HOUSE EXCHANGE SYSTEM

Maintenance

★[*NOTE:—As this Instruction has been completely revised, individual paragraphs have not been " starred "*]

1. Scope of Instruction.—This Instruction gives details of maintenance information and adjustments for the House Exchange System. Apparatus other than that special to the House Exchange System is not dealt with, unless its use in the system calls for special comment.

Related Instructions giving a description of the system, apparatus and operating procedure are Q 1001, Q 1002 and Q 1003. Installation details are given in Q 3001.

Fig. 1 shows a " Unit, Transfer, Intercom., No. 1A (Mk. I) " with the cover removed, and the relay mounting swung out for adjustment purposes.

Fig. 2 shows a " Unit, Transfer, Intercom., No. 1A (Mk. II) ". The supporting bar is shown swung out for illustration only.

Fig. 3 shows a " Telephone, Intercom., No. 1/2A " with the cover removed.

Fig. 4 shows a " Telephone, Intercom., No. 1/2A " with cover and key assembly removed.

Fig. 5 shows a key assembly for a " Telephone, Intercom., No. 1/2 ".

Fig. 6 shows the key plate removed from the key assembly.

2. General.—Experience has shown that the facilities of this system are not always fully appreciated by both subscribers and maintenance officers. Supervising officers therefore should ensure that members of their staff who will be required to maintain house exchange systems should have had a training course on them. Both the facilities and circuit arrangements of this system differ from the ordinary run of subscribers' apparatus, but faults are easily dealt with if the system is clearly undertsood. When visiting a subscriber's installation, opportunity should be taken to see that the booklet " How to use the House Exchange System " is available to the subscriber. Additional copies should be obtained from the Installation Control or the fitting staff, if required.

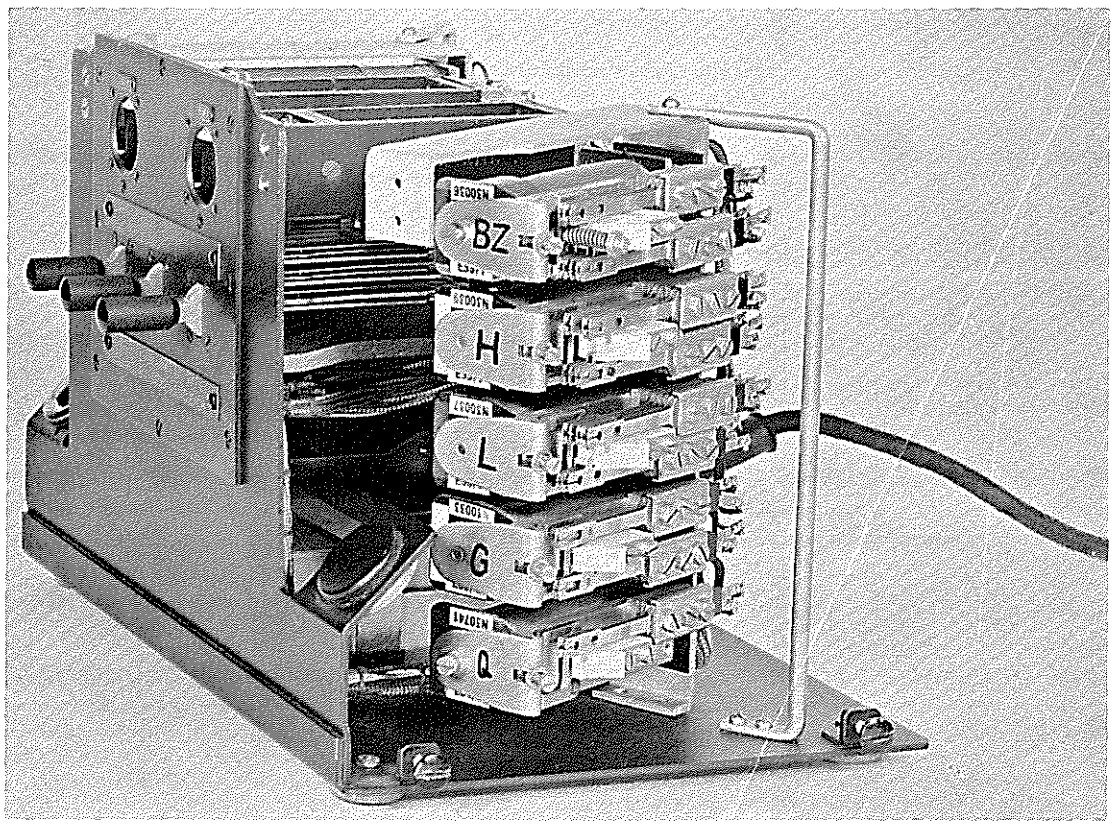


FIG. 1.—UNIT, TRANSFER NO. 1A (MK. I), SHOWING METHOD OF ACCESS TO RELAYS FOR ADJUSTMENTS

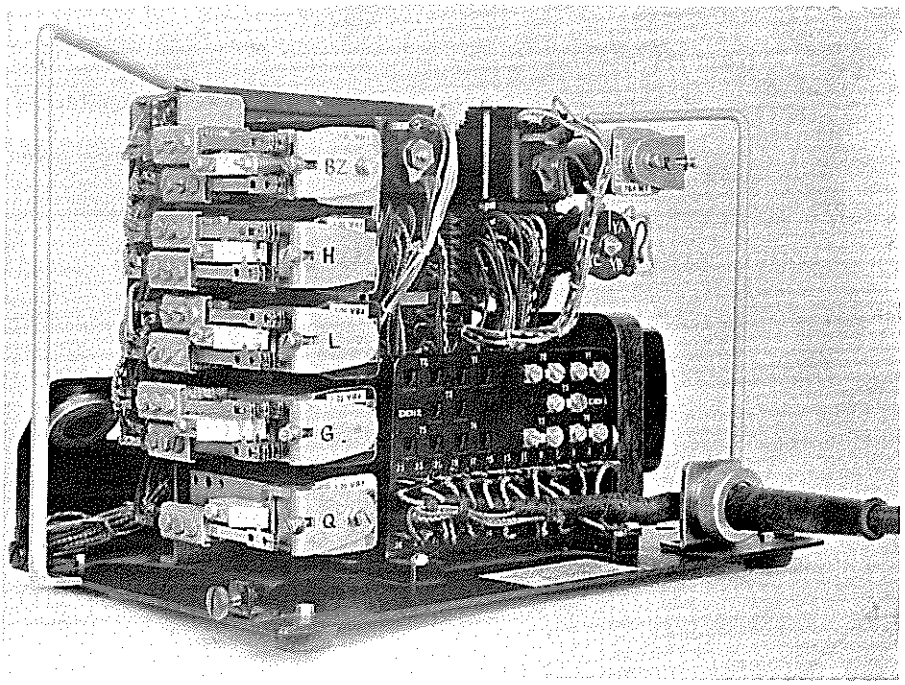


FIG. 2.—UNIT, TRANSFER, INTERCOM., NO. 1A (MK. II), BACK VIEW (THE RELAY GUARD SWUNG OUT FOR ILLUSTRATION ONLY)

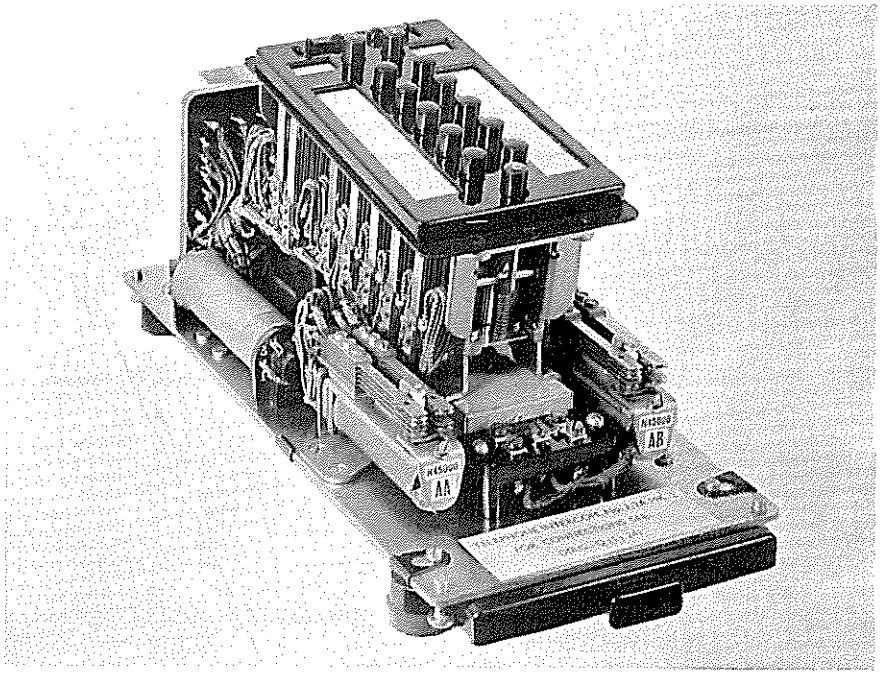


FIG. 3.—TELEPHONE, INTERCOM., NO. 1/2A, WITH COVER REMOVED

The majority of faults reported prove to be due to dirty contacts. These faults are fairly simple to locate and clear if the faultsman has a good working knowledge of the system. When an installation is visited he should ascertain if there are any other faults existing in addition to the one necessitating the visit. If so, they should be cleared and reported to the Maintenance Control.

3. Work to be done at subscribers' premises. Where possible, all work should be done at subscribers' premises. Where this is impracticable, the faulty apparatus should be jacked-out and repaired at a suitable local centre; the spare equipment (see par. 4) should be used to replace the faulty equipment while it is being repaired. Alternatively, if a "Telephone, Intercom., No. ...." is faulty, it may be possible to jack-in an instrument from another multiple extension of which little use is made, while the fault is being cleared. If cabling or re-terminating is required, it may be necessary to arrange for the work to be done at a time convenient to the subscriber.

4. Provision of spare equipment.—When it is necessary to remove a telephone or transfer unit for maintenance reasons, there should be a spare item available so that the subscriber's service is not interrupted. Spares for this purpose should be held at a convenient stores point. The Area can, if necessary, be split into several localities for this purpose and when suitable locations (e.g. Section or Normal Stocks) have been fixed, the spare apparatus to be held in each locality should be calculated on the following basis:—

Telephones, Intercom., No. 1/1	At least one of each: then 1 per 100 working telephones in the locality
,, ,, No. 1/2A	
Unit, Transfer, Intercom., No. 1	One
,, ,, ,, No. 1A	,,
,, ,, ,, No. 2	,,
,, ,, ,, No. 3	,,

Other spare components (e.g. "Jack, No. 54") may be held as required.

5. Access to telephone, etc.—

(*a*) The telephone case is removed by unscrewing the four captive screws in the metal base of the telephone.

(*b*) Where a dust shield is fitted the exposed part should be wiped to remove dust before further dismantling. Fig. 4 shows the position of the screws holding the key-plate to the key assembly, and those holding the key assembly to the telephone.

(*c*) The key-plate is removed by withdrawing the three screws marked "A" in Fig. 4. If a dust shield is fitted, it may then be removed by lifting the

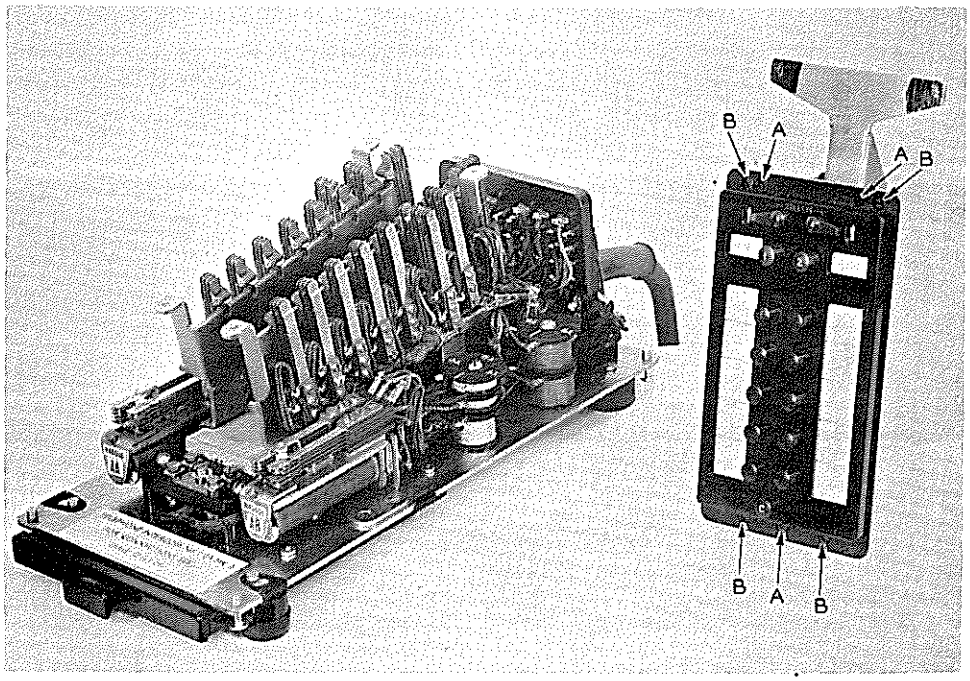


FIG. 4.—TELEPHONE, INTERCOM., NO. 1/2A, WITH COVER AND KEY ASSEMBLY REMOVED

edges, pulling it taut and lifting clear of the buttons, etc. The key assembly may then be removed by withdrawing the four screws marked " B ". It is possible to remove the key-plate, key assembly and dust shield (if fitted) complete, by withdrawing the four screws marked " B ". Care should be taken that the screws "A" and " B " are not lost.

(*d*) Access to the buzzer is obtained by loosening the two captive screws which hold the buzzer cover to the cover of the " Plug No. 4001 ".

(*e*) Access to the transfer units is obtained by looscning the four screws in the base, and removing the cover. The relay mounting may then be swung out sideways for relay adjustment, screws in the front pancl first being withdrawn.

7. Method of fitting dust shields.—It is unnecessary to remove the key mechanism to fit a dust shield. The procedure is as follows:—

(*a*) Remove the cover from the telephone and clean all loose dust from the mechanism, using a "Brush, Cleaning " and a duster.

(*b*) Remove the key-plate. See par. 5.

(*c*) Remove all dust adhering to the sides of the key plungers, etc., and to the metal key-plate. *It is important to ensure that all dust is removed before the dust shield is fitted.*

(*d*) Hold the dust shield by the top and bottom so that it is taut, and lower the shield carefully over

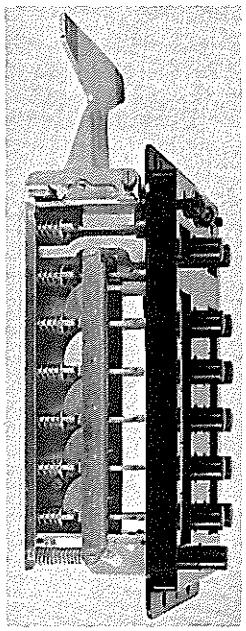


FIG. 5.—KEY ASSEMBLY FOR TELEPHONE, INTERCOM., NO. 1/2

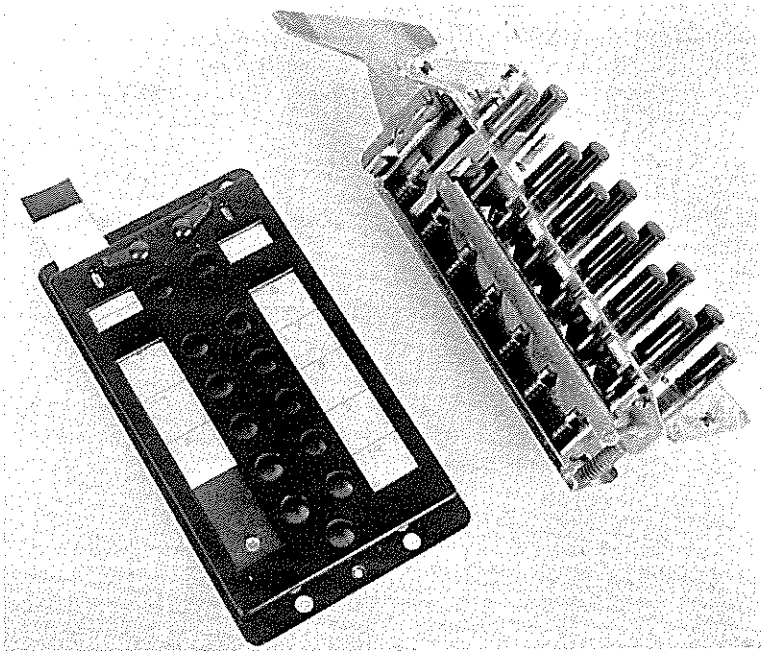


FIG. 6.—KEY PLATE REMOVED FROM KEY ASSEMBLY (ALSO SHOWS REMOVAL OF " LABEL No. 222 "

6. Dust shields.—Dust shields are to be used on existing installations only when the presence of dust causes undue maintenance difficulty. The decision to fit dust shields on some or all telephones of an installation should be taken locally in light of the particular conditions, incidence of faults, etc.

The Rate Book descriptions of the shields are:—

" Dust-shield D1/90044 " (for use on " Telephone, Intercom., No. 1/1 ")

" Dust-shield D2/90044 " (for use on " Telephone, Intercom., No. 1/2 ")

They are made of black varnished cloth and have holes punched in them so that they may be fitted over the key assembly.

NOTE:—" Dust-shield D2/90044 " *must not be used* on " Telephone, Intercom., No. 1/1.... "

the keys; then press the shield into position flat on the key-plate. A small screwdriver (" Screwdriver, Inst., No. 1 ") will be found useful to make the shield lie quite flat. The holes and slots in the shield are cut to be a close fit to the key-buttons, etc. If these directions are followed carefully, it will be found a simple matter to fit the shield.

(*e*) Release all the keys, by momentarily depressing the cradle-switch lever. Set the trigger keys on the face-plate in a horizontal position, and replace the key-plate over the keys. Do not replace the fixing screws, but hold the key-plate down firmly with one hand and check the mechanical action of all the keys.

(*f*) Having ascertained that the keys operate satisfactorily, in particular the trigger keys, replace

the three small screws. Check again that all keys operate satisfactorily.

(*g*) Replace the cover. This will press down the shield over the mechanism and the relay(s). The shield must not be cut.

8. Cleaning of dust shields.—Dust shields prevent most of the dust that enters the telephone from reaching the contacts. For the shields to remain effective, however, it is necessary for them to be cleaned occasionally. It is not intended that special visits be made for this purpose, but that the shields should be cleaned during a normal maintenance visit. If the case of a telephone using a dust shield has to be removed, the shield should be cleaned. Otherwise, shield cleaning should be done only when time is available for preventive maintenance work. The method to be adopted for cleaning shields is as follows:—

(*a*) Remove the cover of the telephone and wipe off the dust adhering to the sides of the shields.

(*b*) Remove the face-plate by the method described in par. 5, and carefully lift off the dust shield.

(*c*) Wipe the shield, and remove any dust from the mechanism or the base-plate.

(*d*) Replace the shield; check the action of the trigger keys, and replace the telephone cover, by the methods described in sub-pars. 7(*d*) to (*g*).

9. Cords.—The telephone handset cord is a Cord, Instrument, No. 3/42A, Brown, 42 in. as used on other handset telephones.

The multiple cord has spare conductors included so that it is not always necessary to change the whole cord if one of the conductors becomes faulty. When it is necessary to change this cord it will usually be more convenient to do the work elsewhere than at the subscriber's premises. If, however, facilities for such work are available at the subscriber's premises, the work should be done there.

Replacement cords are supplied with the cord guide clamping rings and rubber sleeves fitted in position. When a cord is changed, these parts (except the rubber sleeves) should be returned to the Supplies Dept., so that they may be re-used. The Rate Book descriptions of these parts are:—

Guide (Part No. 1/SGU/135)
Securing Ring (Part No. 1/SRI/3)
Clamping Ring (Part No. 1/SRI/4).

10. Power supply.—The voltage of the installation should be between 18 and 28 volts under all conditions of load. The maximum current demand at 18 volts is approximately 0·6 amp. for an installation with five internal extensions, and 1·3 amp. for an installation with ten internal extensions. When faulty operation occurs and low voltage is suspected to be the cause, the supply voltage should be checked with an artificial load connected. For an installation with five extensions the appropriate load can be obtained by means of a 30-ohm resistance, or Coil, Testing, No. 1 using terminals Nos. 4 and 7. For an installation with ten extensions, the artificial load can be obtained by means of a 14-ohm resistance, e.g. a Coil, Testing, No. 1 using terminals Nos. 1 and 6, with terminals No. 5 and 7 short-circuited.

11. Relay adjustments.—Relays should be adjusted in accordance with the relative M.A.I. as follows:—

3000-type relays	....	M.A.I. No. 44 (Automatic, B 5144)
600-type relays	....	M.A.I. No. 54 (Automatic, B 5154).

NOTE:—Relays No. 4128 and No. 3330 (relays Q and BZ, respectively) are 'red label' relays, and reference to a card is necessary if re-adjustment is attempted. For the convenience of maintenance officers, the information on both these adjustment cards is reproduced on Dgm. Q (L) 170, to which reference should be made, when necessary.

12. Mechanical adjustments.—Adjustments of the key assembly should not be attempted by the maintenance officer. When a mechanical defect is discovered, the key assembly should be removed (par. 5) and inspected to prove where the defect may be. If this defect cannot be cleared by cleaning or by removing an obstruction, the telephone should be changed, and the faulty one returned to the Supplies Dept. for repair. The key assembly should *not* be lubricated.

Where it is found that the plastic buttons are binding on the plastic key-plate it is permissible to enlarge the hole at the point of contact slightly. This should be done by using a suitable round file or by scraping with a sharp pen-knife. Where it is clear that the key-plate has become distorted, e.g. when several of the buttons are sticking, the telephone should be changed. Lubricant must *not* be used in an attempt to cure this trouble.

The plastic key-plate is removed as described in par. 5. When it is replaced, care must be taken to ensure that the trigger keys are correctly located in the operating bars that project from the key assembly.

13. Key-spring adjustments.—Key springs are of the buffered type, similar to those used on Messrs. Siemens' and G.E.Co'.s pendant-armature relays. The 'make' and 'break' contact springs are tensioned against a thick supporting spring (the buffer spring). The contact pressure is determined by the tension of the contact spring against its buffer and the distance which the 'make' or 'break' spring is moved (i.e. its 'follow'). The springs are tensioned and positioned during assembly and the travel of the spring is determined by the design of the plunger cams and should rarely require adjustment. Minor adjustments such as re-tensioning of springs, re-positioning of buffers and correction of contact

opening may be carried out locally. If a major or general re-adjustment is necessary the telephone should be changed. Pliers, Adjusting, No. 2 can be used for re-tensioning springs. Access to the springs for adjustment can be obtained by removing the key assembly. To obtain the prescribed contact clearances, the tips of the contact springs may be bent, using Pliers, Adjusting, No. 5, and bending carefully from each side of the spring tip, in turn, to avoid twisting the spring. It may also sometimes be necessary (always after re-tensioning) to slightly re-position the associated buffer. This can be done by using Pliers, Adjusting, No. 2 or pressing carefully with the tip of a small screwdriver.

NOTE:—Measurement of ' make ' contact pressures and ' break ' contact clearances can only be made with the key assembly in position and the associated key operated.

The following information details as far as possible the adjustments required to ensure that the spring-sets will function satisfactorily and give reliable service.

(*a*) *Roller spring.*—The first lever spring, which is fitted with an operating roller, should be tensioned so that, when relieved of the pressure of other springs, it rests lightly on its supporting stud (Fig. 7). The operating roller should be free on its bearing without excessive play.

(*b*) *Buffer tensions.*—All ' make ' and ' break ' contact springs should be tensioned to rest against the tips of their associated buffers with a pressure of 10 gm. (minimum), measured at the tip of the spring adjacent to the contact (Fig. 8). Buffer springs are designed so that if the contact springs are straight after being tensioned they will normally rest against the tips of the buffers.

(*c*) *Contact pressures* of all ' make ' springs should be measured with the spring-set operated, and those of ' break ' springs with the spring-set normal [see Figs. 9(a) and 9(b), respectively], except for the ' make-before-break ' spring-set, for which see sub-par. 14 (*c*) (ii). The contact pressure should be 15 gm. measured immediately adjacent to the contact.

(*d*) *Contact clearance.*—The contact clearance between ' make ' contacts when the spring-set is normal, and between ' break ' contacts when the spring-set is operated, should be 10 mils (minimum) (see Fig. 10). This clearance may be obtained by bending the spring tips or by a fine adjustment of buffer position. *NOTE*:—If the buffer is re-positioned, it will be necessary to re-check the buffer tensions.

Gauges, Feeler, No. 1, Part No. 10C should be used for checking contact clearance. It will be found necessary to bend the end of the gauge by 90° in order to check certain clearances when the key assembly is in position. This will not affect its general use and, therefore, a bent gauge should not be considered unfit for service.

(*e*) *Sequence of contact operations.*—All ' break ' contacts must break (open) before ' make ' contacts make (close). On ' change-over ' units, the lever spring must leave the ' break ' spring before it makes contact with the ' make ' spring. On ' make-before-break ' units, the lever spring must make contact with the ' make ' spring before the latter breaks from the ' break ' spring,

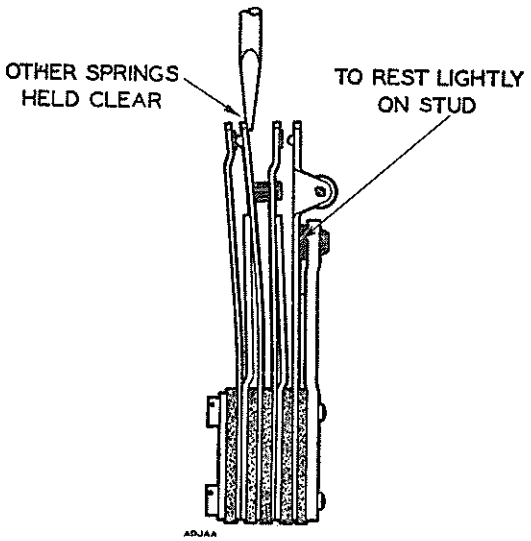


FIG. 7.—ROLLER SPRING

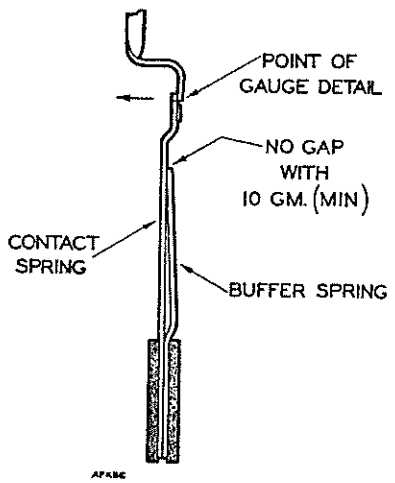


FIG. 8.—METHOD OF MEASURING BUFFER TENSION

(*f*) *Lever springs.*—The lever springs of ' make ' and ' make-before-break ' units should be tensioned so that their lifting studs rest lightly on the preceding lever spring. When checking this, succeeding lever springs should be lifted clear (see Fig. 11).

★(*g*) *Twin contact spring-sets.*—The twin contact points should make or break simultaneously. Where necessary the individual contact tongues should be adjusted by means of an Adjuster, Spring, No. 2.

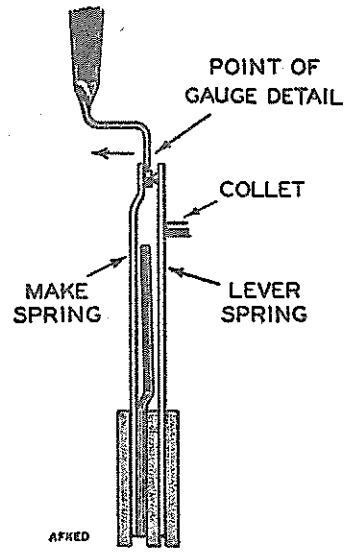
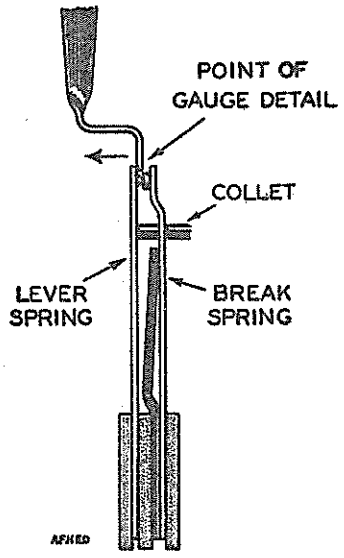
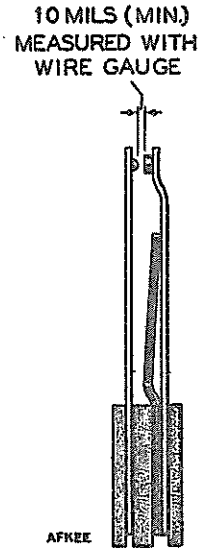


FIG. 9(a).—MEASUREMENT OF CONTACT PRESSURE ON 'MAKE' SPRING (OPERATED)



★FIG. 9(b).—MEASUREMENT OF CONTACT PRESSURE ON 'BREAK' SPRING (NORMAL)



★FIG. 10.—CONTACT CLEARANCE

14. Adjustment of typical spring-sets.

(*a*) *Two 'make' contact unit. Fig. 12 (L1 and L2 springs).*

(i) Tension spring 1 against its supporting stud, with spring 3 lifted clear

(ii) Tension 'make' springs 2 and 4 against their buffers — 10 gm. (minimum)

(iii) Tension spring 3 against spring 1

(iv) Adjust contact clearance — 10 mils (minimum)

(v) Check that, when the key assembly is replaced and the key operated, the 'make' springs are lifted clear of the tips of their buffers and that there is a contact pressure of 15 gm. (minimum).

(*b*) *'Make' and 'change-over' unit. Fig. 13 (a) (C.B. springs)* (see also par. 13). Fig. 13(b) shows the Hold spring-set, adjustment of which is similar.

(i) Tension spring 1 inwards against its supporting stud, with spring 4 lifted clear

(ii) Tension 'make' springs 2 and 5 inwards against their buffers — 10 gm. (minimum)

(iii) Tension spring 3 outwards against its buffer — 10 gm. (minimum); hold spring 4 clear to test the buffer tension

(iv) Tension spring 4 inwards so that spring 3 is lifted clear of its buffer and the lifting stud of spring 4 is resting against spring 1

(v) Check that the contact pressure between springs 3 and 4 is 15 gm. (minimum)

(vi) Adjust contact clearance of 'make' contacts to 10 mils (minimum)

(vii) Check that, when the key assembly is in position and the spring-set operated (by fully depressing a button), the 'make' contact springs are lifted clear of the tips of their buffers and that there is a contact pressure of 15 gm. (minimum).

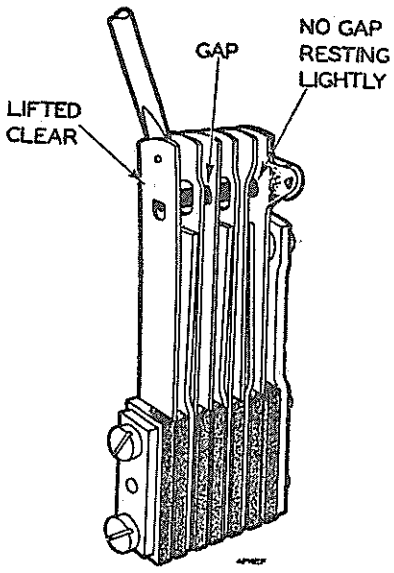


FIG. 11.—LEVER SPRINGS OF 'MAKE' AND 'K' CONTACTS (SHOWING LEVER SPRING LIFTED CLEAR)

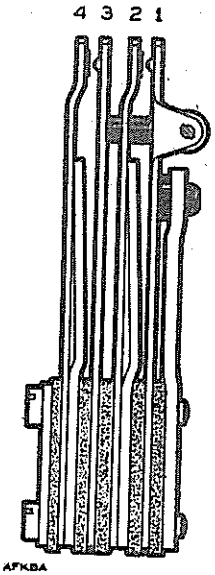


FIG. 12.—TWO 'MAKE' CONTACTS

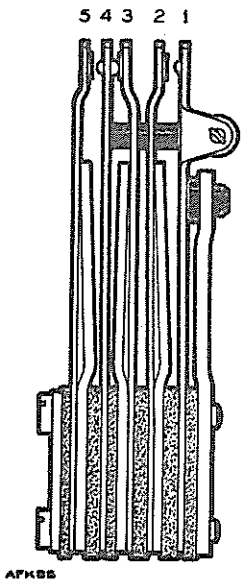


FIG. 13(a).—C.B. SPRING-SET

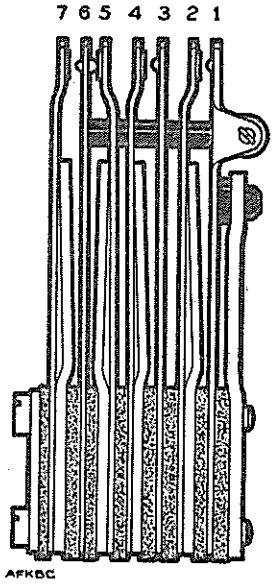


FIG. 13(b).—HOLD SPRING-SET

(c) *' Make-before-break ' and two ' change-over ' unit. Fig. 14 (Exchange spring-set).*

(i) Tension spring 1 against its supporting stud, with succeeding lever springs lifted clear

(ii) Tension spring 3 to make contact with spring 2, with a pressure of 30 gm. (minimum)

(iii) Position spring 2 so that the contact clearance of the ' make ' contacts is 10 mils (minimum)

(iv) Tension ' make ' springs 6 and 9 inwards against their buffers — 10 gm. (minimum)

(v) Tension ' break ' springs 4 and 7 outwards against their buffers — 10 gm. (minimum); hold springs 5 and 8 clear when measuring buffer tension

(vi) Tension lever springs 5 and 8 inwards to lift springs 4 and 7 clear of their buffers, and check that the lifting studs rest lightly against the preceding lever springs

(vii) Check that the contact pressure between springs 4 and 5 and 7 and 8 is 15 gm. (minimum)

(viii) Adjust ' make ' contact springs 6 and 9 to have a contact opening of 10 mils (minimum)

(ix) Check that, when the key assembly is in position and the spring-set operated (by depressing the button), there is 10 mils (minimum) contact clearance between springs 2 and 3, 4 and 5, 7 and 8 and that the contact pressure between springs 1 and 3, 5 and 6, 8 and 9 is 15 gm. (minimum).

(d) *' Change-over ' and three ' break ' unit. Fig. 15 (H.M. spring-set).*

NOTE:—This spring-set is considered as normal with the handset off for adjustment purposes only.

(i) Tension spring 1 inwards against its supporting stud, with succeeding lever springs lifted clear

(ii) With spring 3 lifted clear, tension spring 2 inwards against its buffer — 10 gm. (minimum); position its buffer to give a 10 mils (minimum) contact clearance with spring 1

(iii) Tension spring 3 against spring 2 to give a contact pressure of 15 gm. (minimum); there being just perceptible clearance between the lifting stud of spring 3 and spring 1

(iv) Tension ' break ' springs 4, 6 and 8 against their buffers — 10 gm. (minimum)

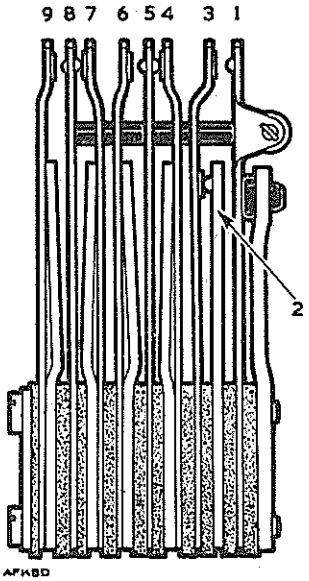


FIG. 14.—EXCHANGE SPRING-SET

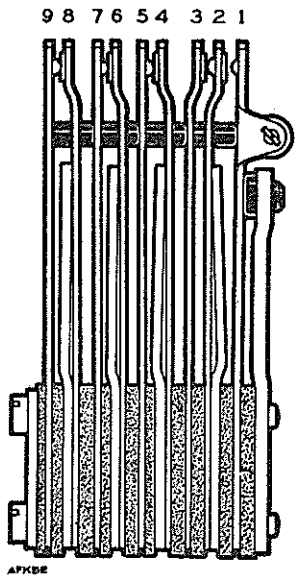


FIG. 15.— H.M. SPRING-SET

(v) Tension lever springs 5, 7 and 9 inwards to lift springs 4, 6 and 8 clear of their buffers and so that their lifting studs rest lightly against the preceding lever springs

(vi) Check that (v) gives a contact pressure of 15 gm. (minimum) between springs 4 and 5, 6 and 7, and 8 and 9

(vii) Replace the key assembly and operate the cradle-switch lever, by hand. Check that the contact clearance between the break springs of the change-over unit and that of the three break units is 10 mils (minimum), also that the contacts of the make portion of the change-over have a contact pressure of 15 gm. (minimum).

15. *Common bank (C.B. spring-set).*—As there is less physical movement available for the operation of this spring-set, it is necessary to keep the clearance between its operating roller and the operating arm within fairly close limits. This clearance should be not less than 2 mils nor more than 16 mils.

16. Labels.—Labelling instructions are contained in A 3203. "Label No. 222 and 222A" may be removed by inserting a pin into the label and pushing it out as indicated in Fig. 6. It should be noted that these labels are reversible. These labels should be replaced when repeated change of markings by the subscriber has rendered them unsightly.

It is desirable that a supply of these labels should be carried by the maintenance officer.

17. Indicators.—The exchange line indicators are bridged with a "Rectifier Element No. 1/6A". If the operation of the indicator is suspect, the indicator itself may be checked to see that it operates at the specified current value of 7 mA. A "Rheostat F" and a detector should be used for this purpose. Do not attempt to adjust the indicator: if faulty it should be changed.

18. Plugs and jacks.—Jack springs should be adjusted so that there is a clearance of approximately 18 mils between the two springs of each pair. Each spring should be curled outwards at the tip to facilitate entry of the plug. Care should be taken, however, to see that this curl is not too great; otherwise it may cause contact with the springs of an adjacent pair.

19. "Buzzer, No. 21".—If re-adjustment is required, the following sequence should be followed:—

(*a*) Loosen the locking nut on the tension-adjustment screw with a "Spanner, Flat, No. 1".

(*b*) Withdraw the tension screw until the armature is unbiassed. Check that the contact spring and tension spring are approximately parallel with the armature.

(*c*) Loosen the locking screw and adjust the contact screw to protrude about $\frac{1}{8}$ in. from the pillar, using "Screwdriver, Instrument, No. 1".

(*d*) Increase the tension on the armature, until the contact makes and the buzzer operates. Lock the tension screw. The buzzer now gives the lowest volume of sound that can be obtained reliably.

(*e*) Screw up the contact screw until the required volume of sound is given and then tighten the locking screw.

If the subscriber requires a lower volume of sound than that obtainable from the minimum given above, refer to Q 3001, par. 34.

NOTE:—The above adjustments assume that the power supply to the system is in order, and that the distances (cable resistances) between stations do not exceed the maximum allowable. Power supply is dealt with in POWER, General, S 1010, and the cable resistance in TRANSMISSION, Telephone, B 3567.

20. Cable.—The present standard cable to be used for House Exchange Systems is "Cable, P.V.C. No. 1, 24- or 41-wire". Previous to 1955 a lead-covered cable was used, and this, unless used very carefully, was not entirely satisfactory. If, therefore, a fault is proved in a length of cable and this cable is lead covered, consideration should always be given to renewing the length with "Cable P.V.C. No. 1", especially if the cable sheath shows signs of physical damage or has sharp bends, etc. It may, however, be possible to clear the fault by unlacing the cable ends, and removing a short length of sheath. If the fault is cleared this way, the end should be carefully relaced, taking care not to do it too tightly. It is advisable, however, to renew the length (using "Cable, P.V.C. No. 1") if the station affected has a bad fault history. A 496 procedure should be used if the work cannot be done at the time, and a suitable temporary arrangement made to give service.

INTERNAL WIRING, Stations, A 1018 gives details of the use of "Cable, P.V.C. No. 1", and par. 23(*b*) of this Instruction gives further information about low insulation faults.

21. Location of faults.—Faults may be located fairly easily if the principles of the system are understood, and work is done systematically.

A "Telephone, Intercom., No ...." may be checked easily by exchanging the instruments at two adjacent stations. If the fault moves with the telephone, the fault is in the telephone. If not, the fault is elsewhere.

If a fault is proved in the multiple cabling, it will be necessary to disconnect and test each branch and multiple cable. This is a fairly simple matter if accurate records and labelling exist. Q 3001 gives details of junction-box labels and also instructs the installation staff to leave a layout diagram of the system for reference at the main station. The maintenance officer should see that the junction-box labels are kept in good condition, and that details of

any extension to the system are entered on the layout diagram. Before starting to trace a multiple fault the appropriate loose-leaf diagram should also be on hand.

The exact procedure will of course vary with each individual installation, but the following notes will serve as guides to help in avoiding false tests:—

(*a*) For an exchange line fault (A and B wires) work from the junction box into which the exchange line is fed.

(*b*) For an exchange circuit fault (C, D and D^1 wires) work from the main station or the faulty telephone.

(*c*) For a multiple extension fault, work from the junction box in which the extension's local jumper is run.

(*d*) When making a test make sure that nothing is left in circuit with the wires under test. This is best done by removing the multiple jumper and the local jumpers (if any) and by jacking-out the telephone or unit transfer plug.

(*e*) Having made a test on the multiple into a junction box and proved the fault clear so far, connect each branch cable in turn and test. If all is clear re-connect all jumpers, etc., in that junction box, thus extending the multiple to the next junction box. Then disconnect all relevant jumpers in the next junction box and make similar tests. Proceed in this way until the fault is found.

22. Junction box multiple jumpers.—These were previously supplied in square-section hard-drawn brass. This material was found to deteriorate due to "season cracking" after several years in service, especially where extremes of temperature occur. This cracking gives rise to intermittent disconnexion faults which are very difficult to prove and locate and, in consequence, "Wire, Copper, Tinned, No. 18 S.W.G." has been adopted as the new standard.

Where a fault of this nature is suspected, or if it is found that the square-section wire is very brittle, all the jumpers should be replaced with "Wire, Copper, Tinned, No. 18 S.W.G.".

23. Special maintenance information.—Certain points are set out below which are known to occur from time to time, and to which special attention is often necessary.

(*a*) *Loose jumper screws.*—The screws holding the jumper wires in junction boxes must be screwed down tightly. Loose screws often give rise to intermittent disconnexion troubles which are difficult to locate (see Fig. 16). Vibration due to passing traffic may sometimes cause faults of this kind to develop and it will normally be well worth while to check the screws generally if one is found to be faulty. The reason why disconnexion faults are prevalent is because if two screws are tightly screwed down one on each side of the loose one, the jumper wire may tend to bow slightly and hold it from the terminal.

(*b*) *Low insulation in multiple cables.*—It is known that high-voltage surges occur during dialling and clear down of an exchange call. Breakdown of insulation may occur at any point on the multiple, and is often first detected by reports of "wrong numbers" or in a more advanced stage "premature ring-trip". If the low insulation is due to voltage surges, it is most likely to appear in the multiple cable where the conductors leave the sheathing, or at the exchange-line springs of "Jacks No. 53 (or 54)", when these springs are silver-plated. All future supplies of "Jacks No. 53 and 54" will be fitted with nickel-silver-plated springs which reduce the risk of "tracking" under high-voltage. Unfortunately, it is often difficult to register these faults on a "Detector No. 4", and it may be necessary to use an ohmmeter when testing for such faults. An ohmmeter may break the fault down altogether, however, and thus enable a detector to be used for fault tracing. All installations should be fitted with high-voltage surge suppressors ("Units, Voltage-limiting, No. 3A") to minimize this trouble. If low insulation developes across an exchange line, the insulation should be checked to ascertain that the voltage-limiting units have been fitted. Many low-insulation faults are due to poor cabling or the installation of House Exchange equipment in unsuitable situations (see Q 3001).

If rewiring is necessary, the maintenance officer should see that the instructions in INTERNAL WIRING, Stations, A 1018 are followed (see par. 20). Sharp bends and tight lacing of the jack wiring both hasten an insulation breakdown.

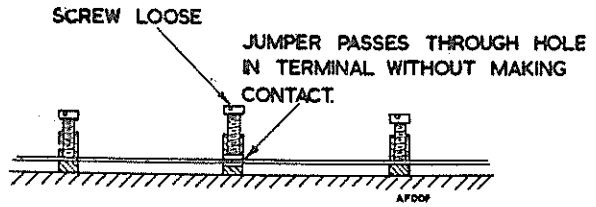


FIG. 16.—SHOWING LOOSE CONNEXION SCREW IN JUNCTION BOX

(*c*) *Buzzers.*—The " Buzzer No. 21 " is, owing to the circuit arrangements, liable to continuous operation under certain conditions if adjusted to give a low volume of sound. If trouble of this nature is experienced, and the subscriber insists on a reduced volume of sound, the matter should be referred to the Eng. Dept. (S1/1).

(*d*) *Loud alarms from the non-multiple extension.*—Although not primarily a maintenance problem, it should be mentioned that loud sounding magneto bells or extension bells cannot be operated satisfactorily from a non-multiple extension, see Q 3001 (par. 38). Occasionally, such equipment is fitted in error, as of course the non-multiple extension is an ordinary telephone. However, such an arrangement cannot be maintained satisfactorily as the ringing supply (from the BZ relay) is inadequate, and in cases of difficulty the Instruction referred to above should be consulted.

24. Tools.—The tools listed in TOOLS & TRANSPORT, Hand Tools, A 0040 for use by subscribers' apparatus maintenance officers will cover all the requirements of this Instruction.

References:—Q 1001, Q 1002, Q 1003, Q 3001
(Tp 2/8) Automatic, B 5144, B 5154
INTERNAL WIRING, Stations, A 1018
TOOLS & TRANSPORT, Hand Tools, A 0040
TRANSMISSION, Telephone, B 3567

Instructions cancelled:—Q 3904, Q 5010

END