POST OFFICE 600-TYPE RELAYS

[Maintenance Adjustment Instruction (M.A.I.) No. 54]

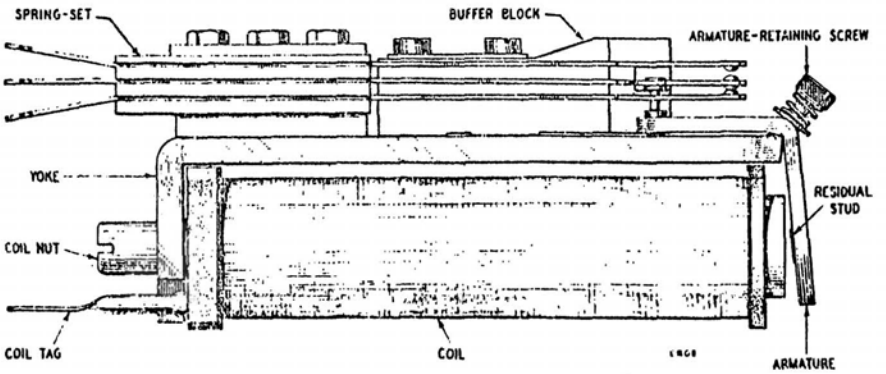
1. General.—The 600-type relay is the Dept.'s standard *minor* type relay. For information concerning its design, construction, use, and details of its mechanical and electrical characteristics, reference should be made to General, Q 1005 and Q 1020. In general principles the relay is similar to the 3000-type, and the adjustments are basically those specified for that type of relay in B 5144. Owing to the less onerous requirements of the circuits in which it is used (e.g. subscribers' line circuits), the 600-type relay has an important advantage over the 3000-type since all relays in the series are adjusted in accordance with the standard adjustment data detailed in this Instruction. Thus, unlike the 3000-type relay, none of the 600-type relays are designed to meet current or timing specifications, i.e. there are no "special" relays. Such features as "X" and "Y" operation, or an adjustable residual gap, are not provided on this relay. Where 600-type relays are used as L relays associated with subscribers' lines which have a loop resistance greater than 600 ohms, reference should be made to H 5026.

★2. List of contents.

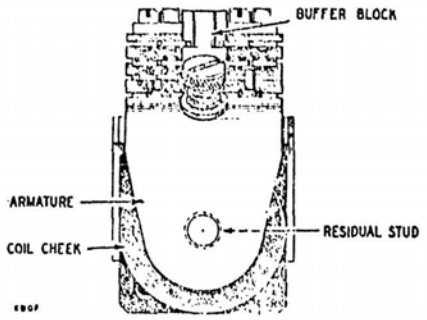
GENERAL

★3. Principles of adjustment.—General views of a typical relay are given in Figs. 1 and 2. The adjustments specified in this Instruction have, as a basis, the adjustments specified in B 5144, to which reference should be made. The adjustments cover, as far as possible, all the maintenance work that may be required, but, when the main principles of adjustment have been studied, it will be seen that the adjustment of a relay consists of the following three steps which are applicable to all relays of the 600-type:—

(*a*) Adjust armature travel
(*b*) Adjust each buffered spring against the block step



★FIG. 1. SIDE VIEW OF A 600-TYPE RELAY



★FIG. 2. FRONT VIEW OF A 600-TYPE RELAY

(*c*) Adjust each lever spring in turn.

When this is done correctly, with due regard to the straightness of the springs, it is not necessary to make current tests.

★**4. Adjustment tolerances.**—'Test' and 're-adjust' values are used for checking and re-adjustment purposes respectively. These values may be defined as follows:—

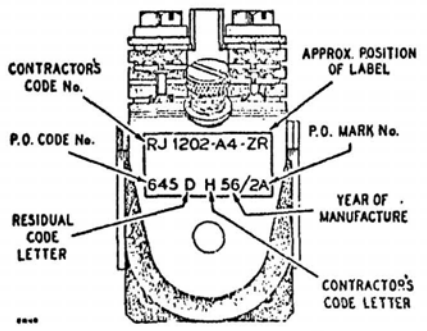
(*a*) '*Test*' *Values*.—These values represent the limits of adjustment within which reliable operation is ensured. A relay requires to be re-adjusted if any of its adjustments are proved to be outside the range of these values.

(*b*) '*Re-adjust*' *Values*.—These values represent a closer limit of adjustment than that provided by the 'test' values. A relay adjusted to these values will have a greater factor of safety and should not need attention so frequently as would be the case if the limits of the 'test' values were used for adjustments. When a relay requires re-adjustment the 're-adjust' values should be applied.

5. Adjustment labels.—A guide to the adjustments required on any particular relay is given on the code label (see Fig. 3), the shape of which need not necessarily be the same as is shown. The interpretation of the colours is as follows:—

(*a*) *A white label* indicates that the relay is fitted with 14-mil springs, and that all adjustments are standard as specified in this Instruction. It is important to note that current tests are not necessary.

(*b*) *A green label* indicates that the relay is fitted with 12-mil springs, but that all other adjustments are standard as specified in this Instruction. (All "green label" relays have been superseded for new work by "white label" relays, and when the replacement of a "green label" relay becomes necessary for any reason, the relative "white label" relay will be issued.)



★FIG. 3. CODE LABEL

RESIDUAL AIR-GAP

6. Residual studs.—The stud should be firmly secured in the armature. There are three sizes of residual stud, viz. 4, 8 and 12 mils, respectively, all of phosphor bronze; the letter 'A', 'D', or 'B' on the P.O. code label indicates that a nominal stud size of 4, 8, or 12 mils, respectively, is fitted. The figures given in Table 1 show the minimum permissible gaps between the armature and the core, when the relay is operated. If a residual stud has worn down so far that the appropriate minimum gap cannot be obtained, the armature should be changed.

TABLE 1

Nominal stud size	Residual code letter	Minimum residual gap (test values)
4 mils	A	2 mils
8 ,,	D	5 ,,
12 ,,	B	8 ,,

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

7. Measurement of residual gap.—The minimum residual air-gap should be measured by inserting the holed end of the appropriate feeler-gauge between the armature and the core face (see Fig. 4), and allowing the residual stud 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 stud projects

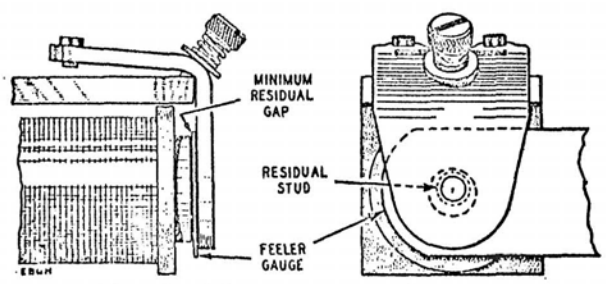


FIG. 4. MEASUREMENT OF RESIDUAL

too far or too little. Care should be taken to ensure that the armature rests on the knife-edge when making this test.

ARMATURE ADJUSTMENTS

8. Armature-retaining screw.—The spring of the armature-retaining screw should have sufficient tension to ensure that the armature is securely pivoted. If the spring is found to be weak, the complete armature-retaining screw and spring should be changed. Final tightening of the screw should be obtained by using a small screwdriver and not by using the fingers, *but care should be taken not to overturn the screw.*

9. Armature travel.—This is the distance between the striking face of the residual stud and the core (see Fig. 5). The standard travel is 25 mils.

10. *The standard tolerance* is $\pm$ 3 mils for testing, and $\pm$ 2 mils for re-adjusting.

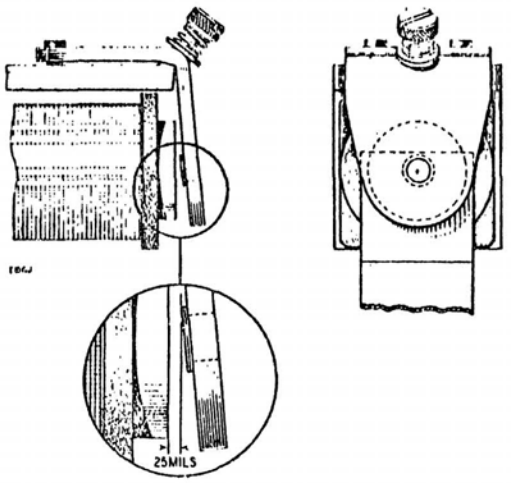


FIG. 5. MEASURING ARMATURE TRAVEL

11. When measuring an armature travel, a feeler-gauge of the minimum re-adjust value (normally 23 mils) should be inserted between the striking face of the residual stud and the core (see Fig. 5). A slight movement should be felt in the armature—in the direction of the core—when an attempt is made to operate the armature by hand. If the gauge of the maximum re-adjust value (normally 27 mils) 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 (see Fig. 4). This gap, i.e. the gap at the inner edge of the core face nearest to the yoke, will usually be much less than the distance from core face to residual stud and, therefore, a false measurement of the armature travel will be obtained if the gauge is inserted too far.

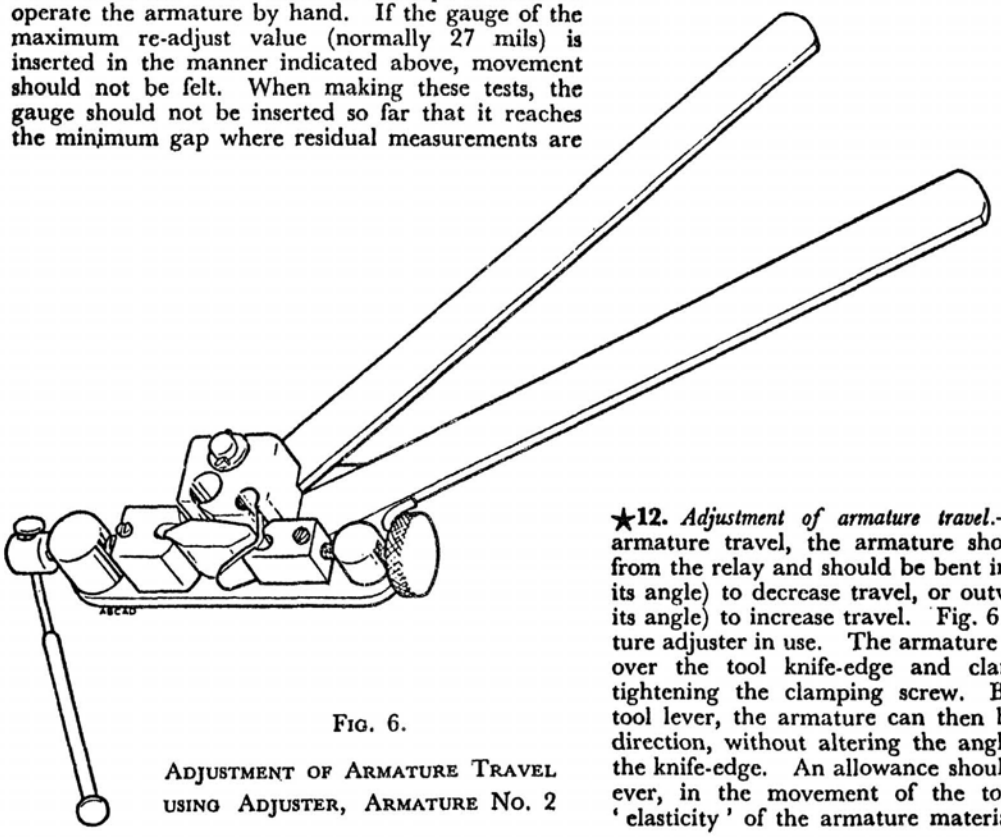


FIG. 6.

ADJUSTMENT OF ARMATURE TRAVEL USING ADJUSTER, ARMATURE NO. 2

★**12.** *Adjustment of armature travel.*—To adjust the armature travel, the armature should be removed from the relay and should be bent inwards (reducing its angle) to decrease travel, or outwards (increasing its angle) to increase travel. Fig. 6 shows the armature adjuster in use. The armature should be placed over the tool knife-edge and clamped firmly by tightening the clamping screw. By operating the tool lever, the armature can then be bent in either direction, without altering the angle which engages the knife-edge. An allowance should be made, however, in the movement of the tool lever for the 'elasticity' of the armature material.

TENSIONING OF SPRINGS

13. Alternative tools.—Springs may be tensioned either with the spring adjuster or with bent duckbill pliers. The instructions which follow refer to the use of the spring adjuster, 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.

14. Principles.—It is important to understand why the tension of a spring should not be increased by merely giving a bend or set to the back end. 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 a set is finally put on the back end of the spring to increase the pressure at the contact point, the tendency to sag is counteracted by the hump and the spring remains straight.

15. *Example.*—The following example shows the details of this method, as applied when increasing the tension 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 performing the operation when the relay is mounted with the springs on either the left-hand or right-hand side:—

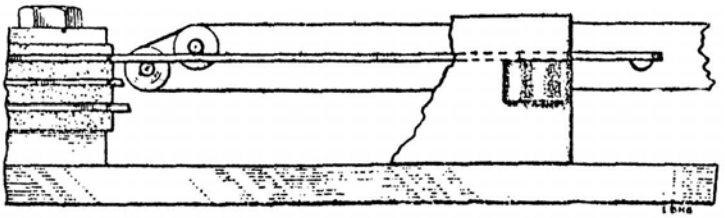
(*a*) Place the tool over the spring (with the prongs as shown) at the back end of the spring (see Fig. 7).

(*b*) 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. 8).

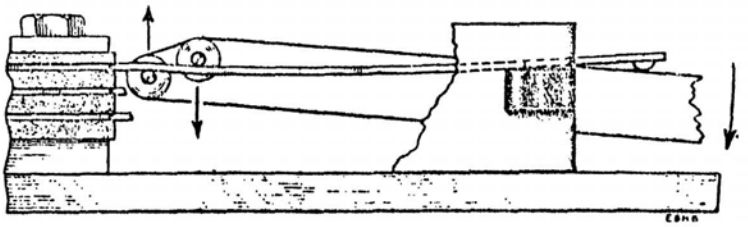
(*c*) Keeping the spring under pressure, draw the tool gently but firmly along the spring so that a "bow" is extended towards the buffer-block step (see Fig. 9).

(*d*) 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. 10).

(*e*) Replace the tool at the back end, and give a "set" to the spring, to increase the pressure on the buffer-block step until the spring becomes straight (see Fig. 11).



★FIG. 7. POSITION OF SPRING ADJUSTER



★FIG. 8. PRESSURE APPLIED TO SPRING

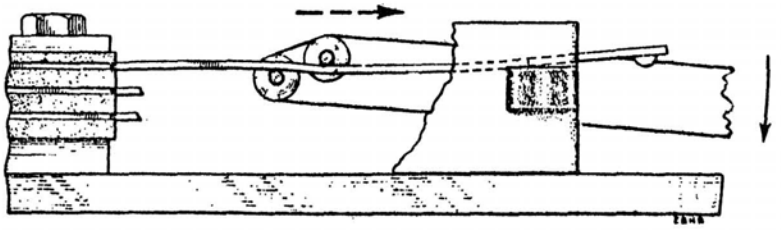


FIG. 9. STROKING THE SPRING

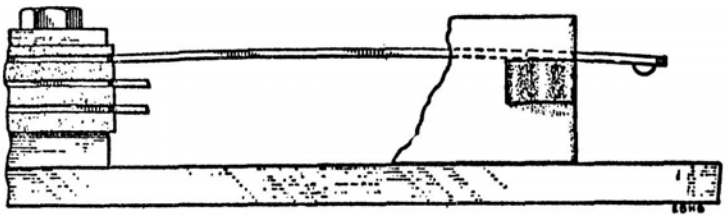


FIG. 10. BOW IN THE SPRING

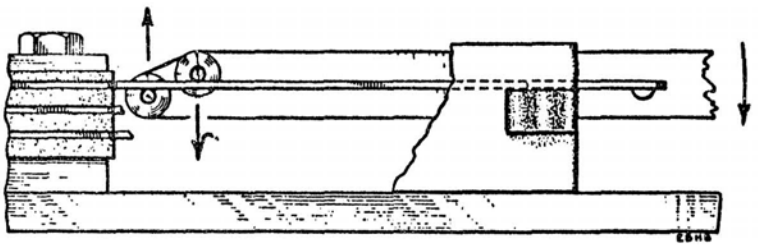


FIG. 11. GIVING FINAL SET TO THE SPRING

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 the increasing or decreasing of tension in any spring without further explanation, the appropriate end of the tool being used (see Fig. 12).

ALIGNMENT OF SPRING-SETS

★**16. Straightness of springs.**—It is a fundamental requirement of this type of relay that every spring, including the lug which rests on the buffer block, shall appear straight and flat as judged by eye when the relay is midway between the normal and operated positions, i.e. when all buffered springs are in contact

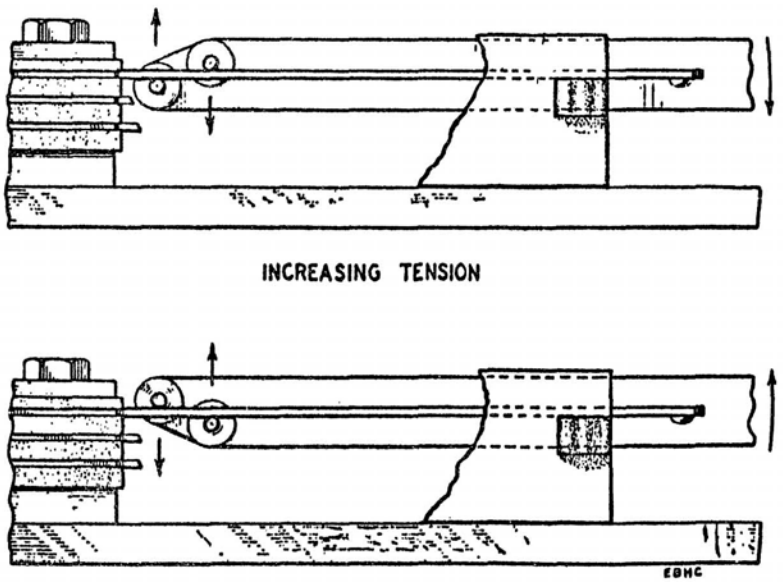
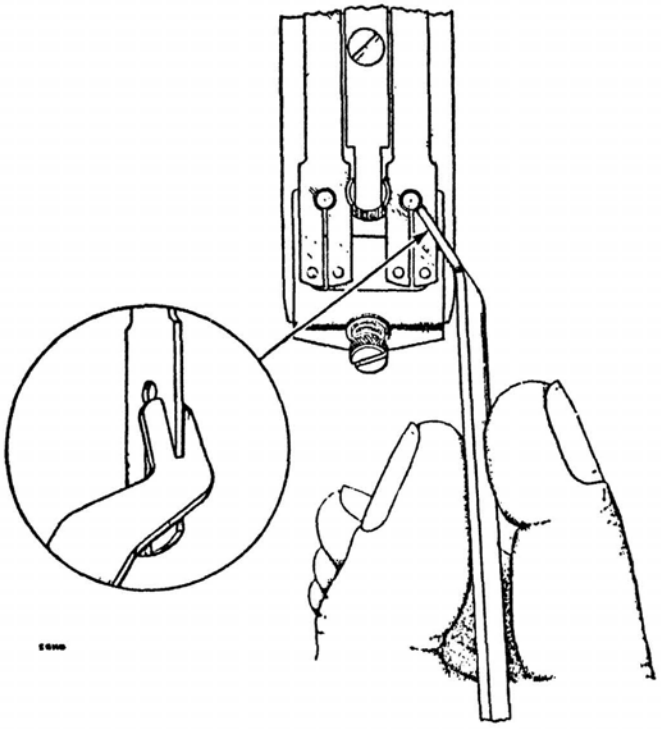


FIG. 12. INCREASING OR DECREASING TENSION

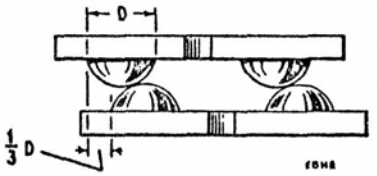
with the buffer block, and all lever springs are midway between 'break' and 'make' springs. The buffer block and lifting pins are manufactured to such dimensions that, with straight springs, all clearances —including the spring lift from the buffer block—will be obtained automatically, or at least with a minimum of adjustment. Slight bending of the front end of the springs (i.e. in front of the lifting pin or stud) is permitted, if the clearances specified in pars. 19 to 22 are not obtained. For certain L relays of subscribers' uniselector circuits the AT and ATW diagrams indicate that the L1 should make before other L contacts. This condition should be obtained by setting the 'make' spring just in front of the buffer block. A spring lug should not be bent to obtain a particular sequence of contact operation, nor should the buffer blocks be filed to obtain contact clearances, or for any other reason.

17. Twin-contact tongues.—Twin-contact points should make or break approximately at the same time as far as can be judged by 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 (see Fig. 13). The tongues of each buffered spring should then be adjusted, by means of the tongue-adjusting tool, so that the twin-contact points make or break approximately at the same time.



★FIG. 13. ADJUSTMENT OF TWIN-CONTACT TONGUES

★18. Alignment 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 be out of alignment by more than one-third of the diameter of a contact (see Fig. 14). This can be judged by eye. If faulty, the spring-set should be changed.



★FIG. 14. ALIGNMENT OF CONTACT POINTS

SPRING-SET CLEARANCES

19. Contact clearances.—The clearance between 'make' contacts when the armature is normal, and between 'break' contacts when the armature is operated, should be a minimum of 10 mils, i.e. 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.

20. Sequence of contact operation.—Apart from make-before-break ('K') units, it should be checked that all 'break' contact units break before any 'make' 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 springs should be checked and corrected if necessary, as in the case of incorrect contact clearance. For make-before-break ('K') units, the make and break operations will occur in the reverse order to those of a change-over unit

21. 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

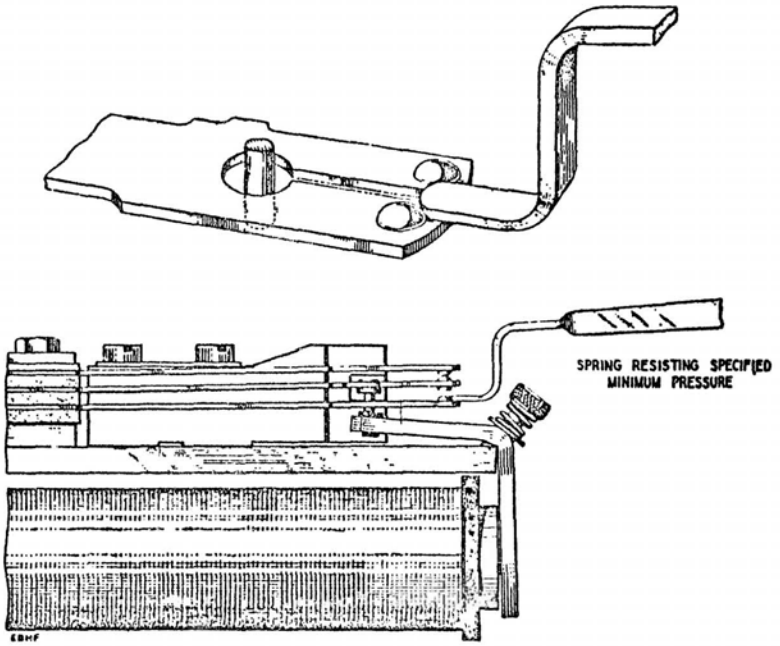
'make' contacts, and normal for 'break' contacts. The *nominal* value is about 5 mils, with a *minimum* of about 2 mils. If the lift is judged to be insufficient, the straightness of the springs, particularly the spring lugs, should be checked, and corrected if necessary. A contributory cause may be the wearing down of the contact points and, if this wear is found to be excessive, the spring-set concerned should be changed.

22. Lifting-pin clearances.—There should not be any clearance between lifting pins and studs.

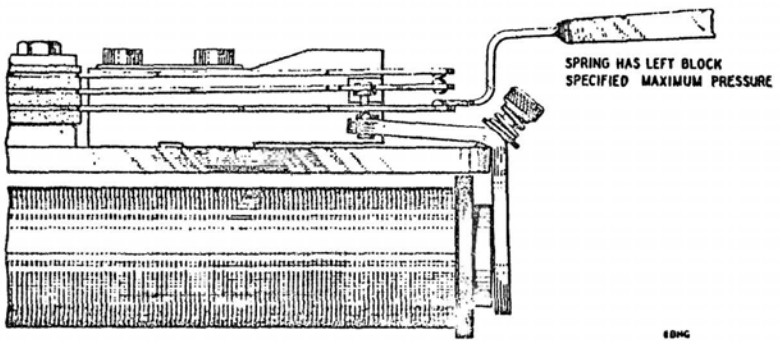
SPRING PRESSURES

★23. Block pressure.—Contact pressures are not measured directly (except for the 'make' spring of make-before-break contact units) as they are governed by lever-spring tensions and block pressures. The 'make' and 'break' contact springs should be tensioned so that their lugs rest against the steps of the block with a specified "block pressure." Block pressure is the pressure of a 'break' or 'make' contact spring resting against a buffer block and is measured by applying a tension gauge to the tip of the spring, as shown in Figs. 15 and 16. Block pressures vary with the thickness of the springs, and the appropriate "test" and "re-adjust" values are given in Table 2.

The contact springs should resist a pressure of the appropriate minimum value, as shown in Fig. 15. The springs should leave the steps of the block at the appropriate maximum value, as shown in Fig. 16. The pointer of the gauge should be applied to the tip of the spring and not to the lug.



★Fig. 15. CHECKING MINIMUM BLOCK PRESSURE

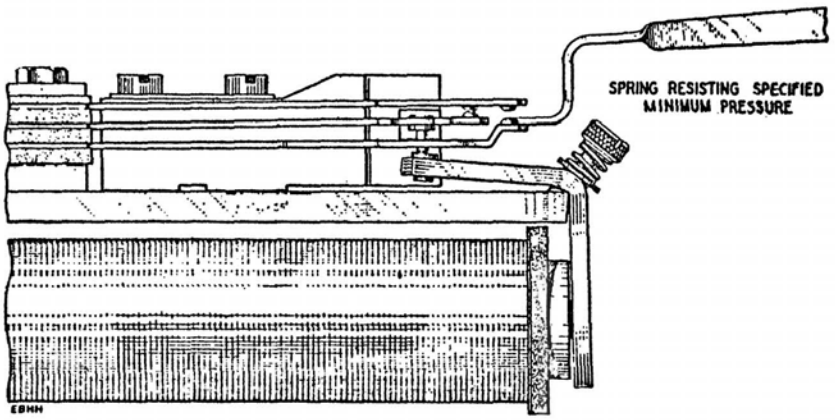


★FIG. 16. CHECKING MAXIMUM BLOCK PRESSURE

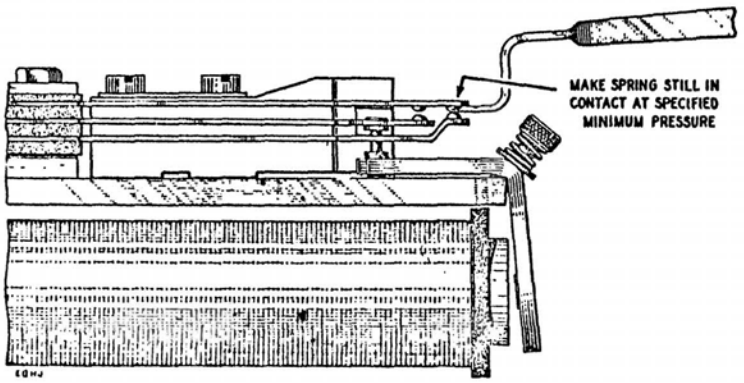
TABLE 2

Type of spring	Spring thickness	Block pressure			
		Test		Re-adjust	
		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.
'Break' spring of "K" contact units	14 mils (white label)	30 „	—	30 „	—
'Make' and 'break' springs other than on "K" contact units	12 mils (green label)	10 „	16 gm.	11 „	15 gm.
'Break' spring of "K" contact units	12 mils (green label)	20 „	—	20 „	—

24. For make-before-break contact units, the tension of the 'break' spring (i.e. the lowest of the three springs) against the block steps should be measured with the armature operated (see Fig. 17). The 'break' spring should exert a pressure on the block step in accordance with the requirements indicated in par. 23. The tension of the 'make' spring (i.e. the top spring) should be measured directly against the 'break' spring with the armature normal, the pressure gauge being applied to the tip of the 'make' spring (see Fig. 18). The contact pressures should be in accordance with those in Table 3.



★FIG. 17. CHECKING 'BREAK' SPRING PRESSURE OF K UNIT (ARMATURE OPERATED)



★FIG. 18. CHECKING DIRECT CONTACT PRESSURE OF K UNIT (ARMATURE UNOPERATED)

TABLE 3

Spring thickness	Contact pressure			
	Test		Re-adjust	
	Min.	Max.	Min.	Max.
14 mils (white label)	15 gm.	21 gm.	16 gm.	20 gm.
12 mils (green label)	10 „	16 „	11 „	15 „

The tolerances permitted in the adjustment of 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 permanently tensioned against the block.

25. *Lever-spring pressures—'Break' contacts.*—Where a lever spring is associated with a 'break' spring, it should be tensioned so that, when the armature is normal, the 'break' spring leaves the block step in accordance with the general requirements of spring lift (see par. 21). The pressure of the lever spring towards the armature under these conditions should be measured as indicated in Fig. 19, and should be within the following limits:—

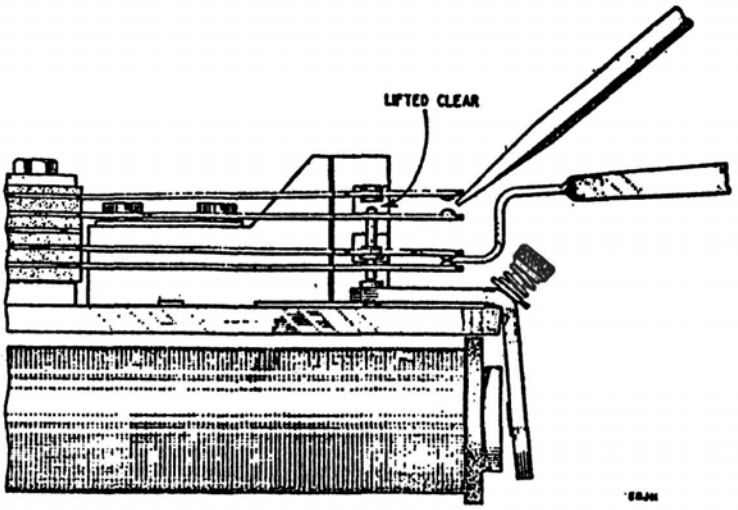
Test	Re-adjust
4 to 9 gm.	5 to 8 gm.

The pressure is measured by applying the pressure gauge to the tip of each lever spring. Any lever spring above the spring under test should be lifted clear, using the tip of a small screwdriver applied to both of the twin-contact tongues together.

26. When applying this test to a lever spring of a 'break' or change-over contact unit, the 'break' spring will follow the lever spring for a short distance, so that the two springs will move together as one, and therefore it may be found a matter of convenience to apply the gauge to the tip of the 'break' spring, instead of the lever spring.

27. *'Make' contacts.*—Each lever spring should be tensioned towards the armature so that it exerts a pressure in accordance with the table in par. 25. The method of measuring the lever-spring pressure of 'make' contacts is the same as for 'break' units, and is shown in Fig. 20.

★28. *Gross lever-spring pressure.*—The measurements indicated in pars. 25 to 27 apply to individual lever springs when re-adjusting a relay. When testing a relay, however, it will suffice if the gross pressure is measured on the innermost lever spring (i.e. the one nearest the armature) and is within the limits of 'n' times the test values, where 'n' is the number of lever springs in the spring-set. Therefore, the



★FIG. 19. CHECKING LEVER SPRING PRESSURE ('BREAK' CONTACT UNITS)

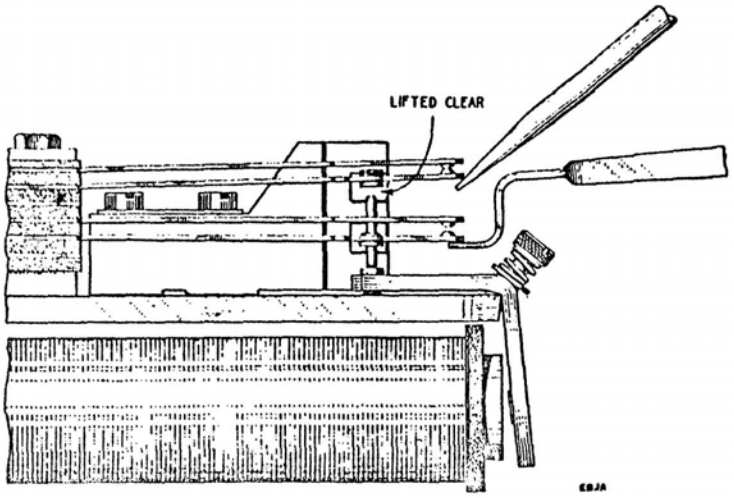


FIG. 20. CHECKING LEVER SPRING PRESSURE (' MAKE ' CONTACT UNITS)

minimum gross pressure of a spring-set having three lever springs will be 12 gm., and the maximum 27 gm. When the gross pressure is measured, the minimum inward tension of the extreme outer lever spring should not be less than 4 gm. To verify that all inner lever springs are tensioned towards the armature, the pressure due to the outer lever spring or springs should be relieved and, with an inner ' make ' or ' make-before-break ' contact unit, it should be noted that the lever spring does not exhibit any tendency to leave the lifting pin (or stud) of an adjacent lever spring, or from the armature stud. When checking the lever spring of a ' break ' or ' change-over ' contact unit in this way, it is permissible for the spring lift of the ' break ' contact spring to be reduced to zero, but the ' break ' contact must not break. Reduction of spring lift may cause the lifting pin (or stud) of an inner ' break ' or ' change-over ' unit to leave the stud or lifting pin of an adjacent lever spring and, if the ' break ' or ' change-over ' unit being checked is adjacent to the armature, its lifting pin may leave the armature stud.

ADJUSTMENT OF CONTACT UNITS

29. If a spring-set is found to be out of adjustment, it should be re-adjusted in all respects, to obviate the necessity for further re-adjustment to individual details later.

30. Order of spring adjustment.—When re-adjusting a spring-set, each contact unit (make, break, etc.) should be treated as an entirely independent unit, commencing on 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 pars. 31 to 34.

31. ' Make ' contact unit (abbreviation—M).

(*a*) Straighten the springs if necessary (see pars. 16 to 18).

(*b*) Tension the ' make ' spring against the block step (see par. 23).

(*c*) Tension the lever spring against the lifting pin or stud below it (see pars. 25 to 28).

(*d*) Check the contact clearance and spring lift, and correct if necessary (see pars. 19 to 22).

32. ' Break ' contact unit (abbreviation—B).

(*a*) Straighten the springs if necessary (see pars. 16 to 18).

(*b*) Operate the armature, and tension the ' break ' spring against the block step (see par. 23).

(*c*) Release the armature, and tension the lever spring so that the ' break ' spring clears the block step by a minimum of 2 mils and, in addition, is tensioned against the lifting pin or stud below it (see pars. 25 to 28).

(*d*) Check the contact clearance and spring lift, and correct if necessary (see pars. 19 to 22).

33. ' Change-over ' contact unit (abbreviation—C).

(*a*) Straighten the springs, if necessary (see pars. 16 to 18).

(*b*) Tension the ' make ' spring against the block step (see par. 23).

(*c*) Operate the armature and tension the ' break ' spring against the block step (see par. 23).

(*d*) Release the armature, and tension the lever spring so that the ' break ' spring clears the block step by a minimum of 2 mils and, in addition, is tensioned against the lifting pin or stud below it (see pars. 25 to 28).

(*e*) Check the contact clearances, sequence of break and make, and the spring lift, and correct if necessary (see pars. 19 to 22).

34. 'Make-before-break' contact unit (abbreviation—K).

(*a*) Straighten the springs if necessary (see pars. 16 to 18).

(*b*) Operate the armature and tension the 'break' spring, i.e. the lowest of the three springs, against the block step (see pars. 23 to 24).

(*c*) Release the armature, and tension the 'make' spring, i.e. the top spring, against the 'break' spring (see par. 24).

(*d*) Tension the lever spring, i.e. the middle spring, against the lifting pin or stud below it (see pars. 25 to 28).

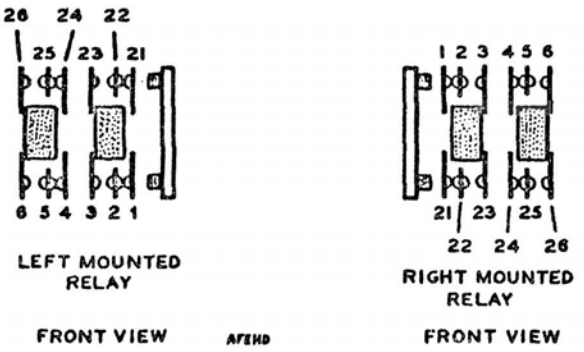
(*e*) Check the contact clearances, and correct if necessary, by adjusting the tips of the lever spring (see pars. 19 to 22).

MISCELLANEOUS

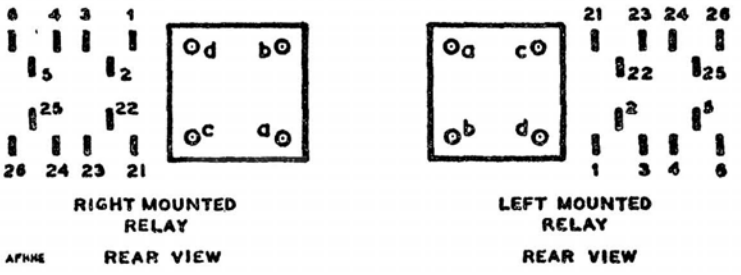
★**35. Numbering of contact springs.**—Fig. 21 illustrates the method of numbering the contact springs as viewed from the front. The standard method of mounting the relay in each of the horizontal positions is shown, with the width of the springs in a vertical plane. Spring No. 1 will be the inner spring of the lower spring-set, with the relay mounted in the left position on the mounting plate. When the relay is mounted in the right position, spring No. 1 will be the inner spring of the upper spring-set. The spring tags are shown in Fig. 22, and it will be seen that those of the lever springs occupy inward positions with respect to the 'make' and 'break' springs.

★**36. Positions of coil tags.**—The positions of coil tags as viewed from the rear of a relay having two windings are illustrated in Fig. 22. The inner winding (the winding nearest the core) is terminated on tags *a* and *b* and the outer winding to tags *c* and *d*. The inner ends of each winding are connected to tags *a* and *c* respectively. When one winding only is required, tags *a* and *b* only are provided.

★**37. Tools required.**—The following tools are required for the adjustment of 600-type relays:—



★FIG. 21. NUMBERING OF SPRINGS



★FIG. 22. NUMBERING OF SPRINGS AND LETTERING OF COIL TAGS

Rate-book description	General description and use
Screwdriver, Instrument, No. 1	Small screwdriver for armature-retaining screw
,, ,, No. 2	Medium screwdriver for buffer-block and spring-set fixing screws
,, ,, No. 4	Long screwdriver for core fixing nut
Gauges, Feeler, No. 1	Feeler gauges for general use
,, ,, No. 9	
Screwdriver, Off-set, No. 1	Off-set screwdriver for spring-set fixing screws
★Spanner, Box, Cranked, No. 5	Off-set spanner for spring-set fixing screws
Gauge, Tension, No. 1	For measuring tension of springs
,, ,, No. 2	
Cleaner, Contact, No. 1	Contact cleaner
Insulator, Contact, No. 1	Insulator for relay contact points
Guide, No. 1	Armature shoehorn, to facilitate replacement of armature
Adjuster, Armature, No. 2	For adjustment of armature travel
Adjuster, Spring, No. 2	For alignment of twin contacts
,, ,, No. 12	For tensioning of springs
Pliers, Adjusting, No. 2	Bent duck-bill pliers for spring adjustments

The spring-set fixing screws now fitted are hexagon headed and are not slotted. Screwdriver Off-set No. 1 is retained for existing spring-set screws.

★**38.** If a tool is damaged or faulty, it should be changed. The tools specified in par. 37 should be used only for the purpose for which they are intended, and a tool should not be used if it is in such a condition that screws, nuts or springs would be damaged by its use.

39. Replacement of parts.—Reference should be made to B 5506 for the procedure to be adopted and details of parts.

References:—B 5144, 5506, H 5026
(Tp 2) General, Q.1005, Q.1020

END