HOUSE EXCHANGE SYSTEMS Nos. 1 AND 2

Installation

★[*NOTE:—As this Instruction has been completely revised, individual paragraphs have not been 'starred'. Changes in installation procedure and equipment are the principal amendments*]

1. General.—This Instruction relates to the installation of the House Exchange Systems (H.E.S.) Nos. 1 and 2. The items of equipment used are described in Q 1002. The facilities given and definitions of terms used are described in Q 1001.

2. Contents.—

3. Advice Notes.—The Advice Note for a house exchange installation will specify the number of exchange lines and multiple stations to be provided and, for an installation with one exchange line and five or fewer stations, will specify if jacks and cabling for two exchange lines and ten stations are to be provided. The Advice Note will also specify other requirements such as a non-multiple extension, a second-choice main station, and miscellaneous items, e.g. extension bells.

4. Equipment required for C.B. manual and automatic areas.—Table 1 shows the main items of equipment required for simple installations of different sizes in C.B. and automatic areas. By suitable modifications to junction-box wiring, as described in par. 15, a maximum of six stations may be accommodated on H.E.S. No. 1 installations, and 11 stations on H.E.S. No. 2 installations. For the telephones to be used when a hearing-aid handset is required see par. 32. Units, Transfer, Intercom., Nos. 1, 1A and 2 for all new installations should he of the Mk. II type, which incorporates voltage limiters on the exchange line terminations.

5. Equipment required for L.B. areas.—The equipment shown in Table 1 for C.B. areas should be used but, in addition, an auxiliary apparatus unit must be associated with each exchange line, to present C.B. line conditions to the house exchange equipment. In C.B.S. Nos. 1, 2 and 3 exchange areas, one Unit, Auxiliary Apparatus, CBS 536 (Dgm. CBS 536) is required per exchange line. The units will normally be fitted at the public exchange but, if the exchange is fed from a primary battery and the house exchange installation is fed from secondary cells, it may be preferable to fit the units at the subscriber's premises. In magneto exchange areas, one Unit, Auxiliary Apparatus, CBS 1074 (Dgm. CBS 1074) is required per exchange line. These units will be fitted at the public exchange. In addition, at magneto exchanges, it will be necessary to fit a Vibrator, Ringing, No. 2B or No. 3B if this is not already provided.

6. Layout of system.—Table 2 gives the sizes of junction boxes and cables for H.E.S. No. 1 and No. 2 installations and quotes a typical layout diagram appropriate to each. The layout of the installation should be economical in cabling; alternative cabling schemes for use when circumstances favour them are shown on Dgm. Q(L) 151. The typical layout diagrams show cables to two or three multiple stations from each junction box, but overall economy can sometimes be obtained by fitting more junction boxes and serving fewer stations from each. The typical layout diagram for a H.E.S. No. 2 installation shows the use of an auxiliary junction box at the main station but, in some circumstances, for simple installations having not more than ten multiple stations or without a 2nd-choice main station, it may be more economical to dispense with the auxiliary junction box. An example of this would be where the most economical station layout provides for a spare terminal strip in the main station junction box to which the exchange lines and the cable to the transfer unit may then be connected. A layout without an auxiliary junction box is shown on Dgm. Q(L) 151.

TABLE 1.—MAIN ITEMS OF STATION EQUIPMENT FOR HOUSE EXCHANGE SYSTEMS NOS. 1 AND 2

Size of installation E =exchange line M =multiple stn. N =non-multiple extn.					Apparatus at each multiple station (M) (*see Notes 2 and 3*)			Telephone at non-multiple extension (N)	Additional apparatus			
Equipped for up to (*see Note 1*)			Cabled for (*see Note 1*)						Main station	2nd-choice main station		Jack No.... (one per unit at main and 2nd-choice stations)
E	M	N	E	M+N	Telephone, Intercom., No.... (one per station) C.B.	Telephone, Intercom., No.... (one per station) Automatic	Jack No.... (one per telephone)		Unit, Transfer, Intercom., No....	Unit, Transfer, Intercom., No....	Indicator No....	
1	5	–	1	5	1/1A	1/1AL	53	–	1	1	–	53
1	5	–	2	10	1/1A	1/1AL	54	–	1	1	–	53
1	10	–	2	10	1/2A	1/2AL	54	–	1	1	–	53
2	10	–	2	10	1/2A	1/2AL	54	–	2	2	–	53
1	4	1	1	5	1/1A	1/1AL	53	*See Notes 3 and 4*	1A	1	400K	53
1	4	1	2	10	1/1A	1/1AL	54		1 and 3	1	400K	53
1	9	1	2	10	1/2A	1/2AL	54		1 and 3	1	400K	53
2	9	1	2	10	1/2A	1/2AL	54		2 and 3	2	400K	53

NOTE 1:—M and M+N may be increased by one on all sizes of installation shown, by modification to the junction box wiring as described in par. 15.

NOTE 2:—See also par. 31 for the type of main station telephone on H.E.S. No. 2 installations where local stations are required to be able to call the main station when it is engaged on an exchange call.

NOTE 3:—See par. 32 for telephones to be used when a hearing-aid handset is required.

NOTE 4:—Standard C.B. or automatic telephone instruments should be used at the non-multiple extension in appropriate circumstances.

TABLE 2.—SIZES OF JUNCTION BOXES AND CABLES FOR HOUSE EXCHANGE SYSTEMS NOS. 1 AND 2

Size of installation E =exchange line M =multiple stn. N =non-multiple extn.					Boxes, Junction, Intercom., No....			Cable, P.V.C., No. 1...			Diagram showing typical layout of system (*see Note 2*)
Equipped for up to			Cabled for		For main station		For other positions (quantity as required)	Between junction boxes and to telephone jack	From main juctinon box to auxiliary junction box	From junction box to transfer unit jack	
E	M	N	E	M + N	Main box	Auxiliary box (*see Note 1*)					
1	5	–	1	5	1	–	1	24-wire	–	24-wire	Q(L) 111
1	5	–	2	10	2	1	2	41 ,,	24-wire	24 ,,	Q(L) 211
1	10	–	2	10	2	1	2	41 ,,	24 ,,	24 ,,	Q(L) 211
2	10	–	2	10	2	1	2	41 ,,	24 ,,	24 ,,	Q(L) 211
1	4	1	1	5	1	–	1	24 ,,	–	24 ,,	Q(L) 112
1	4	1	2	10	2	1	2	41 ,,	24-wire	24 ,,	Q(L) 212
1	9	1	2	10	2	1	2	41 ,,	24 ,,	24 ,,	Q(L) 212
2	9	1	2	10	2	1	2	41 ,,	24 ,,	24 ,,	Q(L) 212

NOTE 1:—In some circumstances, the auxiliary junction box may be omitted (see par. 6).

NOTE 2:—Dgm. Q(L) 151 shows alternative arrangements of junction boxes and cable (see par. 6).

7. Unsuitable situations.—Very damp or dusty situations are unsuitable for house exchange installations and applications for the system to be installed in premises where such conditions are likely to be prevalent are to be strongly discouraged. If damp conditions are found to exist during the installation of a system, the positions of junction boxes and jacks should be chosen to avoid them. To prevent moisture, which may condense on cable sheaths, running into the junction boxes and jacks, the cables should enter from below (see pars. 12 and 22).

8. Limits of distance between multiple stations.—The layout of the installation should be arranged so that the route length of the cable between any two stations does not exceed the limits for satisfactory signalling and transmission as specified in TRANSMISSION, Telephone, B 3567.

9. External multiple stations.—Where full intercommunication facilities are required at an external point, an external multiple station may be provided if:

(*a*) the route length of cable between the external and any internal multiple station does not exceed the limits for satisfactory signalling and transmission as specified in TRANSMISSION, Telephone, B 3567

(*b*) local conditions permit the use of external cable, either overhead or underground.

10. Non-multiple extension.—The running of the two-wire extension wiring to the non-multiple extension, whether internal or external, and the fitting of the telephone, should follow ordinary subscribers' installation practice. TRANSMISSION, Telephone, B 3567 gives details of the appropriate transmission and signalling limits.

11. Cabling of the system.—The cabling for internal multiple stations should be in accordance with standard practice, using Cable, P.V.C. No. 1, 24-wire or 41-wire, as indicated in Table 2. For external multiple stations the same type of cable will often be suitable, and in these cases the precautions described in INTERNAL WIRING, Stations, A 1018 regarding the use of plastic-covered cables externally must be strictly observed. Where these conditions cannot be adhered to a suitable external type cable should be used.

12. Fitting of junction boxes.—Junction boxes should be placed so that the cables can be fed into them from below (see par. 7). Normally the junction boxes should be screwed direct to a wall or other permanent mounting surface, using the screws provided with the boxes, and with the three rubber buttons, also provided, placed in the recesses underneath the base to act as cushions between the box and the mounting surface. Exceptionally, the boxes may be mounted on wallboards, e.g. if heavy condensation of moisture would occur inside the boxes if they were mounted in the normal manner, or if associated with the outlets of under-floor duct systems.

13. Clamping of cables in junction boxes.—Clamps are provided for holding the cables where they enter junction boxes. When it is necessary to terminate a cable of smaller diameter than can be held directly by the cable clamp (e.g. a 24-wire cable terminated on Box, Junction, Intercom., No. 2), the diameter of the cable should be increased where it enters the clamp by wrapping with Tape, Insulating, Adhesive. The bonding bar is not required on new installations for which Cable, P.V.C. has been used, but where lead cable exists it should be retained.

14. Wiring of junction boxes.—Dgms. Q(L) 113–115 and Q(L) 213–216 show junction box wiring for typical installations. The cable ends should be stripped, laced-out and terminated in the standard manner on the screw terminals at the back of the terminal strips. Exceptionally, where cables are brought in at the top of the junction box, the pairs should be formed-out in the reverse order to that shown on the diagrams quoted above. The wire-link connexions between the front terminals of the junction boxes should be made as required, using the lengths of Wire, Cadmium-copper, Tinned, 26 lb. provided with the boxes. Additional wire for these links may be obtained from the Supplies Dept. Covered-wire connexions are necessary where direct link connexions between terminals cannot be made, e.g. for the connexions between the multiple pair corresponding to any station and the 'home line' and 'ring' terminals on the instrument strip for that station. These connexions should be made with Wire, P.V.C., No. 1, 2-Wire, 6½ or equivalent.

15. Modifications to standard junction-box wiring.—*Installations with 'extra' station.*—It is possible to make use of the 'home station' local key on each multiple station telephone to serve a 6th station on H.E.S. No. 1 installations, or an 11th station on H.E.S. No. 2 installations by cross-connecting a certain pair of wires in the multiple cable to the local A and B wires corresponding to the 'home station' on each 'instrument strip' in the junction boxes throughout the installation. For example, on H.E.S. No. 1 installations local pair 4 (A and B wires) on the instrument strip for station 4 would be cross-connected to pair 6 (A and B wires) on the multiple, as shown on Dgm. Q(L) 113. When the facility of calling the main station while it is engaged on an exchange call is given to multiple stations, the 'home station' key of the main station cannot be used for an extra station as it must be used in answering a local call (to release the exchange-line key to the 'hold' position) because the number of the calling station may not be known. Installations with this facility cannot therefore be fitted with the additional station.

16. *Exchange service restricted.*—When it is desired to restrict the service of a station so that exchange calls cannot be originated from it, except at the discretion of the main station attendant, the D-wire terminal on the instrument strip of the station to be restricted should be cross-connected to the D1-wire, instead of to the D-wire of the multiple. The connexions to be made for different circumstances are shown in insets 'A' of Dgms. Q(L) 113, 114, 213 and 214.

17. *Exchange service prohibited.*—When it is desired to restrict a station to local calls only, the multiple C-, D- and D1-wires should not be linked to the instrument strip of the station to be restricted. Instead, the C-wire terminal on the instrument strip should be connected to the earth common, so that the telephone buzzer will operate whenever an exchange line key is pressed. The connexions to be made for different circumstances are shown in insets 'B' of Dgms. Q(L) 113, 114, 213 and 214.

18. *Installations with one exchange line and between 6 and 11 stations.*—These installations will be fitted with Telephones, Intercom., No. 1/2A or No. 1/2AL using the first exchange line key only. The C-wire of the second exchange line should be cross-connected to the earth common on the main-station junction box so that, whenever the second exchange line key is pressed at any station, the telephone buzzer will operate.

19. Labelling of terminal strips.—Labels No. 226... for Box, Junction, Intercom., No. 1 and Labels No. 227...for Box, Junction, Intercom., No. 2 should be obtained from the Supplies Dept. as required and the appropriate label fitted at the top of each terminal strip in the junction boxes. The labels should be secured by the upper fixing screws of the terminal strips. The glazed surface of the label should be removed with fine glass paper and the appropriate instrument and transfer unit numbers signwritten on the labels locally using an ink or ball-point pen. Stock labels are illustrated in Q 1002.

20. Numbering of stations.—The main station or the 1st-choice main station should normally be station No. 1. The non-multiple extension may be given any number in the scheme provided that the appropriate junction-box connexions are made. Typical connexions are shown on Dgms. Q(L) 115, 215 and 216 (see also par. 29).

21. Junction box covers.—When the positions of cables in the junction boxes have been decided, the knockouts covering the appropriate cable entry slots in the covers should be carefully broken out, using Pliers, Cutting, 5 in., square nose and the rough edges filed off with a File, Half-round, Smooth, 6 in. Only those entry slots to be used should be removed. Junction boxes may be reissued with not more than two unrepaired broken knockouts, and if these entry slots cannot be used they should be repaired with plugs (Part No. 1/SPL/392 for Cover No. 1 or Part No. 2/SPL/392 for Cover No. 2). Additional Parts Nos. 1/SPL/392 or 2/SPL/392 may be obtained from the Factories Dept., Bilton Way, Enfield, Middx. on form A 1093.

22. Fitting of jacks.—The position of the jacks will be determined by those of their associated telephones or transfer units and the two should be considered together so that they will be within the range of the standard 6 ft. cords fitted to the units and telephones. Normally, the jacks should be mounted direct on walls or similar permanent surfaces, but not on floors. Jacks should be placed so that the cables can be led into them from below (see par. 7). Where the jacks have unavoidably to be located on damp walls, they should be mounted on baseplates (Part No. 1/SBA/4) screwed to the wall. The 4BA screws provided should be used for fixing the jack to the baseplate. The jacks should be fitted so that they, or the plugs fitted to them, are not likely to be struck by cleaners' brooms nor so that the telephone or unit cord can trail on the floor. Where a wall or similar fixing is impossible, e.g. at a desk remote from the wall, the jacks may be fixed to the floor, using Tablets, Polished, Hardwood, No. 2 in positions giving maximum protection from damage. The positions chosen for fixing the jacks should allow sufficient space for the plugs to be fitted and removed without difficulty. The cable may be led into the jack at any one of three positions, as indicated on Dgm. Q(L) 204. The knockout should be carefully broken away from the cable-entry slot and any rough edges filed off. Jacks reissued after repair will be accompanied by sufficient plugs (Part No. 1/SPL/391) to repair the previously used entry slots. The plugs will be wrapped with the fixing screws and should be fitted as required. Additional Parts No. 1/SPL/391 may be obtained from the Factories Dept., Bilton Way, Enfield, Middx. on form A 1093.

23. Wiring of jacks.—Diagrams Q(L) 102–104 and Q(L) 202–205 show the cable connexions to the jacks. The connexions must he soldered to the jack-spring tags.

24. Fitting Units, Transfer, Intercom.—Units, Transfer, Intercom., Nos. 1 and 2 as supplied from stock are suitable for use at main stations and 2nd-choice main stations on installations with multiple stations only. For use at all 1st-choice main stations and at 2nd-choice main stations on installations with a non-multiple extension, the units should be modified locally as described in pars. 25 and 26. Illustrations of the face equipment of units as supplied, and as modified, are given in Figs. 1–4 and the figures appropriate to different installations are given in Table 3. The units required for these installations are given in Table 1. The unit(s) will normally stand on a table or desk, adjacent to the main station telephone. Units should not be placed where the cords are likely to come into contact with a damp wall.

TABLE 3

Installation (*see Table 1*)					Face equipment of Units, Transfer, Intercom.		
Equipped for			Cabled for		At main station (without 2nd-choice main station)	At 1st-choice main station	At 2nd-choice main station
E	M	N	E	M + N			
1	5	–	1	5	Fig. 1A	Fig. 1B	Fig. 1A
1	5	–	2	10	,, 1A	,, 1B	,, 1A
1	10	–	2	10	,, 1A	,, 1B	,, 1A
2	10	–	2	10	,, 3A	,, 3B	,, 3A
1	4	1	1	5	,, 2A	,, 2B	,, 1C
1	4	1	2	10	Figs. 1A and 4A	Figs. 1A and 4B	,, 1C
1	9	1	2	10	,, 1A and 4A	,, 1B and 4B	,, 1C
2	9	1	2	10	,, 3A and 4A	,, 3B and 4B	,, 3C

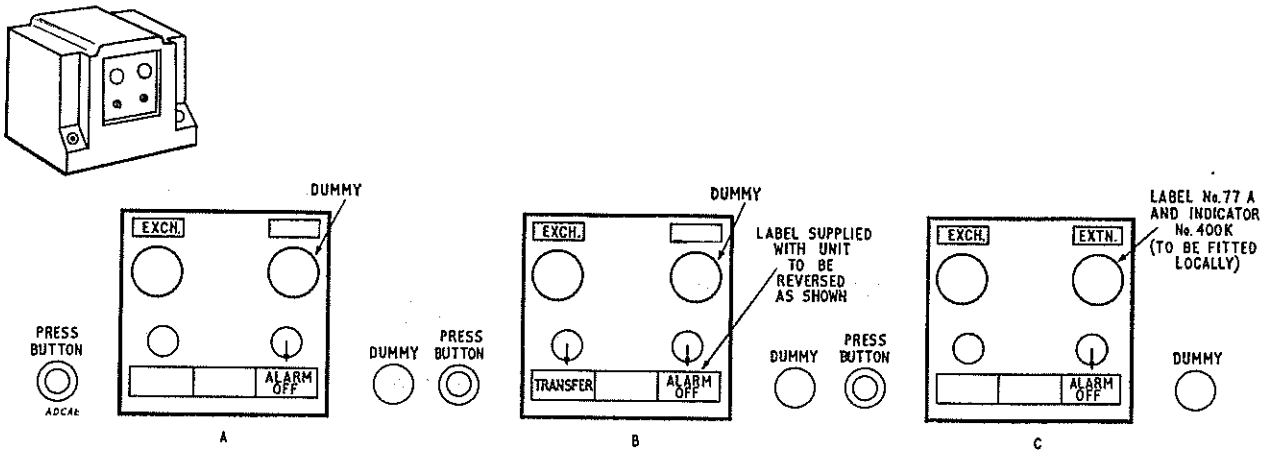

FIG. 1.—UNIT, TRANSFER, INTERCOM., NO. 1 [SEE ALSO DGM. Q(L) 153]

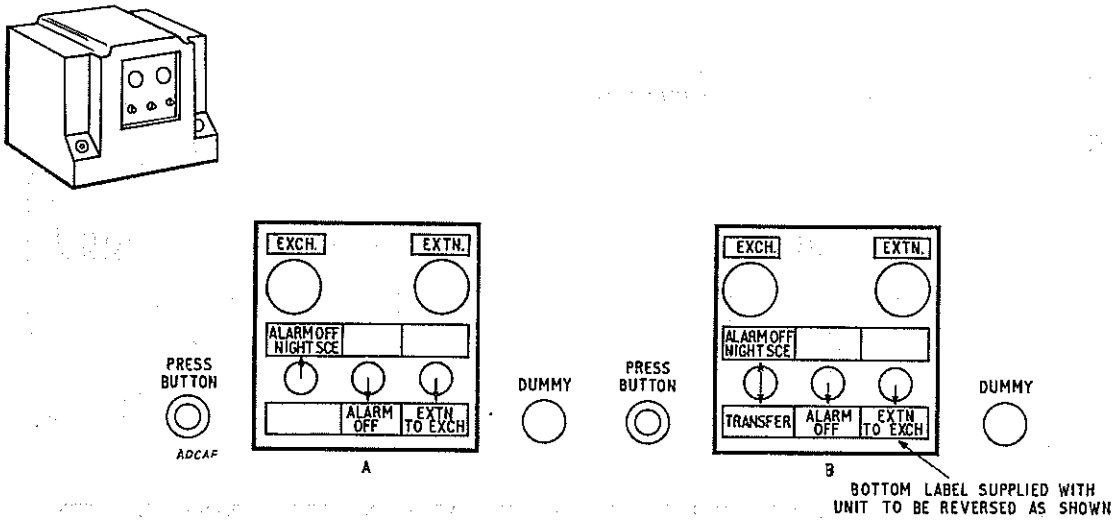

FIG. 2.—UNIT, TRANSFER, INTERCOM., NO. 1A [SEE ALSO DGM. Q(L) 154]

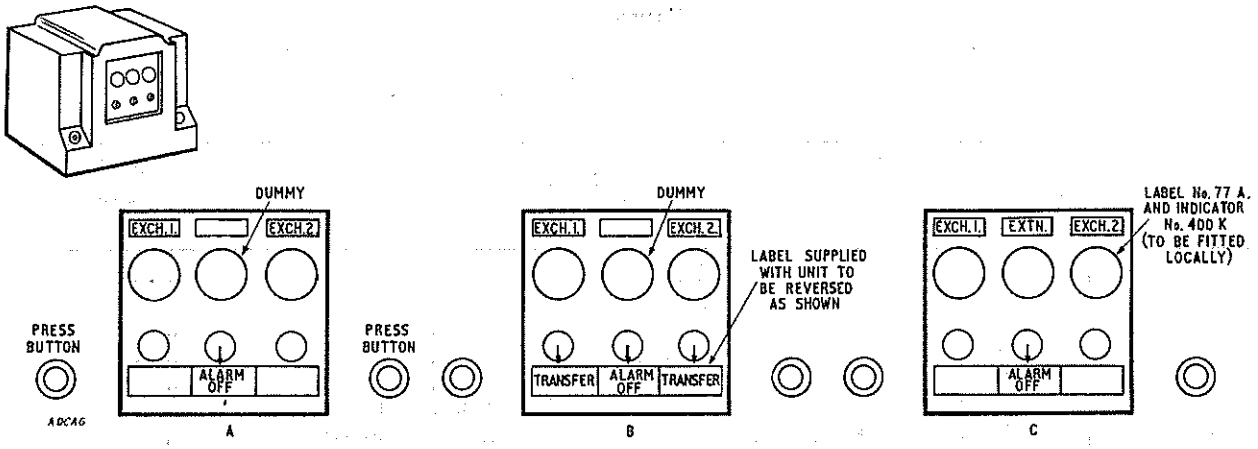

FIG. 3.—UNIT, TRANSFER, INTERCOM., NO. 2 [SEE ALSO DGM. Q(L) 155]

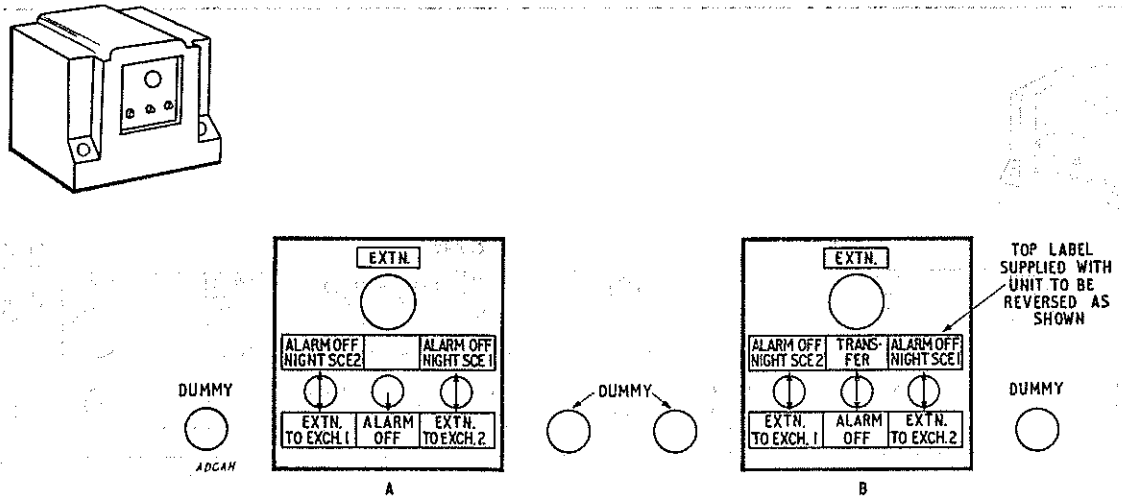

FIG. 4.—UNIT, TRANSFER, INTERCOM., NO. 3 [SEE ALSO DGM. Q(L) 156A]

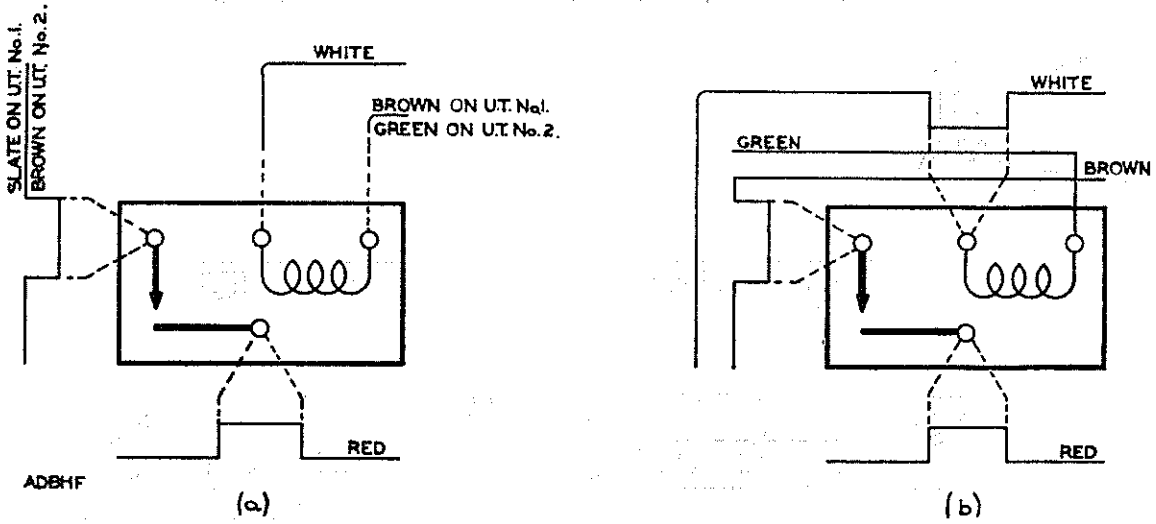

FIG. 5.—METHOD OF CONNECTING ADDITIONAL INDICATOR ON UNITS, TRANSFER, INTERCOM., NOS. 1 AND 2

25. Modification to 1st-choice main station units.—On installations with a 2nd-choice main station, certain modifications must be made to the 1st-choice main station units. Straps on the terminal block inside the unit, between terminals as detailed in Table 4, must be removed to enable the exchange lines to be extended to the 2nd-choice main station when the appropriate keys are operated. The terminals are on the upper portion of the terminal block to which the instrument cord is connected. Details of the terminal blocks are shown in dgms. Q(L) 142–143 and Q(L) 242–243.

TABLE 4

Unit, Transfer, Intercom., No....	Straps to be removed at 1st-choice main station
1	T1, T2, T3, T4
1A	T1, T2, T3, T4, T5
2	Exch. 1:— T1, T2, T3, T4
3	Exch. 2:— T1, T2, T3, T4
	T1

To obtain access to the terminal block, the cover of the unit should be removed after loosening the four fixing screws at the sides. The cover may be most easily removed if lifted vertically until it clears the cord gland at the back, when it may then be moved forward to clear the key handles on the front panel. In addition to the removal of the straps, certain of the lever key labels on the 1st-choice main station unit should be reversed, as indicated in detail B of Figs. 1–4. These labels are engraved on both sides, the reverse showing the appropriate TRANSFER key designation.

26. Modification to 2nd-choice main station units.—On installations with a non-multiple extension and a 2nd-choice main station, the transfer unit at the latter must be modified, as indicated in detail C of Figs. 1 and 3, by fitting locally an Indicator No. 400K (without plate) and a Label No. 77A in place of the indicator dummy and Label No. 77 with which the unit is supplied. The indicator and label should be requisitioned separately, as required. Spare wires to enable the indicator to be connected in circuit are provided in the cable forms of Units, Transfer, Intercom., Nos. 1 and 2. The colours of the wires to be used for connecting the indicator in all new units and in old ones rewired on repair are shown in Fig. 5(*a*). For old units containing the original wiring Fig. 5(*b*) applies.

27. Visual exchange-line-engaged signal at main stations.—This facility is optional on the Mk. II pattern of Units, Transfer, Intercom., Nos. 1, 1A and 2 and should only be provided when required by the subscriber. If the subscriber desires the facility, it may be provided by connecting the wire from relay contact G3 to the 500-ohm resistor (YA in Unit, Transfer, Intercom., No. 1; YC in Unit, Transfer, Intercom., No. 1A or YA; YB in Unit, Transfer, Intercom., No. 2) so that the indicator is operated when relay G operates. The wire is left disconnected at the tag of the resistor but is of sufficient length to enable it to be connected if the visual engaged signal is required.

28. Fitting Telephones, Intercom.—Telephones, Intercom. as supplied from stock are suitable for installation without modification on house exchange multiple stations in manual and automatic exchange areas. At stations requiring certain special facilities the telephones must be modified locally, as described in pars. 30 and 31. The labels for the dial, or dummy dial, must be obtained in accordance with A 3202. Labels for local keys should be obtained as instructed in par. 29.

29. Labels No. 222....—These are local station designation labels for Telephones, Intercom., Nos. 1/1... and 1/2..., details and illustrations of which are given on Dgm. Q(L) 110. One label per multiple station on H.E.S. No. 1 and two per multiple station on H.E.S. No. 2 installations should be ordered from the Supplies Dept. Labels No. 222... which are not shown on Dgm. Q(L) 110 and are required for special installations should be prepared by the Area Drawing Office using the blank Label No. 222A, B or E.

The labels are fitted by inserting each into the appropriate slot in the top edge of the sloping key panel of the telephone. They may be withdrawn by first moving them forward with the point of a pin inserted into the small slot provided for the purpose above the label window.

30. Modifications to Telephones, Intercom.—*To allow exchange-line monitoring or trunk-offering.*—At a station which is to have the facility of trunk-offering or of monitoring on exchange calls, alterations must be made to certain strap connexions between terminals on the main terminal block in the Telephone, Intercom. Dgms. Q(L) 131 and Q(L) 231 show the connexions to the terminal block of a Telephone, Intercom., No. 1/1A and No. 1/2A respectively. To give the monitoring and trunk-offering facility, the strap must be removed from terminals 1 and 2 (at the top of the block) and connected between terminals 2 and 3. The right-hand group of three terminals is associated with exchange line No. 1 and the left-hand group with exchange line No. 2. The right-hand group of terminals only is fitted in Telephone, Intercom., No. 1/1A.

31. *To allow a multiple station to call the main station when it is engaged on an exchange call.*—This facility can only be provided when the total number of stations does not exceed five on H.E.S. No. 1 installations and ten on H.E.S. No. 2 installations.

The strap on the main station Telephone, Intercom., terminal block between terminals CM1 and CM2 must be removed and connected between terminals CM2 and CM3. The CM terminals are situated at the lower right-hand side of the terminal block. A further strap between the R and B tags of the main station internal circuit must be provided to enable the main station to answer the internal call. In earlier issues of these instruments, this facility involved special adjustment of the telephone buzzer and the provision of a secondary cell power supply to the installation to limit the voltage range. The later type of Telephone, Intercom. includes a resistor (YC) in the buzzer circuit which makes the special power supply and buzzer adjustment unnecessary. Where the facility is required on an existing installation fitted with the earlier type of Telephone, Intercom. at the main station, the telephone should be changed.

32. Telephones with hearing-aid handsets.—To provide this facility at multiple stations and non-multiple extensions, Handsets No. 4 should be fitted. Dgm. Q(L) 135 shows the method of connexion at a multiple station; particular attention should be paid to the note which refers to non-release of operated buttons. Dgm. N 1840 shows the connexions for a non-multiple extension fitted with a 700-type telephone instrument. If a hearing-aid handset is required at an existing non-multiple extension which has a 200-type or 300-type telephone, this should be changed for the 700-type equivalent.

33. Adjustment of Buzzer No. 21.—If the power supply to the system is in accordance with POWER, General, S 1010, with an effective earth, and the cable resistances between the stations are within the limits specified in TRANSMISSION, Telephone, B 3567, the Buzzer No. 21 on Telephones, Intercom. should operate satisfactorily without readjustment on installation. If the buzzer does not operate satisfactorily and the circuit and power supply are found to be correct, then the buzzer should be readjusted in accordance with Q 5001.

At any multiple station instrument, the buzzer can be operated by depressing the key of another station which is engaging an exchange line.

If, at the subscriber's request, it is required to reduce the loudness of the buzzer below the minimum obtained by the previous adjustment, the most satisfactory methods of achieving this are by:—

(*a*) affixing a small disk of chamois leather to the outer coil pole-face of the buzzer, or

(*b*) inserting a soft rubber pad (Part No. 1/SPA/3) between the buzzer and the plug cover.

Either, or both, of these methods may be used depending upon the local situation of the buzzer and the degree of quietening required. The chamois leather disk should be affixed to the pole-face with 'Bostik' adhesive. To fit the rubber pad beneath the buzzer, the bolts holding the buzzer are removed and the pad is inserted between the buzzer and the plug cover; the pad is cut so that it can be fitted without disconnecting any of the buzzer wiring. Two $\frac{5}{8}$ in. 5BA bolts should be used to refix the buzzer. The loudness of the buzzer can be altered within a limited range by tightening the screws and so compressing the rubber; two 5BA locknuts should then be fitted to the bolts on the inside of the jack to ensure that the bolts do not work loose. Before replacing the cover an ebonite washer (Part No. 34/SWA/2) should be fitted over each of the cover-fixing screws; these washers will allow the cover to be screwed down firmly without unduly compressing the pad.

34. Bells in lieu of buzzers at main and multiple station telephones.—These cannot be provided, but the alternative of an extension bell fitted adjacent to the telephone plug may be allowed (see par. 36). The buzzer must remain operative so that the buzzer tone will be transmitted to other stations when exchange calls are being transferred. If required, the buzzer tone may be reduced, as described in par. 33.

35. Cords of non-standard length.—Telephones, Intercom., and Units, Transfer, Intercom., are issued fitted with instrument cords of standard length, i.e. 72 in., and the position of the house exchange stations should be chosen so as to avoid demands for cords of other lengths. Exceptionally, cords 120 in. or 180 in. long, which are available on requisition, may be provided in lieu of the standard length.

36. Extension and loud-sounding bells, hooters and lamp signals at main and multiple stations.—

(*a*) *Extension bells.*—Bells No. 56C, with the bell-coils connected in parallel, should normally be used as extension bells from Telephones, Intercom. and from main-station transfer units. The points of connexion for extension bells are shown on Dgms. Q(L) 102–104 and Q(L) 202–205. One extension bell only is permissible from a multiple station telephone buzzer but, from a main-station transfer unit, extension bells may be connected in parallel up to a maximum of five.

On installations with a Unit, Transfer, Intercom., No. 2 for two exchange lines, one extension bell circuit is common on both lines, and on installations with a Unit, Transfer, Intercom., No. 1A the exchange line and the non-multiple extension line have a common extension bell circuit. At installations with a Unit, Transfer, Intercom., No. 3, a separate extension bell circuit is available for the non-multiple extension and bells connected to it should be fitted with gongs of a different tone from those of the exchange line bells, where these are also provided.

(*b*) *Loud-sounding bells.*—

(i) *Continuous-ringing trembler bells* manually restored may be indirectly operated from multiple-station telephones or main-station transfer units as follows:—

Low-voltage bells may be operated from an Indicator No. 4001AN (Dgm. N 609) connected, using terminals 1 and 2 of the indicator, to the normal extension bell points of the telephone or unit jack. The types of bells and local circuits used should be in accordance with A 3113. For high-voltage bells, e.g. Bell No. 61... or Bell No. 62..., Relay-switch No. 3106L $\frac{1-15}{AW}$ should be connected in place of the Indicator No. 4001AN. Neither of these arrangements should be used at a main station where the calling-in facility (see par. 31) is given, owing to the liability of the indicator or relay-switch to 'hold-in'.

When Relay-switch No. 3106L $\frac{1-15}{AW}$ is being used in conjunction with a Telephone, Intercom., No. 1/1A or No. 1/2A on an installation where the distance between stations on the system is near the maximum allowed (see par. 8), it may be necessary to short-circuit resistor YB (No. 1/1A)or YC (No. 1/2A) in the telephone to obtain sufficient current for the relay-switch. Only one indicator or relay-switch may be connected.

(ii) *Discontinuous-ringing trembler bells*, when required to operate from multiple-station telephones and main-station transfer units, should be directly connected as described in (*a*) using a Bell No. 48A. When operated from a transfer unit, the current in each bell should be limited to 50 mA (measured with the armature held unoperated), by including a suitable resistor in series with the bell; a maximum of five Bells No. 48A may then be connected in parallel to each extension bell circuit.

(*c*) *Hooters and lamp signals.*—Continuously-operated, manually restored hooters or lamp signals may be operated from the local circuit of an Indicator No. 4001AN or Relay-switch No. 3106L $\frac{1-15}{AW}$ connected as described in (*b*) (i) on multiple-station telephones and main-station transfer units. Only one indicator or relay-switch may be connected.

37. Extension and loud-sounding bells, hooters and lamp signals at non-multiple extensions.—The operation of additional ringing equipment may be unreliable, due to the limited power available from the relay BZ of the main-station transfer unit, when working at the lower end of tbe voltage range of 18–28V. For satisfactory operation a Converter, Ringing, No. 10A or No. 7, with the necessary modifications to the Unit, Transfer, Intercom., No. 1A or No. 3, can be provided as detailed in Works Specn. S 2055.

(*a*) *Magneto bells*—A Bell No. 64... or No. 59A should normally be used as an extension bell; loud-sounding magneto bells cannot be satisfactorily operated and should not be provided.

(*b*) *Loud-sounding trembler bells (low voltage).*—Continuous-ringing bells should be connected as shown in Dgm. N 1288, Fig. 1.

(*c*) *Hooters, lamp signals and loud-sounding bells (mains operated).*—These items should be connected as indicated in Dgm. Q(L) 199.

38. Association with a P.B.X.—As indicated in Q 1001, a house exchange system may be associated with a P.B.X. by one of the following methods:—

(*a*) By terminating one or two extensions from the P.B.X. in place of exchange lines on a normal house exchange installation (see par. 39).

(*b*) By terminating a non-multiple extension from a house exchange system as an exchange line on a P.B.X. (see par. 40).

(*c*) By a special installation whereby each house exchange multiple station has an individual line to the P.B.X., connected as an exchange line at the house exchange station and as an extension at the P.B.X. Explanatory details of this arrangement are shown in Dgm. Q(L) 208.

39. *Connexion to a P.BX. in the manner of par. 38(a).*—The house exchange system should be installed in the normal manner; standard practice for the particular type of P.B.X. concerned should be followed to determine the transmission and signalling limits for the complete installation and whether or not auxiliary apparatus units will be needed in the connecting circuits. The house exchange station most distant from the point of connexion of the lines from the P.B.X. should be considered as the P.B.X. extension station for the purpose of determining the appropriate limits. If the house exchange system is to have a non-multiple extension, the normal transmission and signalling limits are reduced by 50 ohms for connexions via the P.B.X., including that station, and considerations similar to those for connecting an Extension Plan 7 to a P.B.X. will apply as indicated in P.B.X.s, B 3001. When working to a C.B.S. cordless P.B.X., a Unit, Auxiliary Apparatus, CBS 536 (Dgm. CBS 536) per circuit will be required either at the house exchange end or at the P.B.X. end of the circuit, whichever is the more suitable from the point of view of power supply to the unit.

40. *Connexion to a P.B.X. in the manner of par. 30(b).*—The house exchange system should be installed in the normal manner as for an installation with a non-multiple extension but with the non-multiple extension line terminated on the P.B.X. Where the combined resistance of the line from the house exchange system and of the longest extension on the P.B.X. does not exceed the 'non-multiple to

main station signalling resistance' limits given in TRANSMISSION, Telephone, B 3567, the house exchange extension may be terminated direct on a normal exchange line equipment at the P.B.X. on Switchboards, CBS 364, CBS 484, CBS N 934 and CB 935 except that, where the exchange line indicator is an Indicator No. 3700A or No. 4000A, it may be necessary to change it for the more sensitive Indicator No. 2200A. For long lines connected to these switchboards and for any lines (up to the maximum resistance given in TRANSMISSION, Telephone, B 3567 for the non-multiple extension alone) connected to switchboards of other types, the terminations should be in accordance with Table 5. Extension of exchange calls over these connecting circuits is not normally allowed (see Q 1001), and Key-stops No. 1 should be fitted as necessary on the Unit, Transfer, Intercom., No. 1A or No. 3 at the house exchange system to prevent the movement of the relevant keys to the EXTN. to EXCH. position. Omission of the key-stops will enable limited extension of exchange calls to be given as described in Q 1001.

41. Connecting circuits between two house exchange systems.—Two house exchange systems may be interconnected by terminating a non-multiple extension of one system, designated system A, as an exchange line on the other system, designated system B. Applications for system B to work auxiliary to system A in one installation are discouraged because of traffic and operating difficulties. Where the two systems are independent, the arrangement may be provided if the combined resistance of the non-multiple extension from system A and the most distant station from the main station of system B does not exceed the 'non-multiple to main station signalling resistance' limits given in TRANSMISSION, Telephone, B 3567. The extension of exchange calls over the interconnecting circuit is not normally allowed, and Key-stops No. 1 should be fitted as necessary on the Unit, Transfer, Intercom., No. 1A or No. 3 at system A to prevent the movement of the relevant keys to the EXTN. TO EXCH. position. Omission of the key-stops will enable limited extension of exchange calls to be given as described in Q 1001.

42. Power supply.—The power supply to the system should be provided in accordance with POWER, General, S 1010. When the power supply is a direct power lead, two 4-μF capacitors (connected in parallel between power lead and earth) are required for smoothing. On installations fitted with Units, Transfer, Intercom., No. 1A a Capacitor, M.C., No. 103 2/2 (8-μF) should be fitted adjacent to the power-lead protector or in any other convenient position. On installations fitted with Unit, Transfer, Intercom., No. 1 or No. 2, two 4-μF capacitors may conveniently be placed inside the unit and connected to tags 13 and 15 on the unit terminal block, or alternatively a Capacitor, M.C., No. 103 2/2 can be used. Smoothing capacitors are not required on any installation where the power supply is derived from a battery of cells. When a Battery-unit N 634 and a Rectifier No. 33B are used, the alarm bell in the Unit, Transfer, Intercom., No. 1 or No. 2 may be used as a power fail alarm in conjunction with a Lamp, Alarm-indicating, No. 4 as indicated on Dgm. N 2304.

43. Earth.—An earth connexion to the system should be provided in association with the power supply in accordance with POWER, General, S 1010, except where primary cells are used, when an earth connexion, in accordance with PROTECTION, General, S 3901 should be provided to the system independently.

TABLE 5

Switchboard	Termination Dgm.	Remarks
CBS 364	N 987	—
CBS 484	N 988	—
CBS N 934	N 988	—
CB 935	N 742	—
CB 873	N 714	—
AT 3796	N 724	—
Sections, Switch, B.E., C.B., Multiple, No. 9 with Indicators No. 22B	N 985 (Figs. 4c and 5)	Note 10 of Dgm. N 985 applies. A and B reversal not required
Ditto with Indicators No. 3100A2	N 985 (Figs. 4c and 6)	Note 10 of Dgm. N 985 applies. A and B reversal not required
Sections, Switch, B.E., C.B., No. 10	SA 7309 (Figs. 1, 3c and 5)	Note 4(*b*) of Dgm. SA 7309 applies. A and B reversal not required
Section, Switch, P.M.B.X., No. 1A and S.A. 7560	SA 7518	Connect straps to Item 6 of Table 2 on Dgm. SA 7518. A and B reversal not required
P.A.B.X.	—	Refer to Eng. Dept. (S3)

44. Testing.—Each new installation, when completed, should be tested as indicated in pars. 45 to 47.

45. *Insulation resistance.*—The wiring should be tested for insulation with a 250V ohmmeter. Before testing is commenced, all telephone and transfer unit jacks should be connected to the cable ends and all necessary cross-connexions made in the junction boxes. The telephones and transfer units should not be plugged into the jacks, and the battery and earth, the exchange lines and non-multiple extension line should be disconnected at the protectors or their equivalents. Also the straps between the A- and B-wires of the battery and earth pairs on the main-station junction box should be temporarily disconnected. Battery is connected to terminals 7 and 8 and earth to terminals 9 and 10 on H.E.S. No. 1 installations, and on H.E.S. No. 2 installations battery is connected to terminals 13 and 14 and earth to terminals 15 and 16. The tests should be made from the multiple strip of 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. The pairs should then be bunched and tested to earth. The insulation resistance measured on each test should be not less than 2 megohms. On installations with a main-station auxiliary junction box, the wires connected to terminals 19–30 of this box must be tested separately. Where a 2nd-choice main station at a H.E.S. No. 1 installation is provided but without the provision of an auxiliary junction box, a separate test should be made on terminals 23–30 of the main-station unit strip connexion in the main-station junction box.

46. *Continuity.*—The wiring should be tested for continuity at each junction box, using a dry cell and Detector No. 4, or other suitable tester.

47. *Tests for correct operation.*—The installation should be tested for correct operation as follows:—

(*a*) A call to the exchange on each exchange line from each station.

(*b*) A local call from each station to every other station on the system.

(*c*) A conference call from each station to all other stations on the system.

Details of the full operating procedure are given in Q 1003.

48. Records.—Before the completed installation is handed over to the maintenance staff a cardboard-mounted chart should be prepared, preferably in the Area Drawing Office, showing the cable routes, location of junction boxes, transfer units, stations, extension bells (if any) and power supply. The chart should refer to floor and room numbers or other means of locating the principal items of the installation; it may also show the equipment fitted. A convenient size for the chart is 8 in. $\times 6\frac{1}{2}$ in. so that it can be housed in the back of the transfer unit at the main station. Care should be taken to record any removals or changes in the installation on the chart.

49. Instruction booklet for subscribers.—A booklet of instructions A 1366 (see Q 3902) on 'How to use the House Exchange System' should be left with the subscriber for his use.

References:—A 3113, A 3202, Q 1001, Q 1002, Q 1003, Q 3902, Q 5001
(S1) P.B.X.s, B 3001
INTERNAL WIRING, Stations, A 1018
POWER, General, S 1010
PROTECTION, General, S 3901
TRANSMISSION, Telephone, B 3567

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