RELAYS - 3000 TYPE

(This Instruction replaces Issue 1, December, 1941.)

1. CONTENTS.

Paragraph No.

2. GENERAL.

2.1 Introduction. This Instruction describes the adjustment of the 3000 type relay. For information concerning its design, construction and use, and details of its mechanical and electrical characteristics, reference should be made to Telephone Engineering Instructions, Relays A 1101 and A 1111.

2.2 Principles of Adjustments. Adjustment of all 3000 type relays may be divided into four stages, as follows -

(i) Adjust residual (if adjustable) or check residual stud.
(ii) Adjust armature travel.
(iii) Adjust each buffered spring against the block step.
(iv) Adjust each lever spring in turn.

When this has been done correctly, with due regard to the straightness of springs, it is not necessary to make current tests or any further adjustments - except for the special relays.

2.3 Adjustment Tolerances.

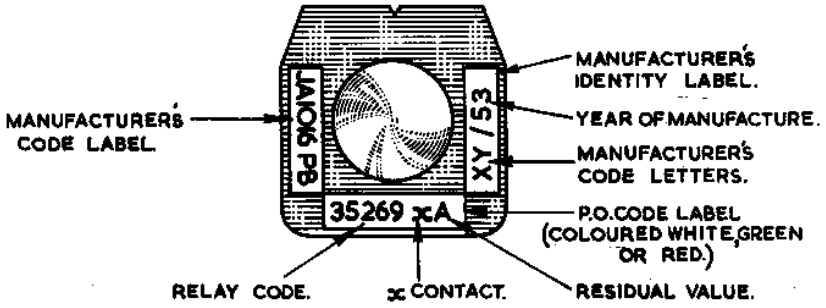
(i) Test Values. These values represent the safe limits of adjustment within which reliable operation is guaranteed. When specified, they should be used for checking adjustments. A relay requires to be readjusted if its adjustment is proved to lie outside the range of these values.

(ii) Readjust Values. These values represent the most accurate adjustment that can be obtained under practical conditions. A relay, when found faulty, should be readjusted to these values.

2.4 Retardation Coils. Retardation coils of the 3000 type are provided for association with 3000 type relays and consist of yoke, armature and coil of the standard pattern, but spring-sets are omitted. Adjustment of residual and other maintenance operations follow the standard practice for 3000 type relays as specified in this Instruction.

If an adjustable residual screw is fitted to a 3000 type retardation coil, the nominal value for adjustment is quoted on the code label as for the 3000 type relay (see Paragraph 2.5).

2.5 Code Labels. A guide to the nature of the adjustments required on any particular relay is given on the code label (see Fig. 1), and the interpretation of the colours of these labels and of the figures that are printed on them is given below. In certain circumstances, it may be necessary to replace, or renew, a code label locally. Such circumstances and the procedure to be adopted are given in Telephone Engineering Instruction, Relays A 1002.



CODE LABELS, SHOWING ADJUSTMENT INFORMATION.

FIG. 1.

White Labels. For the majority of 3000 type relays, all adjustments are made to the standard values specified in this Instruction. Such relays are identified by the P.O. code number being printed on a white label, which indicates that standard 14-mil springs are fitted. Current tests are not necessary for relays bearing a white code label.

(i) If an adjustable residual is fitted, the nominal value of residual, in mils, is shown on the label in the space following the code number. If restricted tolerances are required on residual and travel adjustments (see Paragraphs 3.3 and 4.3), the residual value is shown in brackets.

(ii) If a stud residual is fitted, the letter A, B or C on the P.O. code label indicates that it has a nominal length of 4, 12 or 20 mils, respectively.

(iii) X or Y operation is indicated by the letter X or Y in the space following the P.O. code number. The X or Y contact unit will be in the right-hand spring-set, and the standard adjustment details will be found in Paragraphs 9.6-9.15.

Green Labels. Relays which have 12-mil springs, but which are adjusted in all other respects in the standard manner, are identified by a green code label. Current tests are not necessary. Residual gaps and X or Y operation are indicated in the same manner as on white labels.

Red Labels. All relays bearing red code labels are special in some respect, and reference to a relay sheet is necessary before any readjustments are made. Any special adjustments shown on a relay sheet override this Instruction (see Paragraph 10.2).

3. RESIDUAL AIR-GAP.

3.1 Residual Studs (Fixed). The stud should be firmly secured in the armature. There are three sizes of residual studs, all of phosphor bronze, 4, 12 and 20 mils high. This dimension refers to the actual projection of the stud but, for maintenance purposes, it is not necessary to measure the actual projection, but merely to know the minimum gap between armature and core when the relay is operated. For this purpose, a holed feeler-gauge is used in the same manner as for residual screws (see Paragraph 3.4), and the figures below show the minimum permissible gaps. If a residual stud has worn down so far that these gaps are not obtained, the armature should be changed.

Designation Letter on White or Green P.O. Code Label.	Nominal Stud Size.	Minimum Residual Gap (Test Values).
A	4 mils	2 mils
B	12 mils	5 mils
C	20 mils	9 mils

A residual stud in service will seldom be found too long but, if this is found to be the cause of incorrect operation, the armature should be changed.

3.2 Residual Screws (Adjustable). Residual screws are fitted on armatures of relays requiring accurate release times or release currents. The nominal value of the residual air-gap is normally specified on the P.O. code label of the relay, and the maximum and minimum measurements are shown in the following table. The figures quoted are not the projection of the residual screw, but refer to residual air-gaps obtained by the method of measurement described in Paragraph 3.4.

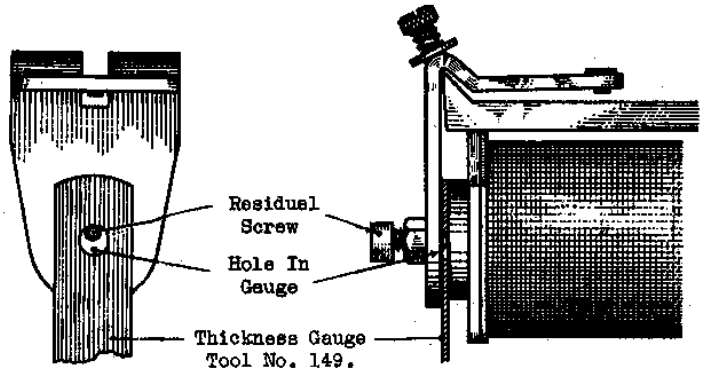
Nominal Value.	Test Values.	Readjust Values.
3 mils	+ 2, - 1 mil	± 1 mil
4 to 5 mils	± 2 mils	± 1 mil
6 to 11 mils	± 3 mils	± 2 mils
12 to 19 mils	± 4 mils	± 2 mils
20 mils and over	± 5 mils	± 2 mils
Any value (except 3 mils) shown in brackets on the adjustment label (see Paragraph 3.3).	± 2 mils	± 1 mil
3 mils shown in brackets on the adjustment label.	+ 2, - 1 mil	± 1 mil

3.3 On relays having restricted residual tolerances, the residual value is shown in brackets on the code label. The tolerances on residuals shown in brackets are quoted at the foot of the table in Paragraph 3.2.

For red-label relays, the residual value indicated on the relative relay sheet should always be used for checking or readjustment purposes, and for these relays the tolerances indicated in Paragraphs 3.1 and 3.2 apply, unless otherwise stated on the relay sheet.

3.4 Measurement of Residual Gap (Fig. 2). The residual gap is measured by inserting the holed end of the appropriate Feeler Gauge, Tool No. 149, between the armature and the core face, and allowing the residual screw to penetrate the hole. The armature should then be operated by hand. The degree of freedom of movement of the gauge over the core face will show whether the residual screw projects too far or too little. The gauge should cover the point at which the residual is a minimum, namely, at the edge of the core face, nearest the yoke.

On shunt-field relays, the gauge will not quite reach the inner edge of the core face, but the method of measurement described above should still be used.



MEASUREMENT OF RESIDUAL GAP.

FIG. 2.

3.5 Adjustment of Residual Gap. The method of adjustment is as follows -

(i) Loosen the locking nut and reduce the residual to zero.
(ii) Insert a feeler-gauge of the appropriate minimum readjust value, and operate the armature by hand.
(iii) Turn the residual screw until the feeler-gauge is felt to be loose.
(iv) A feeler-gauge of the appropriate maximum readjust value should then be substituted, and it should be felt to bind when the armature is operated by hand.
(v) Tighten the locking nut.
(vi) Recheck the residual adjustments after tightening the locking nut.

4. ARMATURE ADJUSTMENTS.

4.1 Armature-Retaining Screw. The spring of the armature-retaining screw should have sufficient tension to ensure that the armature is securely pivoted along the knife-edge. This requirement is particularly important on a relay having a single contact unit or on a relay on which the spring-set load is unbalanced, and it should be verified that there is no tendency for the armature to leave the knife-edge on the side of least spring pressure during operation or release. If the spring is found to be weak, the complete armature-retaining screw and spring should be changed. The screw should be finally tightened by using a small screwdriver and not by using the fingers, but care should be taken not to overturn the screw.

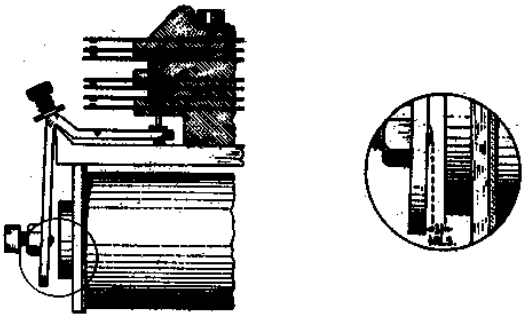


FIG. 3. ARMATURE TRAVEL.

4.2 Armature Travel. (Fig. 3.) This is the distance between the striking face of the

residual stud or screw, and the core. The standard travel is 31 mils but, when X or Y contact units are fitted, the travel should be 43 mils.

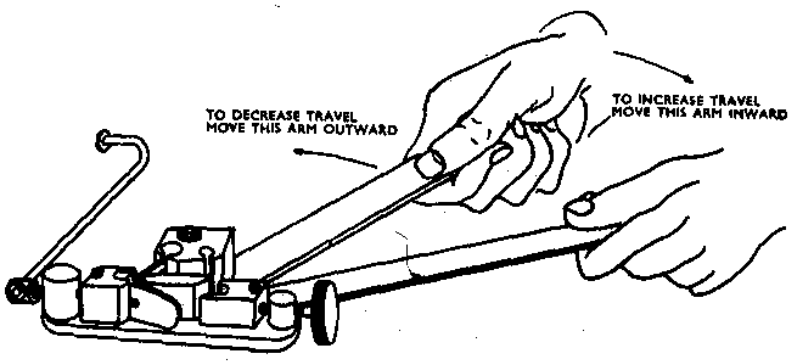
4.3 The tolerances permitted are as follows -

Type of Relay.	Test.	Readjust.
Standard.	± 3 mils	± 2 mils
Standard, with restricted tolerances (residual value shown on adjustment label in brackets).	± 3 mils	± 1 mil
Special, with travel less than 31 mils specified on adjustment card.	± 2 mils	± 1 mil

4.4 When measuring an armature travel, a feeler-gauge of the minimum value (normally 28 mils test or 29 mils readjust) should be inserted between the striking face of the residual stud or screw, and the core. A slight movement of the armature should be felt in the direction of the core when an attempt is made to operate the armature by hand. When the gauge of the maximum value (normally 34 mils test or 33 mils readjust) is inserted in the manner indicated above, movement should not be felt. When making these tests, the gauge should not be inserted so far that it reaches the minimum gap where residual measurements are made. This gap, that is, at the edge of the core face nearest to the yoke, will usually be less than the distance from the core face to residual stud or screw, so that a false measurement of the armature travel will be obtained if the gauge is inserted too far.

4.5 Adjustment of Armature Travel. To adjust the armature travel, the armature should be removed from the relay and the armature bent inwards to decrease the travel, or outwards to increase the travel. Armature Bender (Tool No. 53) should be used for this purpose (see Fig. 4). The armature should be placed over the tool knife-edge and clamped firmly by tightening the clamping screw. By operating the tool levers, the armature can then be bent in either direction, without altering the angle of the V-groove which accommodates the knife-edge. An allowance must be made, however, in the movement of the tool lever for the elasticity of the armature material.

★ 4.6 Worn Lifting Studs. Should the armature lifting studs be badly pitted the armature should be changed. Do not attempt to re-align the springset assembly to overcome this defect.



ADJUSTMENT OF ARMATURE TRAVEL, USING ARMATURE BENDER (TOOL NO. 53).

FIG. 4.

5. ADJUSTMENT OF CONTACT UNITS.

5.1 Order of Spring Adjustments. If a spring-set is found to be out of adjustment, it is advisable to readjust in all respects, otherwise, while rectifying the adjustment of one detail, some other detail may be accidentally displaced, and further adjustments will have to be made later. If the apparatus to be adjusted is in an awkward position or in a bad light, a more accurate adjustment is likely to be obtained if the switch or relay-set is jacked-out and taken to a repair bench.

5.2 When readjusting a spring-set, each contact unit (make, break, etc.) should be treated as an entirely independent unit, commencing with the one nearest to the yoke and working successively to the top contact unit in the spring-set. Each spring-set should be adjusted separately. The spring adjustments required for each type of contact unit are given in the paragraphs that follow.

5.3 "Make" Contact Unit (abbreviation M).

(i) Straighten springs if necessary (Paragraphs 6.1 to 6.3).
(ii) Tension the make spring against the block (Paragraphs 7.1 and 7.2).
(iii) Tension the lever spring against the lifting pin or stud below it (Paragraphs 7.5 to 7.8).
(iv) Check the contact clearance and spring lift, and correct where necessary (Paragraphs 9.1 to 9.5).

5.4 "Break" Contact Unit (abbreviation B).

(i) Straighten springs if necessary (Paragraphs 6.1 to 6.3).
(ii) Operate the armature, and tension the break spring against the block step (Paragraphs 7.1 and 7.2).
(iii) Release the armature and tension the lever spring so that the break spring leaves the block step and, in addition, is tensioned against the lifting pin or stud below it (Paragraphs 7.5 to 7.8).
(iv) Check the contact clearance and spring lift, and correct where necessary (Paragraphs 9.1 to 9.5).

5.5 "Change-over" Contact Unit (abbreviation C).

(i) Straighten springs if necessary (Paragraphs 6.1 to 6.3).
(ii) Tension the make spring against the block step (Paragraphs 7.1 and 7.2).
(iii) Operate the armature and tension the break spring against the block step (Paragraphs 7.2 and 7.3).
(iv) Release the armature and tension the lever spring so that the break spring leaves the block step and, in addition, is tensioned against the lifting pin or stud below it (Paragraphs 7.5 to 7.8).
(v) Check the contact clearances, sequence of break and make, and the spring lift, and correct where necessary (Paragraphs 9.1 to 9.5).

5.6 Standard "Make-Before-Break" Contact Unit (abbreviation K). This adjustment is the standard adjustment for all K contact units with the exception of certain X operated relays (for which see Paragraph 5.7).

(i) Straighten springs if necessary (Paragraphs 6.1 to 6.3).
(ii) Operate the armature and tension the break spring (that is, the lowest of the three springs) against the block step (Paragraphs 7.1 and 7.2).
(iii) Release the armature and tension the make spring (that is, the top spring) against the break spring (Paragraphs 7.1 to 7.3(i)).
(iv) Tension the lever spring (that is, the middle spring) against the lifting pin or stud below it (Paragraphs 7.5 to 7.8).
(v) Check the contact clearances and correct, if necessary, by adjusting the tips of the lever spring (Paragraphs 9.1 to 9.5).

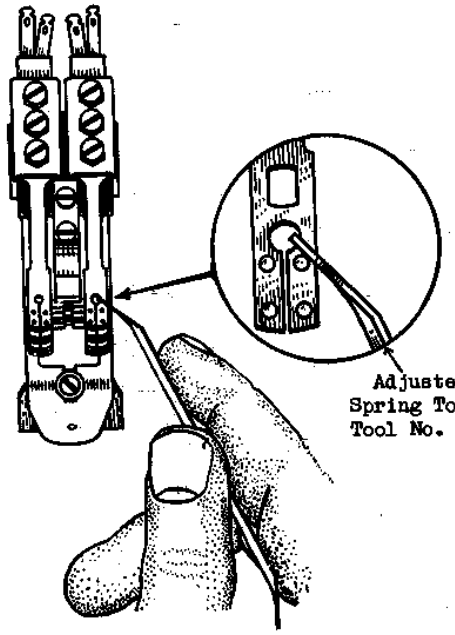
5.7 Non-Standard Make-Before-Break Contact Unit. The standard adjustment for K contact units described in Paragraph 5.6 does not apply to certain K contact units of X contact relays when the lever springs of the K units are unsupported by a preceding break unit (Fig. 11).

Application of the standard K contact adjustment to these units may result in bunching of the springs when the armature is normal. When the lever spring of a K unit on an X contact relay is supported by a break spring, the adjustment of this unit is as for a standard K unit. The following adjustment should be applied to all non-standard K units -

(i) Straighten springs if necessary (Paragraphs 6.1 to 6.3).
(ii) Operate the armature and tension the break spring (that is, the lowest of the three springs) against the block step (Paragraphs 7.1 and 7.2).
(iii) Release the armature and tension the make spring (that is, the top spring) so that the break spring leaves the block step (Paragraph 7.3(i)).
(iv) Tension the lever spring (that is, the middle spring) against the lifting pin or stud below it (Paragraphs 7.5 to 7.8).
(v) Check the contact clearances and spring lift and correct, if necessary, by adjusting the tips of the lever spring (Paragraphs 9.1 to 9.5).

6. ALIGNMENT OF SPRING-SETS.

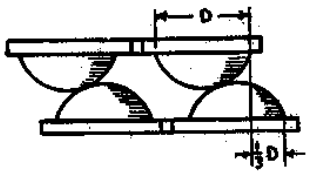
6.1 Straightness of Springs. It is a fundamental requirement of this type of relay that every spring, including the lug that rests on the buffer block, shall appear straight and flat when the relay is midway between the operated and unoperated position, that is to say, when all buffered springs are in contact with the buffer block, and all lever springs are midway between break and make springs. The buffer block and lifting pins are manufactured to such dimensions that, with straight springs, all clearances, including the spring lift from the buffer block, are obtained automatically, or at least with a minimum of adjustment. It is difficult to judge exact straightness of springs when assembled on a relay and, therefore, slight bending of the front end of the springs (that is, in front of the lifting pin or stud) is permissible if the clearances specified in Paragraphs 9.1 to 9.5 are not obtained. A spring lug should never be bent to obtain a particular sequence of contact operation, for example, X or Y operation. Short lifting pins are provided for this purpose (see Paragraphs 9.6 to 9.15). Buffer blocks should never be filed to obtain contact clearances or for any other reason.



ADJUSTMENT OF TWIN-CONTACT TONGUES.

FIG. 5.

6.2 Twin-Contact Tongues. Twin-contact points should make or break approximately at the same time, as far as can be judged by the eye. The springs are provided with independent tongues for each contact point. The tongues of the lever springs should first be adjusted to lie parallel with each other and with the yoke when viewed from the front. The tongues of each buffered spring should then be adjusted, using the spring tongue adjusting tool, so that the twin-contact points make or break approximately at the same time (see Fig. 5).



MAXIMUM OVERLAP OF CONTACT POINTS.

FIG. 6.

6.3 Overlap of Contact Points. Pairs of contact points which make electrical contact one with the other (one in one spring and the other in the adjacent spring) should not overlap each other by more than one-third of the diameter of a contact (see Fig. 6). This can be judged by eye. If faulty, the spring-set should be changed.

7. SPRING TENSIONS.

7.1 Block Pressures and Contact Pressures. With the exception of the make spring of make-before-break contact units, contact pressures are not measured directly, but adequate pressure is ensured by tensioning the contact springs so that their lugs rest against the steps of the block with a certain block pressure. A block pressure is the pressure required at the tip of the spring to lift the lug away from the block. Block pressures and contact pressures vary with the thickness of the aprings, and the appropriate test and readjust values are given in the following table -

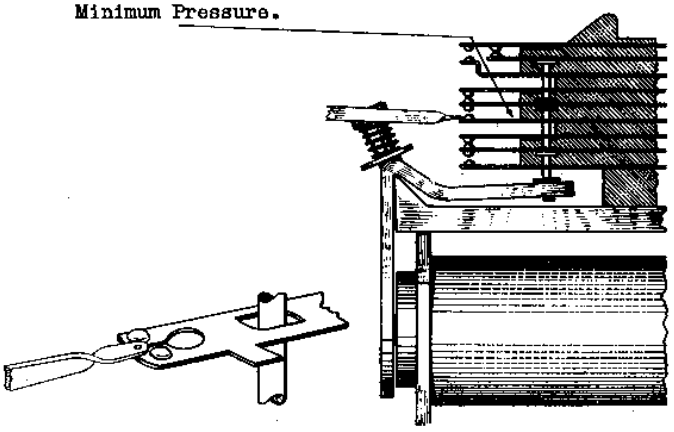
Type of Spring	Spring Thickness	Block Pressure				Contact Pressure			
		Test		Readjust		Test		Readjust	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Make and break springs, other than on K contact units	14 mils (white label)	15 gm.	21 gm.	16 gm.	20 gm.	-	-	-	-
	12 mils (green label)	10 gm.	16 gm.	11 gm.	15 gm.	-	-	-	-
Break spring of standard K contact units (Paragraph 5.6)	14 mils (white label)	30 gm.	-	30 gm.	-	-	-	-	-
	12 mils (green label)	21 gm.	-	21 gm.	-	-	-	-	-
Break spring of non-standard K contact units (Paragraph 5.7)	14 mils (white label)	15 gm.	21 gm.	16 gm.	20 gm.	-	-	-	-
Make spring of standard K contact units	14 mils (white label)	-	-	-	-	15 gm.	21 gm.	16 gm.	20 gm.
	12 mils (green label)	-	-	-	-	10 gm.	16 gm.	11 gm.	15 gm.
Make spring of non-standard K contact units	14 mils (white label)	-	-	-	-	(See Paragraph 7.3(11.)			

7.2 Block Pressures. The contact springs should resist a pressure of the appropriate minimum value, as shown in Fig. 7. The springs should leave the steps of the block at the appropriate maximum value, as shown in Fig. 8. The gauge detail should be applied to the tip of the spring and not to the lug. Block pressures of break contacts should be measured with the armature operated; block pressures of make contacts should be measured with the armature unoperated. On both standard and non-standard make-before-break contact units, the tension of the break spring (that is, the lowest of the three springs) against the block should also be measured with the armature operated as shown in Fig. 9.

7.3 Contact Pressures.

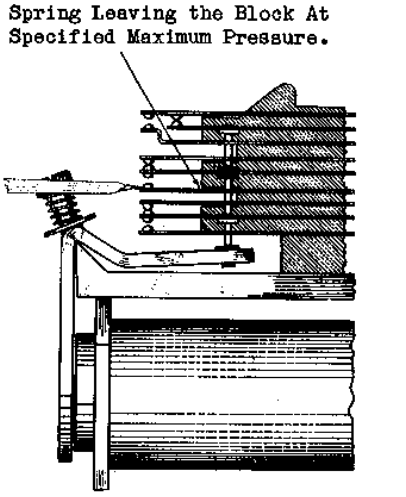
(i) Standard Make-Before-Break Contact Units. The tension of the make spring (that is, the top spring) should be measured directly against the break spring with the armature unoperated, the gauge detail being applied to the tip of the make spring (see Fig. 10). The tolerances permitted in the adjustment of these make-before-break contact units are subject to the condition that the final adjustment of the contact unit is such that the break spring is tensioned against the block in both the operated and unoperated positions.

(ii) Non-Standard Make-Before-Break Contact Units. The tension of the make spring (that is, the top spring) should be such that the break spring leaves the block step when the armature is unoperated (see Fig. 11).



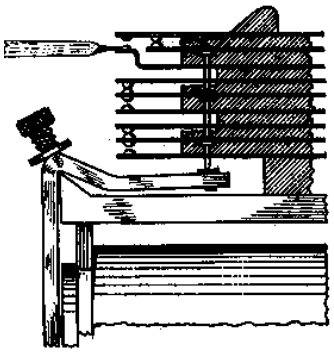
MEASURING MINIMUM BLOCK PRESSURE.

FIG. 7.



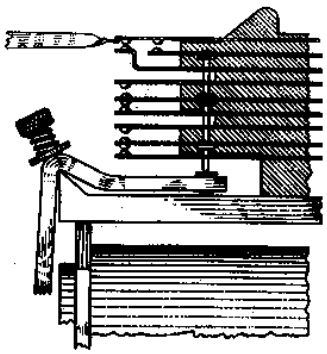
MEASURING MAXIMUM BLOCK PRESSURE.

FIG. 8.



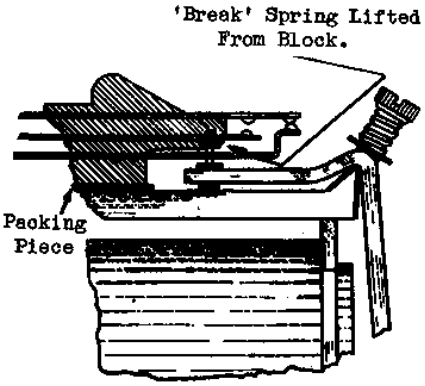
MEASURING BLOCK PRESSURE OF BREAK SPRING OF STANDARD OR NON-STANDARD K UNIT (ARMATURE OPERATED).

FIG. 9.



CHECKING CONTACT PRESSURE OF MAKE SPRING OF STANDARD K UNIT (ARMATURE UNOPERATED).

FIG. 10.



ADJUSTMENT OF MAKE SPRING OF NON-STANDARD K UNIT (ARMATURE UNOPERATED).

FIG. 11.

7.4 Special relays, on which the adjustments specified in Paragraphs 7.1 to 7.3 may not apply, are indicated by red code labels, and the special adjustments concerned are given on relay sheets (see Paragraph 10.2).

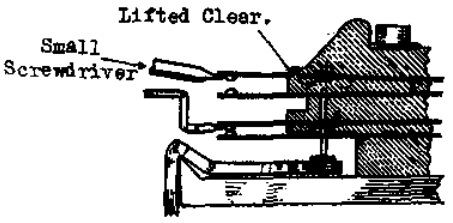
7.5 Lever-Spring Pressures. Break Contacts. If a lever spring is associated with a break spring, it should be tensioned so that, when the armature is unoperated, the break spring leaves the block step in accordance with the general requirements of spring lift (Paragraph 9.4). The pressure of the lever spring towards the armature under these conditions should be within the following limits -

Test	...	...	4-9 gm.
Readjust	...	...	5-8 gm.

This pressure is measured by applying the gauge detail to the tip of each lever spring, any lever spring above the spring under test being lifted clear (see Fig. 12), using the tip of a small screwdriver applied to both of the twin-contact tongues together.

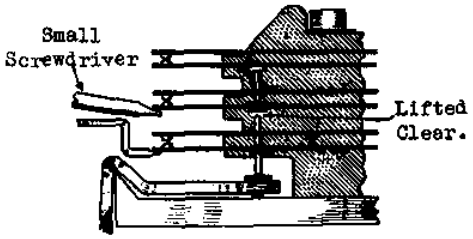
7.6 When applying this test to a lever spring of a break or change-over contact unit, it should be noted that the resultant tension of the lever spring and its associated break spring is actually measured; the lifting pin of the lever spring should, therefore, just lift from the armature stud when a pressure of 8 gm. is applied but should not leave the stud when a pressure of 5 gm. is applied to the tip of the lever spring (see Fig. 12).

7.7 Make Contacts. Each lever spring should be tensioned towards the armature so that it exerts a pressure in accordance with the table in Paragraph 7.5. The method of measuring the lever-spring pressure for make contact units is the same as for break contact units and is shown in Fig. 13.



MEASURING LEVER-SPRING PRESSURE (BREAK CONTACT UNITS).

FIG. 12.



MEASURING LEVER-SPRING PRESSURE (MAKE CONTACT UNITS).

FIG. 13.

7.8 Gross Lever-Spring Pressure. The measurements indicated in Paragraphs 7.5 to 7.7 apply primarily to individual lever springs, but, if there is more than one lever spring, it will suffice if the gross stud pressure is measured at the lowest lever spring (that is, the one nearest to the armature) and falls within the limits of "n" times the test or readjust values quoted in Paragraph 7.5, where "n" is the number of lever springs. For example, for a 14-mil spring-set comprising three lever springs, the minimum gross pressure (test values) should be 12 gm. and the maximum 27 gm. Furthermore, whenever the lever-spring pressure is measured as a gross pressure, it is essential to check the inward tension of the extreme upper lever spring in the spring-set (that is, the one furthest from the armature) in addition to the total pressure measurement. This pressure should be as for a single-contact unit, namely, 4 to 9 gm. (test) or 5 to 8 gm. (readjust). To verify that all other lever springs are finally tensioned towards the armature, the pressure due to the upper lever spring or springs should be relieved and, under these conditions, the spring being checked should not exhibit any tendency to leave the lifting pin or stud of the lever spring immediately below it.

7.9 For X contact relays, the lever-spring pressure of each ordinary make contact unit should be measured with the armature normal (that is, at 43 mils travel), but the

lever-spring pressure of each ordinary break or change-over contact unit should be measured with a 31-mil gauge in the armature core gap (that is, at 31 mils travel). Further details will be found in Paragraphs 9.6 to 9.15.

8. TENSIONING OF SPRINGS.

8.1 Alternative Tools. Springs should be tensioned either with a Spring Adjuster (Tool No. 16A) or with Bent Duckbill Pliers (Tool No. 211). The instructions which follow refer to the use of Tool No. 16A, but the principles apply to both. It is important, when using pliers, that the spring be gripped lightly, otherwise the required tension will not be obtained.

8.2 Principles. The tension of a spring should not be increased by merely giving a bend or "set" near its root. If this were done, the pressure at the lifting pin or stud (or at the buffer-block step) would be increased, but the extra pressure would cause the spring to sag and upset the contact clearances. The correct method, therefore, is first to form a uniform hump or bow in the spring by the process known as "stroking," so that when, finally, a set is put on the root of the spring to increase the pressure at the lifting pin or stud (or at the buffer-block step), the tendency to sag is counteracted by the hump and the spring remains straight.

8.3 Example. The following example shows the details of this method, as applied to the tensioning of a make spring on to the buffer-block step. For simplicity, the directions are given assuming that the relay is mounted with its spring-sets uppermost, but, once the principle is understood, there should not be any difficulty in carrying out the operation while the relay is mounted on its side, either left-hand or right-hand.

(i) Place the tool over the spring, with the prongs as shown, at the root of the spring (see Fig. 14a).

(ii) Use the tool as a lever to exert a light pressure on the spring as shown, at the same time pressing the tip of the tool upwards (see Fig. 14b).

(iii) Keeping the spring under pressure, draw the tool gently but firmly along the spring so that a bow is extended towards the buffer-block step (see Fig. 14c).

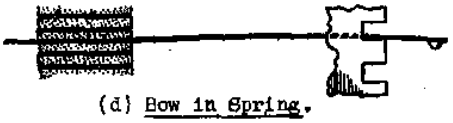
(iv) The shape of the spring after this stroking will be as shown, a uniform bow being formed along the length of the spring (see Fig. 14d).

(v) Replace the tool at the root, and give a set to the spring to increase the pressure on the buffer-block step until the spring becomes straight (see Fig. 14e).

(a) Position of Spring Adjuster (Tool No. 16A).

(b) Bending the Spring and Pressing Upwards.

(c) Stroking the Spring.

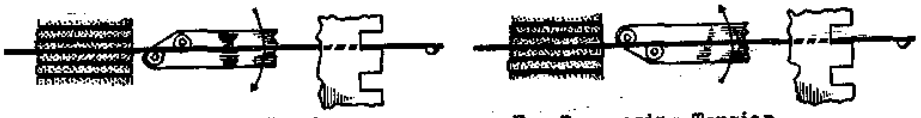


(d) Bow in Spring.

(e) Final Set in Spring.

FIG. 14. TENSIONING SPRINGS.

The final setting of the spring will apply the necessary increased pressure at the buffer-block, and yet the spring will be quite straight at the end of the adjustment. Once the principle of stroking and setting is understood, it can be applied to increase or decrease the tension of any spring without further explanation, the appropriate end of the tool being used (see Fig. 15).



For Increasing Tension. For Decreasing Tension

INCREASING OR DECREASING TENSION.

FIG. 15.

9. SPRING-SET CLEARANCES.

9.1 Contact Clearances. The clearance between make contacts when the armature is normal, and between break contacts with the armature is operated, should not be less than 10 mils, that is, half the height of a standard dome-shaped contact point when new. The clearance can usually be gauged by eye, and is normally much greater than this. If incorrect, the straightness of the springs, particularly the twin-contact tongues, should be checked and corrected where necessary.

9.2 Contact Clearances on Impulsing Relays. On impulsing relays, the contact clearance of the K unit is of special importance and should be adjusted to meet the following condition -

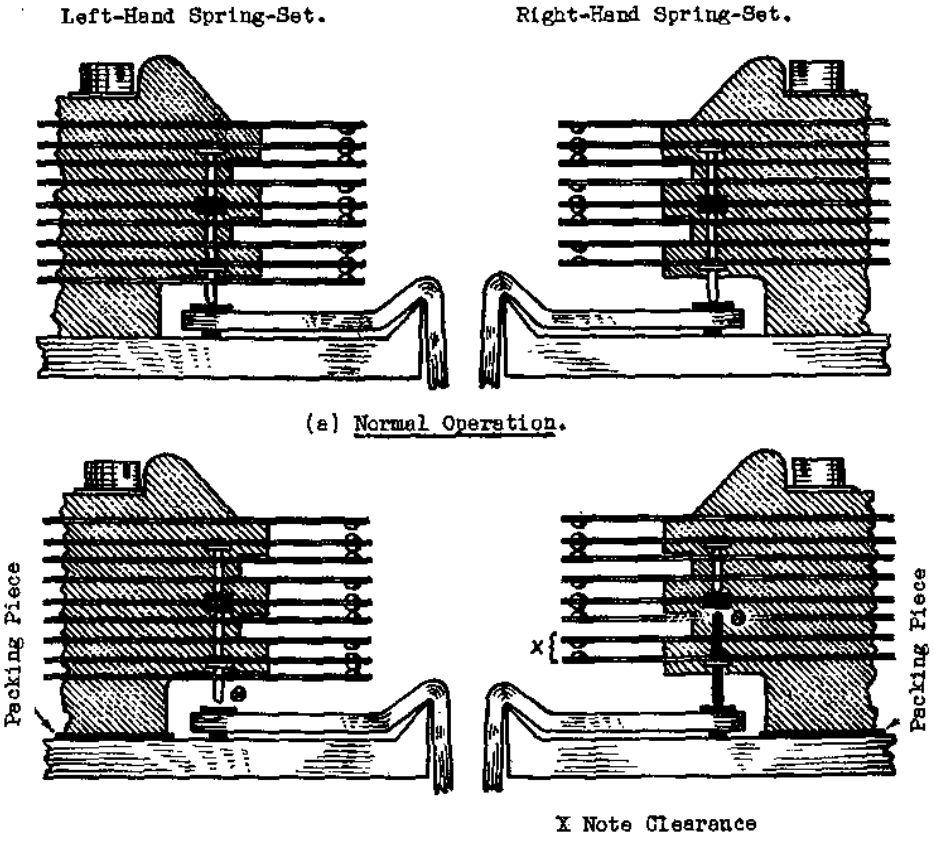
If the armature travel is more than 25 mils, the make contact clearance should be adjusted to be approximately equal to the break contact clearance, as judged by the eye. If the armature travel is 25 mils or less, the make contact clearance should be adjusted to be slightly greater than the break contact clearance. After this adjustment has been made, it should be verified that the break contact clearance is not less than 10 mils, but, if it is, the requirement should be met by reducing the make contact clearance slightly. If the relay carries a make contact unit in addition, the contact clearance of the make spring should be adjusted to be approximately equal to that of the make contact clearance of the K unit. Contact clearance has a considerable effect on impulsing results. Large make contact clearances on heavily adjusted impulsing relays or small make contact clearances on lightly adjusted impulsing relays should be avoided.

9.3 Sequence of Contact Operation. Apart from any X or Y contact units and K units, it should be checked that all break contact units break before any make contact unit makes. Similarly, in a change-over unit, the lever spring should leave the break spring before it makes contact with the make spring. If this requirement is not met, the straightness of the spring should be checked and corrected where necessary, as for incorrect contact clearance. For K (make-before-break) units, the make and break operations will occur in the reverse order to those of a change-over unit.

9.4 Spring Lift. The lift of a spring is the movement of its lug away from the buffer-block step, either away from or towards the yoke, and, although the word "lift" suggests a movement in a vertical direction, in practice, the spring lift is horizontal because a relay is mounted on its side. Spring lift should be checked by eye, the armature being operated for make contacts and unoperated for break contacts. The nominal value is about 5 mils, with a minimum of about 2 mils. If the lift is judged to be insufficient, the straightness of the springs, particularly the spring lugs, should be checked, and corrected where necessary. A contributory cause may be the wearing down of the contact points and, when this wear is found to be excessive, the spring-set concerned should be changed. (For certain K units and certain special relays, the spring lift is specified on the relay sheet to be zero, that is, the spring concerned should not lift off the block.)

9.5 Lifting-Pin Clearances. Clearances between lifting pins and studs are not permitted, except for certain relays with X or Y contact units (see Paragraphs 9.6 to 9.15) and certain special relays.

9.6 X Operation. Early operation of a contact unit, either make or break, is obtained by a shortened lifting pin immediately above the X unit, thereby delaying the action of the other contact units in the spring-set. The action of the whole of the spring-set on the opposite side is also delayed by packing in the buffer-block, complete with both spring-sets, so that the armature has to travel about 10 mils before it starts to actuate the springs. To prevent this from delaying the action of the X contact unit, the lifting pin below the X contact unit is lengthened by an amount equal to the thickness of the packing. This is shown in Fig. 16. Thus, a relay containing an X contact unit has a packing piece (metal plate) under the buffer-block and spring-sets, and the X lever spring has special lifting pins, a short one above and a long one below.



X OPERATION WITH ASSOCIATED CHANGE-OVER UNITS (COMPARED WITH NORMAL OPERATION).

FIG. 16.

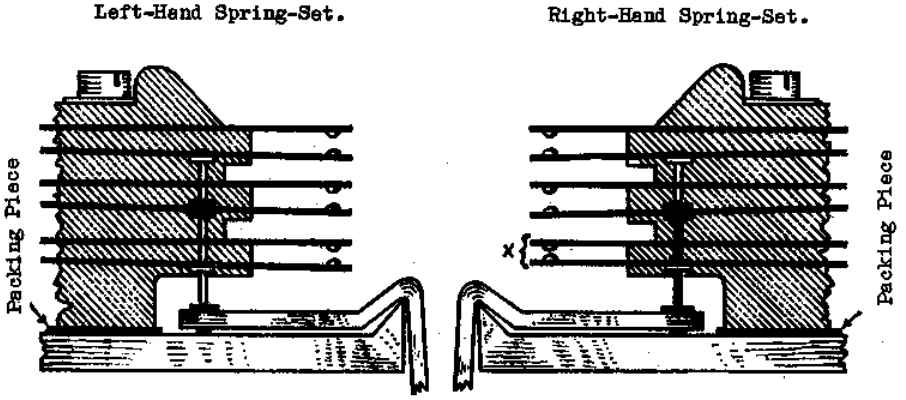
9.7 Adjustment of an X Contact Unit is exactly the same as for ordinary make and break units (Paragraphs 5.3 to 5.4), the correct sequence of contact operation being obtained by means of the constructional design of the spring-set.

9.8 Associated Contact Units. Since the X action is obtained by delaying the action of all other contact units (in the X spring-set and in the spring-set opposite), the adjustments of those other units may be slightly affected.

9.9 A normal break or change-over contact unit on an X contact relay is adjusted, as regards lever spring pressure, when the armature is situated 31 mils from the core, that is, corresponding to the condition that exists on a normal relay with 31 mils travel. This can be effected by inserting a 31-mil gauge between the armature and the core, and operating the armature, electrically if possible. In this way, the extra travel provided for operation of the X contact unit is taken up.

9.10 When all the normal break and change-over units have been adjusted in this manner, the 31-mil gauge should be removed and the armature allowed to release fully. It is then necessary to ensure that the X unit will make or break contact before any normal break spring is moved. The lowest normal break spring in each spring-set should, therefore, be given additional upward tension until there is sufficient lifting-pin clearance (see Fig. 16) to allow this sequence of movement. This lifting-pin clearance, however, should not be so great that the normal lift of the break springs away from the block is less than standard (see Paragraph 9.4).

9.11 A normal make or make-before-break contact unit on an X contact relay is adjusted, as regards lever-spring pressure, when the armature is fully released, that is, at 43 mils travel. Departures from the standard procedure are not necessary, and the lifting-pin clearance that would have occurred if there had been a break spring in the contact unit is taken up by the movement of the lever spring towards the yoke (see Fig. 17).



X OPERATION WITH ASSOCIATED MAKE CONTACT UNITS.

FIG. 17.

9.12 The order of adjustment of the spring-sets on an X contact relay may, therefore, be summarised as follows -

(i) Adjust the X contact unit in the standard manner (Paragraphs 5.3 to 5.4).

(ii) Adjust each of the remaining make and make-before-break contact units in the standard manner, with the armature at 43 mils during lever-spring adjustments.

(iii) Adjust each of the remaining break and change-over contact units in the standard manner, with the armature at 31 mils during lever-spring adjustments.

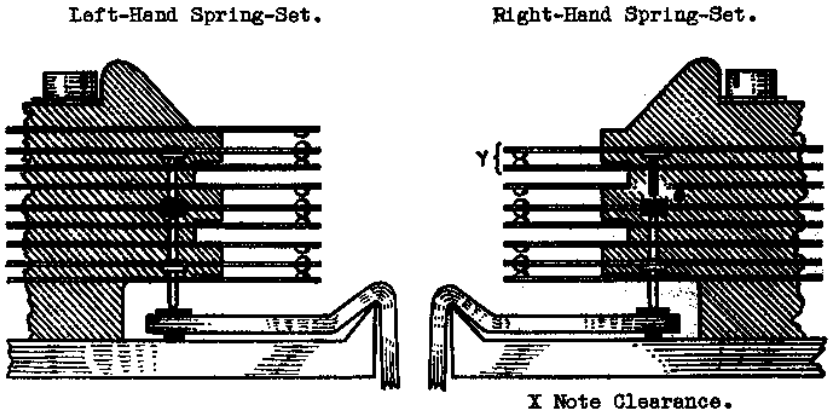
(iv) Increase the tension of the lowest normal break spring in each spring-set until the required lifting-pin clearance is obtained.

If it is desired to check the lever-spring pressures during adjustment operations, this should be done before the final increase in tension of the lowest break spring is made; otherwise the extra tension of that spring will cause it to follow the lever springs when the pressure gauge is applied.

9.13 Y Operation. Late operation of a contact unit, either break or make, is obtained by a shortened lifting-pin on the Y lever spring which delays its action (see Fig. 18). A packing piece under the buffer-block is not required.

9.14 Adjustment of Y Contact Units. A Y contact unit is adjusted in exactly the same way as an ordinary make or break contact unit, except that, when the Y unit is a break unit (as shown in Fig. 18), the Y lever spring is not tensioned to meet the values specified in Paragraph 7.5. The lever spring should be tensioned down until the Y break spring leaves the block step to the extent of the normal spring lift (see Paragraph 9.4), but a clearance should be left below the Y lever spring as shown in Fig. 18 to ensure that the Y contact unit is the last to be operated.

9.15 On a Y make contact unit, the lifting-pin clearance is taken up as a result of the Y lever spring moving towards the yoke. The contact opening of a Y make unit is, therefore, slightly greater than normal.



Y BREAK CONTACT UNIT.

FIG. 18.

10. CURRENT AND TIMING TESTS.

10.1 General. Relays which require special current or timing tests are identified by a red P.O. code label on the coil cheek (see Fig. 1), and the special requirements for such relays are given on individual relay sheets.

10.2 Relay Sheets should be obtained for red label relays, but only one copy of any particular relay sheet should be held at an exchange.

10.3 Test Points. Where test points are shown on relevant adjustment data, they represent circuit points to which a Current Flow Test Set should be connected to check the characteristics of special relays against current values.

10.4 Selection of Test Points. The following notes are given for guidance in the selection of test points -

(i) The testing equipment should be connected so as to indicate the current flowing through the relay coil; particular attention should be paid to this point when there is normally a circuit in parallel with the relay to be tested.

(ii) The connection of battery or earth to any point of the circuit for the purpose of the test should not cause a damaging current to flow through a resistor, rectifier, low-voltage lamp, etc., connected to the same point. If a doubt exists, the item should be disconnected.

(iii) To avoid magnetic interference with the relay under test, any adjacent relays which have slugged or short-circuited coils, and which normally are operated by the relay under test, should be disconnected.

(iv) The necessity to disconnect soldered connections can usually be avoided by such measures as insulating relay contacts in circuit, etc.

10.5 Current Values. The values of operate current, etc., quoted on the relay sheet are expressed in milliamperes, and should be read as follows -

(i) Saturate. This is the minimum value which must be applied to the relay prior to making the individual current tests which follow. Where not quoted or the word "full" appears, the full potential of the exchange battery must be connected across the relay.

(ii) Hold. This is the value at which the relay must remain operated when the current is reduced in one step from the saturate value, for example, if 12 mA is quoted as the hold value, then the relay must hold at this value when the current is reduced from the saturate value. The relay may, however, hold at a lower value, but the other values, release, non-operate, etc., given on the sheet must also be met.

(iii) Release. This is the value at which the relay must release when the current is reduced in one step from the saturate or hold value, if the latter is quoted, for example, if 10 mA is quoted, then the relay must release at this value. The relay may, however, release at a higher value, but the other values given on the sheet must also be met.

(iv) Non-operate. This is the value at which the relay must not operate, for example, if 8 mA is quoted then, when 8 mA is applied, the relay must not operate. The relay may, however, fail to operate at a higher value, but the other values given on the sheet must also be met. (See also Paragraph 10.6.)

(v) Operate. This is the value at which the relay must fully operate, for example, if 16 mA is quoted then, when 16 mA is applied, the relay must

fully operate. It may, however, operate with less current, but the other values given on the sheet must also be met.

10.6 Test Values and Order of Current Tests. Test values of operate current, etc., are for use when testing a relay to determine if it requires readjustment. The tests should be made under the correct magnetic conditions, that is, after saturation. When more than one test current is to be measured, the order of tests should be as follows -

Saturate, Hold, Release, Non-operate and then Operate current tests.

It is normally, unnecessary to apply the saturate current more than once for any series of tests. In the definition of non-operate current, it is stated that all break springs must be free of the buffer-block steps and, from this it follows, when the non-operate current is applied, there must not be any appreciable reduction of make contact clearance even when break springs are not fitted. This requirement should be rigidly observed.

10.7 Readjust Values and Adjustment. Readjust values of operate current, etc., are for use when the test values are not met, and the relay requires readjusting. The following notes are given for guidance when readjusting a relay to meet the readjust values -

(i) The armature should be removed, and the pole face, knife edge, and the backstop should be cleaned with a chamois leather.

(ii) The residual, armature travel and block pressures should be adjusted within tolerances.

(iii) The lever-spring pressures should be varied within the specified limits.

(iv) When it is specified on the relay sheet that certain springs are to be "adjusted to meet current tests" and no limits are quoted, then the lever spring pressures -

(a) Should not be reduced to such an extent that spring lift is reduced below the standard requirements (see Paragraph 9.4).

(b) May exceed the minimum limit of 8 gm. quoted in Paragraphs 7.5 and 7.6. The maximum lever spring tension for 12- and 14-mil springs will then be as follows -

Spring	Break	Make
12 mils	10 gm.	25 gm.
14 mils	10 gm.	30 gm.
12 mils with thick break contact spring	25 gm.	
14 mils with thick break contact spring	30 gm.	

10.8 With the exception of timed relays (see Paragraph 10.10), if difficulty is experienced in adjusting any relay to function correctly, either the coil or the complete relay should be changed. Change of the complete relay will be necessary in the case of a relay with a bracketed residual.

10.9 Current Tester. A Current Flow Test Set is shown on Drawing C.E. 860 and this set is to be used for current tests.

10.10 Timing Tests. Timing testers are used in adjusting a particular relay to meet timing requirements.

10.11 Operate Lag. If the operate lag of a relay is found to be outside the range permitted, the relay should be readjusted so that its lag lies between the maximum and the mean value of the range. To meet such values, it should first be checked that the block tension, lever tension, armature travel and residual (if adjustable) are within the tolerances. The lever-spring tension should then be varied to meet the required lag, and, except where lever-spring tension limits are quoted, the lever tensions should be as shown in Paragraph 10.7 (iv).

10.12 Release Lag. If the release lag of a relay is found to be outside the range permitted, it should be readjusted so that its lag lies between the minimum and the mean value of the timing range. To meet such values, it should first be checked that the block tension, lever tension, armature travel and residual are within tolerances. The residual should be varied to meet the required release lag. After any residual readjustment, the armature travel should be checked and readjusted, if necessary. The residual value ($\pm$ 1 mil) shown on the relay spool cheek should be used as the readjust value. Variations from the marked residual value will sometimes be necessary to obtain the required timing.

10.13 A Test Clip has been developed primarily for use in connection with the testing of relays, and a description and method of use is given in Telephone Engineering Instruction, Relays AD 0002.

11. MISCELLANEOUS.

11.1 Special Applications of 3000 Type Relays. The undermentioned items are basically the same as the 3000 type relay, but their adjustment is the subject of individual adjustment instructions as detailed. Relay sheets will not generally be provided for these relays.

(i) Thermal Relays.

(ii) High Voltage Relays.

(iii) Ringing and Tone Vibrators.

(iv) Relay Switches.

11.2 Breakdown Tests. Where it is suspected that a relay, as a result of incorrect performance, may be breaking down, the following further tests may be advisable -

(i) Resistance. Test for resistance specified on relay label.

(ii) Breakdown. Test for breakdown, using a 500 volt megger if available or the 400 volt insulation test on an automatic exchange test desk, as follows -

(a) Between all terminals and frame.

(b) Between all windings.

(c) Between all insulated parts.

(iii) Insulation Resistance. The insulation resistance between windings and core for any relay and between windings also on double wound relays shall be not less than 100 megohms measured as in (b) above.

11.3 Tools for 3000 Type Relays. The following additional tools are required for the adjustment of 3000 Type Relays and are included in Tool Kit, No. 11.

Tool No.	Description.	Serial and Item.	Use.
16A	Adjuster, Spring	52/16A	Spring adjuster.
16B	Adjuster, Spring Tongue	52/16B	Adjusting relative positions of twin contact points.
36	Armature Shoe-horn	52G/27	Replacing armatures.
53	Bender, Armature	52/39	Armature bending.
139	Gauge, Thickness, 0.0015" to 0.015"	52F/11	General.
149	Gauge, Thickness, 0.002" to 0.046", holed one end	52F/25	Armature travel and residual.
151	Gauge, Tension, 10 to 80 gms.	52F/21	General.
154	Gauge, Tension, 4 to 24 gms.	52F/24	General.
171	Insulator, Contact	52G/10	Insulator for relay contact points.
201	Mirror, Magnifying, Dental Type, No. 2	52C/3	General.
211	Pliers, Bent, Duckbill	52E/4	General.
281	Spanner, Box, D.E. 7/32" x 1/4", with screwdriver	52A/25	Residual screw adjustment.

The tools specified above should be used only for the purposes for which they are intended. Any tool that is in such a condition that screws, nuts, or springs would be damaged by its use should be changed.

11.4 Replacement of Parts. Parts of any relay can be changed if found to be faulty, except those of a relay with a "bracketed" residual value. In the latter case, it is not permissible to change the yoke or coil, and, if either of these items is found to be faulty, the complete relay should be changed. Reference should be made to Telephone Engineering Instruction, Relays A 1102, for the procedure to be adopted and the part numbers of the various items.

END.