

AUTOMATIC TELEPHONE & ELECTRIC COMPANY LIMITED
LONDON & LIVERPOOL—ENGLAND

PRIVATE AUTOMATIC EXCHANGE
25 LINE TYPE 25-4A OR
50 LINE TYPE 50-7A L.261642 GROUPS 1-4

OPERATING BULLETIN No. 3001
ISSUE 5

OPERATING DIVISION—STROWGER WORKS, LIVERPOOL, 7
1954

CONTENTS

PART I GENERAL

	Page Number
1. GENERAL DESCRIPTION	1
2. INSTALLATION	4
3. OPERATION	9
4. MAINTENANCE	13
25-4A P.A.X. TYPICAL EQUIPMENT LAYOUT	490001 Shts. 1 & 2
50-7A P.A.X. TYPICAL EQUIPMENT LAYOUT	490002 Shts. 1 & 2

PART 2 CIRCUIT DIAGRAMS AND NOTES

THROUGH CIRCUIT EXPLANATORY	E.202636
THROUGH CIRCUIT	S.202636
CODE CALL (AUDIBLE) CIRCUIT EXPLANATORY	E.202820
CODE CALL (AUDIBLE) CIRCUIT	S.202820
CODE CALL (VISUAL) CIRCUIT EXPLANATORY	E.20441
CODE CALL (VISUAL) CIRCUIT	20441
FIRE ALARM SYSTEM CIRCUIT EXPLANATORY.	E.206770
FIRE ALARM SYSTEM CIRCUIT.	S.206770
SECRETARIAL SERVICE CIRCUIT EXPLANATORY	} OBSOLETE. IGNORE E.203291
SECRETARIAL SERVICE CIRCUIT	} ALL REFERENCES 203291
CONFERENCE AND KEY-CALLING CIRCUIT EXPLANATORY.	E.206760
CONFERENCE AND KEY-CALLING CIRCUIT.	S.206760
PARTY LINE REVERTIVE CALL CIRCUIT EXPLANATORY	E.205390
PARTY LINE REVERTIVE CALL CIRCUIT	S.205390

PART 3 OPERATING AND ADJUSTMENT INFORMATION

JACKING-IN TWO-MOTION SELECTOR	ES.351 - 107
FITTING RELAY SET AND SELECTOR COVERS.	ES.351 - 105
GLOSSARY OF TERMS USED IN TELEPHONY	ES.360 -1517
SYMBOLS USED ON P.A.X. AND P.A.B.X. CIRCUIT DIAGRAMS.	ES.351 - 104
CONVENTIONAL NUMBERING OF APPARATUS	ES.351 - 101
EXPLANATORY NOTES OF ADJUSTMENT SHEETS	AS.129
EXPLANATORY OF CONVENTION FOR RELAYS	AS.139

CONTENTS (continued)

PART 4 RELAY ADJUSTMENT SHEETS

A.202635	Sheets 1 & 2	A.206770	AR.202820
A.206760	Sheets 1 & 2	AR.20441	AR.203291
ARS.3000		A.230993	AR.205390

ASSOCIATED ENGINEERING ADJUSTMENT FOLDERS

5000 TYPE RELAY	EA.210
600 TYPE RELAY	EA.310
THERMAL RELAY	EA.216
ADJUSTMENT SHEETS FOR TELEPHONES	EA.217
52A TYPE TWO-MOTION SELECTOR MECHANISM	EA.301
B.P.O. No.2 - UNISELECTOR	EA.854
DIAL 24C	EA.805

PRIVATE AUTOMATIC EXCHANGE
25 LINE TYPE 25-4A OR
50 LINE TYPE 50-7A L.261642 GROUPS 1-4

GENERAL DESCRIPTION

- I.1. EXCHANGE EQUIPMENT
- I.2. NUMBERING SCHEME
- I.3. POWER
- I.4. SPECIAL SERVICES
- I.5. THE AUTOMATIC SYSTEM

1.1. EXCHANGE EQUIPMENT

The type 25-4A P.A.X. provides for 25 extension lines and under special circumstances this may be increased to 35 lines. The type 50-7A P.A.X. provides for an ultimate capacity of 50 extension lines.

The whole of the equipment in each type of P.A.X. is mounted on a steel rack which is totally enclosed in a black steel cabinet.

The overall dimensions of the 25 line equipment are 4'-6" high and 2'-0" wide, and those of the 50 line equipment are 4'-6" high and 3'-2" wide, both types of equipment are 1'-4" deep.

The covers are removable at front and rear to provide easy access to the equipment for installation and maintenance purposes.

The 25 line unit has a maximum of 4 Finder Switches and 4 Connecting Links, the 50 line unit has a maximum of 7 Finder Switches and 7 Connecting Links. These will provide for 4 and 7 simultaneous conversations respectively.

However, where traffic is extremely heavy, each type of P.A.X. may have an additional Link Unit associated. This, while not increasing the number of extension lines, will provide additional Connecting Links.

The equipment is self contained and provides its own ringing current and tones. These are the conventional Dial, Busy and Interrupted Ring Tones.

Fusing of circuits is carried out by means of Alarm Type Fuses, which on blowing cause operation of the alarm bell (when fitted) and at the same time the bead gives instant indication of the position of the blown fuse.

Alarm indication is not usually provided but Fuse and Release Alarm can be fitted to give audible warning that a fault exists.

1.2. NUMBERING SCHEME

The numbering scheme for a fully equipped P.A.X. of each type is as follows:-

TYPE 25 - 4A
LINES

20 - 29, 30 - 39, 41 - 45
plus when fully extended

TYPE 50 - 7A
LINES

20 - 29, 30 - 39, 40 - 49
50 - 59, 60 - 69

When single-digit tie-lines are provided the total number of lines available for extensions is reduced by a minimum of 10, for each group of tie-lines, as a complete level on the link selector banks must be reserved for each tie-line group.

When two-digit tie-lines are provided the total number of lines available for extensions is reduced by the equivalent number of tie-lines fitted.

In the 50-7A P.A.X. the provision of Code Call and Fire Alarm Facilities will further reduce the total number of lines available by 2 and 3 respectively.

1.3. POWER

Both types of P.A.X. are operated from a 50 volt direct current supply and this is usually obtained from an eliminator. The capacity of the eliminator is determined by the type of P.A.X. Where the supply mains are direct current, batteries, with suitable charging arrangements, are provided.

Batteries may also be supplied when the supply mains are alternating current. In this case, suitable arrangements are made for charging the batteries from the A.C. supply.

In all cases the voltage regulation must be within the limits required by the adjustment of the equipment, which are 45 volts minimum and 55 volts maximum.

1.4. SPECIAL SERVICES

In addition to the normal P.A.X. telephone service, any or all of the following special services can be supplied.

1. Priority cut-in on an engaged extension.
2. Tie-line working between two or more exchanges by dialling either one or two routing digits for each group of tie-lines.
3. Secretarial Service - to allow Principals' calls to be "filtered".
4. Key Calling by means of an external Bank

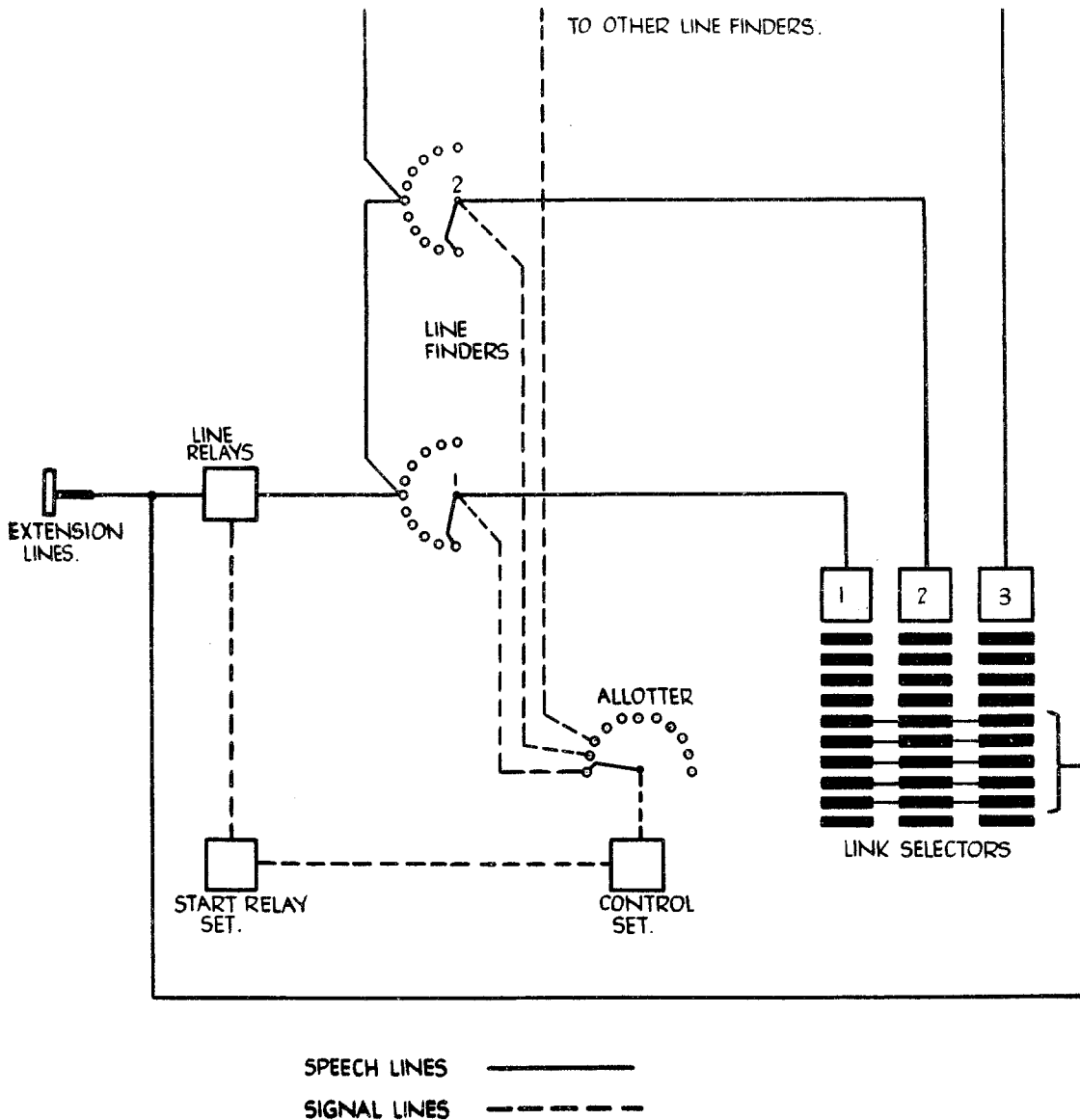


FIGURE 1. TRUNKING DIAGRAM

5. Key Calling Service combined with Conference Facility by means of an external Desk Cabinet.
6. Code Call Service, two methods.
 - (a) Bells.
 - (b) Lamps and Bells.
7. Fire Alarm Working.
8. Revertive Calling.

The P.A.X. is normally supplied without the additional apparatus necessary to provide the special services, which in all cases are required to be ordered separately.

The design of the equipment is such, that any or all of the services can be added at any time.

The additional equipment is located either in the cabinet or external to it, according to the type of service required.

1.5. THE AUTOMATIC SYSTEM

The trunking diagram in Figure 1 shows how

The incoming lines are taken to their individual line relays (L & K) and are then wired to the tags on the bank of No.1 Finder, line 21 to the 1st outlet, line 22 to the 2nd outlet and so on up to line 45 on the 25th outlet.

As there are only 25 outlets to each level of the Finders, lines 46 to 60 are wired in the same way, but on different levels of the Finder.

All the outlets of No.1 Finder are then wired (or multiplied) to the other Finders in turn.

The wipers of each Finder are directly connected to a Link Selector and the banks of these selectors are multiplied together and wired back to the line circuits. The wipers of the Finders are free to rotate around the contacts of the Finder bank and can, therefore, connect any line to the Link Selector associated with it.

Figure 2 shows a Link Selector bank in detail and gives the contact numbering arrangement.

The wipers of the Link Selector are fixed

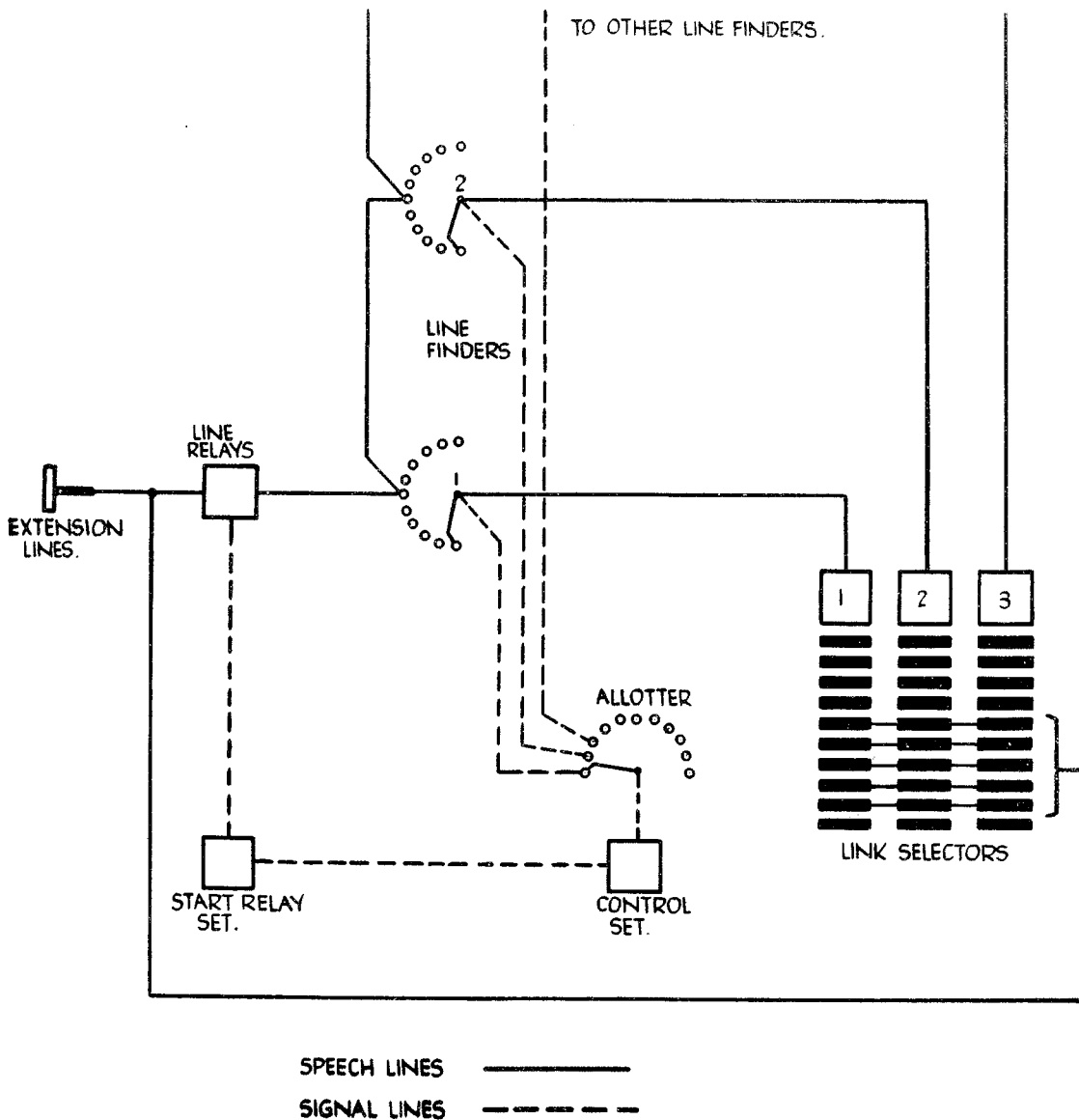


FIGURE I. TRUNKING DIAGRAM

5. Key Calling Service combined with Conference Facility by means of an external Desk Cabinet.
6. Code Call Service, two methods.
 - (a) Bells.
 - (b) Lamps and Bells.
7. Fire Alarm Working.
8. Revertive Calling.

The P.A.X. is normally supplied without the additional apparatus necessary to provide the special services, which in all cases are required to be ordered separately.

The design of the equipment is such, that any or all of the services can be added at any time.

The additional equipment is located either in the cabinet or external to it, according to the type of service required.

1.5. THE AUTOMATIC SYSTEM

The trunking diagram in Figure 1 shows how each piece of apparatus is arranged in the circuit.

The incoming lines are taken to their individual line relays (L & K) and are then wired to the tags on the bank of No.1 Finder, line 21 to the 1st outlet, line 22 to the 2nd outlet and so on up to line 45 on the 25th outlet.

As there are only 25 outlets to each level of the Finders, lines 46 to 60 are wired in the same way, but on different levels of the Finder.

All the outlets of No.1 Finder are then wired (or multiplied) to the other Finders in turn.

The wipers of each Finder are directly connected to a Link Selector and the banks of these selectors are multiplied together and wired back to the line circuits. The wipers of the Finders are free to rotate around the contacts of the Finder bank and can, therefore, connect any line to the Link Selector associated with it.

Figure 2 shows a Link Selector bank in detail and gives the contact numbering arrangement.

The wipers of the Link Selector are fixed to a shaft which is free to step upwards in step with the impulses received when calling extension

GENERAL DESCRIPTION

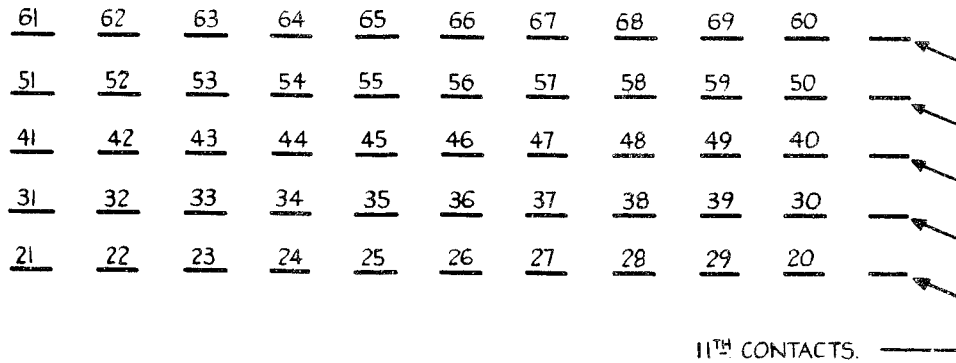


FIGURE 2. NUMBERING OF LINK SELECTOR BANK CONTACTS

dials the first digit of a required number. The second digit dialled will cause this shaft to rotate the wipers into the bank to connect them with the contacts of the called extension's number.

The complete speech circuit can be traced on the trunking diagram, from the telephone, via the line relays, Finder, Link Selector and back to the line circuits. It is obvious, therefore, that any extension can establish a call to any other extension.

The lines shown dotted are signalling lines and are as follows. Each line relay circuit is wired to the common lead of the

Start Relay Set. Thus when any line relay is operated, due to an extension lifting the handset, the Start Relays are operated. This starts the tone relays and passes a signal via the Allotter Control Set and Allotter to energise the Finder, which will commence to hunt for the calling line.

The Allotter wipers are normally standing on a free Finder.

When the finding has been completed the Allotter is stepped to the next free Finder. It can readily be seen from this that the function of the Allotter is to distribute the incoming calls over the Finders in turn.

INSTALLATION

- 2.1. THE EXCHANGE ROOM
- 2.2. CABLING
- 2.3. POWER
- 2.4. EARTHING
- 2.5. EXCHANGE FUSES
- 2.6. JUMPERING
- 2.7. FITTING OF SELECTORS
- 2.8. TESTING
- 2.9. SPECIAL SERVICES

2.1. THE EXCHANGE ROOM

The room should first of all be given a thorough cleaning and all unnecessary objects should be removed. The P.A.X. should then be set in its allotted position, for a final approval. The position should be such that there is adequate space at the front and rear, for maintenance purposes. This space should be a minimum of 3 feet at the front and 2 feet at the rear. One side should preferably lie close to a wall as in Figure 3.

The room lighting should be such that work can be carried out on the exchange in comfort

and wherever possible the front should face any natural light sources.

The distribution box should be fixed to the side wall at a distance of approximately 2 feet from the front of the exchange and at a height sufficient to allow for comfortable working. This ensures that the front of the exchange equipment can be viewed whilst making tests on the distribution box.

2.2. CABLING

The incoming cables from the telephones should be brought into the distribution box in

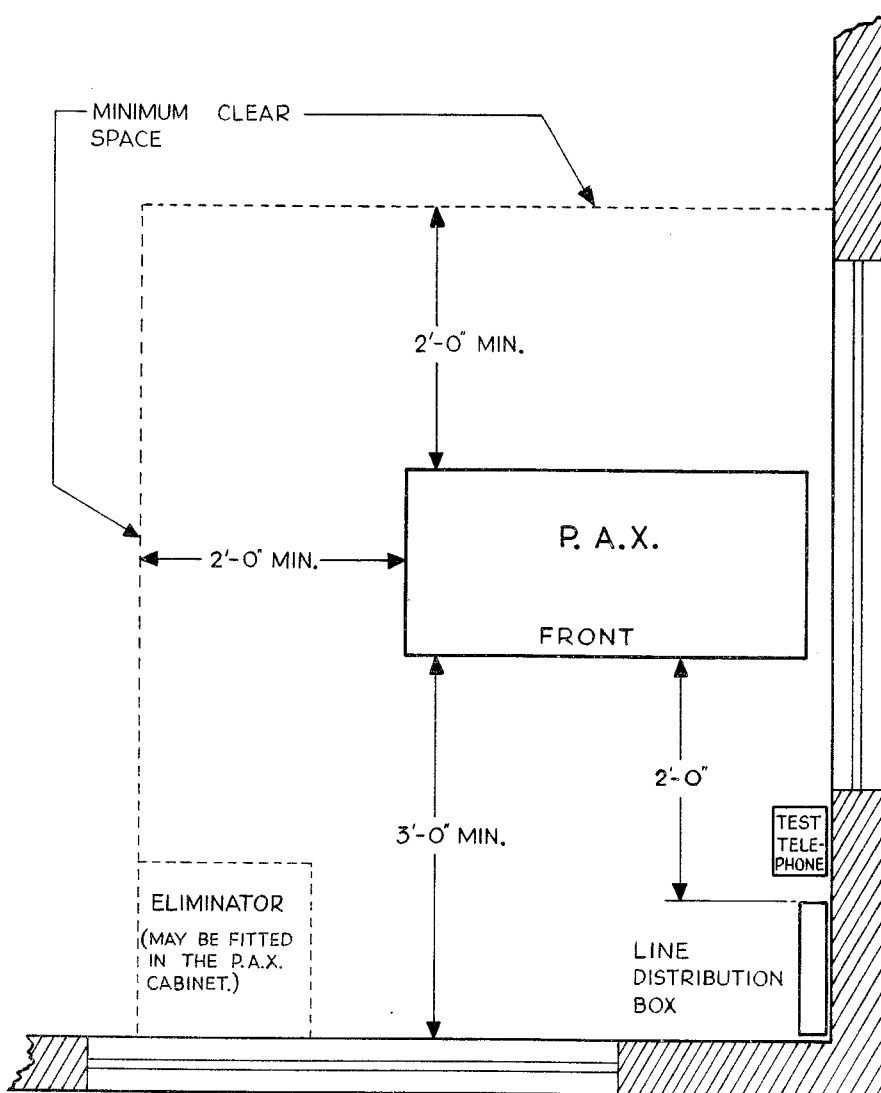


FIGURE 3. TYPICAL EXCHANGE ROOM LAYOUT

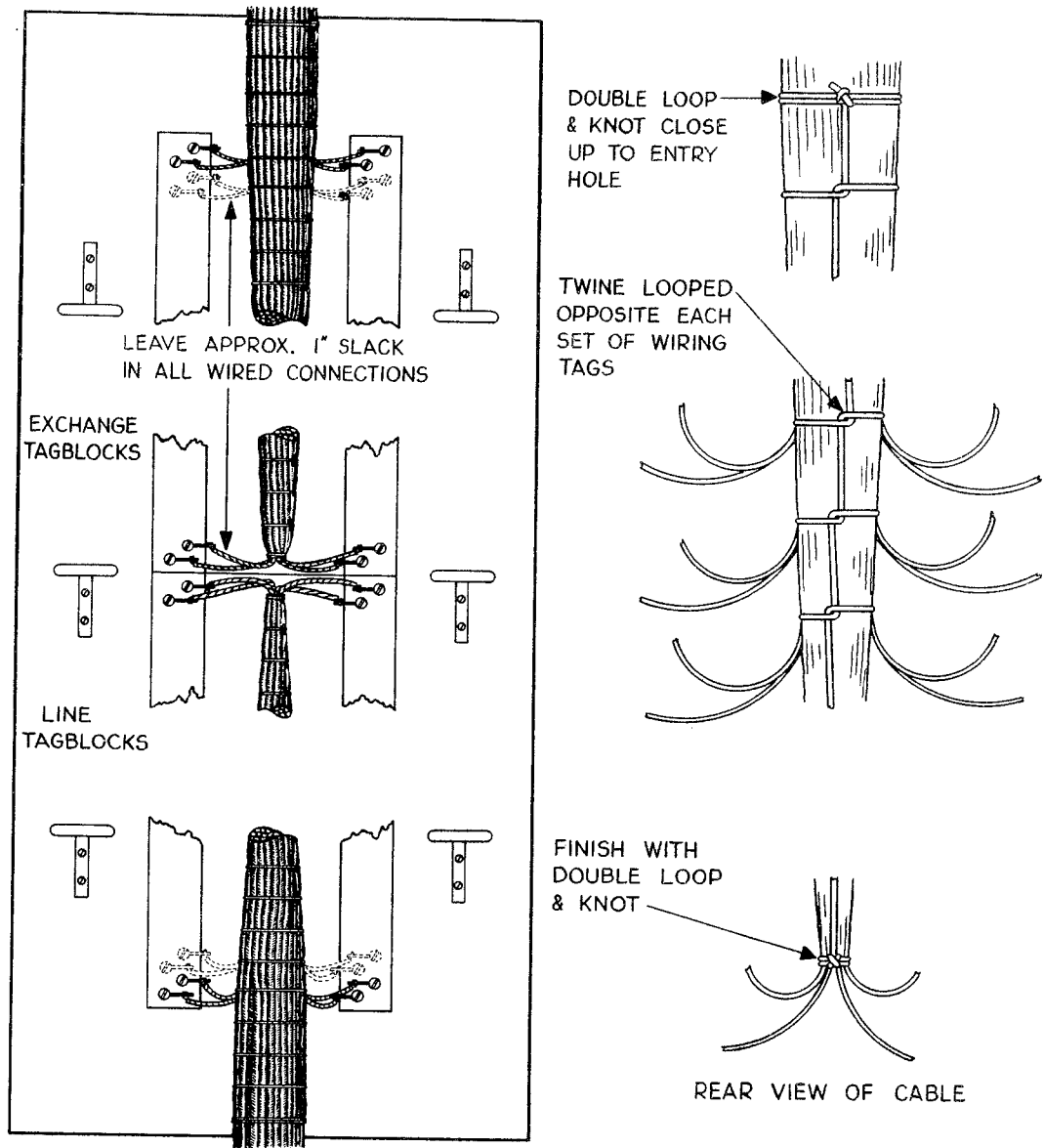


FIGURE 4. CABLE LACING IN THE DISTRIBUTION BOX

a neat manner, wired to the tags of the line tagblocks, and soldered. The cable form from the distribution box entry to the tags should be laced neatly with the waxed twine provided. The method of lacing is illustrated in Figure 4 and the twist of the twine at each loop should lie as shown, otherwise there is a tendency for the loops to slip.

When finished the knots should be at the back of the cable

The switchboard cable provided should then be stripped of its outer cover at one end for approximately 3 to 4 feet. This cable is impregnated during manufacture and will not need further waxing. The stripped end should then be fed into the distribution box, laced into a cable form as with the line cables, and wired and soldered to the exchange line tagblocks. It is essential that the twist-

ed pairs be kept together, one pair for each line.

In some distribution boxes, both line and exchange cables enter the box through a single hole in the bottom. In other types the line cables enter at the bottom and the exchange cables at the top.

If the wall is of brick or similar surface, wooden battening should be fixed between the distribution box and the exchange. The exchange cable is then clipped to this in a neat manner. It can then be fed into the exchange via the cable entrance; stripped and laced into a form in readiness for wiring to the exchange tagblocks (Tags A and B).

The coloured wire is normally taken to tag B and the white (or red) mate wire to tag A.

The basic colour code of the switchboard

type cables supplied is as follows:-

1. Blue	(B)	11. Orange White	(OW)
2. Orange	(O)	12. Orange Green	(OG)
3. Green	(G)	13. Orange Brown	(OBN)
4. Brown	(BN)	14. Orange Slate	(OS)
5. Slate	(S)	15. Green White	(GW)
6. Blue White	(BW)	16. Green Brown	(GBN)
7. Blue Orange	(BO)	17. Green Slate	(GS)
8. Blue Green	(BG)	18. Brown White	(BNW)
9. Blue Brown	(BBN)	19. Brown Slate	(BNS)
10. Blue Slate	(BS)	20. Slate White	(SW)

Each wire is twisted with a white (or red) mate wire. In addition, after the first twenty pairs the same code is repeated with red added to each colour. For example:- Red Blue, Red Orange, etc.

23. POWER

The method of connecting the eliminator or battery to the exchange is shown in the diagrams (Figures 5 and 6).

The eliminators and charging equipment supplied are adjusted to the correct voltage for the site, before they are shipped and, therefore need no further adjustment. The output voltages of eliminators should be checked, however, and must be within the limits 45 to 55 volts on load.

Note:-

An eliminator on "no load" may, even in correct adjustment read up to 65 volts.

Where an eliminator is to be fitted inside the cabinet the wires to the exchange bus bars will be found coiled ready for use, in the base of the cabinet. The ammeter links

and fuse wire will be found tied to the eliminator chassis.

When a battery is to be used the split negative bus bars (i.e. -ve speech and -ve operating) should be strapped together.

24. EARTHING

An independent earth must be brought into the exchange room and taken to the following points.

- (a) Exchange cabinet earth lug in the base of the unit.
- (b) Eliminator earth lug on the side of the frame.
- (c) To the sheaths of all incoming lead covered cables.

Usually they are bonded together and earthed just before they enter the distribution box.

25. EXCHANGE FUSES

The exchange fuses, which are of the alarm type, will be found in a box, tied to the equipment inside the cabinet.

The fuse panels are designated and it is necessary to fit fuses only on those circuits which are initially in use. The type of fuse for each position is shown by a colour dot on the black panel to the left of each position, these dots indicate the colour of the fuse to be used.

The colour code of the fuses is as follows:-

- BLUE - 0.5 amperes
- RED - 1.5 amperes
- BLACK - 3.0 amperes

It will be noticed that the width of the slot at one end of the fuse is different to

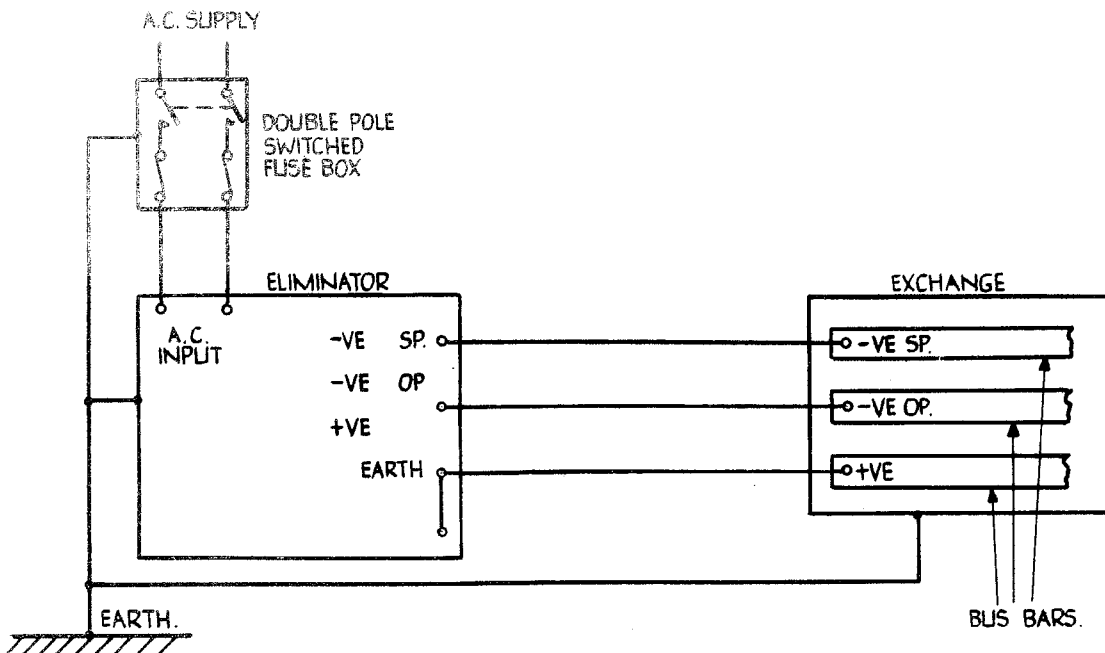


FIGURE 5. WIRING OF ELIMINATOR

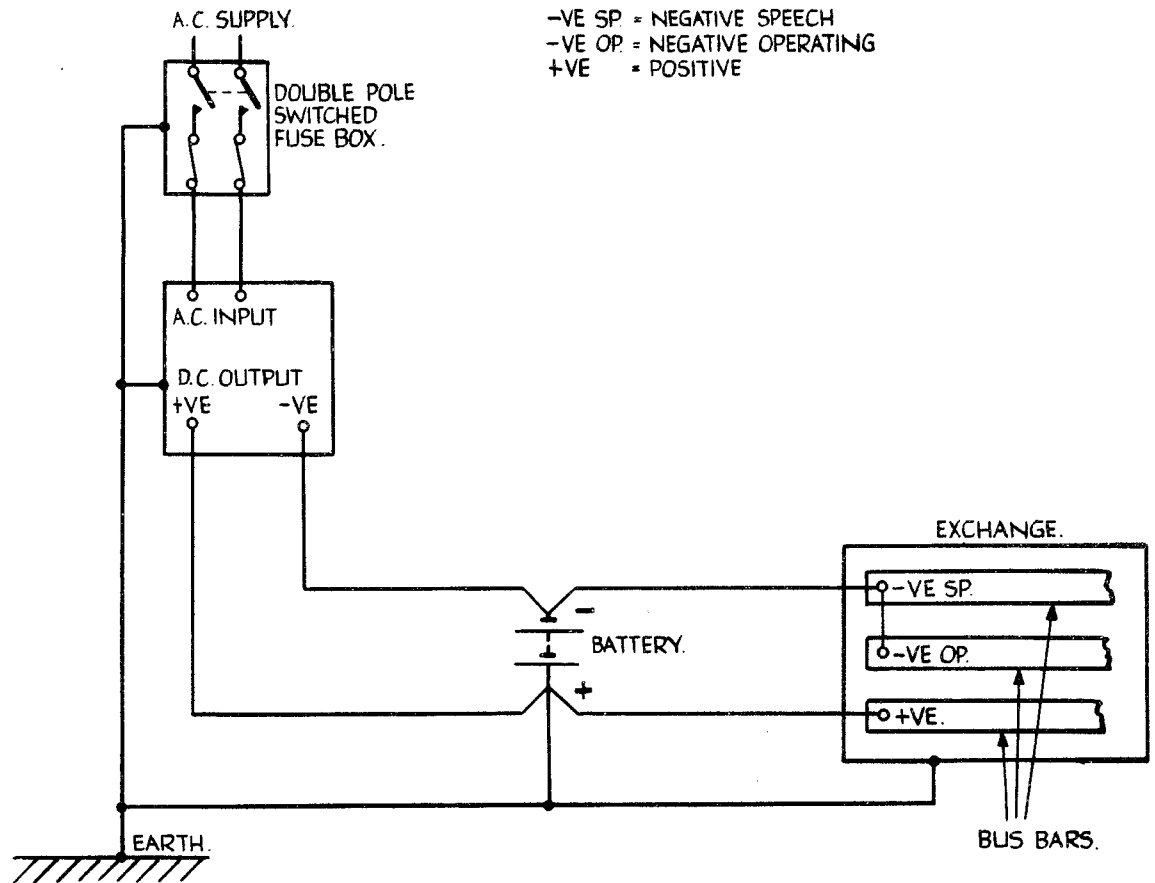


FIGURE 6. WIRING OF BATTERY AND CHARGING UNIT

that of the other. This is to ensure the correct placing of the fuse so that, should it blow, the alarm stud will be connected to the battery bus bar.

2.6. JUMPERING

Twin jumper wire is provided with the exchange and this is used for cross-connections in the distribution box, between the exchange (or numerical) tagblocks and the line (or telephone) tagblocks.

The jumper wire is terminated on the screw terminals of the telephone line and taken via the jumper rings to the screw terminals of the exchange line allotted to it.

By this means, any line can be changed to a different number at any time, without disturbing the permanent cabling.

2.7. FITTING OF SELECTORS

It is important that the selectors are handled with great care when being fitted into the exchange.

Each selector should be removed from its case and the label detached. It will be noticed that the selector wipers are set on the 10th level, this has been done for safety during transit. The wiper carriage must, therefore, be rotated to the end of its travel and released. It must be ensured that it has returned to its normal position before jacking the selector into position.

Each selector has previously been fitted and adjusted in a certain position on the exchange before leaving this works and it will, therefore, have its position number plate fixed in position, on the front. It should occupy the position indicated by this number plate.

To jack the selector into position, the slotted feet of the selector should be placed on the extended lugs of the bank, and the selector gently eased backwards, ensuring that the locating pins on the side of the selector slide into the slots on the side plates of the bank position. The selector can then be gently but firmly pressed down into position. See E.S. 351-107.

The wipers should then be checked for correct alignment with the banks, and correct adjustment on the contacts. The adjustments are set down in the adjustment folder on Two-Motion Selectors. When it is certain that each wiper is in perfect adjustment they should all be tightened with the wiper spanner.

2.8. TESTING

Before the power is switched on, the equipment should be given a thorough check to ensure that,

- (a) All relay armatures are correctly seated on their knife edge. These are likely to come out of position during transit.
- (b) All uniselector and two-motion selector

wiper assemblies are free to move correctly. These can be tested by operating the mechanism by hand.

Note:-

After testing by hand always make sure that the wiper assembly has fully returned to the normal position.

- (c) There are no extraneous pieces of solder or wire in the equipment.

The power can then be switched on and the following tests made.

- (a) That each finder uniselector rotates smoothly.
- (b) Test each link for dial tone, busy tone, interrupted ring tone, ringing and speech.
- (c) Test that the allotter switch steps to each finder in turn and will step over any busied link.
- (d) Make a call from, and to, each telephone.

2.9. SPECIAL SERVICES

For wiring of special services see notes on S202635 and also the relevant special service circuit.

OPERATION

- 3.1. EXTENSION—EXTENSION CALL
- 3.2. ALARMS
- 3.3. FUSING
- 3.4. PRIORITY SERVICE
- 3.5. TIE-LINE WORKING
- 3.6. SECRETARIAL SERVICE
- 3.7. KEY CALLING FACILITY (AUTOMATIC RINGING)
- 3.8. COMBINED KEY CALLING AND
CONFERENCE FACILITY (AUTOMATIC RINGING)
- 3.9. CODE CALL SERVICE
- 3.10. FIRE ALARM SERVICE
- 3.11. REVERTIVE CALLING

3.1. EXTENSION-EXTENSION CALL

Each Finder is directly connected to a Link Selector and when a calling extension removes his telephone handset to originate a call, his line relay operates and causes a Finder to search for the calling line. The Finder will stop on the calling line and switch it through to the Link Selector.

The caller now receives Dial Tone, a continuous tone of low frequency which indicates that dialling can commence.

The first digit dialled causes the link selector wipers to step vertically in response to the dialled impulses.

The second digit dialled rotates the wipers into the bank to make contact with the outlet wired to the required extension's line.

If the called extension is engaged the caller will receive Busy Tone, a regularly interrupted tone of high frequency. On receipt of Busy Tone the caller should replace the handset and try again later.

If the required extension is free, the Link Selector will automatically connect ringing current to the line to ring the extension's bell. The caller now receives Ring Tone, which is of the same frequency as ringing current and interrupted in the same way, thus indicating that the call is effective.

When the called extension lifts his handset, the ringing current and tone are disconnected, and the Link Selector feeds transmission current to the calling and called extensions.

The call is released when both parties replace their handsets, but arrangements are made to release the calling line circuit immediately the caller's handset is replaced. A further call can then be originated.

If an extension dials an un-allotted line, i.e. a line not equipped with line relays, or an equipped line that is not in use, he will receive Busy Tone.

If a call is originated when all Finders are in use, the caller will not receive Dial

Tone and cannot, therefore, proceed with the call.

3.2. ALARMS

Two types of alarm are available but the equipment necessary to provide audible warning is only fitted when required.

3.2.1. Fuse Alarm

When a bead type fuse blows, a circuit is prepared to give a warning.

3.2.2. Release Alarm

If, due to a mechanical failure, a selector fails to restore to normal within 10 seconds after being released, a circuit is prepared to give a warning.

At the same time, the rotary magnet coil is prevented from burning by the insertion in the circuit of a 5000 ohm resistance.

3.3. FUSING

When the power supply is derived from an eliminator two power leads are provided. One to provide the main operating current for the relays and switches, and the other, more efficiently smoothed, to provide the transmission current for the Link Selector.

Although a transmission fuse may be blown, it is possible for the Allotter to pre-select the Finder associated with the faulty Link Selector. The circuit is, therefore, arranged that immediately the Finder locates the calling line the Allotter is stepped forward to find another free link, the finder of which then hunts for the calling line.

Similarly, if the operating fuse of a Finder Switch and Link Selector is blown it is possible for the Allotter to pre-select the faulty switch. On a start signal being received the allotter is stepped on to select the next free Finder Switch.

3.4. PRIORITY SERVICE

An official having this service may speak instantly to any extension on the exchange,

whether the extension is already engaged on a call or not.

The caller dials the required number and the Link Selector wipers extend the call to the required line.

If this line is free the bell rings and the called extension answers. If the called line is engaged no Busy Tone is heard and the caller is instantly switched into the existing conversation.

The call at this stage is not private; when privacy is required both engaged parties must replace their handsets, ringing current is then automatically connected to the required party's bell and the call proceeds in the normal manner.

3.5. TIE-LINE WORKING

3.5.1. Single Digit

A level on the Link Selector bank is allocated to each tie-line group and on a single digit corresponding to this level being dialled, the Link Selector wipers step vertically to the level and then automatically rotate into the bank to search for, and switch to, the first free tie-line in the group.

If all tie-lines in the group are engaged the wipers will rotate to the 11th step and Busy Tone will be returned to the calling extension.

3.5.2. Two Digit

When two digit tie-lines are provided the required numbers in the same group of tie-lines may appear on the same level as ordinary extensions; the Tie-lines, however, must be located at the end of the level in order to provide automatic hunting over the group of lines and Busy Tone at the 11th step when all lines in the group are engaged.

In both cases if a free tie-line is encountered Dial Tone will be returned from the distant P.A.X. and the calling extension will then dial the remaining digits necessary to complete the circuit to the required extension's telephone. The call then proceeds in the normal manner.

As routing digits are dialled to gain access to a tie-line group, it follows that only tie-lines in the same group can be connected to the same level.

Therefore, if tie-lines are required to, say two remote P.A.X.'s, two levels must be used.

3.6. SECRETARIAL SERVICE

For this service a small cabinet equipped with a lamp, keys and buzzer is located near the secretary's telephone and a buzzer is

located in the office of the official having the service. By this arrangement all the calls incoming to the official can be filtered by his secretary.

An incoming call causes the bell of the secretary's phone to ring. On deciding to pass the call to the official, the secretary connects his telephone to the official's by operating the key to the "local" position. The secretary then operates the "buzzer" key and the official's buzzer operates to call his attention.

If the official agrees to accept the call, he informs the secretary accordingly. The secretary then operates the key to the "through" position to connect the official's telephone to the calling line.

The lamp remains dark during the call and glows when the official's handset is replaced.

The secretary then restores the key to "normal".

To call the secretary, the official lifts his handset, which causes the secretary's buzzer to operate. The secretary then operates the key to the "local" position and speaks. The secretary can make a call on the exchange by dialling the required number with the key "normal" and may re-call the official as already described.

When the key is in the "through" position, incoming calls pass automatically to the official's telephone and outgoing calls can also be made from this telephone without the secretary's intervention. Normally such calls are not private but if privacy is required this may be obtained by the removal of straps in the secretary's cabinet.

If desired, complete privacy on all calls to the official can be obtained.

3.7. KEY CALLING FACILITY (AUTOMATIC RINGING)

The equipment for this facility enables an official using a master station to select one of a maximum of 20 allotted extensions to which he may speak without having to dial.

To make a call, the relevant line key (KL) is operated. Ringing is then extended to the required line.

In the event of the called party's line being engaged, the ringing current is disconnected and the master station is switched into the conversation instantly. If the official at the master station requires his calls to be private he may ask the parties holding the P.A.X. call to replace their handsets. When both parties have replaced their handsets ringing will be connected to the required extension, who on again lifting his handset will be connected to the master station; the conversation will then be private.

The official at the master station may

OPERATION

call any other extension, and still keep the "key call" intact, by operating the Hold Key (KH) and dialling the required number in the usual way. By restoring the Hold Key at the completion of the P.A.X. call, the master station is again connected to the extension being held on key call.

The final release of the equipment is controlled by the official at the master station, who at the termination of the call restores the line key (KL)

The key calling facility is independent of the P.A.X. equipment, therefore a lengthy call will not use any of the P.A.X. equipment, thus leaving it free for the ordinary P.A.X. calls.

3.8. COMBINED KEY CALLING AND

CONFERENCE FACILITY (AUTOMATIC RINGING)

This arrangement enables a person at the master station to speak to any - with a maximum of 20 - predetermined extensions, the functions being similar to those of the Key Calling equipment.

In addition, the master station user may call a group consisting of any number of the allotted extensions, up to a maximum of ten, to form a conference.

To call a conference the relevant line keys (KL) are thrown, each line being rung automatically when the key is operated.

If when calling a conference the official at the master station operates the line key of an extension who is already engaged on a call, the master station user will be switched right into the conversation and may request the parties to terminate their call.

When both parties have restored their handsets, the required extension's bell will ring. The extension will then lift his handset, to be connected to the conference.

Any extension may be released from the conference by the restoration of the particular line key concerned at the master station.

In all cases the final release of the equipment is under the control of the official at the master station, who at the termination of the conference will replace his handset and restore the line keys to normal.

The key calling and conference service is independent of the P.A.X. equipment, therefore a lengthy call or conference will not use any of the P.A.X. equipment, thus leaving it free for the ordinary P.A.X. calls.

3.9. CODE CALL SERVICE

This service enables certain authorised persons who are absent from their usual offices to be called by a Code Signalling System.

To each such persons a special code number is allocated which will be prefixed by the "Code Calling" number.

To call a code call party, lift the handset and on hearing "Dial Tone" dial the "Code Calling No.69". If the equipment is free "Dial Tone" will be heard again. The code number of the required party should then be dialled. A tone signal which synchronises with the code being sent is returned to the caller and continues until the call is answered.

After dialling the first part of the number i.e. the "Code Calling" number referred to above, the calling line is extended to the Code Calling apparatus; this apparatus receives the impulses from dialling the second part of the number, i.e. the code number of the required party.

These impulses will step the Uniselector in the apparatus to the required contact; the relays and contactors will then operate and send out the calling signal to the bells or lamps in all the departments.

When the code is recognised the called party will go to the nearest telephone and dial the "Code Answering No.60". The signals will then cease and the called party will automatically and instantly be connected to the caller.

If the Code Call apparatus is already in use when the "Code Calling" number is dialled, "Busy Tone" will be heard by the calling party, who should then replace the handset and call again after a short interval.

Extensions having Priority Facility cannot cut in and seize the equipment when it is in use, but must wait until it is free.

When the handset of either extension is replaced the Line Equipment and Link Selector associated with the replaced handset is released, but both extensions must replace their handsets before the Code Call Equipment is released.

3.10. FIRE ALARM SERVICE

The equipment caters for either 24 or 49 Indicators according to whether the P.A.X. is of the 25 or 50 line type.

The equipment is so arranged that all extensions will dial the same number and each Indicator is suitably marked to indicate the particular group that is calling.

In case of fire a predetermined two digit number followed by "0" is dialled to give the alarm.

Lift the handset and on hearing "Dial Tone", dial the number. After the second digit is dialled, the Link Selector wipers will extend the calling line to the Fire Alarm equipment which is located in the P.A.X. unit. If the Fire Alarm equipment is free "Dial Tone" will again be heard - the digit "0" should then be dialled and "Ring Tone" will be heard.

On hearing "Ring Tone" the caller may wait

for the attendant to answer and then give particulars, or may replace the handset and attend to more urgent business, since the display of the Alarm Signal is dependent on the dialling of the Fire Alarm number only, and once given the alarm can only be cancelled by the attendant.

On dialling "0" the Uniselector in the equipment operates and causes the audible and visual Fire Alarms to operate, and lights the lamp or operates the Indicator associated with the calling line.

As a telephone is usually located at the station where the Indicator is installed, a key is provided for use by the attendant to establish communication with the calling party.

In addition to the telephone number of the calling party being given, the system is arranged to indicate the building, floor or area from which the call originated.

3.11. REVERTIVE CALLING

This facility is used on two-party lines to allow one extension to call the other. The calling extension lifts his handset and, when dial tone is received, dials the revertive call number, usually "9". The calling extension then replaces his handset, and both telephones on the line will commence to ring. As soon as the ringing ceases, the calling party will know that the called extension has answered the call and he may lift his handset to commence the conversation.

MAINTENANCE

- 4.1. GENERAL
- 4.2. FUNCTIONAL TESTS
- 4.3. SOLDERED CONNECTIONS
- 4.4. CONTACT CLEANING
- 4.5. FAULT LOCATION
- 4.6. ROUTE RECORDS
- 4.7. REPAIR OF FUSES
- 4.8. CLEANING OF EQUIPMENT
- 4.9. USE OF TEST JACKS
- 4.10. TAGBLOCK STRAPPING

4.1. GENERAL

Provided that these exchanges are kept reasonably free from dust and damp, they will require very little maintenance.

The covers should be left on the equipment at all times, and should only be removed to carry out periodic lubrication and cleaning, or to clear a fault which is known to exist.

Lubrication of uniselectors and selectors should, under normal conditions, be carried out yearly, but if it is found necessary, this period may be reduced to six months. It is important that lubrication is carried out in accordance with the information contained in the adjustment folders.

Superficial cleaning should take place at the same time as the lubrication and should be carried out with a slightly oil-moistened cloth. The only parts of the equipment to be cleaned are the floor and inside walls of the cabinet, and the inside and outside of the selector covers. This cleaning is done with the object of picking up the dust and preventing its dispersal inside the cabinet.

Dust on the cables, wiring and inaccessible parts of the ironwork and equipment must be left undisturbed. Experience has shown that even when the accumulation of dust on the equipment is considerable, little or no effect on the service is caused so long as the dust is not disturbed.

4.2. FUNCTIONAL TESTS

It is advisable to institute a system of functional testing, to be carried out each week. These tests will ensure that there are no faults in the exchange which are adversely effecting the service and should be carried out at a time when there is little traffic on the exchange, such as early morning.

Tests as follows may be made from any extension, and a different extension should be used each week.

- (a) Make a call to two extensions in each 10's group. That is, to two extensions

in the 20 group, the 30 group, etc., checking for correct tones and clear speech.

- (b) Make ten calls to the extension from which the tests are being made (i.e. by dialling your own number), and ensure that busy tone is being received each time.
- (c) Where tie-lines are fitted, two calls should be made over each line. The same tests should of course be made at the distant exchange, but where the number of tie-lines is under six and the distance is not great they can be effectively tested from one end only. When the dial tone is received from the distant end on a call over a tie-line, then by dialling the tie-line number for the distant exchange the call will be routed back and two lines will be in use together. The codes can be dialled alternately until all lines are held, an extension can then be called and speech tested.

A second test of this type should be made, but to ensure that the lines are not tested in the same direction as before, the first line should be held busy by another extension and should only be released when the last line is ready to be dialled.

The test should be carried out during a time when the exchange is not being used.

If for any reason during these tests, a call fails to mature, or a tone is not received, then the call should be held and the exchange equipment examined to find the source of the failure.

4.3. SOLDERED CONNECTIONS

For making soldered connections use resin-cored solder exclusively. Other fluxes, pastes or compounds should on no account be used. The soldering iron bit should always be kept clean.

Temporary connections, straps or wires should be made good as soon as possible. Untidy tagblocks with loose unsoldered connections are a potential source of trouble and should

be avoided. Solder all connections immediately to avoid tarnish, which makes later soldering difficult.

4.4. CONTACT CLEANING

When it becomes necessary to clean contacts of relays or other contacted springs, the standard contact cleaner or piece of thin sandblasted steel should be used. Never use a file, or a nail file.

4.5. FAULT LOCATION

When locating faults it is always advisable to compare the operation of the suspected circuit with other circuits of the same type. Also compare its operation under fault conditions to that where it is used with equipment known to be in order.

When adjustment trouble is suspected, make quite sure of the cause before interfering with adjustments. Certain electrical faults may cause a piece of apparatus to behave as if the adjustment were faulty and it should be verified that this is not the case before adjustments are altered. Carry out all adjustments in accordance with the adjustment information supplied.

It will be found useful to keep a record of all faults. A simple system showing the faults that have occurred on each item of equipment will assist in the rapid recognition of particular faults when they occur.

4.6. ROUTE RECORDS

A chart should be drawn up showing the route of each extension line, from the exchange to the telephone instruments. Distribution tagblocks which may be installed at various points around the premises should have a chart attached, or be signwritten with an indication of the number of each pair wired on the tags, related to the termination number of that pair on the exchange distribution box line tagblocks.

This scheme will assist in tracing line faults.

4.7. REPAIR OF FUSES

Bead type fuses may be repaired as follows:-

Remove the remaining bits of the blown fuse wire. Pass the new fuse wire through the hole of the alarm spring and the hole in the fuse base and wrap 2 turns round the bead arm. Spot solder the wire at this point. Press the spring and the bead arm to the fuse base and keeping the wire taut, wrap it around one end of the fuse so that the finger pressure may be released from the springs. Spot solder the wire at the alarm springs and cut the fuse wire at this point.

4.8. CLEANING OF EQUIPMENT

Note:

This treatment is severe and should only

be applied to equipment that is definitely giving trouble due to a considerable accumulation of dust.

If, after some years, the accumulation of dust is such that continued and repeated troubles due to dirty contacts are being experienced and the normal superficial cleaning does not reduce the trouble, then the whole equipment should be thoroughly cleaned out.

Proceed as follows:-

Remove all external covers but leave individual covers in position. Protect uncovered mechanisms with paper.

With a suitable vacuum cleaner and clean dry dust brushes, brush the dust off the upper parts of the equipment, such as cable forms, ironwork, tagblocks, wiring, etc., into the nozzle of the cleaner. Take care not to disturb the wiring and do not use brushes on mechanical parts where they will become greasy.

Bellows may be used to blow dust from inaccessible parts into the cleaner nozzle.

Use a rag moistened with polishing oil to clean all flat surfaces. By this means thoroughly clean the whole equipment.

Clean between the armature and core iron of all uncovered relays by inserting a piece of non-fluffy paper or linen tape, pressing the armature lightly until the material is gripped, and then withdrawing the paper or tape partially whilst maintaining the light pressure on the armature.

With clean dry brushes, lightly brush the dust off all relay and other contacted springs and assemblies, taking care not to disturb any adjustments. Commence with the uppermost springs and work downwards.

After allowing the dust to settle, remove internal covers. Clean the armatures and dust the relays and spring assemblies as above.

Clean all covers and apply all functional tests.

After this treatment, trouble with relay contacts may be experienced for a few days until the remaining dust has finally settled.

4.9. USE OF TEST JACKS

4.9.1. Link Selectors

The test jack of a connecting link has 6 U-links which should normally occupy positions T.1-2, T.3-4, T.5-6, T.7-8, T.9-10 and T.11-12.

To busy a connecting link, remove the U-links from T.7-8 and T.9-10 and insert one in T.8-9.

Before making any adjustments to the Link Selector busy as above and in addition remove the U-links from T.1-2, T.3-4, T.5-6 and T.11-12.

To prevent rotary stepping remove the U-link from T.11-12.

MAINTENANCE

4.9.2. Tie-Lines

The test jack associated with each tie-line has one U-link which should normally occupy position T.1-2.

In order to busy the tie-line, transfer the U-link from T.1-2 to T.2-3.

4.10. TAGBLOCK STRAPPING

Drawing S202636 gives the layout and designation of all tags.

4.10.1. Regular Extensions

The twin line wires from the telephone are terminated on tags A and B.

On ordinary lines strap A to +, B to - and PN to L.

4.10.2. Priority Extensions

Strap A to +, B to -, PN to L and K to PC.

PART 2
CIRCUIT DIAGRAMS AND NOTES

DIAGRAM NOTES E.202635 E.202636 RELATING TO
25 AND 50 LINE P.A.X. TYPES 25-4A AND 50-7A

ISSUE 3

1. GENERAL

1.1. This diagram shows the through circuit of a 25-50 line automatic exchange.

1.2. Abbreviations.

NEG. Minus or negative pole of battery.

POS. Plus or Positive pole of battery.

Number before letter indicates coil resistance.

Number after letter indicates contact unit.

2. FACILITIES

Provision is made for:-

2.1. Local connections by dialling two digits.

2.2. Priority of any extension.

2.3. Loudspeaking Telephones.

2.4. Key calling.

2.5. Tie-line working.

2.6. Fire Alarm.

2.7. Code Call.

3. OUTLINE OPERATION

The connecting links to be used are pre-selected by an allotter, and the closing of the subscribers loop which occurs at the commencement of a call, causes a Finder Switch associated with a selector to hunt for the calling line. When the selector is connected to the calling line the allotter is caused to step and find the next free selector.

Simultaneously a group of relays and a vibrator receive a start condition. These relays provide the ringing and tones output, the latter indicating the progress of the call.

The traffic handled may consist of local calls, set up by dialling two digits, or calls to a remote exchange. Contact with the latter is made over incoming and outgoing lines and outgoing calls may be set up by single or two digit working.

4. DETAILED CIRCUIT OPERATION

REGULAR EXTENSION TO EXTENSION WORKING

4.1. INITIAL OPERATION

The allotter circuit (Figure 3) is of the battery testing pre-selecting type, i.e. the allotter normally rests on a free link so that upon a call being originated the finder associated with the link commences to hunt immediately to connect with the calling line. When a link is busy earth is extended to the equivalent contact of allotter bank AS-4 operating relay FH (NEG.5000FH,ST5,ASdm,AS4,U9,T7 & 8, N3, U5 (busy link) common point to N3, B6, T9 & 10, POS. (in all free links).

Relay FH operating.

FHL operates the allotter magnet (NEG.Mag,FHL POS).

Magnet Operating.

ASdm, opens the circuit of relay FH which releases.

Relay FH releasing releases magnet at FHL. Upon the magnet releasing the wipers step to the next outlet. If this outlet is also engaged a similar action takes place until a free link is arrived at, when the allotter comes to rest.

Should a disconnection occur in the busyring circuit of a link the allotter may come to rest upon a busy link. In this case when a start earth is received from the line circuit (as will be described more fully later) relay ST lacking its normal operating battery will not operate to the 5000 ohms battery offered by relay FH. The latter, however, does operate in this circuit and the allotter steps on as before until a free connecting link is encountered.

The busyring earth which steps on the allotter comes from existing free links, and when all the links are engaged, this earth is removed and the allotter prevented from hunting continuously.

4.2. EXTENSION CALLING

Upon the extension lifting his receiver, line relay L operates (NEG, 500L, K4 extensions loop K1, POS).

Relay L operating.

L1 connects low resistance battery to the relevant contact of the finder bank.

L2 prepares circuit to operate relay K.

L3 completes circuit to operate relay ST (NEG. rotary magnet, H4, N1, C5, T7 & 8, U9, (Link) AS4, 500ST (allotter) common L3, K3, (Line CCT) common, U5, N3, B6, T9-10 POS (Link).

Relay ST operating.

ST1 completes circuit to drive finder switch (NEG. finder magnet FSDm, AS3, ST1, FHL, POS).

ST2 prepares circuit to operate relay FH.

ST3 provides POS. to start ringing and tone relays.

ST4 prepares circuit to operate relay A in link.

ST5 prepares holding circuit for relay FH. The finder switch continues to run until wiper 1 encounters the contact connected to a line circuit marking battery.

Relay FH operates (NEG, 150K, K2, L1, finder bank and wiper, allotter bank and wiper AS1, ST2, 11FH, to POS) and locks on its second winding (NEG. 5000FH, ST5, FH2, POS).

FH1 disconnects the driving circuit of the finder and operates the allotter magnet (NEG, Mag. FH1, POS).

Relay A of the selector is also operated (NEG. 200A, U7, of link AS2, YA600, ST4, FH1, POS).

Relay A operating.

A1 operates relay B.
A2 is ineffective at this stage.

Relay B operating.

B1 operates relay C (NEG, 500C, N2, B1, POS).
B2 prepares impulsing circuit for vertical magnet.
B3 connects POS. to operate the vibrator start relay VS.
B4 & B5 connect extension's loop to relay A.
B6 disconnects POS. from allotter circuit and operates relay K (NEG. 130CK. L2, 500L, FS1, B6, T9 & 10. POS).

Relay C operating.

C2, 4, 6 and 7 are at this stage ineffective.
C1 connects dial tone to relay A.
C3 prepares a circuit to hold relay C during impulsing.
C5 disconnects NEG. from the AS4 bank and replaces it with busying POS.

Relay K operating.

K1 removes POS from + line.
K2 prepares the discriminating circuit.
K3 opens the common holding circuit of relay ST.

Relay ST releases.

ST5 releases FH.

Relay FH releasing.

FH1 opens the operate circuit of the allotter magnet, the wipers move on and test for the next available free link.

4.3. EXTENSION DIALS

The action of dialling causes disconnections to occur in the extension's loop, the duration of these 'breaks' being approximately .066 seconds, and time that the circuit is re-made between successive breaks is .033 seconds.

Relay A releases and re-operates in synchronism with these intermittent disconnections.

Relay A when released.

A1 operates the vertical magnet over the circuit (NEG, NR3, E6, C3, B2, A1, POS).

Relay B remains operated during this time due to the effect of its heel end slug. A holding circuit is provided for the second winding of relay C in parallel with the vertical magnet.

Following the first impulse the carriage assembly is raised one step and all the off-normal springs N operate.

N1 prepares a circuit for the operation of the rotary magnet.

N2 disconnects the operating winding of relay C which being slow to release, remains operated until the impulse train is complete.

N3 connects a busying POS. to allotter bank AS4 which is independent of relay C.

When the dial comes to rest the wipers have been raised to the level corresponding to the digit dialled and relay A remains operated. After a slight delay relay C releases.

C1 removes dial tone from the tone winding of relay A.

C2 operates relay E (NEG, 800E, C2, NPA, G5, NR4, N2, B1, POS).

C3 opens the magnet circuit.

The remaining C relay contacts are ineffective.

Relay E operating.

E1 prepares a holding circuit for that relay.
E2 prepares a testing circuit for relay H.
E4 disconnects the tone circuit.
E5 re-operates relay C (NEG, 500C, E5, NR4, N2, B1, POS).
E6 diverts the impulsing circuit to the rotary magnet.

The rest of the contacts of relay E perform no immediate function.

The re-operation of relay C only interests us in so far that combination C3 prepares the vertical magnet impulsing circuit and C2 causes the holding circuit for relay E to be dependent upon combination E1. During the transit time of C2 relay E holds on its slug. The connector banks are so arranged that the wipers reach the first contact level when they are raised two steps, i.e. when digit 2 is dialled.

The second train of impulses cause the wipers to be rotated in the horizontal plane of the selected level, thus stepping them to the required outlet which corresponds to two digits dialled.

Relay A responds as before to the second train of impulses and relays B, C and E are caused to hold during the time the impulses are received.

The operation of relay E has now diverted the impulses from the vertical to the rotary magnet which operates over the circuit (NEG. Mag., H4, E6, C3, B2, A1, POS).

Immediately following the first rotary step the rotary off-normal springs NR operate.

NR1 is ineffective at this stage.

NR2 disconnects the rotary magnet from relay TL.

NR3 disconnects the vertical magnet.

NR4 disconnects the pre-operating winding of relay C.

Relay C releases when impulsing is completed.

C2 disconnects relay E which releases after an interval.

C7 tests the selected outlet for free or engaged condition.

The remaining contacts of relay C at this stage perform no useful function.

4.4. CALLED LINE FREE

During the time taken by relay E to release the called line is tested over the following circuit (POS. B1, N2, NR4, E2, C7, 900H, PN wiper and bank to line circuit).

As we are presuming that the line is disengaged the foregoing circuit is connected to NEG. via (PN tag, L2 1300K to NEG).

Relay H operates.

H1 & H8 connect interrupted ringing to the called line.

H2 connects int. ring tone to the calling line.

H3 connects POS. to the PN wiper and bank.

H4 disconnects the rotary magnet impulsing circuit.

H5 is an 'x' or 'make first' contact which completes a holding circuit for relay H.

H6 & H7 ineffective here.

Upon the release of relay E ringing current is connected to the line (NEG. fuse, U19, 200YA, F5, H8, W1, extension loop, W2, H1, F3, E3, 300F, U32, ring generator to POS).

Although ringing current passes through the 300 ohm winding of relay F the presence of a condenser in the extension bell circuit prevents any direct current from flowing.

The joint effect of the large armature end slug and the short circuited 400 ohm winding prevent this relay from operating under these conditions. Upon the called party lifting his receiver the bell is disconnected by the switch hook springs and the loop completed by the instrument.

Relay F now operates.

F1 & F6 connect relay D to the line.

F3 & F5 disconnect the ringing and complete the circuit for speech transmission.

F2 disconnects the start from the ringing and tone relays.

F4 is a "break first" combination, which removes the short cct. from the second winding of F relay thus causing it to be held in series with relay H and controlled by relay B.

F7 completes the disconnection of the tone winding of relay A. Conversation can now take place over the lines which are coupled by condensers QA and QB, relays A and D supplying the necessary speech current.

4.5. CALLED LINE ENGAGED

If when the call has reached the busy testing stage a POS. potential or a disconnection exists on the PN lead, this is taken as an indication that the called line is engaged. Relay H, therefore, is unable to operate during the time allowed which is the release time of relay E. E2 causes relay G to operate over the circuit (NEG. 500G, H6, TL5, E2, NR4, N2, B1, POS).

Relay G operating.

G1,2,3 and 5 are used for purposes not effective at this time.

G4 connects busy tone to the line (Busy Tone U16, G4, H2, C1, E4, F7, 570A, POS).

4.6. RELEASE OF LINK

The release of the link takes place when both parties have replaced their receivers. When the calling party clears relay A releases, followed after its slow release period by relay B. B6 releases the line circuit relays so that a further call may be made immediately by the calling party. Upon the called party replacing his receiver relay D is released.

D1 releases relays H and F.

Relay H releasing.

H4 completes the homing circuit of the switch (NEG, Mag, H4, N1, G2, E8, R1, T11 and 12, B3, POS).

The rotary magnet rotates the wipers to a position just off the bank, being self interrupted by its 'R' springs. The shaft drops and the switch returns to normal; up to this instant a guard has been maintained on the switch by contacts N3 which extend the earth from the start common to the AS4 bank of the allotter.

5. RINGING AND TONE RELAYS

Ringing current and the lower frequency tones are generated by the vibrator RV.

When POS. is connected to the start common the vibrator commences to oscillate over the circuit (NEG. 200RV, RV1, POS). The speed of operation is 25 oscillations per second.

The intermittent connection of direct current to the ringing transformer TR at terminals 2 and 4 has the effect of inducing an alternating current into the secondary winding (terminals 6 and 8).

The 6 ohm choke coil and condensers QC and QD are introduced into the circuit to create a sinusoidal wave form.

The retard DT acts as a transformer for the generation of dial tone and is fed through condenser QE at the rate of 50 pulses per second. This output is delivered at a fundamental frequency of 50 by the second winding of DT.

Busy tone is created by the self interruption of relay BV which occurs about 300 times

per second. This is the average frequency of the tone. A special feature of this circuit is the change of polarity of the interrupting springs of relay BV brought about by the cyclical operation and release of relay IE. This occurs at half second intervals and prevents metallic transfer of contact material from taking place, thus minimising contact wear.

Interruptions in the ringing current and the intermittent supply of ring and busy tone are controlled by a series of slow operate and release relays designated IA, IB, IC, ID and IE.

The above relays operate and release in a continuous sequence and are controlled by the Vibrator Start (NEG, 800IA, IB3, IC2, start common, POS).

Relay IA operates.

- IA1 prepares a circuit to operate relay IE
- IA2 operates relay IB (NEG. 800IB, IC3, IA2, ID1, POS).
- IA3 releases relay ID (if operated).
- IA4 delivers ringing current to the 'odd' links requiring it.

After an interval relay IB operates.

- IB1 operates relay IE.
- IB2 prepares holding circuit for relay IB.
- IB3 releases relay IA.
- IB4 prepares a circuit for the operation of relay IC.

Following an interval relay IA releases and IA2 operates relay IC which is slow to operate.

- IC1 connects ringing to QF condenser to act as Int.Ring tone.
- IC2 prepares a circuit for the operation of relay ID.
- IC3 releases relay IB.
- IC4 connects ringing to the 'even' links.

After the delayed release of relay IB.

- IB4 operates relay ID (NEG. 800ID, IA3, IB4, IC2, POS).

Relay ID operating.

- ID2 releases relay IC. Following an interval relay IC releases.
- IC1 cuts off int.ring tone.
- IC2 operates relay IA.
- IC3 prepares a circuit to operate relay IB.
- IC4 disconnects interrupted ringing.

The cycle is now complete.

6. TIE-LINE WORKING

6.1. INCOMING CALLS

Incoming lines are wired directly to line circuits. When the line is looped at the distant exchange relay L operates to the following circuit (NEG. 500L, K4, looped line K1, POS). The circuit functions as for a normal extension and the line is seized by the selector.

6.2. OUTGOING CALLS. SINGLE DIGIT

For single digit working an entire level consisting of 10 outlets is employed. The operation up to the point when the impulses of the first digit are completed is similar to that taking place upon a local call. When the carriage assembly reaches the level allocated to the outgoing junctions, normal post springs NPA operate. A circuit is now completed to operate relay TL(NEG, ROT. MAG.H4, N1, G2, NR2, 1000TL, C6, NPA, G5, NR4, N2, B1, POS).

Relay TL operated.

- TL1 & TL7 change the connections of relay D from battery feed to shunt impedance.
- TL2 operates relay F in series with the holding winding of TL.(NEG. 400TL, TL2, 400F, S2, N2, B1, POS).
- TL3 removes the short circuit from the impulse repeating contact of relay A.
- TL4 prepares a circuit for the re-operation of relay C during impulsing.
- TL5 prepares a holding circuit for relay G under conditions of rotary hunting.
- TL6 disconnects the priority lead.

Relay F operated.

- F1, 3, 5 and 6 further extend the bridged relay D.
- F2 disconnects the start POS and completes the circuit to step the wipers to the first outlet.
- F4 & F7 are ineffective at this stage.

If the tie-line is free relay H will operate due to the 1300 ohm NEG. existing on the FN lead (NEG. 1300K FN bank and wiper 900H C7, 500G, TL5, E2, NR4, N2, B1, POS).

The circuit changes brought about by the operation of relay H are identical with those described previously except that relay D is now connected to the line instead of interrupted ringing.

Relay D operates to battery at the distant exchange. Ultimately dial tone is received, on receipt of which the remaining digits of the required number are dialled.

6.3. FIRST LINE IN GROUP BUSY

The operation is as described above up to the point where the wipers step to the first outlet. Owing to the fact that the first line is already in use, the FN lead is at POS. potential due to the operated H relay in the selector which is already holding the junction.

Relay H in the testing selector is thus prevented from operating, and whilst the rotary magnet is operated, at R1 a circuit is completed for the operation of relay G. (NEG, 500G, H6, R1, F2, B3, U15, AL1, 0.4RA, POS). Relay G operating.

- G1 completes a holding circuit for G relay which is effective when a free line is encountered.

G2 releases the rotary magnet.

The magnet restores and at R1 the circuit for G relay is broken. G relay releases and at G2 re-operates the rotary magnet, stepping the wipers to the next outlet.

If the second line is also busy relay G again operates and this form of rotary drive continues until a free outlet or the 11th step is reached. Assuming that a free line is encountered relay G now holds in series with relay H which operates (NEG, 1300K, PN bank and wiper, 900H, C7, 500G, TL5, G1, NR4, N2, B1, POS). From this point the call proceeds as previously described. If all lines are busy the wipers arrive finally on the 11th contact and the S springs operate.

S1 opens the priority circuit.

S2 completes a holding circuit for relay G (NEG, H6, S2, N2, B1, POS) and releases relays F and TL. On release of F7, busy tone is returned to the caller.

6.4. OUTGOING CALLS. TWO DIGITS

When the maximum number of line circuits are required to be in use, and the outgoing lines are less than ten, a level may contain both outlets connected to extensions and to outgoing tie-lines. Because of the automatic rotary hunting feature required by the tie-line group, these circuits must occupy the late choice outlets of the selected level.

The operation is similar to that which has already been shown for single digit working. The only point of difference is that the N.P.A. springs are omitted from the circuit and 150 ohm NEG. is connected to the D lead in the line circuit to operate relay TL. This now takes place when the wipers arrive at the first contact of the group.

The digits corresponding to this first outlet are always allocated as the tie-line routing digits.

The alternative circuit for the operation of relay TL is as follows:-

(NEG, 150K, D bank and wiper 1000TL, C6, G3, NR1, E1, B1, POS). Following the operation of relay TL the call proceeds in the same manner as with single digit working.

7. PRIORITY FACILITY

The priority facility enables an extension to speak to an engaged extension when the line that is dialled is already engaged.

An extension line with priority has tags K and PC strapped on the tagblock. On completion of dialling the two digits, relay G operates if the line is engaged.

Relay G operated.

G5 completes a circuit to operate relay E (NEG. 800E, C2, G5, (TL6) (NPB) S1, T1 & 2

U3, FS bank tags PC to K, K2, L1, FS (P) bank, U27, B6, T9 and 10, POS).

Relay E operated.

E1 completes the circuit to operate relay D NEG. 200D, 500YB, G3, NR1, E1, B1, POS).

E4 disconnects Busy Tone from the calling line.

Relay D operated.

D2 & D3 complete a speech circuit across the called extension lines and the caller can speak and hear.

If required the priority extension may request the extensions to clear the call in order that he may speak in secret to the required party. In this case on the line circuit of the required line being restored, NEG. is replaced on the PN wire from 1300K, in the line circuit and relay H is now operated from (NEG, 1300K, PN bank, 900H, C7, E2, NR4, N2, B1, POS).

Relay H operated.

H6 releases relay G followed by relays D and E.

With relay E normal, ringing current is connected to the called line at E3, and the call proceeds in the normal manner.

8. LOUDSPEAKER BALANCE CIRCUIT

Resistance YC and condenser QD provide a local circuit on clear down by either the calling or called party fitted with a loudspeaker telephone so that the line to the loudspeaker is not left unbalanced. Should either party clear first YC and QD are maintained across the second line to compensate for the disconnection resulting from the first party clearing.

9. CODE CALL

This feature requires additional equipment, which when an appropriate number is dialled, causes a set of bells or lamps to send out a code. The required person, in response to the signalled code, dials the answering number from the nearest telephone and can then speak to the calling party.

The code call number is dialled in the usual manner and if the code call equipment is free relay H operates in the normal manner, and the equipment is seized returning dial tone to the caller. The code digits are then dialled and are repeated into the code call equipment over the D wire from:-

POS, A1 B2, C3, (FA2), H7, to the D wipers and bank, and via the lead and E7 to the "CC" tag.

Contact E7 is included to prevent relay TL operating to the battery on this lead, from the code call equipment during the time that relay E is operated after relay C restores.

The answering number is dialled in a similar manner to a regular call, relay H

switching to the link to the answering side of the code call equipment. Both these links are under the control of the calling party.

10. FIRE ALARM

This feature requires an additional relay FA to be fitted per link and also additional external equipment. Two digits are dialled to seize the Fire Alarm equipment. A third digit is now dialled into the fire alarm equipment to cause a signal to show which line has originated the fire call.

It is possible for a party in the office where the signal is given to speak to the calling party by simply throwing a key.

Circuit Operation.

The two digits are dialled in the regular manner and if the fire alarm equipment is free relay H operates.

H3 operates relay FA to a low resistance NEG on the PN lead.

Relay FA operates.

FA1 holds relay FA over the D wire to the external equipment.

FA2 extends the impulsing lead to the external equipment pulse lead.

FA3 prepares to extend dial tone to the caller.

FA4 provides a hold circuit for relay B after the third digit is dialled correctly.

FA5 transfers the line circuit holding POS to the fire alarm equipment.

The third digit 0 is now dialled into the equipment which searches for the calling line.

When the fire alarm equipment seizes the originating line relay FA is released. At FA3 Ring Tone is now connected to the calling party.

11. TESTING

To busy the link out, certain of the test plugs are removed or interchanged. Plugs are removed from T7/8 and T9/10 and one of the plugs is inserted in T8/9 in the link to be busied. By removing T9/10 POS is removed from the common to prevent the allotter from running idly should all the other links become busy.

At T7/8 the operating NEG for relay ST in the allotter circuit is removed and by inserting a plug in T8/9 the associated outlet on the AS4 bank is connected to POS.

By removing the plug from T11/12 the rotary release circuit is opened enabling mechanical adjustments to be made.

If it is required to operate any of the relays by hand whilst the connector is in position the plugs should be removed from T1/2, T3/4, and T5/6 thus preventing any interference via the Finder bank. A suitable testing plug may be inserted into the switch jack T13/14 when the above plugs are removed to enable dial tests to be made.

12. FUSE ALARM

When fuse alarm is required FB relay is fitted so that when a fuse blows, battery is extended on the alarm bar to operate FB relay to earth. At FBl op. earth is extended for external alarm purposes.

The remaining facilities, loudspeaking telephone, secretarial service, keycalling, and keycalling with conference facility require external equipment and their functions are described in individual explanatories as their respective functions are distinct from this circuit.

13. RELEASE ALARM

The Release Alarm circuit equipment shown in Figure 5 provides a delay alarm and also a high resistance hold POS for the faulty line finder's rotary magnet.

At the conclusion of a call relays A and B release and the circuit is completed to energise the rotary magnet to release the selector from (NEG. Rot. Mag, H4, N1, G2, E8, R1, T11/12, B3, U15, ALL, 0.4 RA, POS).

Relay RA operates.

RA1 extends POS to energise the Thermal Relay TH from NEG, 690TH, RC2, AL2, RA1, ST3, POS.

RA2 Spare.

Relay TH operates after its delay period should the selector fail to restore due to a fault.

TH1 operates relays AL and RC.

Relay AL operates.

AL1 extends high resistance POS to the Rotary Magnet.

AL2 holds relays AL and RC to POS via ST3.

AL3 extends NEG to the last contact of AS4.

AL4 provides a busy POS for the faulty switch via N3, T7/8 to the bank contact of Arc AS4. Also extends the same POS to operate relay ST should the allotter have stepped to the 25th contact (Arc AS4) when a call is originated during the period of a faulty switch.

AL5 prepares an operate circuit for relay MS on seizure of another link to make a call.

AL6 completes the Audible Alarm Circuit.

AL7 Spare.

Relay RC operating.

RC1 holds relay RC to POS, via AL2, RA1 and ST3.

RC2 disconnects the operate circuit of relay TH which releases. Should the release alarm circuit be seized by a faulty selector while a second selector is establishing a connection to the Tie-line level, on operation of AL5 relay MS is operated from NEG. ROT, MAG. H4, N1, G2, E8, R1, T11/12, B3 of the faulty switch (via

CIRCUIT EXPLANATORY E.202635

common to B3 op, F2 nor, of the selector in use), to common AL5, 5000 MS, POS.

Relay MS operates.

MS1 completes the Ringer Start Circuit, by operating VS relay.

MS2 provides an alternative hold circuit for relays AL and RC.

MS3 releases relay RA.

When relay F operates in the selector connecting a tie-line call, F2 disconnects the above operate circuit of relay MS and it releases. At MS2 relays AL and RC release, and at ALL the normal rotary search POS is extended to the selector for hunting over the tie-line level.

During the period of holding of a faulty selector while relay AL is held to POS. from ST3 other selectors on clearing from a call will not release, due to the high resistance POS from ALL, 5000RA, MS3 to COMMON. As soon as another extension originates a call thus operating relay ST, relays AL and RC are released at ST3, and at ALL the normal 0.4 ohm POS.is applied to the Release Common to restore

all selectors previously seized, as well as fully energising the Rotary Magnet of the faulty selector again. The latter, depending on the type of release failure, can in some cases, cause the fault to be overcome and the selector restored to normal.

14. REVERTIVE CALL

This facility is associated with a Party Line Revertive Call circuit such as S.205390 which gives calling facilities between two subscribers on the same line, at the same time releasing the common P.A.X. equipment.

To effect the revertive call feature NPB springs are set to operate on the predetermined level of the selector. When the wipers are stepped to this level by one of the Party Line subscribers, dialling the required digit, the NPB springs operate and POS is returned via 200YE, NPBL, S1, T1/2, FS wiper and arc to operate relays in the Revertive Call Relay Set, which remove the holding loop from the selector which releases. Further operations for Revertive Call are carried out by the Revertive Call Relay Set equipment.

22 CODE CALLING EQUIPMENT FOR P.A.X's.

CIRCUIT EXPLANATORY E.202820

ISSUE 2

1. INTRODUCTION

This equipment in conjunction with the P.A.X., provides for the operation of a code-signalling system whereby a subscriber, who is absent from his usual office, may be called. The code calling number of the required subscriber is dialled by the calling party in the usual way and the required party, hearing or seeing his code signal, dials the answering number from the nearest extension telephone. The signalling then ceases and the conversation takes place via this equipment. A maximum of twenty-two codes is provided.

2. CALLING

H relay in the connecting link switches to battery via the winding of DC relay and SN3.4 nor. DC operates to the busying earth extended by the connecting link over the PN lead. Battery via the winding of RT relay and SN23.24 nor. trips the ringing relay of the connecting link over the negative line, and dial tone is returned to the calling subscriber via SN22.21 nor., DC3.4 op., and condenser QB to the positive line. Earth at DC1.2 op. is extended to start the vibrator circuit in the P.A.X. equipment from where the tone is derived.

The required code selecting number is dialled. Pulses from the contacts of the A relay in the connecting link are received via DC21.22 and DC24.23 op., to step the selecting switch S. As the switch is stepped to the first contact SN relay is operated by earth at bank S1. SN operated removes RT relay from the negative line and G relay is bridged across the lines at SN23.24.25 op. G operates, but is of high resistance to prevent D relay in the link from operating, and at the same time serves as a "leak" for "wetting" the contacts of the connecting link. At SN3.4.5 op., the pre-operating winding of DC relay is transferred from the PN lead to the bank of S1, but DC relay holds during the train of pulses in parallel with the selector switch magnet. At SN21.22 dial tone is cut-off from the positive line.

At the completion of the train of pulses, DC relay falls away, unless digit "0" has been dialled in which case DC relay will be held via SN4.5 and G3.2 op. to earth from bank S1. Similarly, if "0" is dialled as the second digit DC will be held over the same circuit at the end of the train of pulses. When DC relay falls away the selector pulsing circuit is opened at DC21.22 and DC23.24 nor., and earth is extended by DC6.5 nor., G22.23 op. and RT2.1 nor., operates CS relay.

3. CODE SENDING

CS operated starts the code sending switch "C" and prepares the switching circuit for the answering call. At CS1.2 op., earth is maintained on the vibrator start lead and at CS3.4 op., earth is extended via contact 1 of bank C2 and the code switch interrupter springs Cdm to operate A relay. At A1.2 op., earth energises the C magnet which then opens its Cdm springs to release A relay. A restores and releases the magnet which steps its wipers to the next outlet and to reoperate relay A by closing its Cdm springs. This action continues until contact 1 is reached after CS relay has restored. The earth from CS3.4 op., is also extended by contacts of bank C3 to the contactor (CT) direct or via banks S2 to S5 (inclusive) which operates and in turn delivers pulses to the signal system in code determined by the positioning of the S switch. The code signal persists until the call is answered or the calling party clears. At CS23.24 a tone signal is sent back to the calling party by the operation of the contactor in the same code as that being given on the signal system.

4. ANSWERING

Upon the required party dialling the answering number, H relay in the connecting link switches to battery via CS21. op. on the PN lead. RT relay operates to the ringing current extended by the connecting link over the negative line and locks on its second winding to earth from bank S1, DC6.5 nor., G22.23 and RTL.2.3 op. The battery via RT relay again trips the ring-trip relay in the connecting link and at RTL.2.3 op. CS relay is released. The latter relay being a slow release relay permits a margin of time for the ring-trip relay to operate in the connecting link. Contacts CS5.6 and CS25.26 in the lines ensure that no ringing is sent over to the waiting party, thereby no undue clicks or noises are given. The two parties are now in a position to converse. At CS3.4 nor., the earth is removed from the contactor circuit, thereby stopping the code-sending. At CS23.24 nor., the tone is cut-off and at CS1.2 earth is removed from the vibrator start.

5. RELEASE

The release of the equipment is dependent upon both parties having cleared, in which case G is released. The code sending switch C continues stepping to its home position following the release of CS relay. The S switch however, homes when G is released, to earth

from bank S1 to DC6.5 direct, or via G2.1 nor., and G22.21 nor, bank C1., when the switch is in the home position, to the S switch via its interrupter springs. SN relay remains operated until both the switches have homed, to maintain the guard by SN3.4.5 op. With G normal RT relay is also released.

6. MISCELLANEOUS

Should an extension with the priority feature wish to make a call by this equipment, when it is already in use, he must wait for the receipt of dial tone before he continues

dialling the "code" portion of the number after the other party holding the equipment has cleared.

Relay CR is provided so that the signal system may be utilised for other purposes. The operation of an external key operating CR relay will operate the contactor in turn applying current to the signal system.

Contacts RT21 and RT22 (RT1 and RT2) are provided to open the C.S.H. alarm circuit on the P.A.X., when this alarm is fitted, thereby avoiding a false C.S.H. alarm during the progress of a code call.

DATA SHEET

25 - 4A P.A.X.

Rack Mounted - Totally Enclosed
Sheet Steel Covers - Finish Crystalline Black

Height	4' 6"	1.37 metres
Height with Special Service Cabinet	5' 8"	1.73 metres
Width	2' 0"	0.61 metres
Depth	1' 4"	0.41 metres
Floor Space Required	6' x 5'	1.83m x 1.53m
Weight Fully Equipped	290 lbs	130 Kgms.
Selectors (4)	46 lbs	21 Kgms.
Telephones (25)	147 lbs	67 Kgms.
Eliminator 2 amp, 50 volt	50 lbs	23 Kgms.

50 - 7A P.A.X.

Rack Mounted - Totally Enclosed
Sheet Steel Covers - Finish Crystalline Black

Height	4' 6"	1.37 metres
Height with Special Service Cabinet	5' 8"	1.73 metres
Width	3' 2"	0.97 metres
Depth	1' 4"	0.41 metres
Floor Space Required	6' x 6'	1.83m x 1.83m
Weight Fully Equipped	370 lbs	165 Kgms.
Selectors (7)	78 lbs	35 Kgms.
Telephones (50)	294 lbs	133 Kgms.
Eliminator 5 amp, 50 volt	119 lbs	54 Kgms.

EQUIPMENT - BOTH TYPES.

Relays	600 and 3000 type
Uniselectors	B.P.O. No.2.
Selectors	2000 type. Two-motion.
Telephones	332 pattern
Eliminators	100 - 250 volts A.C. input. 50 volt D.C.output.

SPECIAL SERVICES

Priority	Fire Alarm
Conference	Secretarial
Loudspeaker Telephones	Tie-Lines
Code Call (Visual)	Key-Calling
Code Call (Audible)	Revertive Calling