

COMMONWEALTH OF AUSTRALIA
POSTMASTER-GENERAL'S DEPARTMENT

INSTALLATION CIRCULAR No. 10

Intercommunication Telephones —Types A5 & A10

SECTIONS 1 to 5
Distribution List "H" (Modified)—Serial No. 25

TEXT

(The Drawings referred to in the Text are issued separately
under Section 6).

Chief Engineer's Branch,
Postmaster-General's Department,
Treasury Gardens,
Melbourne, C.2

Approved—

R. LAWSON,
Chief Engineer,
9.9.1937

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INSTALLATION CIRCULAR NO.10.

INTERCOMMUNICATION TELEPHONES - TYPES A5 & A10.

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AMENDMENTS.

<i>Amendment No.</i>	<i>Serial No.</i>	<i>Date of Issue.</i>	<i>Drawing Amended.</i>	<i>Initials.</i>
1				
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INSTALLATION CIRCULAR No. 10.

INTERCOMMUNICATION TELEPHONES - TYPES A5 AND A10.

SECTION 1.

INTRODUCTION.

- 1.1 General. This system provides facilities for direct intercommunication between a number of stations in the same building or block of buildings, and in addition allows direct access from these stations to the public exchange with secrecy on exchange calls.
- 1.2 One external extension (with restricted facilities) may be connected with the system if desired.
- 1.3 The system may be connected with C.B. or automatic public exchanges; a standard type of instrument being used at all internal extensions and a standard type of "Unit" fitted at main stations irrespective of the type of public exchange concerned.
- 1.4 Power Supply. Power supply for the system is obtained normally from a power lead. When this is not available dry cells are fitted at the subscriber's premises. The system operates efficiently between voltage limits of 18 and 28 volts and the maximum current required on a system with two exchange lines and 10 extensions is of the order of 1.3 amps.
- 1.5 Definitions.
- 1.51 An Internal Extension Station is one equipped with a "Telephone, Intercommunication, No.1 or No.2".
- 1.52 A Main Station is an internal station equipped with a unit or units (containing the exchange calling equipment) in addition to Telephone, Intercommunication, No.1 or No.2.
- 1.53 An External Extension Station is a 2-wire extension equipped with a standard C.B. or automatic wall or table telephone.
- 1.6 Facilities. A summary of the facilities offered follows :-

1.61 Local Intercommunication Calls.

- 1.611 Internal Extension to Internal Extension - Direct calling between all internal extension stations on the system.
- 1.612 Secrecy - No secrecy is provided on local intercommunication calls.
- 1.613 "Engaged on Exchange" test - An engaged test is given if the called internal extension is engaged on an exchange call.
- 1.614 Internal Extension to External Extension - Direct calling of an external extension from all internal extensions.
- 1.615 External Extension to Internal Extension - An external extension obtains connection to an internal extension via the main station. The main station requests the desired internal extension to call the external extension, i.e. the call is reverted.
- 1.616 Conference Facilities - i.e. facilities for speaking from any station to all or any number of stations on the system simultaneously are provided.

1.62 Exchange Calls.

- 1.621 Internal Extension to Exchange - Direct connection from any internal extension to the public exchange system over any exchange line connected to the installation.
- 1.622 Barred Calls - Direct outgoing exchange calls may be barred to chosen extensions. These extensions may originate exchange calls via the main station at the discretion of the main station operator.
- 1.623 External Extension to Exchange - Connection (via the main station) of an external extension to the public exchange system over any exchange line connected to the installation.
- 1.624 Main Stations - Incoming exchange calls may be answered at any pre-determined station. This extension is known as the main station, and is provided with special unit equipment. Arrangements can be made also for equipping any one of the internal extensions as a second choice main station. On such installations the functions of the first choice main station can be transferred to the second choice main station when desired by the operation of a key or keys at the first choice main station. As an alternative to the second choice main station any internal extension with full facilities may be equipped with an extension bell or bells to enable incoming exchange or external extension calls to be answered at this point.
- 1.625 Transfer Facility - An incoming or originated exchange call (with the exception of directly dialled calls originated by the external extension) may be transferred from any station to any other station connected to the

installation without breaking down the exchange connection. On installations with two exchange lines, an internal extension may hold a call on one exchange line while transferring a call incoming on the second exchange line. If an exchange call is to be transferred to an internal extension which is barred exchange facilities or to an external extension the transfer must be carried out indirectly, i.e. via the main station.

- 1.626 Hold Facility - Any internal extension may hold an exchange call whilst making a call with any other station on the system. While the exchange line is being held the outside subscriber is unable to overhear the conversation between the station to which he is connected and the party called by the same station. In addition, on installations with two exchange lines any station not barred exchange facilities may hold one exchange line whilst making a call on the second exchange line.
- 1.627 Exchange Engaged Test - On engaged exchange lines, an audible test is given on pressing the exchange line button. It is unnecessary to remove the handset from rest while making this test - the test is operative whether the handset is lifted or not.
- 1.628 Secrecy - Secrecy is given on exchange connections. Monitoring facilities may, however, be allowed at main stations or any of the internal extensions if desired.
- 1.7 Night Service. The external extension may be allowed night service facilities. Under these conditions incoming exchange calls will ring the external extension telephone bell in addition to operating the indicator (and alarm bell) at the main station. The external extension cannot receive local calls from internal extensions (except by switching at the first choice main station).
- 1.8 Extension Bells. The exchange line and/or external alarm bell circuit may be extended from the main station to any internal extension (with full facilities) on the system. An internal extension having extension bell facilities may serve in lieu of a second choice main station, but on some installations with an external extension and on installations with two exchange lines it is not possible to extend each indicator circuit separately, and it is therefore necessary to test for the calling line by operating the instrument plunger keys. The provision of an extension bell will enable night service facilities to be given. The instrument buzzer signals may be extended also, if desired.

SECTION 2.EQUIPMENT.2.1 Definitions.

- 2.11 "Telephones, Intercommunication Nos. 1 and 2" are the instruments fitted at internal extensions.
- 2.12 "Unit, Transfer, Intercommunication No. 1" is the first or second choice main station apparatus used on installations with one exchange line and without an external extension.
- 2.13 "Unit, Transfer, Intercommunication No. 1A" is the first choice main station apparatus used on installations with one exchange line and an internal extension.
- 2.14 "Unit, Transfer, Intercommunication No. 2" is the first or second choice main station used on installations with two exchange lines with or without an external extension.
- 2.15 "Unit, Transfer, No. 3" is fitted together with Unit, Transfer, Intercommunication No.2 at the first choice main station on installations with two exchange lines and an external extension.

2.2 Size of Installations. Equipment is available in two sizes for accommodating :-

- (a) One exchange line and 5 stations - type A5.
- (b) Two exchange lines and 10 stations - type A10.

These are the normal capacities, but it is possible to accommodate one additional station on installations of each of the above sizes by a slight modification to the junction box wiring. It is not intended that this facility should be used indiscriminately, but only in cases where probable development will render this course economical.

- 2.21 On installations of either of the above sizes one external extension may be connected in lieu of an internal extension.
- 2.22 The instruments and units used with this system are equipped with plugs and cords, and are connected to jacks at the terminal points of the cable. The plugs and jacks have been standardized so that it is possible to wire an installation with a capacity for two exchange and 10 extension lines at the outset and to fit the smaller size instruments and units initially, the larger size equipment being fitted subsequently when an additional exchange line or additional extensions are required. In addition, on installations with one exchange line and up to 4 stations, a Unit, Transfer, Intercommunication No.1A may immediately be jacked in to replace a Unit, Transfer, Intercommunication No.1 if an external extension is added to the system subsequently. On installations with one exchange line initially but wired for 2 exchange lines, a Unit,

Transfer, Intercommunication No.2 may be immediately jacked in to replace a Unit, Transfer, Intercommunication No.1 when the second exchange line is required.

- 2.3 Second Choice Main Station. With respect to the second choice main station, on units having an external extension the facility for switching this extension to an exchange line is not transferred to the second choice station although the external extension calling and clearing signals are received at the latter station.
- 2.4 Extension Bells. When required they are wired from the instrument jack or the unit jack.
- 2.5 Telephones, Intercommunication, Nos. 1 and 2. The external appearance is shown in Figs. 1 and 2. The mechanism is mounted in a metal base and is enclosed in a moulded bakelite case having a cradle for a handset telephone.

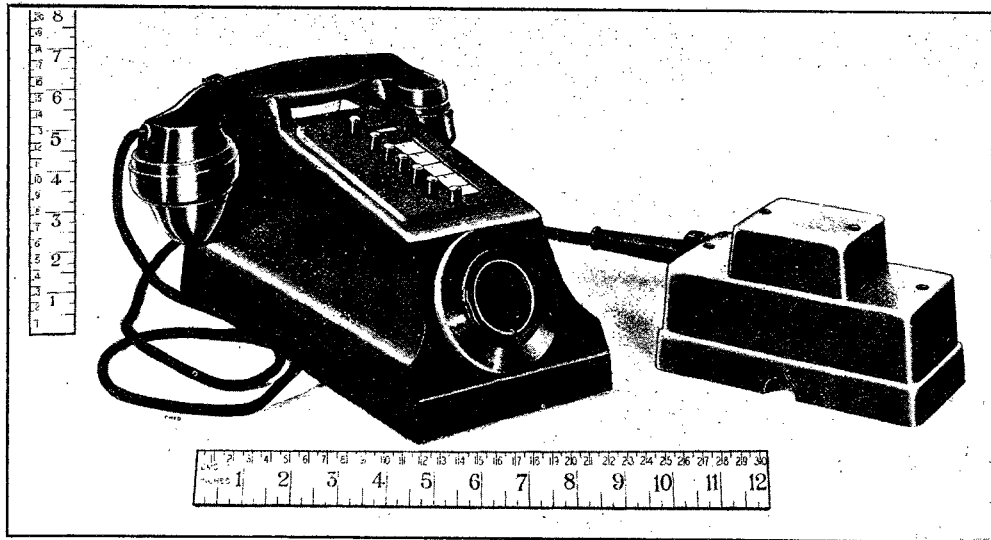


FIG.1. TELEPHONE, INTERCOMMUNICATION, NO. 1.

A dial is fitted to the front of the case and the complete telephone set includes a plug (with buzzer), and the desk cord 6 feet in length. When working with a manual exchange, the dial should be recovered and returned to store and dial dummy No. 3 C.B. fitted.

- 2.51 Telephone, Intercommunication, No.2 - The top of the instrument case accommodates the plunger keys and the designation strips adjacent to them. Slip in paper labels are used with the designation strips. The two exchange keys are coloured red and numbered 1 and 2 respectively on their tops. Immediately below the exchange keys are 10 local keys (5 on either side) coloured black. In the centre below these is the conference key (coloured green) and engraved with a "C" on the top. Immediately above the exchange keys are 2 trigger keys coloured red. They are associated with the exchange keys and their function is discussed in Section 3.

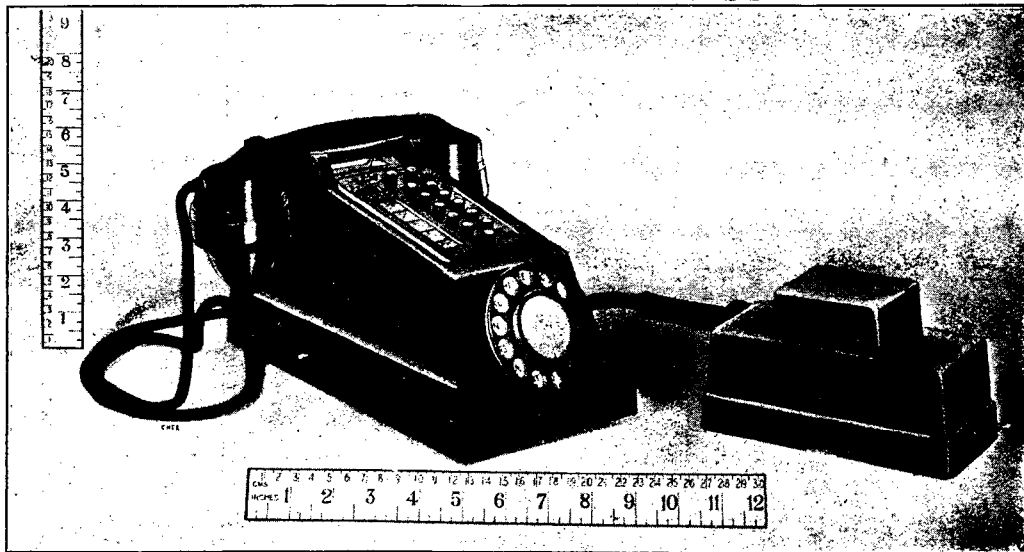


FIG. 2. TELEPHONE, INTERCOMMUNICATION, NO. 2.

2.52 Telephone, Intercommunication, No. 1 - This is housed in a moulded bakelite case of the same dimensions as that used for Telephone, Intercommunication, No. 2. One exchange key, five local keys and a conference key are fitted together with a single designation strip. No trigger key is fitted to the instrument.

2.6 Units, Transfer, Intercommunication, Nos. 1, 1A, 2 and 3.

2.61 The external appearance of these instruments is shown in Figs. 3, 4, 5 and 6. They contain the exchange and/or external extension calling and clearing indicators with associated bell or buzzer to provide an audible alarm, the exchange line transfer keys and keys for switching an external extension to the exchange lines. All units are housed in a standard size bakelite case. The indicators, keys and labels are mounted on the face plate and Exchange Call buttons, the function of which is explained in Section 3, are accommodated at the sides of the case near the bottom. The key labels are of brass, chemically engraved. In order to permit a unit to be used either as a first or second choice main station some of the labels have been engraved on both sides so that by reversing the labels and removing the straps inside the unit, it is suitable for use as a first choice main station on installations where a second choice main station is fitted. To reduce the number of units required, a dummy indicator has been fitted on units Nos. 1 and 2, and an additional indicator eye ball 345/1000 should be fitted locally on these units when they

are used as second choice main stations on installations having an external extension.

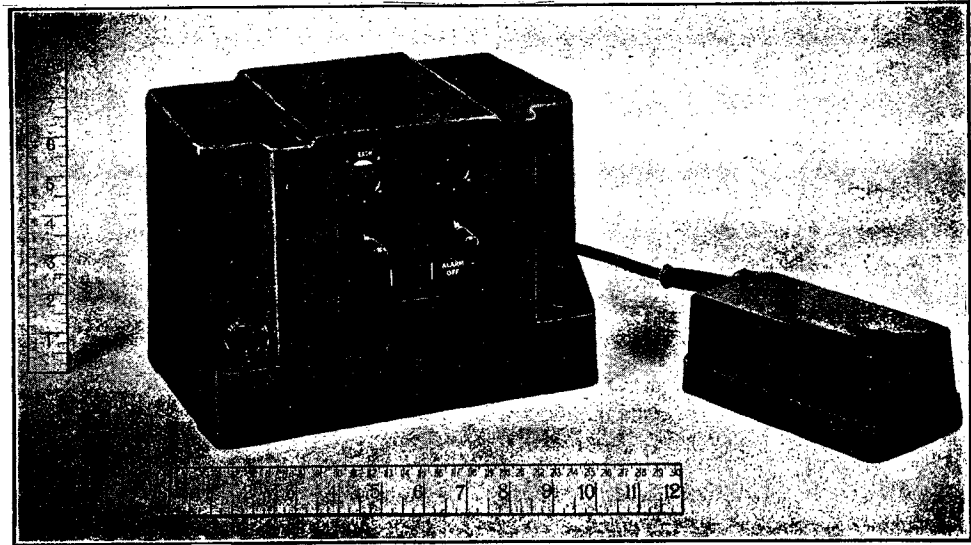


FIG. 3. UNIT, TRANSFER, INTERCOMMUNICATION, NO.1.

2.62 One exchange line and up to 5 internal extensions - Unit Transfer, Intercommunication No.1, is used at either first or second choice main stations for installations having one exchange line and up to 5 internal extensions but without an external extension. This unit is also suitable for use on installations having one exchange line and up to 10 internal extensions.

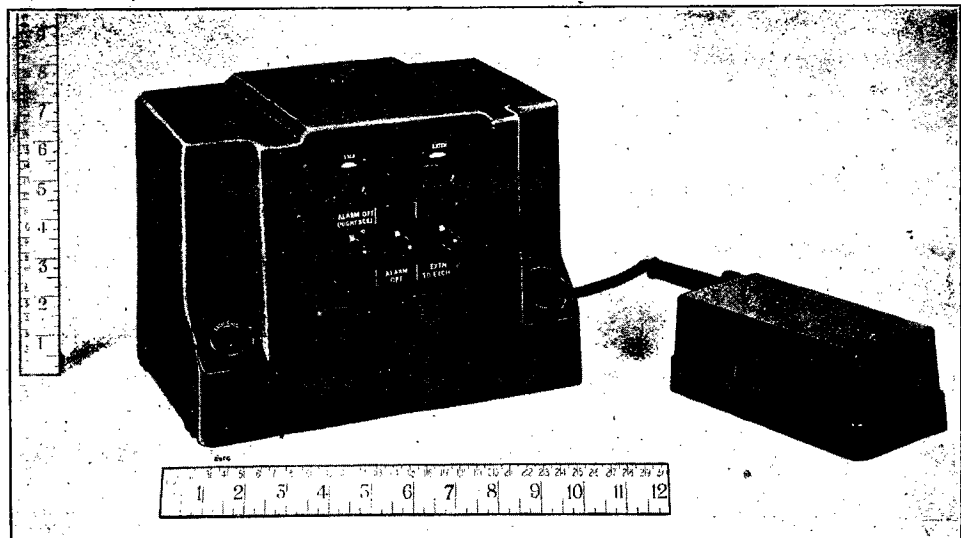


FIG. 4. UNIT, TRANSFER, INTERCOMMUNICATION, NO. 1A.

- 2.63 One exchange line, 1 external extension and 4 internal extensions - Unit, Transfer, Intercommunication, No.1A, is used only at first choice main stations. A Unit, Transfer, Intercommunication, No.1, with an additional indicator is used at second choice main stations on these installations.
- 2.64 One exchange line, 1 external extension and up to 9 internal extensions - A Unit, Transfer, Intercommunication, No.1, together with a Unit, Transfer, Intercommunication No.3, are fitted at first choice main stations. A Unit, Transfer, Intercommunication No.1 with an additional indicator is fitted at second choice main stations.

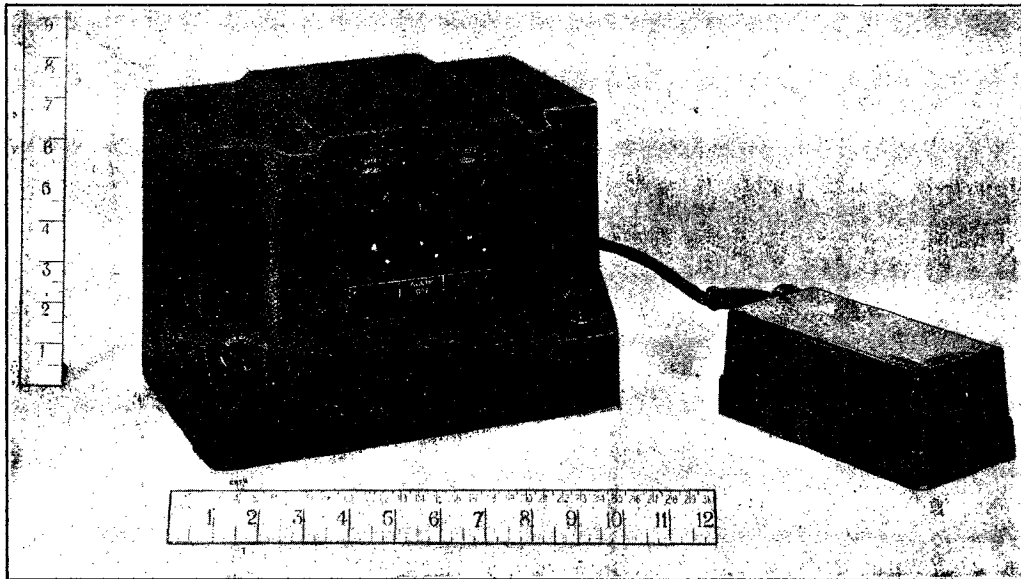


FIG. 5. UNIT, TRANSFER, INTERCOMMUNICATION, NO.2.

- 2.65 Two exchange lines and up to 10 internal extensions - Unit, Transfer, Intercommunication No.2, is used at either first or second choice main stations.
- 2.66 Two exchange lines, 1 external extension and up to 9 internal extensions - Unit, Transfer, Intercommunication No.2, together with Unit, Transfer, Intercommunication No.3, is fitted at the first choice main station and Unit, Transfer, Intercommunication No.2 with an additional indicator eyeball 345/1000 is fitted at the second choice main station.
- 2.67 Face Plate Equipment - Diagrams of the face plate equipment of the various units when used for the several purposes are shown in Drawings C.1235, Sheets 1 & 2.

2.7 Junction Boxes.

2.71 The junction boxes are made up of 4 terminal strips enclosed in a moulded bakelite case. The terminals are staggered and the front portions drilled in order to facilitate cross connection by means of special bare wire of square cross section. This construction also allows the necessary jumper connections to be made with switchboard wire on the front of the strips. The backs of the terminals have screw connections for terminating the cable wires. The boxes are made in 2 sizes having 30 and 48 terminals per strip, and known as Boxes, Junction, Intercommunication Nos. 1 and 2 respectively.

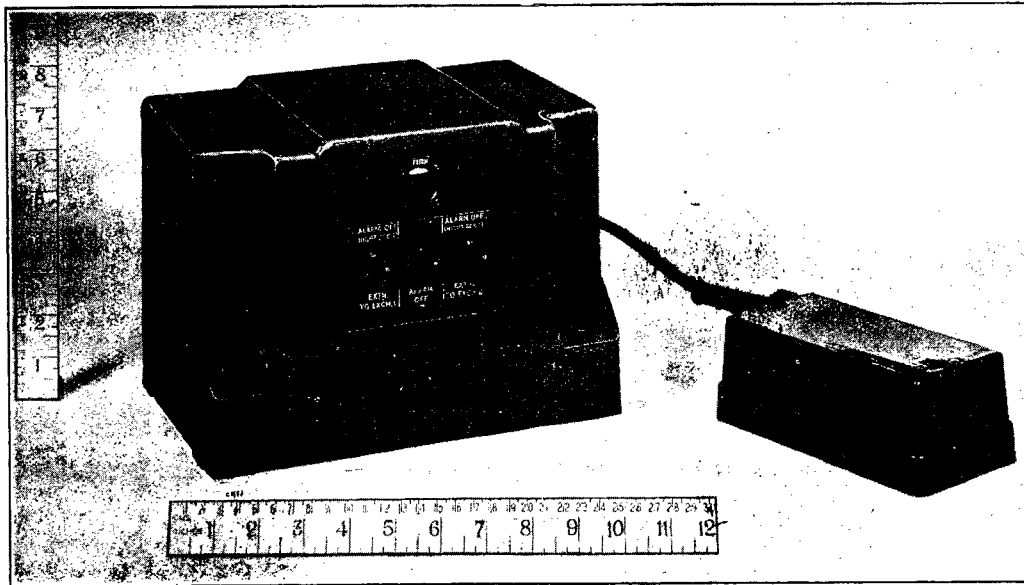


FIG. 6. UNIT, TRANSFER, INTERCOMMUNICATION, No. 3.

2.8 Cable.

2.81 Cable, Switchboard L/C, 12 pr. tw./10 enam. is required for installations using Telephone, Intercommunication No.1, and for connections between the Unit Jacks and the Junction Box on installations using Telephone Intercommunication No.2. For multiple and instrument wiring for installations using Telephone, Intercommunication No.2, Cable, Switchboard L/C 20 pr. tw./10 enam. is required. Although cable, switchboard, 12 pr. tw./10 enam. is shown on the relative drawings, this is not a stock size, and for the present, cable, switchboard, 15 pr. tw./10 enam. should be used, the last 3 pairs being tied back in the form.

SECTION 3.
OPERATING PROCEDURE.

3.1 Key Operation. The mechanical arrangement of the keys on Telephones, Intercommunication, Nos.1 and 2 is such that when depressed consecutively (except when the conference key "C" is depressed) only one key may remain fully operated at any one time. If a local key is depressed the depression of a second local key completely restores the first. If an exchange key is in the operated position, the depression of a local key will partially restore the first key which takes up a "hold" position. If, however, the conference key is first depressed, all local keys may be depressed consecutively and will remain operated.

3.2 Local Calls.

3.21 Calling - The internal extensions call each other or the external extension by lifting the handset telephone and fully depressing the plunger key opposite the number of the required extension. In the fully depressed position this key completes a circuit for operating the called extension's buzzer. When pressure is released, this key automatically takes up the speaking position. The called extension answers by lifting the handset and conversation may then be carried on.

3.22 Called station engaged on local call - Local calls are non-secret; if, therefore, the called station is engaged on a local call, the calling station will break in on the connection.

3.23 Called station engaged on exchange call - If the called extension is engaged on an exchange call the calling extension's own buzzer operates when the key corresponding to the wanted extension's number is fully depressed. This serves as an engaged signal and the calling extension cannot overhear an exchange line conversation. If the wanted extension is holding an exchange line and is engaged meanwhile on a local call, the calling extension may, by ignoring the engaged signal, listen to the local conversation.

3.24 Conference call - When it is desired to make a conference call, the extensions which will participate are first called individually in the normal way. As soon as their attention has been obtained, the conference key is depressed, thus bringing into operation a locking bar which allows any number of local keys to be depressed consecutively and to remain in the speaking position, when pressure is released. The keys corresponding to the extensions which are remaining in readiness are then depressed and the conference may proceed.

3.25 Release of keys - The action of replacing the handset on its rest automatically restores all keys to normal.

3.3 Outgoing Exchange Calls.

3.31 Exchange line busy - An exchange line may be tested by depressing the appropriate key without removing the handset from rest. If the line is

engaged the calling station's buzzer will operate. This engaged test is given also if the handset is lifted before depressing the exchange line key.

- 3.32 Exchange line free - If the exchange line is free the lifting of the handset and depression of the exchange key gives a calling signal to the exchange if manual. If the line is connected to an automatic exchange the caller receives dialling tone (where provided) and dials the required number.
- 3.33 Holding exchange call while making local call - If, during the progress of an exchange call, the caller desires to speak to another extension, the depression of the local key corresponding to the wanted extension automatically releases the exchange key to an intermediate position in which a hold coil is connected across the exchange line. At the termination of the local call the exchange key may be again fully depressed and the exchange line conversation continued.
- 3.34 Transfer of Exchange Calls.

3.341 One exchange line in use - If an extension speaking on an exchange line desires to transfer the call to another extension (with full facilities), the local key corresponding to the extension required is depressed; the exchange line key is automatically released to the hold position (see paragraph 3.33) and the called extension requested to take the particular exchange line. To do this the called extension depresses the key for the exchange line in question, whereupon his buzzer operates and the tone is passed to the first station, who will then release the exchange call from his instrument by restoring the handset to rest. The exchange call is then automatically transferred to the second extension.

3.342 Two exchange lines in use - If, on an installation with 2 exchange lines, the main station is talking on one exchange line while an exchange call comes in on the second line, the main station may take the call by depressing the second exchange line key, thus automatically restoring the first exchange line key to the hold position. The second call is then received and may be transferred to another extension (paragraph 3.341) by depressing the appropriate local key and requesting the called extension to take the second exchange line. On receipt of the usual tone the main station transfers the call by operating the trigger key associated with the second exchange line. The first exchange key has remained meanwhile in the hold position, and by again fully depressing this key the main station may continue the conversation on this line. If the trigger keys were not provided the only means of transferring the call would be by replacing the handset telephone on the switch hook. This would give a clearing signal on the first exchange line also. On Telephones, Inter-

communication No.1, a trigger key is of course unnecessary.

- 3.343 Exchange line calls for extensions with restricted facilities - If an exchange call is to be transferred to an extension with restricted facilities (such as an extension which is barred exchange access except at the discretion of the main station, or an external extension) the exchange line must be transferred first to the main station.
- 3.344 Exchange calls barred (E.C.B.) extensions - If the call is for an E.C.B. extension, the main station after requesting the particular extension to depress the appropriate exchange key depresses and holds the EXCHANGE CALL button corresponding to the exchange line in question. These buttons are on the main station units. On receipt of the usual tone, the main station releases the exchange line key and the EXCHANGE CALL button and the line is transferred to the desired point. The EXCHANGE CALL button must not be released before the exchange line key.
- 3.345 External Extension key - If the call is for the external extension the main station calls the external extension and then connects the exchange line by operating the switching key labelled EXTN TO EXCH on the main station unit.

3.4 Incoming Exchange Calls.

3.41 Incoming exchange calls are received on indicators forming part of the Unit equipment on the main station. In addition, an audible signal (bell or buzzer) is given. The audible alarm relay may be disconnected when not required, by operating the ALARM OFF key. The main station answers by lifting the handset and depressing the appropriate exchange key. Incoming exchange calls may be transferred in the same way as originated calls.

3.42 Calls received at an extension point - On installations having 2 exchange lines, a common alarm bell serves both exchange lines. When a calling signal is received at an extension point, therefore, No.1 exchange line should be tested first. This will minimize the possibility of giving a false call to the public exchange if the latter is manual.

3.5 External Extension Working.

3.51 Day Service - The external extension may be called direct from any internal extension. All outgoing calls from the external extension (except under night service conditions) are passed via the main station. To gain the attention of the main station the external extension user lifts the receiver, thereby operating the external extension indicator (alarm bell or buzzer). To answer, the main station lifts the handset telephone and depresses the instrument key corresponding to the external extension number.

- 3.52 Outgoing Exchange call - If the external extension desires an exchange call, the exchange line or lines are first tested by the main station operator by depressing the exchange key. When a free line has been found the main station attendant operates the unit lever key labelled EXTN TO EXCH and the external extension is then through to the public exchange if manual. If an automatic exchange, the external extension receives dialling tone (if provided) and proceeds to dial. Alternatively the main station may set up the call and afterwards transfer it to the external extension. On completion of the call the external extension replaces the receiver and the external extension indicator at the main station operates and gives a clearing signal.
- 3.53 If control has been transferred to a second choice main station, the external extension calling signal will be received there. The facility for switching the external extension to an exchange line is not available at the second choice main station, and if the external extension desires an exchange call the second choice main station attendant must proceed to the first choice main to carry out the necessary switching. The attendant may remain at the first choice station, in which case he must restore the TRANSFER key to normal so as to receive the clearing signal there. Alternatively he may return to the second choice station to await the clearing signal, on receipt of which he must proceed to the first choice station to restore the EXTN TO EXCH key.
- 3.54 Installations with one exchange line using Telephones, Intercommunication, No.1 and having an external extension - When an internal extension fitted with an extension bell is in control, the exchange and external extension calling signals will be received on the same bell. In such cases the external extension call will be indicated by a continuous ring, whilst if the exchange is calling the ringing of the bell will coincide with the intermittent ringing from the exchange.
- 3.6 Night Service.
- 3.61 The external extension may be switched permanently to an exchange line during the night by the operation of 2 keys on the unit at the main station. These keys are labelled EXTN TO EXCH and ALARM OF (NIGHT SCE) respectively. To guard against mis-operation, it has been arranged that an indicator signal is given if only one of these keys is operated or if other keys are thrown in addition. When the external extension is thus switched, internal extensions may make use of the night service exchange line when this is not in use by the external extension, but exchange calls made by internal extensions are non-secret to the external extension.

3.62 Incoming exchange calls under night service conditions will give a signal at the external extension and also at the main station. The latter signal may be extended by means of a bell to any other point on the installation. Under these conditions the first extension to answer will engage the exchange line.

SECTION 4.

INSTALLATION.

4.1 General. The provision of Intercommunication systems will be covered by Telephone Orders. The standard rental for the system is based on an average of 20 yards of multiple cable per internal extension, additional cable being charged for on a per yard basis. It is essential, therefore, to check carefully the length of cable used on an installation. The type of equipment, i.e. Telephones, Intercommunication Nos.1 or 2, to be provided initially will also be stated on the Telephone Order. If Telephones, Intercommunication No.1 are required, advice will be furnished also as to whether it is considered that within 5 years the instruments will have to be replaced by Telephones, Intercommunication No.2. If so, cable L.C. 20 pr. tw/10 should be used for the initial installation - see paragraph 2.2.

4.2 Apparatus.

4.21 Telephones, Intercommunication - The relays used are the B.P.O. 600 type. Strap connections are provided in each instrument so that the circuit may be modified to give monitoring or trunk offering facilities. Fig.7 illustrates

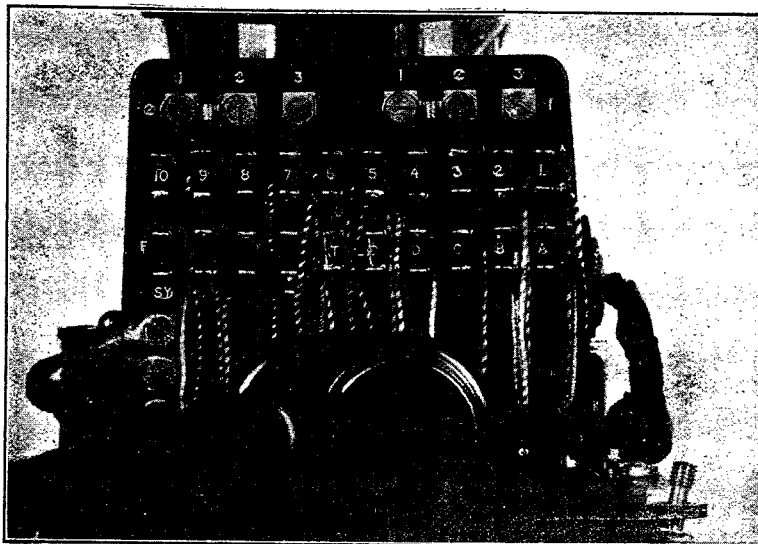


FIG. 7. TERMINAL BLOCK, TELEPHONE, INTERCOMMUNICATION, NO.2.

the terminal block on a Telephone, Intercommunication No.2, and the positions of these straps are shown. If supervision is required in lieu of secrecy, strap 1-2 is removed and strap 2-3 connected. The buzzer is connected on the instrument plug. The instrument cover is secured by 4 screws in the base adjacent to the feet. On instruments fitted with a dial, the cover may be lifted to one side, clear of the apparatus. To remove the cover completely, the dial cord must first be disconnected. The instrument labels may be removed by moving them forward with a pin inserted into the slot at the top of the

designation strip. On the label strip of each telephone, adjacent to the plunger key, the names of the persons using the telephones should be written in black, except that against the key for the main station MAIN shall be written in red. In addition the names relative to telephones on which exchange access is barred shall be underlined in red.

4.22 Units - Standard eyeball indicators and standard lever keys are used; the relays are all of the B.P.O. 3000 type. Units Nos. 1A and 3 contain a special vibrator type relay (BZ) for ringing the external extension. The unit cover is secured by 4 screws in the sides of the case near the bottom. When removing the cover it should be tilted slightly so as to clear the key handles on the face plate.

4.221 Dummy Indicators - Dummy Indicators are fitted on Units, Transfer, Intercommunication Nos. 1 and 2 to facilitate their conversion to second choice main station units for use on installations having an external extension. To convert these units Indicator Eyeball 345/1000 should be fitted. Spare wires have been provided in the cable form to enable this indicator to be connected. The required connections are shown in Fig.8. An indicator label engraved EXTN should be fitted instead of the blank label provided with the dummy indicator.

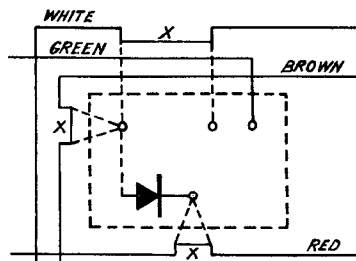


FIG. 8. METHOD OF CONNECTING ADDITIONAL INDICATOR ON UNITS, TRANSFER, INTERCOMMUNICATION, NOS. 1 & 2.

4.222 Modifications to first choice main station Units - On installations with a second choice main station it is necessary to make certain modifications to first choice main station units. Straps inside the unit as detailed in Table 1 must be removed to enable the exchange lines to be extended to the second choice main station when the appropriate keys are thrown.

Unit	Straps to be removed.
Unit, Transfer, Intercom. No. 1	T ₁ T ₂ T ₃ T ₄
" " " No. 1A.	T ₁ T ₂ T ₃ T ₄ T ₅
" " " No. 2	Exch. 1 Exch. 2 T ₁ T ₂ T ₃ T ₄ T ₁ T ₂ T ₃ T ₄
" " " No. 3	T ₁

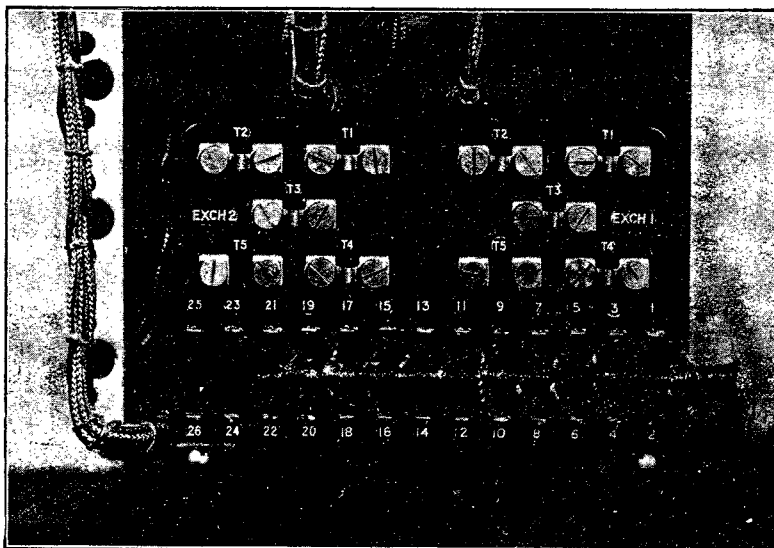


FIG. 9. TERMINAL BLOCK, UNIT, TRANSFER, INTER-COMMUNICATION, NO. 2.

Fig.9 shows the terminal block as fitted on a Unit, Transfer, Inter-communication No.2, and the straps may be seen in position. Certain of the unit labels (which are engraved on both sides) should be reversed, at the first choice main station. Drawing C.1235 shows the arrangements.

4.3 Summary of Apparatus. Table 2 shows variations to Drawing C.1236, Figures 1 - 4 for apparatus required for installations of various sizes.

TABLE 2.

Typical Layout Drawing	Type of installation.	Apparatus Required.				
		Telephone Intercom. No.1	Telephone Intercom. No.2	Standard C.B. or auto. telephone (at external extension)	Units	
					At first choice main station	At second choice main station
C.1236 Fig. 1	1 Exchange line & up to 5 internal extensions (no external extension).	one per extension	-	-	Unit, transfer, Intercom. No.1.	Unit, transfer, Intercom. No.1.
C.1236 Fig. 2	1 Exchange line 1 external extension and up to 4 internal extensions.	one per internal extension	-	1	Unit, transfer, Intercom. No.1A.	Unit, transfer, Intercom. No.1 (additional indicator to be fitted locally).
C.1236 Fig. 3	1 exchange line & from 6 to 10 internal extensions (No external extension).	-	one per extension	-	Unit, transfer, Intercom. No.1.	Unit, transfer, Intercom. No.1.
C.1236 Fig. 3	2 exchange lines & up to 10 internal extensions (no external extension).	-	one per extension	-	Unit, transfer, Intercom. No.2.	Unit, transfer, Intercom. No.2.
C.1236 Fig. 4	1 exchange line & from 5 to 9 internal extensions. 1 external extension.	-	one per internal extension	1	Unit, transfer, Intercom. No.1 & Unit, transfer, Intercom. No.3.	Unit, transfer, Intercom. No.1 (additional indicator to be fitted locally).
C.1236 Fig. 4	2 exchange lines, 1 external extension & from 5 to 9 internal extensions.	-	one per internal extension	1	Unit, transfer, Intercom. No.2 & Unit, transfer, Intercom. No.3.	Unit, transfer, Intercom. No.2 (additional indicator to be fitted locally).

4.4 Junction Boxes. Two sizes of junction box are available, known as Box, Junction, Intercommunication No.1 and Box, Junction, Intercommunication No.2 respectively. The former box has 4 terminal strips with 30 terminals per strip, the latter has 4 strips with 48 terminals per strip. The boxes are provided with a bonding strip fitting underneath the cable clamp screw at the end of the box opposite the labels. This arrangement will provide efficient bonding when all cables are led in at the bonding strip end of the box. When any of the cable is lead in at the opposite end the 2

clamps on the strip concerned must be bonded together on the underside of the strip with switchboard wire. The junction boxes are secured in position with a 3 point fixing so as to reduce the possibility of strain on the bakelite. Three rubber feet are provided to assist in preventing undue strain when the boxes are mounted on uneven surfaces. Fixing screws (wood screw No.10, 1½") are provided with the boxes. Labels should be provided locally. The junction box wiring diagrams (Drawings C.1239 and C.1240) show details of the labels.

4.5 Cabling and Wiring. The standard colour code is used for conductors as follows :-

<u>Pair No.</u>	<u>Colours.</u>
1	Blue and White.
2	Orange and White.
3	Green and White.
4	Brown and White.
5	Slate and White.
6	Blue White and White.
7	Blue Orange and White.
8	Blue Green and White.
9	Blue Brown and White.
10	Blue Slate and White.
11	Orange White and White.
12	Orange Green and White.
13	Orange Brown and White.
14	Orange Slate and White.
15	Green White and White.
16	Green Brown and White.
17	Green Slate and White.
18	Brown White and White.
19	Brown Slate and White.
20	Slate White and White.

When it is necessary to terminate a 12 pr/10 cable on a No.2 junction box, the cable where it fits into the junction box must be packed with lead. Lead strip, 5 lb, is suitable. The standard instructions as regards cabling, which are covered by Installation Circular No.4, should be followed. When the situations of the extensions and main stations are known the best junction box positions having regard to economy of multiple cable should be chosen. Typical layouts for various types of installations are shown on Drawing C.1236.

4.51 The junction boxes have been designed so that normally it is possible to feed two instruments from each intermediate box and three from a terminal box. Special arrangements are necessary at first choice main stations as shown on Drawing C.1236. Each installation should be considered on its merits as it may be possible, by the use of additional junction boxes, to effect a proportionately greater saving in cable. Alternative junction box arrangement for use in special cases is shown in Drawing C.1237. Except in special circumstances, multiple cable should be run only between internal extensions in the same building.

4.52 Terminations - The exchange and external extension lines should be protected and terminated in the standard manner as described in General

Engineering Circular No.9 and Installation Circular No.4. The multiple cable should be terminated in colour order on screw terminals 1 to 24 (or 1 to 40) on the back of the inner strips of the junction boxes; the white wire being taken as the "A" wire of the pair. All cable wires, whether working or spare, should be terminated. The instrument and unit cables are terminated at the junction boxes as shown on the typical wiring diagrams, Drawings C.1239 and C.1240. These diagrams illustrate typical arrangements where the cable is led in at the bottom of the junction box strips. The cable may be brought in at either end, but if brought in at the top it should be noted that the cable forms will differ from those shown on this drawing, the pairs being formed out in the reverse order.

4.53 Gross Connections - The cross connections between the front terminals of the junction boxes are made with bare wire of square section, which is provided loose with the boxes. 5" links are provided with Box No.2 and 4½" links with Box No.1. The wire is designated - "Wire, Brass tinned square section 0.050". The precise cross connections required at any box will depend on the numbering of the telephones served by this box. Typical cross connections are shown on Drawings C.1239 and C.1240. In addition to the bare wire connections, certain connections with covered wire are necessary on the front of the junction boxes in order to connect the instrument, HL and R wires to the multiple pair corresponding to the number of the instrument. Switchboard wire should be used for this purpose. In addition, on installations on which one extension in excess of the normal capacity is fitted, it is necessary to make further connections with switchboard wire at each junction box. The object of this wiring is to connect pair 12 (or 20) in the multiple cable to the pair corresponding to the local number at each instrument. Typical examples are shown on Drawings C.1239 and C.1240. The key which formerly bore the local extension number will then be re-numbered 6 (or 11) on each instrument label. When "Exchange Calls Barred" conditions are required at any local extension, the multiple D¹ wires are formed to the instrument D wires. The method of doing this at the junction box is illustrated in Drawings C.1239 and C.1240, Sheets 1 and 2 respectively. For extensions which are barred exchange service completely, the multiple C, D and D¹ wires are not brought in to the instrument, but the C wires from the instrument are earthed on the instrument strip. The method of connection is shown on Drawings C.1239 and C.1240, Sheets 1 and 2 respectively. On installations having one exchange line and more than 5 extensions, and which are therefore equipped with Telephones, Intercommunication No.2, at the

internal extensions the second exchange line "C" wire should be earthed on the multiple strip at the main station junction box. This form of connection will result in an engaged signal being given if the second exchange line key is depressed.

- 4.54 Jack Wiring - The cable wires must be soldered to the jack tags. The cable may be led into the jacks at any one of three positions, "break-ins" being provided at these points. Wiring diagrams for the instrument and the various unit jacks are shown on Drawings C.1241 and C.1242.
- 4.55 Plug Wiring - The plug point connections on the instruments and units are shown on Drawing C.1238.
- 4.56 Extension Bells - Bells, Trembling, 635H, should be used as extension bells and should be wired from the jacks. On installations with two exchange lines and an external extension, two extension bells (one common to the two exchange lines and one for the external extension) may be fitted. In such cases the bells should be adjusted so that the tones are distinguishable readily.
- 4.57 Cords - The standard length of cord supplied on instruments and units is 6 ft. For the present it is not proposed to provide cords of non-standard lengths, but any cases for which longer cords are requested should be referred to this office.
- 4.6 Testing and Records. After an installation has been completed the following tests should be made :-
- 4.61 Insulation Resistance - The wiring should be tested for insulation with a 250 volt megger, the test being carried out at the main station junction boxes. Before testing, the instrument and unit jacks should be connected to the cable ends and the required cross connections inserted at all junction boxes. No apparatus should, however, be plugged into the jacks, and battery, earth and the exchange and external extension lines should be disconnected at the protectors. Tests should be carried out from the multiple strip on the main station junction box, the wires terminated on the "A" side of the strip being commoned and tested against the wires terminated on the "B" side. For this test care must be taken to remove the straps from the "A" and "B" wires of the "Battery" and "Earth" pairs. Battery appears on terminals 7 and 8 in Box No.1, and on terminals 13 and 14 in Box No.2. Earth appears on terminals 9 and 10 in Box No.1, and 15 and 16 in Box No.2. The pairs should then be bunched and tested to earth. The insulation resistance measured under the above conditions should be not less than 1 megohm. On installations where an auxiliary junction box is fitted to feed

the main station it will be necessary to test the cable wires connected to terminals 25 - 30 of this box separately.

4.62 Continuity - The wiring should be tested for continuity at each junction box by means of a cell and a B.P.O. detector. The lead sheathing of the cable and the bonding at junction boxes should be tested for continuity and efficient connection to earth. If the cable is enclosed in conduit the latter should be tested in the same manner.

4.63 Operation - The installation should be tested thoroughly for correct operation, the following tests being carried out at each instrument.

4.631 An exchange call to be made on each exchange line.

4.632 A local call to be made to each of the other extensions on the system.

4.633 A conference call to be made to all other extensions.

4.64 Records - Immediately after the system has been installed a layout diagram showing the cable runs and junction box positions, together with the numbers of the extensions fed from each box, should be prepared and kept at the main station for reference.

4.7 Power.

4.71 The power will be obtained normally from a power lead; the conditions governing the provision of the power lead being the same (as far as they apply) as for private branch exchange installation (G.E.C.13 - Provision of Power Leads for Private Branch Exchanges - refers). The current taken by installations of this type is approximately 100 mA per extension-extension connection. Thus on the graphs shown in Drawing C.379, each simultaneous connection on an intercommunication system = 2M. The maximum number of simultaneous connections is 5 for an A10 unit; thus the maximum current is 500 mA. The minimum power lead potential at the intercommunication system end should be 18 volts. A 10 uF condenser should be connected across the power lead at the subscriber's premises.

4.72 Where a power lead is not available a dry cell battery should be used. Advice should be furnished this office as to all instances in which it is necessary to utilize dry cells.

SECTION 5.

CIRCUIT OPERATION.

- 5.1 General. This section describes the circuit operation. The Drawings referred to apply generally to the 2 + 10 system, but the operation of the 1 + 5 system is similar, and will be followed readily by a study of Drawing C.1243 in association with the relative portions of the following paragraphs.
- 5.2 Local Call between Internal Extensions (Drawing C.1244, Sheet 1).
- 5.21 To call another internal extension, the caller removes the handset, thereby allowing the HM springs to operate, and fully depresses the local key adjacent to the number of the required extension. Springs CB and L are thereby operated. Earth is extended via HM2, CB2 and the appropriate L2 springs to the B-line of the called extension. HM1 and HM2 prepare a circuit for the transmission bridge. CB1 extends the buzzer to the common wire. HM3 and HM4 have no function at this stage.
- 5.22 Called Extension Free - If the called extension's handset is on the rest, the earth placed on the B-line is extended to the R-wire of the called extension circuit and thence via 1H3, 2H3, HM1 and the buzzer to battery. (Note:- At each instrument the A and B common wires in the multiple cable are jumpered to the HL and R terminals respectively. The called extension's buzzer is therefore actuated for the period during which the caller has the appropriate local button fully depressed.
- 5.23 Called Extension Answers - The called extension answers by removing the handset from its rest. The HM springs then operate and the telephone circuit is connected to the HL and R-wires via 1X3, 2X3, and 1X2, 2X2, HM1, 2H3 and 1H3 respectively. Battery and earth are fed to the line through the transmission bridge RA.
- 5.24 Speaking Conditions - When the caller's finger is removed from the local key, the latter partially restores to the "speaking" position. The L springs remain operated in this position, but the common spring bank CB is released. The telephone circuit and the transmission bridge are connected to the A- and B- lines via the appropriate L1 and L2 springs and so to the called extension's telephone.
- 5.25 Transmission bridges, consisting of battery and earth fed through the two 200-ohm coils of the retardation coil RA, are provided at both stations on this type of call.
- 5.26 Called Extension engaged on a Local Call - If the called extension is engaged on a call to another extension, the earth on the R-wire incoming from

the calling extension will not operate the buzzer at the called extension as the buzzer circuit is disconnected at HML. When the local key on the calling extension's telephone set restores to the "speaking" position however, the telephone circuit is connected to the A- and B- wires as in para. 5.23. A caller is thus able to break into a connection between the two other extensions.

5.27 Called Extension Engaged on an Exchange Call - If the called extension is engaged on an exchange call, the hold (H) springs on the appropriate exchange key will be operated and, at 1H3 or 2H3, the R-wire will be connected to the common. When the caller fully depresses the appropriate local key, the earth placed on the R-wire of the called extension is extended to the common. This earth is returned to the calling extension on the common wire and operates the caller's buzzer via CBL. This serves as an engaged signal indicating that the distant extension is engaged on an exchange call.

5.28 Release of Connection - At the termination of a call both extensions replace their handsets on the rests, which action mechanically restores all operated keys to normal.

5.3 Internal Extension Calling External Extension. (Drawing C.1244, Sheet 3).

5.31 When the calling extension removes the handset from its rest, and fully depresses the appropriate local key, an earth is extended to the B-line (see also para. 5.21). This earth is received on the R-wire of the external extension circuit and thence via 2X4, 1X4, L2, BZ3y, coil of relay BZ to battery, with a parallel circuit via coil of relay H to battery. Relays H and BZ operate. H1 short-circuits the 2 uF condenser and relay Q, while H2 and H3 prepare for the extension of the A- and B-lines. H4 disconnects the external extension calling indicator.

5.32 External extension free - Ringing current is placed on the external extension line in the following manner. Relay BZ in operating breaks its own circuit at BZ3y and, consequently, releases after its slow-release period, whereupon it immediately commences to re-operate. Relay BZ thus alternately operates and releases during the time that the local key at the calling extension is fully depressed. The contacts of relay BZ make and break with a frequency of approximately 16-20 per second, and the resultant reversals of potential sent to line via BZ1 and BZ2 ring the magneto bell at the external extension station. The path of the current with relay BZ operated is: earth, YA, BZ1, coil of relay L, 2X2, 1X2, H1 to X2 (B-line); battery, YB, BZ2, coil of relay L, 2X1 and 1X1 to X1 (A-line). During the ringing period, the two 0.5 uF condensers act as a spark-quench to the contacts BZ1 and BZ2. Relay L does not operate while ringing current is being applied to the line.

- 5.33 When the earth is removed from the R-wire, relay H holds from earth, 1X3, 2X3, coil of relay H, HL-wire, calling extension telephone loop, R-wire, 2X4, 1X4 and coil of relay H to battery. Relay BZ releases, as it will not hold in parallel with H under these conditions. BZ1 and BZ2 extend earth and battery respectively via the coils of relay L, to prepare the transmission bridge for the external extension.
- 5.34 External Extension Answers - The external extension answers by removing the handset from the rest, and the telephone loop thus provided operates relay L. L1 and L2 extend the A- and B- wires from the caller's telephone circuit to the called telephone. L3 serves no purpose at this stage. Relay BZ is disconnected at L2.
- 5.35 External Extension Engaged on a Local Call - If the external extension is engaged on a call with another extension, relays H and L will be operated and, consequently, when a caller depresses the local key appropriate to the external extension number, relay BZ does not operate. When the local key restores to the "speaking" position, the caller breaks into the local connection.
- 5.36 External Extension engaged on an Exchange Call - If the external extension is engaged on an exchange call, key springs 1X4 or 2X4 will be operated, thereby connecting the R-wire to the common. Therefore, when a caller fully depresses the local key adjacent to the external extension number, his own buzzer will operate as described in paragraph 5.27.
- 5.37 Release of Connection - At the termination of a call, both extensions replace their handsets. Relays H and L release and the circuits are restored to normal.
- 5.4 External Extension Calling Internal Extension. (Drawing C.1244, Sheets 1 and 3).
- 5.41 The external extension has not the facility of direct access to internal extensions and must obtain all such calls via the main station.
- 5.42 External Extension Calls Main Station - The main station is called by the action of removing the handset from the rest. Relays L and Q operate via earth, YA, BZ1, coil of relay L, 2X1, 1X1, external extension telephone loop, coil of relay Q, 1X2, 2X2, coil of relay L, BZ2 and YB to battery. Q1 operates relay QR, the contact of which has no function at this stage. L1 and L2 prepare the HL and R-wire circuits respectively, L3 extends an earth to operate the eyeball calling indicator via earth, L3, H4, T1, 1NS1, 2NS1, and indicator coil to battery. An audible alarm is given by a bell, which is actuated by earth from the calling indicator contact via C01.
- 5.43 Main Station Answers - The main station answers by removing the handset and depressing the local key corresponding to the external extension number on the telephone set, thereby connecting the telephone circuit to the A- and B- multiple

wires of the external extension station as follows:- A-wire appropriate L1 springs, 2X3, 1X3, telephone circuit, 1X2, 2X2, CB2 and appropriate L2 springs to the B-line. The transmission bridge is provided from earth, HM2, 200 ohms coil of RA and appropriate L1 springs to the A-line, and battery via 200 ohms coil of RA, HM1, CB2 and appropriate L2 springs to the B-line. HM3 and HM4 have no function at this stage. The A- and B- wires are connected via the multiple to the HL- and R- wires respectively of the external extension station. The main station telephone loop applied to the HL- and R- wires completes a circuit for the operation of relay H via 2X4, 1X4 and 2X3, 1X3. H1 short circuits relay Q, H2 and H3 extend the HL- and R- wires to the external extension telephone, and H4 disconnects the indicator circuit.

5.44 The relays L and H together with the retard coil RA provide the necessary transmission bridges.

5.45 Main Station Calls Internal Extension - The caller now informs the main station of the number of the internal extension with which he requires to communicate. The main station then calls the required extension, the circuit operation being similar to that described in paragraphs 5.24 - 5.25. The called extension, upon answering, is requested by the main station operator to call the external extension; the main station operator then replaces the handset. The operation of the internal extension calling the external extension is described in paragraph 5.3.

5.5 Conference Facilities. (Drawing C.1244, Sheet 1).

5.51 The procedure to be followed when making conference calls is described in Section 3. If a mass call were made instead of first calling the extensions individually, as soon as one extension answered, the buzzers at the other called extensions would commence to operate and continue to do so even though the caller had removed pressure from the local keys. The circuit is earth, HM2, coil of RA, telephone loop to all the B-lines and buzzers in parallel, and the buzzers will therefore operate as soon as the circuit resistance has been sufficiently reduced by HM2 earths in parallel.

5.52 Continuous operation of the buzzer until the extension answers is undesirable and it has been laid down, therefore, that a mass call should be made only after it has been ascertained that a person is in attendance at the called extension.

5.6 Internal Extension with Full Facilities Calling the Exchange. (Drawing C.1244, Sheets 1 and 2.)

5.61 To call the public exchange, the internal extension station removes the handset thereby operating the HM contacts, and depresses (say) Exchange Key No.1, thus operating the X and H springs. 1X1 and 1X2 remove the hold coil and prepare to connect the telephone to the exchange line. 1X2 and 1X3 also discon-

nect the local side of the circuit. 1H1 prepares an engaged test circuit (see paragraph 5.64). 1H2 prepares an operate circuit for relay AA. 1H3 connects the R- and common-wires to provide an engaged test to calling extensions (see paragraph 5.27).

- 5.62 Exchange Line Free - If the exchange line is disengaged, relay AA operates from battery, coil of AA, HM3, 1H2, AA4 and D-wire to earth at G1 on the exchange-line termination (Drawing C.1244, Sheet 2). AA1 and AA3 extend the telephone circuit to the A- and B-wires and thence to the exchange line. AA2 extends the earth via HM2 and 1H1 to the C-wire, to operate relay G at the exchange-line termination. AA4 provides a locking circuit for relay AA via HM3, 1H2, AA4 and HM2 to earth. At the exchange-line termination, relay G in operating removes the earth from the D-wire at G1 in order to avoid intrusion. G2 removes the exchange indicator and 2uF condenser from the speaking circuit. If an automatic exchange is concerned, the caller receives dialling tone and may proceed to set up the connection.
- 5.63 Release of Connection - At the termination of a call, the calling extension replaces the handset, thereby restoring the HM, X and H spring banks. Relays AA and G release, to restore the circuits to normal, when a clear is given to the exchange.
- 5.64 Exchange Line Engaged - When the key of an engaged exchange line is depressed (with the handset on or off the rest), the caller's buzzer will operate from battery, coil of buzzer, AA2, 1H1, and the C-wire to an earth applied by the HM2 contacts of the engaging extension. The caller's AA relay will not operate, due to the absence of earth on the D-wire of an engaged exchange line, and secrecy on exchange calls is thus provided.
- 5.7 External Extension Calling Exchange - Day Service. (Drawing C.1244, Sheet 3).
- 5.71 To gain access to a public exchange, the external extension must first call the main station. This operation is described in paragraphs 5.41 - 5.44.
- 5.72 The main station, having ascertained that the external extension requires an exchange call, proceeds to test an exchange line by depressing the exchange line key on the telephone set (see paragraph 5.64). When a free line is found, it is switched to the external extension line by throwing the appropriate EXTENSION TO EXCHANGE key on the main station unit. The main station then replaces the handset.
- 5.73 Extension to Exchange key contacts function as follows:- X1 and X2 connect the external extension to the A- and B-wires of the exchange line. X3 extends an earth via 2NS2, 1NS2 and X5 to the C-wire, to operate relay G and place engaged-test conditions on the exchange line. X4 disconnects relay BZ from the R-wire and connects the R-wire to the common, in order to busy the extension against incoming

local calls. X6 has no function at this stage. Relay Q operates from the public exchange battery to the extension station's telephone loop and at Q1 operates relay QR. QR1 disconnects the indicator circuit.

5.74 If the public exchange is of the automatic type, relay Q responds to the impulses dialled from the extension, relay QR, however, being slow-to-release, remains operated during the dialling operation.

5.75 Release of Connection - At the termination of a call, the external extension station replaces the handset, to give a through clear to the public exchange. Relay Q releases, followed by relay QR. QR1 now extends earth from X3, to operate the clearing indicator via T1, 1NS1, and 2NS1. The operation of the clearing indicator places an earth via C01 to the bell associated with the main station unit, to provide an audible clear. The main station now restores the EXTENSION TO EXCHANGE key, to re-establish normal conditions.

5.8 Incoming Exchange Call. (Drawing C.1244, Sheet 2).

5.81 All incoming exchange calls are received on indicators fitted in the Unit, Transfer, Intercom. at the main station. The indicators, which are of the eye-ball type, operate to rectified ringing current from the public exchange via the A-line, T1, coil of indicator, 2 uF condenser, G2 and T2 to the B-line. The indicator when operated extends an earth via C01, to operate the alarm bell.

5.82 Main Station Answers - The main station answers all exchange calls by removing the handset and depressing the appropriate exchange key on the telephone set. The circuit operation is then similar to that described in paragraphs 5.61 and 5.62.

5.83 Call for Internal Extension. (Drawing C.1244, Sheet 1). Incoming exchange calls for an internal extension are first received by the main station, as described in paragraphs 5.81 and 5.82.

5.84 Upon ascertaining the number of the extension required, the main station fully depresses the local key corresponding to this number. This operation mechanically restores the exchange line key to the "hold" position. In this position the H springs remain operated but the X springs are released, and the exchange line is now held by a circuit from the A-line, AA1, 600-ohm resistance coil, 1X1, AA3, to the B-line. The main station telephone circuit is disconnected from the exchange line at springs 1X1 and 1X2 and, when pressure is released from the local key, the telephone is switched to the A- and B-lines of the called extension via the appropriate L1 springs, 2X3, 1X3, telephone loop, 1X2, 2X2, CB2, and the appropriate L2 springs. The called extension is then requested to "pick up" the exchange line on which the call is being held. To do this, the distant extension depresses the appropriate exchange key, whereupon the buzzer at that station will

operate as described in paragraph 5.64. Buzzer tone is passed back to the main station from earth, 0.4 ohm coil of the buzzer, 1X3, 2X3 to the HL-wire and thence at the main station via A-wire appropriate L1 springs, 2X3 and 1X3 to the telephone circuit. On receipt of tone, the main station replaces the handset on its rest; this restores all keys to normal, and removes the busy condition from the G- and D-wires. The AA or AB relay at the extension station is then allowed to operate to earth on the D-wire and so connect this extension to the calling exchange line, as detailed in paragraph 5.61.

- 5.85 Called Extension Engaged - If the required extension is engaged on a local call, the main station is enabled to break in on the connection, as described in paragraph 5.26, and offer the exchange call to the extension concerned. If the required extension is engaged on an exchange call the main station can break in on the connection only if provided with monitoring facilities (see paragraph 5.106).
- 5.86 Call for External Extension. (Drawing C.1244, Sheet 3). Upon ascertaining that the external extension is required, the main station calls the external extension by depressing the appropriate local key, the exchange line being held meanwhile in the manner described in paragraph 5.84. The external extension is advised that an exchange call is waiting, and the main station then throws the appropriate EXTENSION TO EXCHANGE key on the main station unit.
- 5.87 The main station replaces the handset on the rest, and the call now proceeds as detailed in paragraphs 5.73 - 5.75.
- 5.9 Transference and Holding of Exchange Calls. (Drawing C.1244, Sheets 1 and 2).
- 5.91 Internal Extension to Internal Extension - If an extension, after speaking on an exchange line, desires to transfer the exchange call to the main station or to another extension having full facilities, the operations are similar to those described for a main station transference (see paragraphs 5.84 and 5.85).
- 5.92 Internal Extension to External Extension - An exchange call cannot be transferred direct from an internal extension to the external extension but must be transferred via the main station. The successive operations are as described in paragraphs 5.91 and 5.86 respectively.
- 5.93 External Extension to Internal Extension - By "flashing" the main station operator it is possible for exchange calls to be transferred from the external extension to any other extension via the main station. In automatic areas, directly-dialled calls originated by the external extension cannot be transferred.
- 5.94 Holding one Exchange Line while Transferring a Call on the Other - If on an installation with two exchange lines, the main station is talking on one line and a call is received on the second line, the main station may temporarily abandon the call on the first line and, by depressing the second exchange key (which

automatically restores the first exchange key to the "hold" position, see paragraph 5.84) may accept the call, the operations being as described in paragraph 5.82.

5.95 The main station then depresses the local key corresponding to the number of the extension to which it is desired to transfer the call. This causes the second exchange line key to restore to the "hold" position.

5.96 If the call is for the external extension, it is transferred as described in paragraph 5.86. If the call is to be transferred to an internal extension, the procedure is as described in paragraph 5.84 except that, on receipt of buzzer tone, the main station releases the second exchange line from the instrument by operating the associated "trigger key". This causes the "hold" springs associated with the second line to restore, while leaving the "hold" springs on the first exchange key in the operated position. The distant extension's AA relay may then operate as described in paragraph 5.84. The first exchange key has meanwhile remained in the "hold" position and, by again fully depressing this key, the main station may continue the conversation on this exchange line. The action of fully depressing the exchange key also restores the local key previously operated. An internal extension station (other than a main station) with full facilities may, in the same manner, hold one exchange line while transferring an originated call on the second exchange line.

5.97 Holding one Exchange Line while making a Call on the other - The depression of the second exchange key automatically restores the first exchange key to the "hold" position. The call is then set up as described in paragraph 5.61. Either exchange call may now be transferred, the procedure being as described in paragraph 5.91. On termination of the call on the second exchange line, operation of the associated trigger key releases this line from the instrument, and connection with the first exchange line may then be re-established by again fully depressing the first exchange key.

5.10 Miscellaneous Facilities. (Drawing C.1244, Sheet 1).

5.101 Any internal extension may be barred the facility of direct access to the exchange lines, but may be allowed exchange calls as occasion demands, at the discretion of the main station operator. At these extensions, the D-wires connected to the AA and AB relays in the telephone set are cross-connected at the junction box to the corresponding D1 multiple wires and not to the D-wires as usual. The multiple D1-wire is normally disconnected from earth but, by operation of a press-button labelled EXCHANGE CALL and situated on the main station unit (Drawing C.1244, Sheet 2), the D1-wire may be earthed and thus allow the AA or AB relay to operate at the E.C.B. extension.

- 5.102 Outgoing Exchange Call - To make an outgoing exchange call, the E.C.B. extension first calls the main station in the normal way (paragraphs 5.21 - 5.28). If an exchange call is to be allowed, the main station operator tests and engages a free exchange line. The E.C.B. extension is then instructed to depress the appropriate exchange key. On receipt of buzzer tone from the E.C.B. extension (see paragraph 5.84), the main station operator holds down the appropriate EXCHANGE CALL button, at the same time replacing the handset on the rest.
- 5.103 When the main station replaces the handset, relay G releases and relay AA or AB at the E.C.B. extension will now operate via the D1-wire, contacts of the EXCHANGE CALL button and G1 to earth. The E.C.B. extension is now connected to the exchange line as described in paragraph 5.62.
- 5.104 Incoming Exchange Call - Incoming exchange calls to E.C.B. extensions may be extended at the discretion of the main station operator. The operation is similar to that described in paragraph 5.84 except that on receipt of buzzer tone, the main station operator depresses the EXCHANGE CALL button and at the same time replaces the handset. The call then proceeds as described in paragraph 5.103.
- 5.105 Transferring Exchange Call from Internal Extension to E.C.B. Extension - An exchange call may be transferred to an E.C.B. extension from another internal extension, by first transferring the call to the main station (paragraph 5.91) and requesting the attendant to re-transfer the call to the extension required (paragraph 5.104).
- 5.106 Monitoring Exchange Calls. (Drawing C.1244, Sheet 1). Secrecy is normally given on exchange connections. Monitoring facilities may, however, be allowed at the main station or any of the internal extensions. By altering the position of the strap (shown in the diagram), the instrument relay at that station is disconnected from the D-wire, and a local operating circuit is provided. Monitoring facilities may be provided on either or both of the exchange lines.
- 5.107 When it is desired to monitor an exchange call, the internal extension having monitoring facilities first tests the exchange line by depressing the appropriate exchange key, without removing the handset from the rest. The operation of the buzzer will indicate an engaged exchange line (see paragraph 5.64). When the handset is removed, relay AA operates via HM3, 1H2, AA4 spring 23, strap 2-3, to earth at HM2. AA2 disconnects the buzzer from the C-wire. On depression of the appropriate exchange key, the telephone circuit is connected to the A- and B-lines of the engaged exchange line via AA1, 1X2, and 1X1, AA3, so that the monitoring extension is now able to listen to the conversation or to offer a trunk call.

- 5.108 Second-Choice Main Station. (Drawing G.1244, Sheet 2). By the operation of a key or keys labelled TRANSFER at the first-choice main station unit (the key straps having previously been removed), the functions of that station may be transferred to the second-choice main station. When the transfer key on the main station unit is thrown, T1, T2, T4 and T3 transfer the A- B- C- and D- wires respectively from the first-choice to the second-choice main station. All incoming exchange calls will now operate the exchange indicators at the second-choice main station unit, those calls which are for internal extension stations being dealt with as described in paragraphs 5.82 - 5.85.
- 5.109 On installations with an external extension, the facility of switching the external extension to an exchange line is not transferred to the second-choice main station, although the external extension calling and clearing signals are received at the latter station, which may therefore deal with requests for local calls by the external extension.
- 5.110 External Extension Calling Exchange - The external extension calls the second-choice main station as described in paragraph 5.42, and the latter answers as described in paragraph 5.43. If the external extension requires an exchange call, the second-choice main station operator requests the external extension to replace the handset. The main station operator, after replacing the handset at the second-choice main station, then proceeds to the first-choice main station and tests for a free exchange line on the telephone set at that station. When a free exchange line is found, it is switched to the external extension in the manner described in paragraphs 5.72 and 5.73.
- 5.111 The handset at the first-choice main station is now replaced. The operator may (after restoring the transfer keys and so placing the first-choice main station in control) wait at this station for the external extension clearing signal and on receipt of this signal, restore the EXTENSION TO EXCHANGE key, re-operate the transfer keys and then return to the second-choice main station. Alternatively, the operator may return to the second-choice main station at once and, on receipt of the clearing signal at that station, proceed again to the first-choice main station in order to restore the EXTENSION TO EXCHANGE key and, subsequently, return to the second-choice main station.
- 5.112 Incoming Exchange Call for External Extension - If an incoming exchange call is for the external extension station, the second-choice main station operator must hold the exchange line, by leaving the handset off the rest at this station. The operator must then proceed to the first-choice main station and, after calling the external extension station (see paragraphs 5.31 - 5.34), switch the exchange call through as described in paragraphs 5.72 and 5.73. The handset at the second-choice main station is replaced after the call is switched through.

- 5.113 Night Service. (Drawing C.1244, Sheet 3). The external extension station may be permanently switched to an exchange line at night, by operation of the EXTENSION TO EXCHANGE key and the NIGHT SERVICE key on the main station unit. X1 and X2 connect the external extension station to the exchange line. X3 and X5 prepare to extend an earth to the C-wire. X4 disconnects relay BZ from the R-wire and connects the R- and common-wires to busy the extension against incoming local calls. The indicator circuit is disconnected by the operation of X6 and NS1. NS2 removes the X3 earth from the C-wire so that the exchange line will test free to internal extensions when it is not in use by the external extension.
- 5.114 The external extension station removes the handset from the rest, thereby applying the telephone loop to the exchange line. Relay Q operates and Q1 operates relay QR. QR1 extends the earth from X3 to the C-wire via X5, so causing the exchange line concerned to test engaged to other local extensions, and also operating relay G which functions as described in paragraph 5.62.
- 5.115 Exchange Line Engaged - If, when the external extension removes the handset from the rest, the exchange line is in use by an internal extension, the external extension will be connected to the engaged exchange line and thus enabled to break in on the exchange call.
- 5.116 Incoming Exchange Call for External Extension - An incoming exchange call on the exchange line to which the external extension is switched will ring the external extension bell and also operate the exchange indicator on the main station unit. On removal of the handset at the external extension station, relays Q, QR and G will operate as described in paragraph 5.114. The exchange indicator at the main station will therefore restore, and the call will then be received at the external extension station.
- 5.117 Extension Bells - The exchange line or external extension alarm bell circuits and the internal extension buzzer signals may be extended to any point or points on the system. The extension bell or buzzer is connected to the terminal marked EB in the diagram and is thus in parallel with the main bell or buzzer.
- 5.118 The extension of the exchange line or external extension alarm bell enables incoming calls to be answered at other points during the absence of the main station operator. On Units, Transfer, Intercom. No.1A and No.2, a common alarm bell serves both indicators, and, at points where signals are provided by an extension bell, it may therefore be necessary to test both of the exchange lines or the exchange line and the external extension by operating the appropriate keys on the intercom. telephone.
- 5.119 Terminal S. (Drawing C.1243, Sheet 3, and C.1244, Sheet 3). The wire from L3 to the terminal marked S has no function in any facilities at present available. It is included, however, to meet future anticipated requirements.