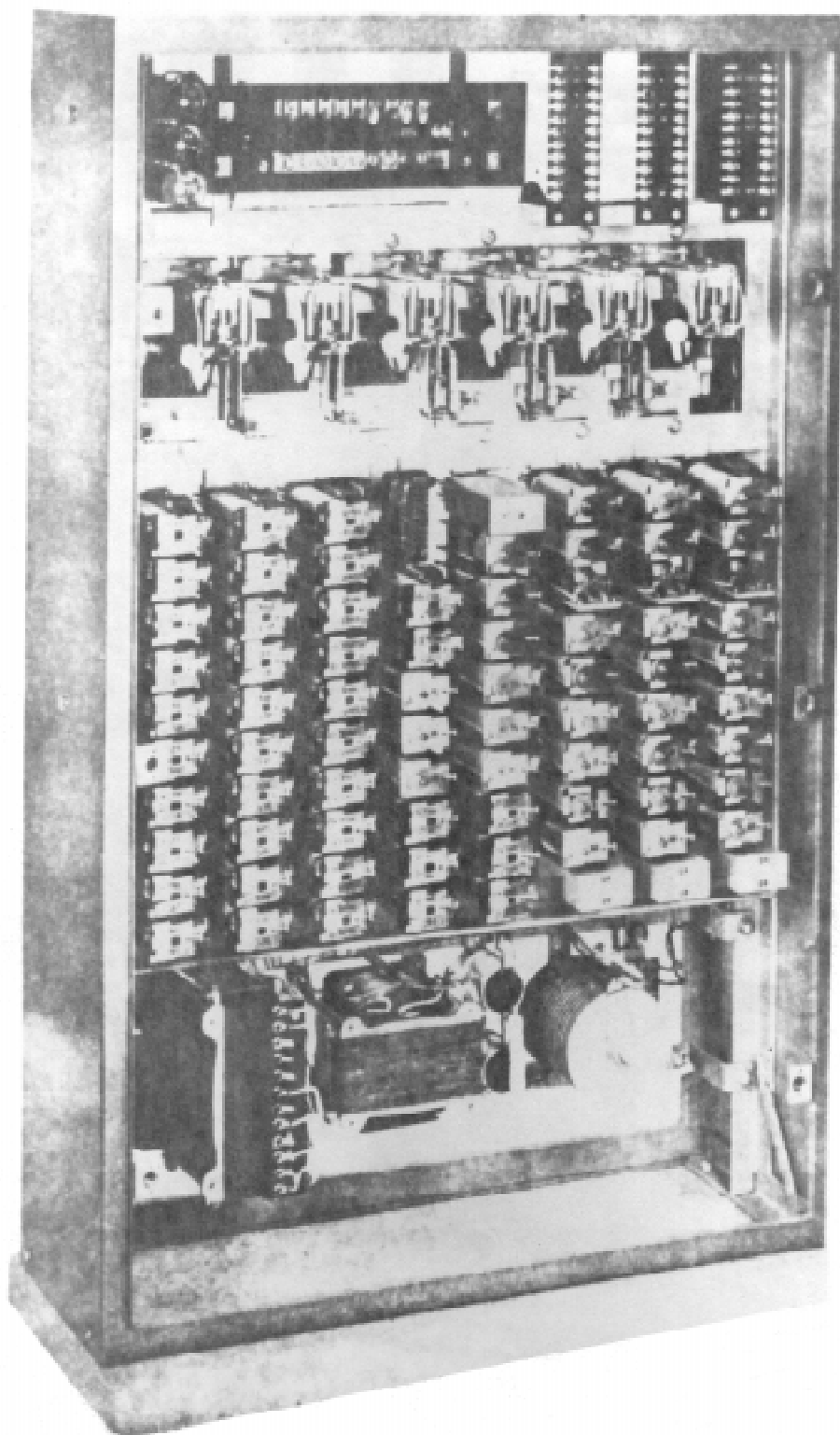
**PRIVATE COMMUNICATION EQUIPMENT DIVISION
STANDARD TELEPHONES AND CABLES LIMITED
FOOTSCRAY SIDCUP KENT**

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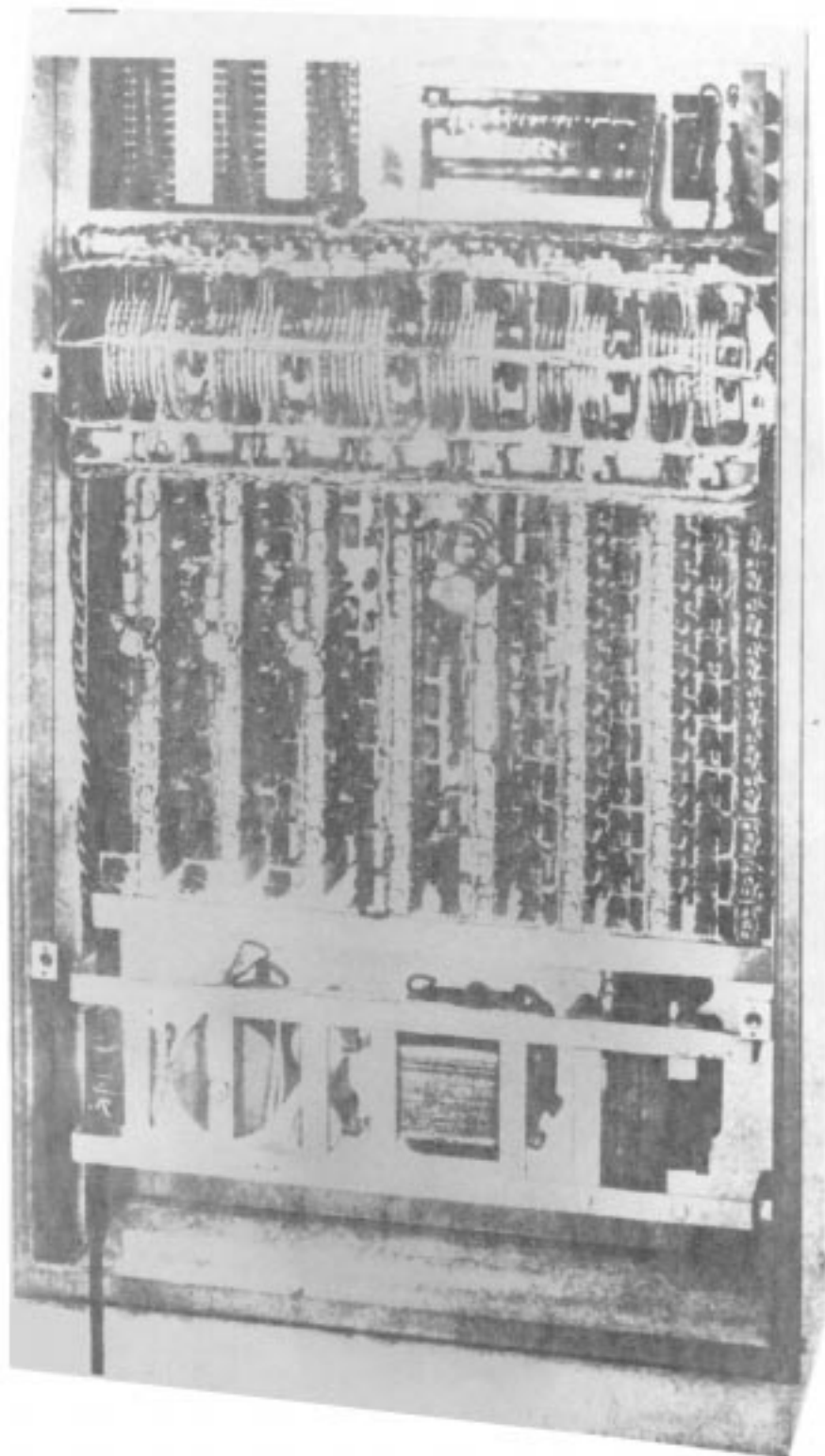
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1 GENERAL

The 4154 PAX is a self contained floor standing automatic exchange housed in a metal cabinet with removable covers front and rear, as shown on drawing P123. The covers are removed by turning the screwdriver-slotted screws through 90 degrees thus enabling the covers to be lifted off.

The capacity of the exchange is 30 extensions and 3 simultaneous conversations.

The power pack is built into the bottom of the cabinet with the exchange equipment mounted on an iron framework immediately above. As the unit has removable covers back and front, easy access is provided to the wiring side of the equipment. (See drawing P123).

When siting the equipment prior to installation it must be remembered that access must be available to both sides of the unit.

The terminal strips for the connection of the extension lines are fitted at the top of the unit above the exchange equipment.

2 DIMENSIONS

Height of Cabinet 36½ ins.

Width of Cabinet 22 ins.

Depth of Cabinet 9¾ ins.

3 WEIGHT

121 lbs.

4 COMPONENTS

All the relays are double armature type i.e. two coils mounted on the same yoke. The connecting circuit relays are P.O. 3000 type.

The Line Finders and Selector Switches are standard P.O. Uniselectors except that the Selector Switches are fitted with off normal change over springs. See paragraph 16 for equipment codes.

5 POWER SUPPLY

The power supply is built in and provision is made for a mains input of 110 or 220 volts A.C. 50 cycles. The factor of safety of the transformer is such that an input of 240 volts A.C. may be used with safety.

Two outputs are provided:

One at 50 volts A.C. 50 cycles, 143MA for ringing tone, and

One at 50 volts DC at 2 amps for speech and relay operation.

A separate Battery and Charger cannot be used with the system because the A.C. ringing current is obtained from the transformer in the power pack. See drawing L-152555.

6 FUSING

Standard G.P.O. type alarm fuses are used to protect the exchange equipment and are as follows:

Fuse No. 1 on	44A 1.5	Line Circuits
Left-hand side	(1.5 amps)	1, 8, 91, 92

Fuse No. 2 on	44A 1.5	Line Circuits
Left-hand side	(1.5 amps)	91, 99, 901, 903
Fuse No. 3 on	44A 1.5	Line Circuits
Left-hand side	(1.5 amps)	904, 909, 9001, 9004
Fuse No. 4 on	44A 1.5	Connecting Circuit
Left-hand side	(1.5 amps)	No. 1.
Fuse No. 5 on	44A 1.5	Connecting Circuit
Left-hand side	(1.5 amps)	No. 2.
Fuse No. 6 on	44A 1.5	Connecting Circuit
Left-hand side	(1.5 amps)	No. 3.
Fuse No. 8 on	44A 3.0	Misc. Signalling
Left-hand side	(3.0 amps)	Circuit, etc.
Fuse No. 2 on	44A 1.5	Ringing Supply
Left-hand side	(1.5 amps)	
Fuse No. 1 on	44A 1.5	Alarm Extension
Left-hand side	(1.5 amps)	Bell
Fuse No. 2 on	44A 1.5	200 240 volts
Left-hand side	(1.5 amps)	A.C. Supply
Power Pack	Lamp	
Rectifier	(Bulgin)	

Precaution: switch off mains before replacing Mains Fuse.

7 NUMBERING SCHEME

(a) Extension Lines

1, 2, 3, and 4 digit numbering is used i.e.

1 to 8 8 Lines

91 to 99 9 Lines

901 to 909 9 Lines

9001 to 9004 4 Lines

30 Lines

(b) Tie-Lines

When it is required to dial into a distant PAX or other apparatus any of the extensions 1 to 8 may be used for this purpose.

To convert the exchange for through dialling strapping is carried out on the small terminal block at the top of the fourth vertical row of relays. An enlargement of this terminal block is shown on the right hand side of Fig. 5. Drawing L-152446. The left-hand row of terminals are for Connecting Circuit No. 1, the centre row for No. 2, and the right-hand row for No. 3. The top terminal of each row is wired to a TL relay and this must be connected to the selected terminal of the eight (marked 2 to 9) immediately below it.

If extension No. 1 is selected for the through dialling or tie-line outlet, then the strapping must be as follows:

Strap Terminal TL 1 to terminal 2 in left-hand row.

Strap Terminal TL 2 to terminal 12 in centre row.

Strap Terminal TL 3 to terminal 22 in right-hand row.

If extension lines 1 and 2 are to be used as tie-lines, then terminals 2 and 3, 12 and 13, and 22 and 23 must be connected to the associated TL relay.

The maximum tie-line loop resistance, including distant apparatus, must not exceed 1000 ohms.

No additional equipment is required for tie-line working.

8 RINGING AND TONES

Dial Tone 400 cycles continuous.

Ring Tone 50 cycles interrupted.

Busy Tone 400 cycles interrupted.

Ringing current is supplied at 70V A.C. 50 cycles interrupted 1 sec on 1 sec off.

9 PRIORITY

Priority facilities can be associated with any line. A telephone equipped with a push button which will connect positive battery to a third wire must be used when this facility is required. Two additional wires, making a total of four, must be cabled to each instrument requiring priority facilities.

When using the priority facility the button must be held operated during conversation. The wanted subscriber is not automatically re-rung and must be asked to call the priority caller after clearing down the call in progress.

10 TELEPHONES

Telephone instruments used with this exchange must have ringers which operate satisfactorily on 50 cycles ringing current.

Our light weight telephone, type 66 LAU 43 ABA (Black) is suitable for use with this exchange.

If P.O. 706 type instruments (S.T.C. code 66 LAU 25 ABA) are required, the gongs must be adjusted to give the best results on 50 cycles.

Priority instruments for the system are available but must be specially ordered.

11 LOUDSPEAKING INSTRUMENTS

(a) The 'Handsfree' telephone set, type 66 LAU 35 AB, with separate loudspeaker unit may be used with this system.

(b) The loudspeaking Master Station, with direct access to 20 extensions may also be used with this system. To use all facilities on this instrument two line circuits are required.

Equipment required:

66 LAU 36 AB Loudspeaking Master Station (with enclosed H.M.T.)

or

66 LAU 46 AB Loudspeaking Master Station (with plug-in H.M.T.)

498 LSU 241112 Direct Access Relay Set.

165 LSU 1013.01 Wall Mounting Shelf for Relay Set and Uniselector.

12 SECRETARIAL TELEPHONES

Secretarial telephones and associated Executive telephones may be used if required. Codes are as follows:

66 LAU 30 ABA Secretarial Telephone.

66 LAU 31 ABA Executive Telephone.

13 'NON-BUSY' LINE

This facility is fitted as standard equipment and works as follows:

When a non-busy extension is in use a third party can cut into the existing conversation automatically. Busy tone is not returned to a third party when this extension is in use. An extension provided with the "non-busy" facility can be used for a "Fire" or "Accident" number.

The non-busy line is arranged by carrying out the following strapping on the small terminal block adjacent to the oscillator, "OSC".

IF line 7 is required as the non-busy line, strap as follows:

Strap NB1 (terminal 1) to terminal 8 (line 7, C.C.1)

Strap NB2 (terminal 11) to terminal 18 (line 7, C.C.2)

Strap NB3 (terminal 21) to terminal 28 (line 7, C.C.3)

14 DRAWINGS

L-152446 Shts 1 & 2 Connecting Circuit Schematic.

L-152555 Equipment and Schematic
Power Pack

15 CIRCUIT DESCRIPTION

Each connecting circuit has a linefinder and a connecting selector. When an extension calls, the linefinder connects the line to the connecting circuit which returns dial tone. When an extension dials, the connecting selector is stepped by the dial impulses and tests the called extensions line circuit at the end of impulsing. If the line circuit is free, calling extension will receive ringing tone and called extension will be rung. If the circuit is busy, busy tone will be returned to the calling extension.

15.1 An Extension lifts the Handset

Relay L of the line circuit operates on extension loop.

L21-22 connects relay K to the corresponding outlet of 2nd arc of line finders (UB2).

L23-24 connects 800 ohms resistive winding of relay K in parallel with its 1000 ohms inductive winding.

L25-26 connects relay AU of start circuit.

Due to operation of relay AU, the start circuit sends an earth through EN-wire of one free connection circuit. (For description of start circuit see paragraph 15.6 (a)). Relay AR of free connecting circuit operates through EN-wire.

AR1-2 closes holding circuit of relay AR.

AR3-4 closes operating circuit line finder.

AR21-22 prepares operation of relay HA.

AR23-24 prepares circuit of dial tone.

Line finder keeps driving until its 2nd arc wiper reaches the outlet corresponding to calling extension. High speed relay HA operates by its 145 ohms winding and 400 ohms resistor. Change-over contact of HA breaks driving circuit of line finder, and closes a circuit for the 50 ohms holding winding of HA in series with relay K of the line circuit.

Relay K operates.

K1-2 holds relay K and HA through the line finder wiper.

K3-4 and K5-6 disconnect relay L from extension line.

Relay L releases and disconnects 800 ohms resistance from relay K.

Operation of HA removes short-circuit from relay HAR, which operates in series with line finder coil.

HAR1-2, HAR3-4 connect A and B leads of calling extension.

HAR5-7 removes relay AR from start circuit and connects it to the holding circuit under control of UL.

HAR21-22 prepares to connect dial tone to the calling extension.

HAR23-24 prepares testing circuit for called extension.

HAR25-26 causes relay C to operate on 1st outlet of UL2.

HAR27-28 starts signalling circuit and prepares holding circuit for relays F and HB.

Extension line is extended to the connecting circuit causing relay A to operate on extension loop.

A1-3 connects relay B.

A21-23 in tie-line connections this contact will permit through dialling.

Relay B operates and:

B1-2 replaces AR21-22 in holding circuit of HA and K.

B3-5 prepares holding circuit for relay C.

B6-8 prepares impulsing circuit for connecting selector UL.

B21-22 replaces AR3-4 in holding circuit of HAR.

B23-25 connects EN-wire to SD-wire which gives a path for starting of next connecting circuit.

B26-27 connects holding circuit to AR.

B28-29 prevents operation of LB which will be used for releasing.

Relay C operates due to HAR25-26 at this stage only the following contacts have any function:

C5-7, 21-22 prepare impulsing circuit for selector UL.

C23-24 disconnects testing circuit.

C25-27 connects dial tone to calling extension.

Calling extension receives dial tone and connecting circuit is ready to receive dial impulses.

15.2 Dialling

Relay A follows the impulses and establishes a path to selector UL through A1-2, C6-7, C21-22, B7-8.

Selector UL drives step by step. When the wipers leave the 1st outlet, the operating circuit of relay C is disconnected. However, C holds during impulse sequence through A1-3, C6-7, B4-5.

The mechanically operated spring set of selector UL operates at first impulse. Relay AR is disconnected and releases. Dial tone is disconnected from calling extension.

If first digit is any number from 1 to 8, relay C releases at the end of the impulse train and C23-24 closes testing circuit of called extension line circuit.

If first digit is 9, relay C holds to the earth connected to the 10th outlet of UL2. Therefore testing is not effected. In this case a second digit will be dialled.

If second digit is any number from 1 to 9 relay C releases at the end of the impulse train and testing is effected. If second digit is '0' the wipers reach the 20th outlet and C holds again. Relay also holds if third digit is '0' because the wipers reach the 30th outlet.

Therefore testing is effected only when the wipers reach an outlet where there is no earth at UL2.

15.3 Testing of Called Extension Line Circuit

When relay C releases testing of called extension line circuit is made through C23-24, 385 ohms winding of

relay HB, HAR23-24, wiper UL1 and P-wire of called extension line circuit.

If called extension is free, a battery through 1000 ohms winding of relay K is found. Relays HB and K operate:

HB1-2, 3-4 connect A and B leads of called extension.

HB5-7 connect ringing tone to calling extension.

HB21-22 (x contact) closes holding circuit of relay HB.

HB23-24 connects an earth to P-wire of called extension line circuit to busy it.

HB25-27 prepares operation of relay D.

Relay CR operates on back contact C3-4 and earth of UL. CR21-22 prepares a circuit to permit priority extensions to enter an existing connection (see paragraph 15.7). Called extension receives ringing current through 900 ohms winding of relay F.

If called extension is engaged in an existing connection, an earth (if it is engaged as a called extension) or a very low potential (if it is engaged as a calling extension) may exist in the P-wire. In both cases relay HB cannot operate and busy tone is connected to the calling extension through HAR 21-22, C25-26, HB5-6, D3-4.

15.4 Called Extension Answers

On lifting the handset called extension loops the line causing relay F to operate:

F1-2 closes circuit for the feed relay D.

F3-5, 6-8 disconnects ringing current and connects called extension to relay D.

F21-22 (x contact) breaks short circuit to 400 ohms holding winding of relay F.

F23-24 disconnects ringing tone from calling extension.

F25-26 breaks operating circuit of relay C.

F27-28 disconnects signalling circuit.

Relay D operates on extension loop. The function of its contacts will be described in paragraph 15.7.

The extension can now converse through QA and QB.

During conversation the following relays are operated: K of both extensions, A, B, CR, D, F, HA, HAR, HB.

15.5 Releasing of Connecting Circuit

The connecting circuit is released when the calling extension restores his handset. Relay A releases and causes relay B to release. Relays HA and HAR also release. Back contact B6-7 closes a driving circuit for selector UL. Relay LB operates and guards circuit against incoming calls until connecting selector restores to normal.

Connecting selector drives until normal position is reached. At this position off-normal spring set returns to normal and selector driving circuit is disconnected.

When selector drives, relay C also operates through B3-4 and contact UL. Contact C1-2 holds connection between EN and SD wires, and C23-24 disconnects testing circuit. Relay CR releases.

Release of relay HAR causes relays F and HB to release. Connecting circuit is now ready for a new call.

If called extension does not restore the handset when the calling extension clears down, the line circuit becomes free and will put out a start earth. A line finder will connect the line to the connecting circuit and dial tone will be returned.

15.6 Start and Signalling Circuit

(a) Start Circuit

This circuit provides a starting chain for the connecting circuits which work as follows:

Let us assume that all relays of this circuit are released. When a call starts, relay AU operates:

AU21-22 closes circuit for relay AA and short-circuits relay AB.

AU23-24 closes starting circuit of first cord circuit.

Relay AA operates in series with 250 ohms resistor:

AA21-22 prepares circuit for relay AC.

AA23-25 closes holding circuit of relay AA (relay AB cannot operate because it is short-circuited).

If first connecting circuit is free, its relay AR operates and seizure of connecting circuit begins. If first connecting circuit is busy a connection between its EN and SD wires exists and the starting earth is applied to the second connecting circuit. If second one is also busy the starting earth progresses to the third connecting circuit.

When the calling extension is connected to a connecting circuit, relay AU releases and removes short-circuit from relay AB which operates through 250 ohms resistor and contact AA23-25.

AB1-2 closes circuit for relay AC and applies short-circuit to relay AD.

AB3-5 prepares to short-circuit relay AA.

AB6-8 prepares starting of second connecting circuit.

Relay AC operates through 250 ohms resistor.

AC21-23 closes its holding circuit maintaining the short-circuit on relay AD.

When another extension calls, the start earth is applied to EN wire of 2nd connecting circuit and may be extended to the other circuits if this is busy.

AU21-22 short-circuits relay AA which releases and maintains AB operated.

Release of AA removes short-circuit from relay AD which operates through 200 ohms resistor and AC22-23. Relay AC remains holding.

When a connecting circuit is connected to calling extension, relay AU releases causing AB to release.

A start for third connecting circuit is therefore prepared.

At the next operation of AU, EN-wire of third connecting circuit receives the start earth. Relay AA operates.

When AU releases, relay AB operates. Relay AC releases. At the fourth operation of relay AU, EN-wire of 2nd connecting circuit receives the start earth. When AR releases the whole system is restored to normal.

(b) Signalling Circuit

Ring current is obtained from an additional winding of the power supply transformer. This current is also transmitted through a .47uF capacitor as ringing tone to the calling extension.

Dial tone is continuous 400c/s tone obtained from a transistorised oscillator.

IA, IB, and IC relays are a self impulsing chain of relays. IC interrupts the ringing current and IB interrupts the busy tone.

The signalling circuit starts when relay AS operates:

AS1-2 Starts operation of relay chain.

AS3-4 connects oscillator.

The three relays IA, IB, IC are connected in series. Relay IA operates first because the others are slow operating.

IA1-2 short-circuits relay IB.

Relay IC operates and short-circuits relay IA which releases slowly.

Relay IB operates in series with IB which is short-circuited by IB21-22 and releases.

Relay IA operates in series with IB which is short-circuited.

Intermittent operation of all three relays is therefore obtained.

Operation of IC connects ringing current and ringing tone. 400c/s tone interrupted by IB1-3 is transmitted as busy tone.

15.7 Priority Facility

Priority facility may be assigned to any extension. When an extension has this facility an earth is applied to the corresponding outlet of 1st arc of line finders, or the outlet is wired to the extensions PR lead.

A priority extension dials in the usual way. If called extension is engaged in an existing connection, relay D operates through 50 ohms resistor, coil of relay D, HB25-26, CR21-22, 600 ohms resistor, TL3-4, wiper and 1st arc of line finder, earth:

D1-2, D21-22 connect priority extension to the existing connection.

D3-4 connects capacitor QD in series with busy tone in order to transmit to the three extensions an attenuated busy tone. Extensions in the existing connection are therefore advised that a third party is on the line.

If priority extension wishes to release the connection, the handset may be restored. Operation of relay C and restoring of connecting selector to normal, causes relay CR to release. Relay D releases also and busy tone is disconnected from existing connection.

If, invited by the priority extension, the other extensions release their connection, called extension becomes free and relay HB operates on testing circuit. Relay D is released and called extension receives ringing current. Conversation is established in the usual way.

15.8 Tie-line Facility

When tie-line facility is foreseen, relays TL and CRB should be mounted in each connecting circuit. Rectifier MRA should be mounted in each line circuit used as tie-line. Relay TL is connected to the corresponding outlets or 2nd arc of connecting selector UL

When tie-line number is dialled relay TL operates through the earth of contact CR25.

TL1-2 prepares operation of CRB.

TL3-4 breaks priority circuit.

TL5-7 disconnects battery from relay D and prepares connection of this relay over called line.

TL21-22 disconnects earth from relay D.

TL23-24 prepares operation of relay F if the tie-line is free.

TL-25-27 connects contact A21-22 in series with called line.

Relay HB operates and causes relay F to operate. 400 ohms winding of F is connected in series with 400 ohms winding of HB.

Called line is looped and calling extension hears dial tone on distant exchange.

Now calling extension can dial to the distant exchange. Relay CRB operates at first impulse which are repeated through 3rd and 4th arcs of UL, contacts HB1-2, F4-5, A21-22, TL26-27, CRB1-2, I7-8, HB3-4.

15.9 Emergency Line Facility

Any extension can call the emergency line no matter if it is busy or free.

Relay NB should be connected to the corresponding outlet of the line intended to be emergency line.

When any extension calls the emergency line, relay HB operates and contact NB1-2 gives him priority facility.

16 STOCK LIST

Line Circuits, Fig.1

L	1000 ohms	
K	1000 ohms	11233CCN
N1 Resistor	800 ohms	
MRA Rectifier	(tie lines only)	280 LU 748

Line Finder, Fig. 2B

UB Uniselector	4158 DA
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Connecting Circuit, Fig. 2A

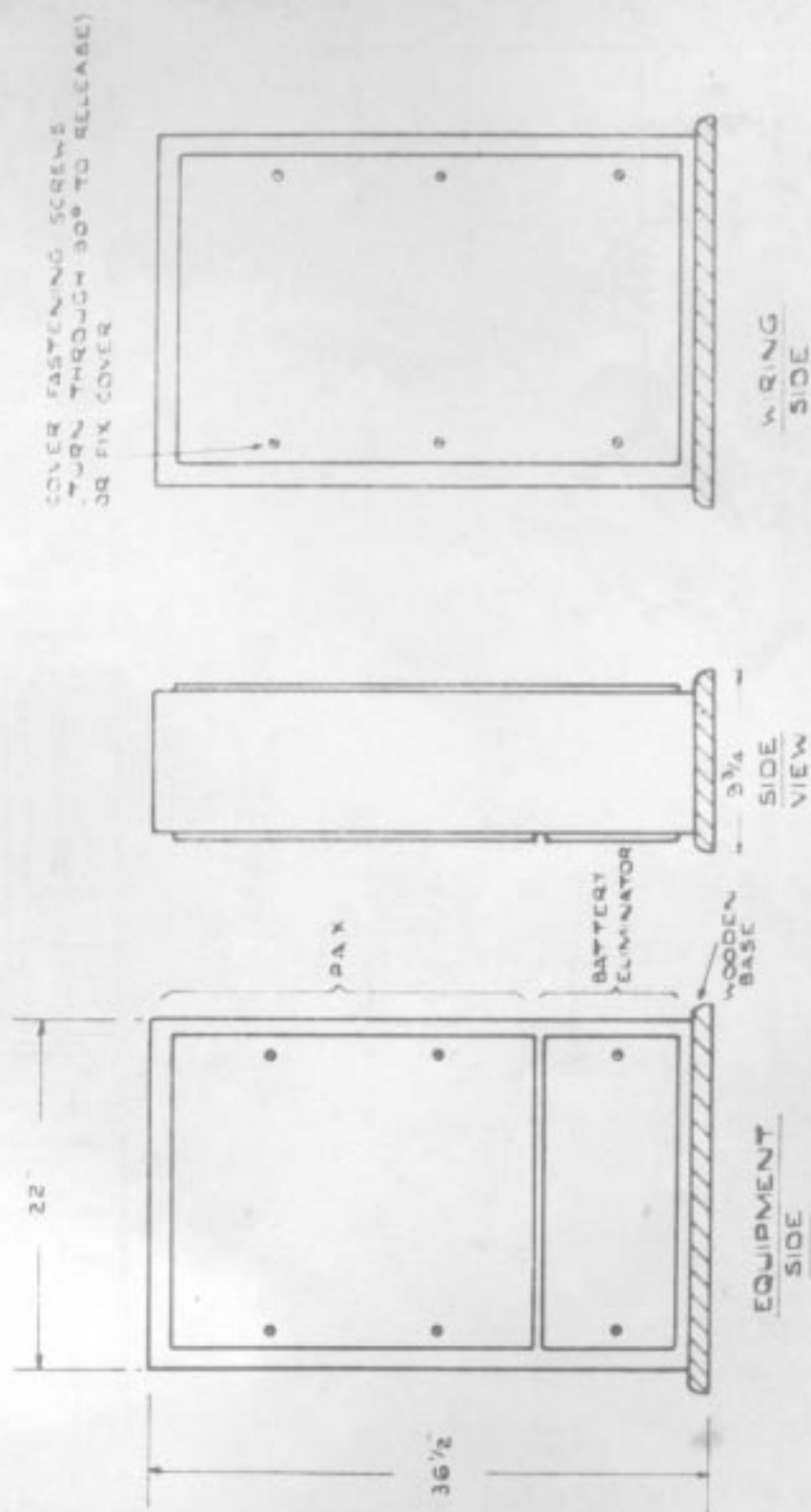
A	Relay	250 250 500	11002 BDN
B	Relay	800 2000 NL	11007 PAM
C	Relay	500 2000	11006 ALM
D	Relay	250 250	11003 BAZ
AR	Relay	800	11004 JAH
CRB	Relay	800	11001 PAY
HB	Relay	400 385	11006 ALN
F	Relay	900 400	11007 HAU
HAR	Relay	2000	11007 AHH
HA (High Speed)	50 145	89 CB	
TL	Relay	2000	11006 ALO
LB	Relay	1500	11233 CCW
VG	Relay	1500 (not used)	11233 CCW
CR	Relay	1500	11222 CBG
NB	Relay	1500	11222 CBG
QA	Capacitor	2 microfarad	11014 A
QB	Capacitor	2 microfarad	11014 A
QC	Capacitor	0.47 microfarad	
QD	Capacitor	0.02 microfarad	
MRA	Rectifier		280 LU 625

Start Signalling Circuit, Fig. 3A

AA	Relay	1500	11232 CBO
AB	Relay	1500	11232 CBO
AC	Relay	1500	11221 CBM
AD	Relay	1500	11221 CBM
AU	Relay	1000	11222 CAR
AS	Relay	1000	11222 CAR
OSC	Oscillator		11003-C
IA	Relay	800	11001 FBE
IB	Relay	800	11002 JBE
IC	Relay	800	11002 JBF

Power Supply

TR	Transformer	0 200 240 volts	
CH	Choke		CHS 20
C	Capacitors	2 600 microfarad	CE 1561 8
		In parallel	50V Plessey
R	Resistor	400 ohm 15 W	Vitrohm
MRA	Rectifier		B84 4 1W
F1	Fuse	110V 2A	F 283 2A
		220V 1A	Delay Fuse
			(Bulgin)
			F 283 1A
			Delay Fuse



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4154 P.A.X.
CABINET DIAGRAM

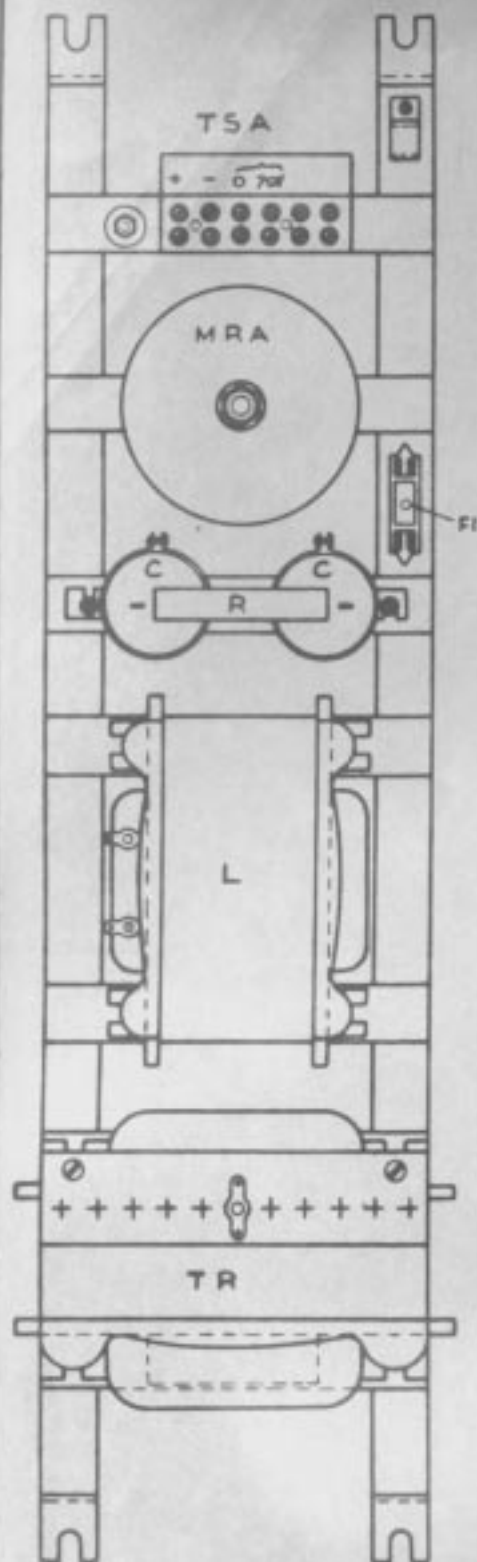
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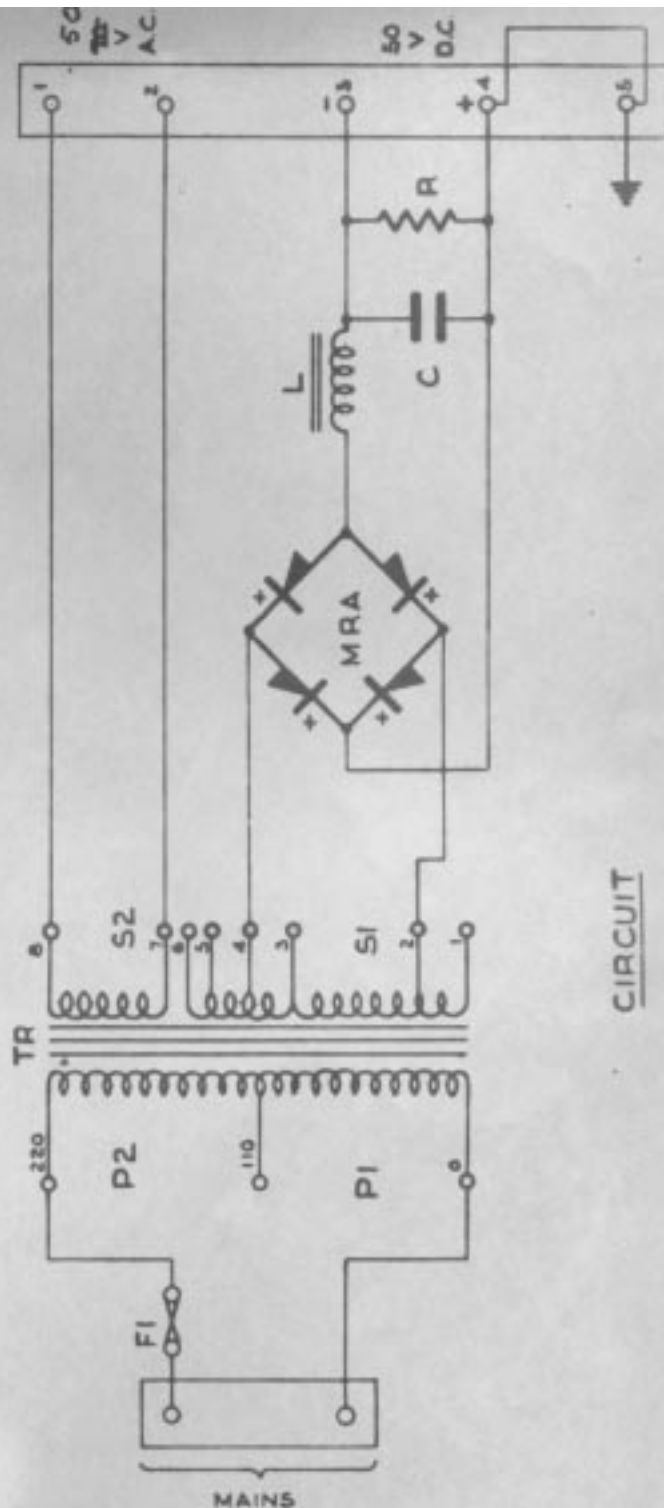
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P. 123



TR - TRANSFORMER
 MRA - RECTIFIER TYPE 884-4-1W
 L - CHOKE TYPE CHS-20
 C - 2 ELECTROLYTIC CAPACITORS
 600 MFD IN PARALLEL
 50V WORKING

EQUIPMENT LAYOUT



CIRCUIT

EQUIPMENT CODES

R - RESISTOR 400 Ω 10 W
 FI - FUSE 110V - 2A
 220V - 1A