RELAYS
STEP-BY-STEP
AECO HORIZONTAL-TYPE RELAYS NOT LISTED IN SECTION 040-236-711

1. GENERAL

1.01 This section covers AECo horizontal-type relays not listed in Section 040-236-711. These relays include pin-, pivot-, and pendulum-type relays not having corresponding WECo code numbers and used on AECo or WECo engineered circuits which show schematics of the relay spring combinations on the circuit requirement tables.

1.02 This section is reissued to revise the title and the paragraph covering the contents of the section; to add a paragraph covering supplementary requirements; to revise the residual, heelpiece airgap, armature travel, stud gap, and electrical requirements; and to reword definitions and requirements to bring them into agreement with corresponding definitions and requirements in Section 040-236-701. It is also reissued to revise corresponding procedures. Detailed reasons for reissue will be found at the end of the section. Since these changes constitute a general revision, the arrows ordinarily used to indicate changes have been omitted.

1.03 Supplementary Requirements: The circuit requirement tables contain requirements which supplement those covered in this section, except for timing requirements applicable to B, C, and E position and similar functioning relays of selectors, connectors, repeaters, and test distributors. In such cases reference shall be made to Section 040-013-711 for timing, residual, and electrical requirements.

1.04 Section 040-236-701 covers the requirements for all WECo step-by-step relays and for similar AECo relays for which:

(1) The spring combination schematics of the relays do not appear on the circuit requirement table.

(2) The spring combination schematics of the relays appear on the circuit requirement table but the relays, together with their requirements, have been listed in Section 040-236-711.

Spring combination schematics are not shown on new circuits issued after May 1, 1935.

1.05 Reference shall be made to Section 020-010-711 covering general requirements and definitions for additional information necessary for the proper application of the requirements listed herein.

1.06 Operate: A relay is said to operate if, when current is connected to its winding, the armature moves all the way up to the core, except where a residual airgap is specified, all normally closed contacts break, and all normally open contacts make. Where a residual airgap is specified, the residual screw instead of the armature touches the core.

1.07 Nonoperate: A relay is said to nonoperate if, when current is connected to its winding, the armature does not move sufficiently to close any normally open contacts or to reduce the contact pressure on normally closed contacts enough to cause an unreliable contact. [See exceptions under 2.13(c).]

1.08 Hold: A relay is said to hold if, after it has operated and the current is reduced abruptly to the hold value, or is interrupted momentarily, the armature does not move sufficiently from its operated position to cause normally open contacts to become unreliable or to cause normally closed contacts to make.

1.09 Release: A relay is said to release if the armature moves from its operated position sufficiently to cause normally open contacts to break and normally closed contacts to make reliably.

1.10 Heelpiece airgap is the gap between the end of the heelpiece and the nearest point on the armature when the relay is electrically operated.

1.11 Residual airgap is the gap between the face of the relay core and the nearest point on the armature with the relay electrically operated and the residual screw touching the core.

1.12 Armature travel (stroke) is the gap between the core and the armature (or the core and the residual screw where a residual airgap is specified) with the relay in the normal (unoperated) position.

1.13 Armature stud gap is the clearance between the armature stud and the first lever spring when the armature is resting against the backstop.

1.14 Spring assembly is an arrangement of all the springs operated by one armature lever of a relay having either one or two armature levers.

1.15 Spring combination consists of all spring assemblies of a relay.

1.16 Contact springs are the individual springs of a spring combination or spring assembly.

1.17 Standard make-before-break contact springs are an arrangement of springs where the lever spring makes contact when the relay is operated (see Fig. 1).

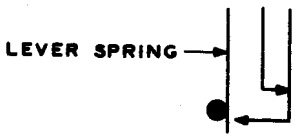


Fig. 1 - Standard Make-before-Break Contact Springs

1.18 Special make-before-break contact springs are an arrangement of springs where the lever spring breaks contact when the relay is operated (see Fig. 2).

Fig. 2 - Special Make-before-Break Contact Springs

1.19 Preliminary contacts are contacts for which separate electrical requirements are specified on the circuit requirement table.

1.20 2-step operation relays are relays having separate electrical requirements for one or more pairs of contact springs.

1.21 If relays having two armature levers are equipped with two armature backstops, only the upper stop should be used for adjusting purposes and the lower stop should be made ineffective.

1.22 Where normal post spring assemblies interfere with checking requirements or making adjustments, these assemblies should be removed from the switch or rotated to make the relays accessible.

1.23 Where reference is made to the circuit requirement table, this shall be understood to include AECo relay adjustment sheets (AH-drawings) if circuit requirements tables are not available.

1.24 Pendulum-type Relays - Measurement of Contact Pressure and Tension of Armature Weight Against Heelpiece: Fig. 3 - If circuit requirement tables specify requirements for contact pressure and for tension of the armature weight against the heelpiece, measure the contact pressure at the point of contact using the No. 70D gauge with the relay electrically operated. Gauge the tension of the armature weight against the heelpiece by feel with the armature in the unoperated position.

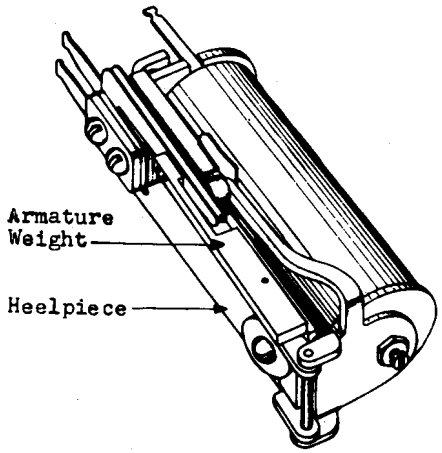


Fig. 3 - Pendulum-type Relay

2. REQUIREMENTS

2.01 Cleaning: The contacts and other parts shall be cleaned when necessary in accordance with Section 069-306-801.

2.02 Relay Mounting: Relays shall be fastened securely to the mounting plate.

Gauge by feel.

2.03 Vertical Clearance Between Relays

(a) There shall be a clearance between the armature or springs of any relay and the armature, springs, or heelpiece of the relay above or below it of

Min 1/32 inch

Gauge by eye.

(b) There shall be a clearance between the armature backstop and the heelpiece of the relay above it.

Gauge by eye.

2.04 Contact Alignment

(a) Relays Having Round-type Contacts: Fig. 4(1) - Contacts shall not be out of alignment more than 40 per cent of their base diameter.

Gauge by eye.

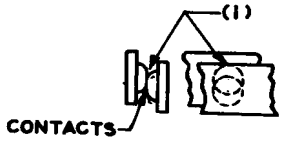


Fig. 4 - Maximum Permissible Contact Misalignment

(b) Relays Having Heavy Bar Contacts: Fig. 5 - On relays equipped with bar contacts, the contact alignment shall be within the limit indicated in Fig. 5.

Gauge by eye.

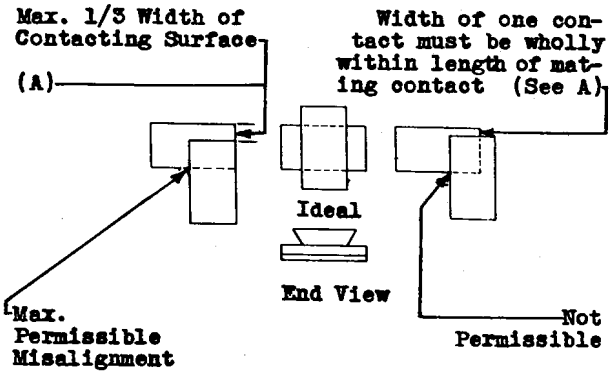


Fig. 5 - Alignment of Heavy Bar Contacts - Plan View of Contacting Surfaces

2.05 Armature Movement

(a) Pin-type Armatures: Fig. 6(A) - The armature shall move freely on its bearings and the end play shall be

Max 0.030 inch

Gauge by eye and feel.

To check the end play, hold the armature against one of the bearing lugs and observe the clearance between the other side of the armature and the other bearing lug.

(b) Pivot-type Armatures: Fig. 7(A) - The armature shall move freely on its bearings and shall have perceptible end play.

Gauge by eye and feel.

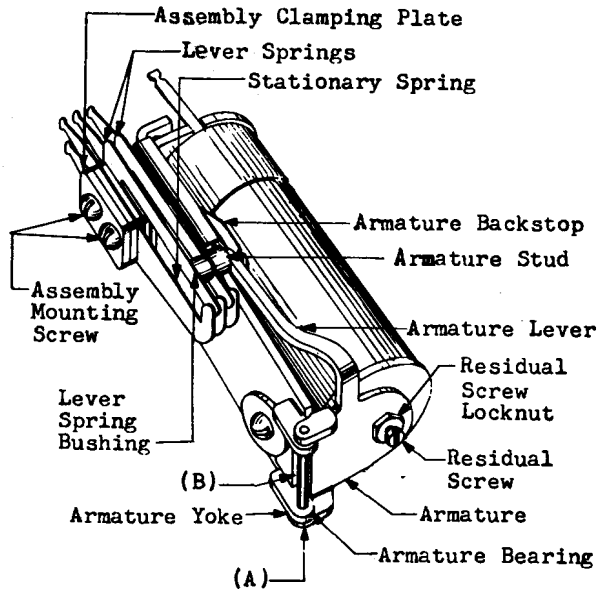


Fig. 6 - Pin-type Relay

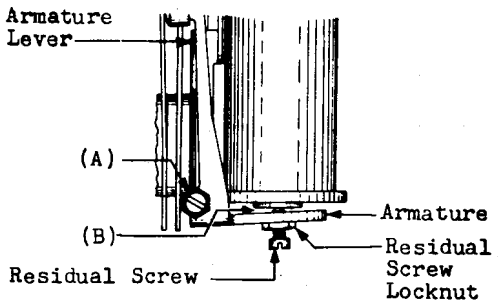


Fig. 7 - Pivot-type Relay

2.06 Residual Airgap: Fig. 7(B) - With the relay electrically energized, it shall meet the residual airgap requirement

specified in the RESID column of the circuit requirement table or in Section 040-013-711. The residual values specified on the circuit requirement table shall be interpreted in accordance with the following table:

Residual Specified on Circuit Req Table	Minimum	Maximum
0	Armature shall touch core	See note 1
0.0015 inch	Armature shall not touch core	0.004 inch See note 2
0.003 inch	Armature shall not touch core	0.005 inch
0.005 inch	0.003 inch	0.007 inch
0.006 inch	0.004 inch	0.008 inch
0.009 inch	0.007 inch	0.011 inch
SL or Slight	Armature shall not touch core	0.002 inch See notes 2&3
S	Armature shall not touch core	As specified

Notes

1. If zero (0) residual is specified on the circuit requirement table for B position relays of local selectors, connectors, and repeaters, the relays shall be adjusted to meet SL (slight) residual. When these circuits are reissued, they will specify SL residual.

2. In readjusting the following relays to meet timing requirements, it may be desirable to adjust the residual toward the minimum.

   B relays of local selectors, connectors, and repeaters

   C relays of local selectors and connectors

   E relays of connectors

   Similar functioning relays of other circuits

3. If pulsing tests are applied to the B position relays of local selectors, connectors, and repeaters and similar functioning relays of other circuits, the maximum 0.002-inch limit is waived as a test requirement, since the maximum limit is controlled by the pulsing test.

Check the residual airgaps as follows:

(a) Residual Airgaps of Zero (0); Minimum Limit S, SL, or Slight: Insert a strip of KS-7187 Bell Seal bond paper between the armature and core. Electrically energize the relay, and when necessary, supplement the energizing force of the relay by pressing the armature toward the core by hand sufficiently for a dot or impression to appear on the paper if a residual airgap is present. Release the relay and withdraw the paper. Absence of a dot or impression on the bond paper indicates zero (0) residual airgap. Presence of a dot or impression indicates that the residual screw protrudes beyond the face of the armature and, therefore, that the minimum requirements for S, SL, or Slight residual airgaps are met.

(b) Residual Airgap of 0.003 Inch or Less; Maximum Limit of SL or Slight: Insert the proper KS-6909 gauge between the armature and core as shown on Fig. 8 so that the residual screw is free to touch the core through the hole in the gauge. Then, holding the gauge against the armature, insert a strip of KS-7187 Bell Seal bond paper between the gauge and core so that the paper is back of the hole in the gauge as viewed from in front of the relay. Electrically energize the relay and, when necessary, supplement the energizing force by pressing the armature toward the core by hand with sufficient force to cause a dot or impression to appear on the paper if the residual airgap is greater than the thickness of the gauge. Release the relay and withdraw the paper and the gauge. Absence of a dot or impression on the paper indicates that the residual airgap is less than the thickness of the gauge. Presence of a dot or impression on the paper indicates that the gap is greater than the thickness of the gauge.

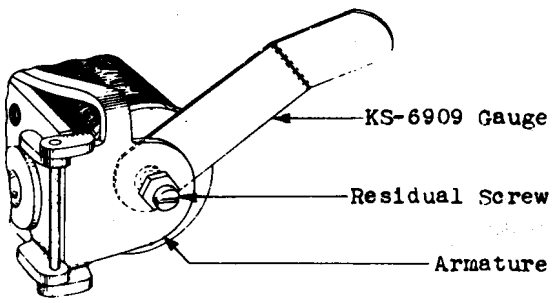


Fig. 8 - Checking the Residual Airgap

(c) Residual Airgaps of 0.004 Inch or More: Insert the proper KS-6909 gauge between the armature and core as shown in Fig. 8 so that the residual screw is free to touch the core through the hole in the gauge. Electrically energize the relay. When the gauge is tight, the residual airgap is less than the thickness of the gauge. When the gauge is not tight, the gap is greater than the thickness of the gauge.

(d) Examples

(1) Specified Residual Airgap S-4: The S gap (Min) is checked in accordance with (a) and is met if a dot appears on the bond paper. The 4 gap (Max 0.004 inch) is checked in accordance with (c) and is met if the 0.004-inch gauge is tight.

(2) Specified Residual Airgap 7-11: Both the minimum 0.007-inch and the maximum 0.011-inch gaps are checked in accordance with (c). The minimum 0.007-inch requirement is met if the 0.007-inch gauge is not tight, and the maximum 0.011-inch requirement is met if the 0.011-inch gauge is tight.

2.07 Heelpiece Airgap (Relays with pin-type armatures only)

(a) Fig. 6(B) - When the relay is electrically operated with the specified residual airgap:

(1) The armature shall be parallel to the heelpiece.

Gauge by eye, using the P-220366 dental mirror.

(2) The clearance between the armature and heelpiece measured at the closest point shall be

Min - Armature shall not touch the heelpiece

Max 0.004 inch

Use gauges and checking methods covered in (b).

Note: On B position and similar functioning relays, C position relays, and E position connector relays, it may be necessary to readjust the heelpiece airgap toward the minimum value to facilitate meeting the pulsing tests.

(b) Insert the gauge specified for the type of relay listed in the following table between the armature and heelpiece as shown in the figures referred to in the table. Take care not to extend the gauge between the armature and the core. Electrically operate the relay. The requirement for minimum gap is met if the gauge does not bind. The requirement for maximum gap is met if the gauge is tight. Be sure to check the gap over the entire width of the heelpiece.

Type of Relay	Gap	Use		Refer to	
		Gauge	Blade (Inch)	Fig.	Notes
Single Armature Pin-type Relay	Min	KS-6909	0.0015	10	1
	Max	KS-6909	0.004	9	
Double Armature Pin-type Relay	Min	KS-6909	0.0015	9	1,2
	Max	KS-6909	0.004	9	2
Pivot-type Relay	Min	75F	0.002	-	1,3
	Max	75C	0.004	-	3

Notes

1. This requirement is also considered met if light can be observed between the armature and heelpiece throughout the entire width of the heelpiece. Use the P-220366 dental mirror.
2. On relays having heavy pin bearings, use the No. 92R gauge (minimum requirement) and the No. 75C gauge (maximum requirement) inserted at an angle from the right.
3. Insert the gauge from the right just above the armature arm. In checking these relays it may be necessary in some cases to remove the relay from the mounting plate.

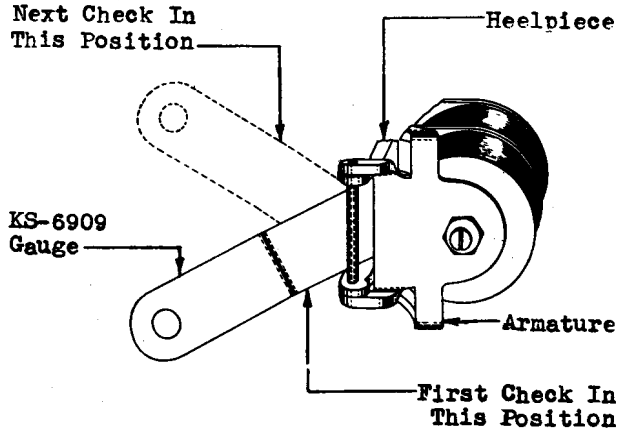


Fig. 9 - Checking Minimum and Maximum Heelpiece Airgap on Double Armature Relays and the Maximum Airgap on Single Armature Pin-type Relays

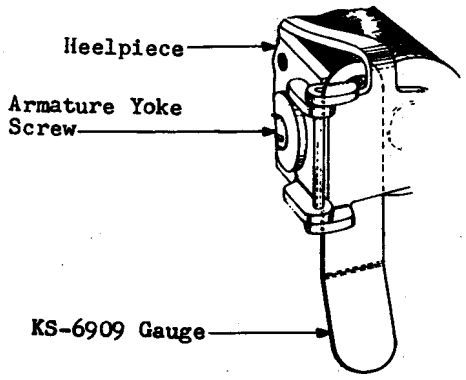


Fig. 10 - Checking Minimum Heelpiece Airgap on Single Armature Relays

2.08 Armature Travel (Stroke): If armature travel (stroke) is specified on the spring combination figure on the circuit requirement table, the relay shall meet the following requirements. (The armature travel specified on the spring combination figure is the nominal value.)

(a) If Difference Between Armature Travel and Highest Spring Gauging Value Specified on Spring Combination Figure is 0.005 Inch or Greater - Fig. 11 and 12

Min The armature shall leave the armature backstop with the relay electrically energized against a gauge 0.002-inch smaller than the specified armature travel, inserted between the armature and core, or between the armature and residual screw, if a residual is specified.

Use the KS-6909 and KS-6938 gauges.

Insert the gauge as covered in (c) and energize the relay electrically. Observe the position of the armature lever with respect to the backstop.

Max With the relay in the normal position, a gauge 0.003-inch larger than the specified armature travel shall not enter between the armature and the core, or the armature and the residual screw, if residual is specified.

Use the KS-6909 and KS-6938 gauges.

Attempt to insert the gauges as described in (c). If the gauge just enters, the requirement is considered met if the armature does not leave the backstop when the relay is electrically energized against the gauge.

Example 1: Fig. 11 - The armature should leave the backstop when the relay is electrically energized against a gauge of 0.018 inch. With the relay in the normal position, a gauge of 0.023 inch should not enter between the armature and the core, or residual screw, if specified.

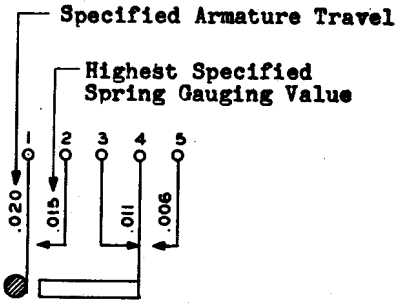


Fig. 11 - Armature Travel Requirement on Single Armature Relay - Difference Between Armature Travel and Highest Spring Gauging Value Specified on a Spring Combination Figure Is 0.005 Inch or Greater

Example 2: Fig. 12 - The armature should leave the backstop when the relay is electrically energized against a gauge of 0.026 inch. With the relay in the normal position, a gauge of 0.031 inch should not enter between the armature and the core, or residual screw, if specified.

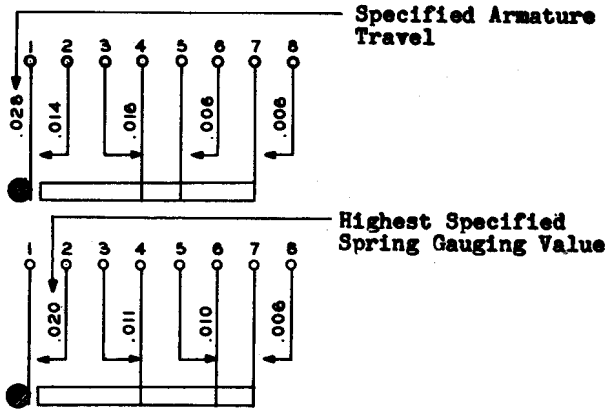


Fig. 12 - Armature Travel Requirement on Double Armature Relay - Difference Between Armature Travel and Highest Spring Gauging Value Specified on a Spring Combination Figure Is 0.005 Inch or Greater

(b) If Difference Between Armature Travel and Highest Spring Gauging Value Specified on Spring Combination Figure is 0.004 Inch or Less - Fig. 13

Min The armature shall leave the armature backstop when the relay is electrically energized against a gauge which is 0.002-inch larger than the gauge on which the springs with the highest gauging values actually make or break when properly adjusted.

Use the KS-6909 and KS-6938 gauges.

Insert the gauge as covered in (c) and energize the relay electrically. Observe the position of the armature lever with respect to the backstop.

Max When the relay is in its normal position, a gauge 0.003-inch larger than the specified armature travel shall not enter between the armature and the core, or the armature and the residual screw, if a residual airgap is specified.

Use the KS-6909 and KS-6938 gauges.

Attempt to insert the gauge as described in (c). If the gauge just enters, the requirement is considered met if the armature does not leave the backstop when the relay is electrically energized against the gauge.

Example: Fig. 13 - The armature should leave the backstop when the relay is electrically energized against a gauge 0.002-inch greater than that on which springs 1 and 2 actually make. With the relay in the normal position, a gauge of 0.018 inch should not enter between the armature and the core, or residual screw, if specified.

(c) Method of Inserting Gauges: Insert the gauge between the nearest point on the core and the armature where no residual airgap is specified, or between the core and residual screw where a residual airgap is specified. Insert the gauge approximately vertically so that it completely covers the core and rests against the armature lever as shown in Fig. 14. The armature lever acts as a stop for the gauge. If springs or other parts of the switch interfere with positioning the gauge as shown in Fig. 14, insert the gauge approximately at the angle shown in Fig. 15. Take care to insert the gauge so that it completely covers the core but does not project more than 1/16 inch beyond the core toward the heelpiece as gauged by eye. When inserted in this way, the bend in the blade will coincide approximately with the circumference of the relay spoolhead. If the gauge is inserted so that it extends beyond the core, the armature rather than the residual screw may contact the gauge as shown in Fig. 16. This is most likely to occur when gauging relays having low residual airgap and high armature travel requirements. In such cases, insert the gauge only far enough to engage the residual screw.

Note: When gauging values over 0.040 inch are specified on the spring combination figures herein, it will be satisfactory to stack two gauges to make up the required value.

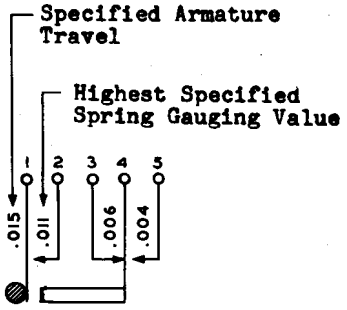


Fig. 13 - Armature Travel Requirement - Difference Between Armature Travel and Highest Spring Gauging Value Specified in a Spring Combination Figure Is 0.004 Inch or Less

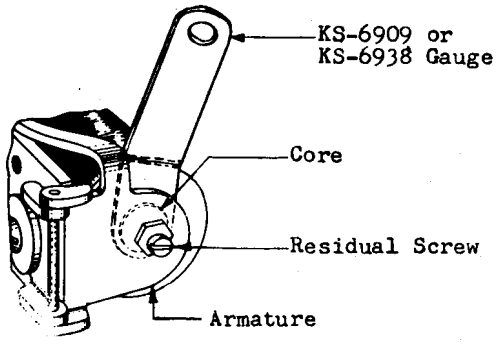


Fig. 14 - Checking Armature Travel and Spring Gauging

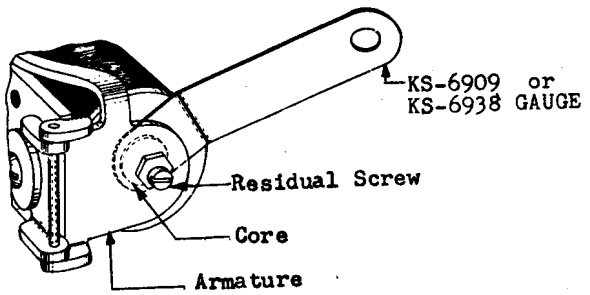


Fig. 15 - Checking Armature Travel and Spring Gauging Where the Method Illustrated in Fig. 14 Cannot Be Applied

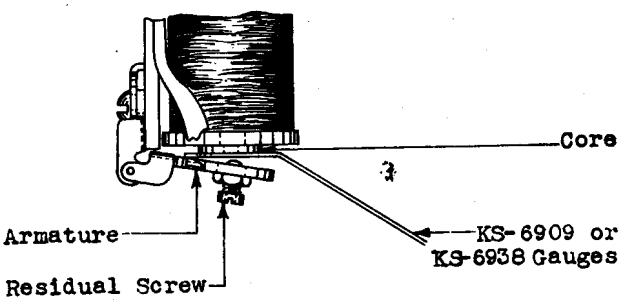


Fig. 16 - Incorrect Method of Checking Armature Travel and Spring Gauging

2.09 Stud Gap: The following stud gap requirements shall apply.

(a) Position of First Lever Spring With Respect to Armature Stud: Fig. 17(A) - With the armature resting against the backstop, the gap between the first lever spring and the armature stud shall be as shown in the following table:

Gauge by eye.

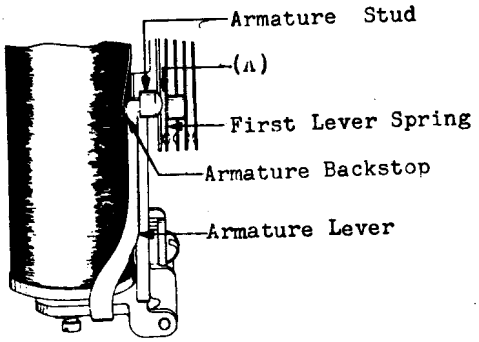


Fig. 17 - Illustrating Armature Stud Gap Requirement

Type of Relay	Type of First Lever Spring	Armature Stud Gap (See 1.13)
Single Armature Relays (See Exception A Below)	Balancing or Normally Open Contact Spring	See note 1
	Normally Closed Contact Spring	Perceptible
	Spl Make-before-Break Contact Springs Per Fig. 2	
Double Armature Relays	Normally Open Contact Springs on Both Assemblies	See note 2
	Normally Closed Contact Springs on Both Assemblies	Perceptible on Each Assembly Max 0.012 Inch on at Least One Assembly
	Normally Closed Contact Spring on One Assembly and Spl Make-before-Break Contact Springs Per Fig. 2 on Other Assembly	
	Normally Open Contact Spring on One Assembly and	See note 1
	Normally Closed Contact Spring or Spl Make-before-Break Contact Springs Per Fig. 2 on Other Assembly	Perceptible
Exception A B Relay of Plunger Type Line Switches	Normally Closed Contact Spring	Stud Gap Specified on CRT ±0.004 Inch

Notes

1. The spring shall rest against the stud with sufficient pressure to hold the armature against the backstop.
2. Each spring shall rest against its associated stud, and the combined tension of the two springs shall hold the armature against the backstop.

(b) B Relay of Primary Line Switches - Stud Gap at No. 2 Spring on BCO Spring Combination: Fig. 18(A) - With the armature resting against the backstop, there shall be a perceptible clearance between the No. 2 spring and the stud on the next lever spring.

Gauge by eye and feel.

2.10 Spring Tension of Restoring Spring - BCO Spring Combination on B Relay of Primary Line Switches: Fig. 18(B) - The tension of the restoring spring shall be sufficient to hold the armature against the backstop.

Gauge by eye and feel.

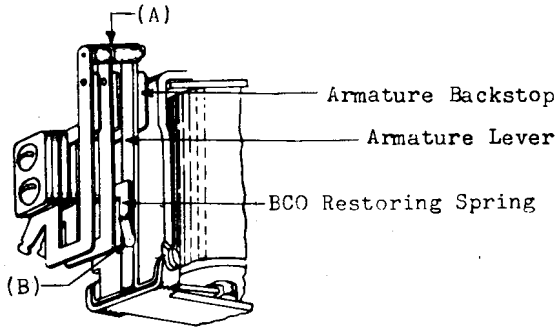


Fig. 18 - BCO Part of Primary Line Switch B Relay

2.11 Straightness of Springs: All springs, from the point where they leave the assembly clamping plates and insulators to the ends of the springs, shall be free of sharp bends and kinks due to adjustment, but a maximum 1/32-inch bow in the spring is permissible.

Gauge by eye.

2.12 Spring Gauging: All relays shall meet the spring gauging requirements specified on the spring combination figures shown on the circuit requirement table with the tolerances specified in the following subparagraphs of this requirement. The values specified on the spring combination figures are nominal values.

(a) Standard Tolerances [Subject to exception (b) (1) through (b) (4)]

(1) All Relays Except B (BCO) Relays of Primary Line Switches: The following tolerances shall apply to the spring gauging values specified on the spring combination figures shown on the circuit requirement table.

To check the spring gauging requirement, insert the KS-6909 or KS-6938 gauge between the armature and core as described in 2.08. Electrically energize the relay. Where a soak current is specified on the circuit requirement table, use this current to energize the relay. Determine visually whether the contacts are open or closed. This will be facilitated by using the No. 510C test lamp with the No. 561A straight tip or the No. 562B curved tip held below the contacts.

Specified Spring Gauging Value	Normally Open Contacts Shall Not Make and Normally Closed Contacts Shall Not Break With a Tolerance of Plus (+) See Exceptions (b)(1)-(b)(4)	Normally Open Contacts Shall Make and Normally Closed Contacts Shall Break With a Tolerance of Minus (-) See Exceptions (b)(1)-(b)(4)
0.005 inch or greater	0.002 inch	0.002 inch
0.004 inch	0.002 inch	0.001 inch
0.003 inch or less	0.002 inch	0.000 inch
All values for B relays of secondary and outtrunk switches	0.003 inch	0.003 inch

Note: In order to determine whether pitted contacts are open or closed, it may be necessary to apply the KS-6320 orange stick to the lever spring and attempt to move the spring.

(2) B Relay of Primary Line Switches - BCO Spring Combination: The spring gauging values shown on the spring combination figures on the circuit requirement table for these relays represent contact separation. The contact separation of normally closed contacts with the relay operated, and of normally open contacts with the relay normal shall be

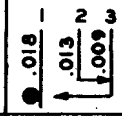
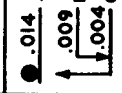
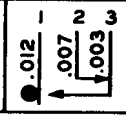
The spring gauging value shown on the spring combination figure ±0.004 inch tolerance.

Use the No. 103A gauge inserted between the contacts.

(b) Exceptions To Standard Tolerances

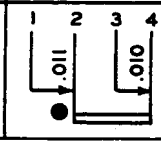
(1) All Make-before-Break Contact Springs: The following exceptions to the standard tolerances apply to these springs with reference to the difference between spring gauging values specified for normally open and normally closed contacts.

Difference Between Spring Gauging Values	Exceptions to Standard Tolerances Normally closed contacts shall not break with relay electrically energized against gauge indicated below	See Example (EX) No. Below
0.004 inch or less	0.002 inch smaller than value on which normally open contacts just make	1
0.005 inch or greater	0.003 inch smaller than value on which normally open contacts just make	2
All values on C relays of selectors	0.001 inch smaller than value on which normally open contacts just make	3

EX NO.	SPRING COMB.	SPRINGS 1 AND 3		SPRINGS 2 AND 3	
		CONT MUST NOT MAKE ON †	IF CONT MAKE ON	CONT MUST NOT BREAK ON	CONT MUST BREAK ON †
1		0.015 0.015 0.015	0.013 0.012 0.011	0.011 0.010 0.009	0.007 0.007 0.007
2		0.011 0.011 0.011	0.009 0.008 0.007	0.006 0.005 0.004	0.003 0.003 0.003
3		0.009 0.009	0.006 0.005	0.005 0.004	0.003 0.003

†Standard Tolerances Apply

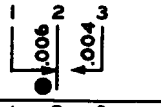
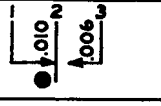
(2) Break Contact Springs of Spring Assemblies Having Two or More Sets of Break Contacts: [Exclusive of Standard Make-before-Break Spring Assemblies per Fig. 1 See Example (1)] - The sequence of operations as indicated by the specified spring gauging values for the break contacts shall be maintained, necessitating exceptions to the standard tolerances as indicated by example 4.

EX NO.	SPRING COMB.	SPRINGS 1 AND 2		SPRINGS 3 AND 4	
		CONT MUST NOT BREAK ON †	IF CONT JUST BREAK ON	CONT MUST NOT BREAK ON	CONT MUST BREAK ON †
4		0.013 0.013 0.013 0.013	0.012 0.011 0.010 0.009	0.012 0.011 0.010 0.009	0.008 0.008 0.008 0.008

†Standard Tolerances Apply

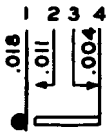
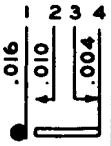
(3) Break-Make Contacts: The following exceptions to the standard tolerances apply to these springs with references to the difference between the gauging values specified for normally closed and normally open contacts.

Difference Between Specified Gauging Values	Exceptions to Standard Gauging Tolerances Normally open contacts shall not make when relay is electrically energized against a gauge of	See Example (EX) No. Below
0.002 inch or less	0.001 inch-less than gauge on which normally closed contacts just break	5
0.003 inch or greater	0.002 inch-less than gauge on which normally closed contacts just break	6

EX NO.	SPRING COMB.	SPRINGS 1 AND 2		SPRINGS 2 AND 3	
		CONT MUST NOT BREAK ON †	IF CONT JUST BREAK ON	CONT MUST NOT MAKE ON	CONT MUST MAKE ON †
5		0.008 0.008 0.008	0.007 0.006 0.005	0.006 0.005 0.004	0.003 0.003 0.003
6		0.012 0.012 0.012	0.010 0.009 0.008	0.008 0.007 0.006	0.004 0.004 0.004

†Standard Tolerances Apply

(4) 2-step Operation Relays: The following exceptions to the standard tolerances apply on 2-step operation relays if the circuit requirement table specifies that normally open contacts shall make before the normally closed contacts break. These exceptions are specified with reference to the difference in the spring gauging values specified for these contacts.

Difference Between Spring Gauging Values	Exception to General Tolerances	Spring Comb.
0.007 inch or greater	The normally open contacts shall make before their lever spring strikes the bushing of the normally closed spring.	
0.006 inch or less	The normally open contacts may or may not make before their lever spring strikes the bushing on the lever spring of the normally closed contacts. However, the normally open contacts shall make before the normally closed contacts break.	

Note: The above requirement applies to contacts designated + in each combination shown on Fig. 19. These requirements do not apply to springs 2, 3, 5, and 6 of combinations similar to Fig. 20.

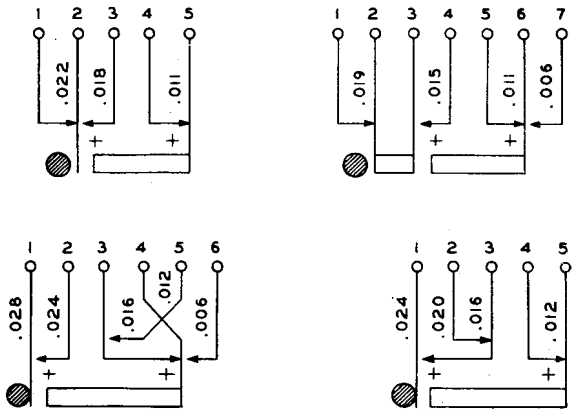


Fig. 19 - Typical Spring Combinations to Which Exception 2.12(b)(4) Applies

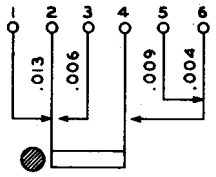


Fig. 20 - Typical Spring Combination to Which Exception 2.12(b)(4) Does Not Apply

2.13 Electrical Requirements

DC Requirements

(a) The relay shall meet the electrical requirements specified on the circuit requirement table.

Use the 35-type test set.

(b) The soak value specified on the circuit requirement table shall be applied, or if the circuit requirement table refers to the section, the relay shall be soaked before applying the electrical (test or readjust) requirement by passing through the relay winding or windings under test the maximum current (within the fusing limit of the test box) permitted by the test clip data with minimum resistance in the test set.

(c) Exceptions to Nonoperate Requirements:

(1) 2-step Operation Relays: The contact springs for which separate electrical requirements are specified may make or break on the nonoperate requirement for the entire spring combination.

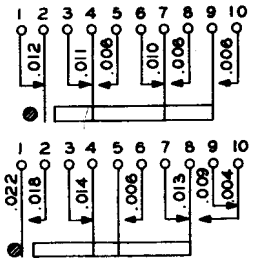
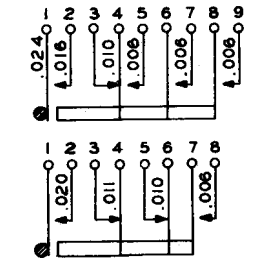
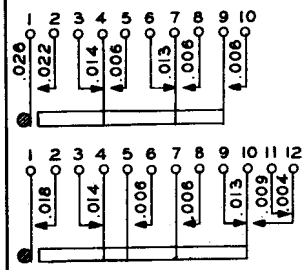
(2) Special Make-before-Break Springs per Fig. 2: The make contacts may make on the nonoperate requirement for the entire spring combination.

(3) Spring Combinations Having Three or More Normally Closed Contacts: The first two normally closed contacts in the sequence, as indicated by the specified spring gauging values, may break on the nonoperate requirement for the entire spring combination.

Note 1: On double armature relays, the contacts permitted to break need not be in the same pile-up.

Note 2: For the purposes of this requirement, the break contacts of standard make-before-break springs per Fig. 1 are not considered as break contacts.

(4) The following examples illustrate when normally closed contacts may break on the nonoperate requirement for the entire spring combination.

Spring Combination	Springs Which May Break Contact	Springs Which Shall Not Break Contact
	3&4,7&8 Bottom	1&2,3&4 6&7 Top
	3&4 Top and 3&4 Bottom or 3&4,5&6 Bottom	5&6 Bottom 3&4 Top
	3&4 Top and 3&4 Bottom	6&7 Top and 9&10 Bottom

AC Requirements

(d) Full Selective Ring-trip Relays: These relays shall operate and nonoperate during the ringing period in series with the following noninductive resistances as applied by the test set and the test line or their equivalents, with the ringing machine voltages within the limits indicated.

Test or Readjust	Series Resistance ±1%		AC Voltage Range
	Opr	N.O.	
Test	900	1230	64-80
Readjust	970	1120	72-80

No testing or readjusting shall be done during the silent or battery period.

3. ADJUSTING PROCEDURES

3.001 List of Tools, Gauges, Test Apparatus, and Materials

Code or Spec No.	Description
Tools	
40	Offset Screwdriver
43	3/16- and 1/4-inch Hex Open Double-end Flat Wrench
48	Combination 7/32- and 1/4-inch Hex. Double-end Socket Wrench and Screwdriver
206	30-degree Offset Screwdriver
207	90-degree Offset Screwdriver
256	Spring Adjuster
259	Spring Adjuster
326B	Adjuster
415B (or replaced 415A)	Spring Adjuster
416B (or replaced 416A)	Spring Adjuster
417A	1/4- and 3/8-inch Hex. Open Double-end Flat Wrench
418A	5/16- and 7/32-inch Hex. Open Double-end Flat Wrench
436A	Heelpiece Adjusting Tool
510C	Test Lamp [must be equipped with No. 561A straight tip or No. 562B curved tip and W2CB (24 volt) or W2BL (48 volt) cord]
563A	90-degree Offset Screwdriver
564A	45-degree Offset Screwdriver
597A (or replaced AECo H14768)	Armature Adjuster
KS-6320	Orange Stick
KS-7782	Pliers
AECo H7066	Spring Adjuster
AECo H14769	Armature Backstop Adjuster
P220366	Dental Mirror

Code or Spec No.	Description
-	3-inch Cabinet Screwdriver
-	4-inch Regular Screwdriver
R2739	90-degree Offset Screwdriver
Gauges	
70D	50-0-50 Gram Gauge
74D	Thickness Gauge Nest
92R	0.0015-inch Nonmagnetic Offset Thickness Gauge
103A	0.012-inch, 0.014-inch, and 0.015-inch Thickness Gauge
KS-6909	Thickness Gauge Nest
KS-6938	Thickness Gauge Nest
Test Apparatus	
35-type	Current Flow Test Set
Materials	
KS-7187	1/2- by 1-1/2-inch Bell Seal Bond Paper, Substance No. 20
KS-7860	Petroleum Spirits
-	Hardwood Toothpicks, Flat at One End and Pointed at the Other

3.01 Cleaning (Rq 2.01)

(1) Clean the contacts and other parts of the relay in accordance with Section 069-306-801.

3.02 Relay Mounting (Rq 2.02)
3.03 Vertical Clearance Between Relays (Rq 2.03)

(1) Shift the position of the relay when necessary to obtain the required clearance by loosening the mounting screws with the 4-inch regular screwdriver. Securely tighten the screws.

3.04 Contact Alignment (Rq 2.04)

(1) If the contacts are misaligned proceed as follows:

(a) If the assembly is loose, align the springs as required and tighten the springs assembly clamping screws with the 4-inch regular screwdriver or with the No. 563A or 564A offset screwdrivers as shown in Fig. 21.

(b) If the contact alignment requirement is not met and the spring assembly screws are tight, refer the matter to the supervisor.

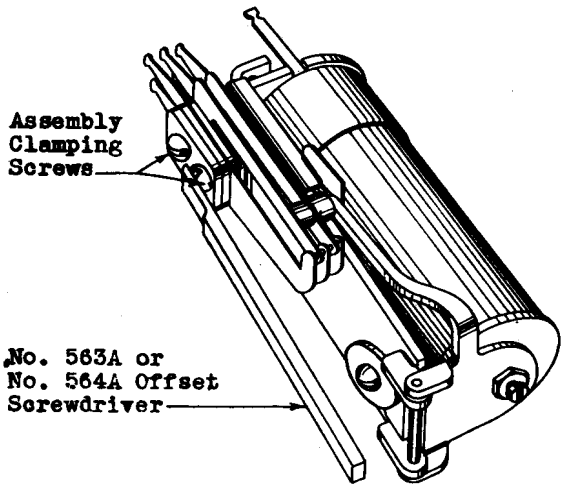


Fig. 21 - Aligning Contact Springs

3.05 Armature Movement (Rq 2.05)

Relays With Pin-type Armatures

(1) If the requirement is not met, replace the armature as covered in Section 040-236-801.

Relays With Pivot-type Armatures

(2) If the armature binds and there is some end play, loosen the pivot screw locknut with the No. 43, 417A, or 418A wrench depending on the nut provided on the relay. Turn the pivot bearing screw sufficiently in a counterclockwise direction with the No. 40, 206, 207, or R2739 offset screwdrivers as shown in Fig. 22 to permit removing the armature. Then remove the armature and check for burrs on the heelpiece, armature bearings, pivots, or armature. Replace the parts at fault in accordance with Section 040-236-801.

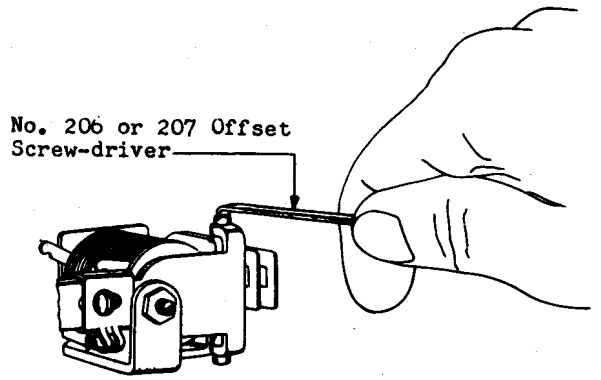


Fig. 22 - Method of Adjusting for Armature Movement

(3) If the trouble is not due to burrs, clean the bearing surface with a clean toothpick which has been dipped in petroleum spirits. Do not use the same toothpick for more than one operation. Exercise care that the petroleum spirits do not come in contact with insulators, studs, or spoolheads. Remount the armature, position the pivot screw to obtain the required end play, and securely tighten the lockout.

(4) If there is no armature end play, loosen the locknut with the No. 43, 417A, or 418A wrench and reposition the pivot screw with the No. 40, 206, 207, or R2739 offset screwdrivers. If the end play is excessive, turn the screw in a clockwise direction. Then tighten the locknut securely.

3.06 Residual Airgap (Rq 2.06)
3.07 Heelpiece Airgap (Rq 2.07

(1) First adjust the residual airgap and then the heelpiece airgap as described below.

(2) To change the residual airgap, loosen the residual screw locknut with the socket wrench of the No. 48 combination wrench and screwdriver. Using the screwdriver, turn the residual screw in to increase the gap and out to decrease the gap.

(3) Then readjust the heelpiece airgap if necessary as follows. Loosen the armature yoke mounting screw with the No. 563A or 564A offset screwdriver. Set the armature so that there is a gap between it and the heelpiece of approximately 0.025 inch as gauged by eye, and tighten the armature yoke screw to hold the armature temporarily in this position.

(4) Insert the No. 436A heelpiece adjusting tool between the armature and heelpiece as shown in Fig. 23 and 24 for the various types of relays. Energize the relay. Loosen the armature yoke screw about 1/8 turn and tap the armature lightly toward the heelpiece with the handle of the screwdriver portion of the No. 48 combination wrench and screwdriver until the No. 436A tool binds. Exercise care not to tap the yoke. The purpose of tapping the armature is to take up all the play in the yoke bearing in the direction of the heelpiece. If the yoke is tapped rather than the armature, the play will be taken up in the opposite direction. Hold the armature in this position with the fingers and tighten the armature yoke mounting screw securely. When using the No. 436A tool from the heelpiece side, exercise care not to mutilate the tool when tightening the armature yoke screw. Remove the tool and recheck the heelpiece airgap.

(5) If B and C position relays do not meet the pulsing tests after the heelpiece has been adjusted with the No. 436A tool as described in (3) and (4), it may be necessary to readjust the heelpiece airgap closer to the minimum limit.

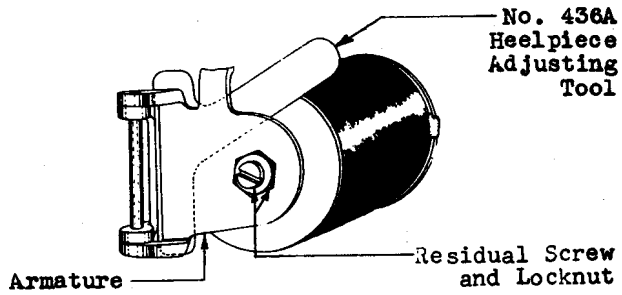


Fig. 23 - Adjusting the Heelpiece Airgap With the No. 436A Heelpiece Adjusting Tool Inserted From the Armature Side

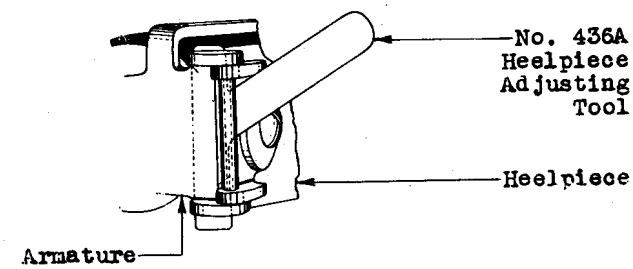


Fig. 24 - Adjusting the Heelpiece Airgap With the No. 436A Heelpiece Adjusting Tool Inserted From the Heelpiece Side (All Except the Z Position Relays and Relays With Extra Heavy Armature Hinges)

(6) In certain cases changing the residual airgap or heelpiece airgap may cause the relay to fail to meet the spring gauging requirement. If the relay was known to meet this requirement prior to the gap adjustments and no longer meets the requirement, the condition may readily be corrected by adjusting the armature lever slightly with the No. 597A armature adjuster. With the armature held against the core, apply the adjuster to the straight portion of the lever arm at the point shown in Fig. 25, taking care not to burr the lever arm. If the lever arm is adjusted in this way, make sure that the first lever spring is parallel to the heelpiece when the armature is in the released position.

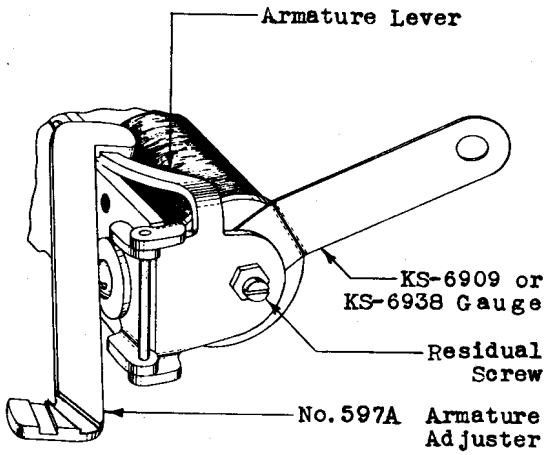


Fig. 25 - Method of Adjusting the Armature Lever

3.08 Armature Travel (Stroke) (Rq 2.08)
3.09 Stud Gap (Rq 2.09)

First Lever Spring Is a Normally Open Contact Spring or a Balancing Spring

(1) If the relay fails to meet the armature travel requirement, insert between the core and armature where no residual is specified, or between the core and the residual screw where a residual is specified, a gauge of the value specified for armature travel in the proper spring combination figure on the circuit requirement table plus the plus tolerance specified in the armature travel requirement. Energize the relay.

(2) If under this condition all first lever springs are not parallel to the heelpiece, make the following adjustment. With the No. 597A armature adjuster applied to the armature lever as shown in Fig. 25, adjust the lever until the associated first lever spring is approximately parallel to the heelpiece.

(3) Note whether the armature backstop is touching the armature lever. If it is not touching, adjust the backstop so that it just touches the armature lever, using the No. 326B or 416B adjuster, or the H14769 armature backstop adjuster if the relay has a pin-type armature (see Fig. 26). If the relay is used as a Z position relay on a 197-type switch, adjust the armature lever as necessary using the KS-7782 pliers as shown in Fig. 27. After making this adjustment de-energize the relay, remove the gauge, and insert the gauge of the value specified for armature travel in the proper spring combination figures on the circuit requirement table minus the minus tolerance specified in the armature travel requirement. Re-energize the relay and note that the armature leaves the backstop.

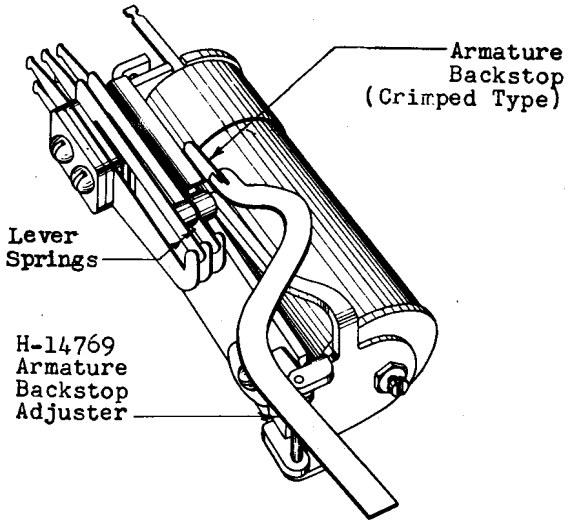


Fig. 26 - Adjusting the Clearance Between the Armature Stud and the First Lever Spring on Relays Equipped With Pin-type Armature

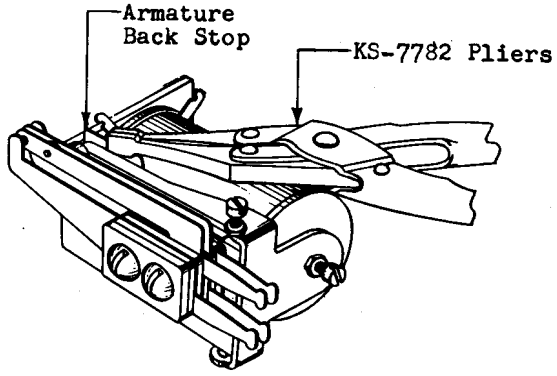


Fig. 27 - Adjusting the Armature Stud Gap on Relays Equipped With Pivot-type Armature

(4) If the first lever spring does not hold the armature against the backstop, tension this spring as required using the No. 415B, 416B, or 259 spring adjuster or the KS-7782 pliers.

(5) Check that springs other than the first lever spring meet the spring gauging specified in the spring combination figures, as defined in the spring

gauging requirement. and if necessary readjust the springs as covered in 3.11

First Lever Spring Is a Normally Closed Contact Spring

(6) Before adjusting the relay to meet the stud gap requirement, adjust all lever springs if necessary, so that they are positioned to be as nearly parallel to the heelpiece as practicable. To position the first lever spring parallel to the heelpiece, adjust the associated break contact spring as required, using the No. 415B or 416B spring adjuster. Then adjust the stud gap as covered in (7) through (9).

(7) Relays With Pin-type Armatures: To change the clearance between the armature stud and the first lever spring, adjust the end of the armature backstop with the No. 326B, 416B, or the H14769 armature backstop adjuster away from the armature stud to increase the gap and towards the stud to decrease the gap.

(8) Relays With Pivot-type Armatures (Except B Relays of Primary Line Switches): To change the clearance between the armature stud and the first lever spring, adjust the armature backstop with the KS-7782 pliers away from the armature stud to increase the gap and towards the stud to decrease the gap. See Fig. 27.

(9) B Relays of Primary Line Switches

(a) To change the clearance between the BCO armature stud and the first lever spring of the BCO spring combination, adjust the No. 1 spring with the No. 415B or 416B spring adjusters away from the lever spring to decrease the gap and towards the lever spring to increase the gap. If it is impossible to obtain the gap in this manner and still meet the spring gauging requirements, the armature backstop is probably too far away from the heelpiece. In this case remove the line switch from the shelf as described in Section 030-761-701. Then remove the line switch jack assembly mounting screw and the A relay mounting screw with the 3-inch cabinet screwdriver. Now remove the BCO spring combination by removing the mounting screws with the 3-inch cabinet screwdriver. Adjust the armature backstop to rest approximately flat against the heelpiece with the KS-7782 pliers and reassemble all parts. Then adjust the No. 1 spring as described above to obtain the stud gap.

(b) If there is not a perceptible clearance between the No. 2 spring and the stud of the next lever spring of the BCO spring combination of primary line switches, change the position of the break contact spring associated with the next lever spring with the No. 415B or 416B spring adjusters.

(10) After adjusting the stud gap as covered in (7) through (9), check that the other springs meet the spring gauging limits specified in the spring combination figures on the circuit requirement table. Readjust if necessary as described in 3.13.

3.10 Spring Tension of Restoring Spring - BCO Spring Combination on B Relay of Primary Line Switches (Rq 2.10)

(1) If the BCO armature restoring spring has not enough tension to hold the armature arm against the backstop, adjust the spring with the No. 7066 spring adjuster. Apply the spring adjuster near the bend in the spring as shown in Fig. 28 and then give a slight twist to the adjuster.

3.11 Straightness of Springs (Rq 2.11)

(1) Do not straighten kinked lever springs unless the kinks interfere with proper adjustment of the springs, since removing kinks tends to weaken the springs and to shorten their life. Normally straight springs that have been adjusted should have no sharp bends. A gradual bow, however, is permissible.

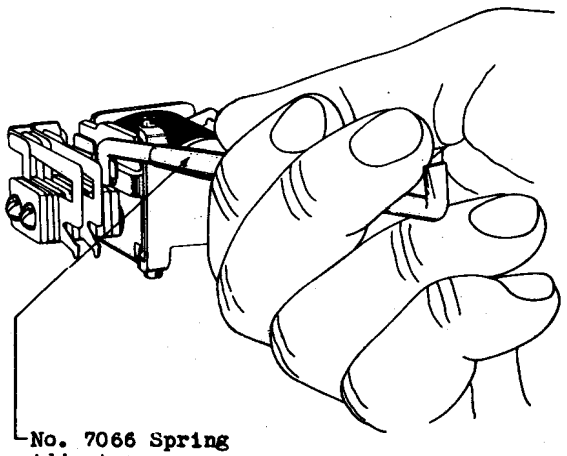


Fig. 28 - Method of Adjusting the BCO Armature Restoring Spring Tension

(2) If a spring is excessively bowed or bent, straighten it with the No. 415B or 416B spring adjuster. In some cases it may be necessary to use the No. 259 spring adjuster or the KS-7782 pliers.

(3) To remove an excessive bow in a lever spring, place the adjuster or pliers on the spring just behind the stud and slide the tool along the spring to a point near the inner end as shown in Fig. 29 and 30. Draw the adjuster or pliers forward the length of the bow carefully, exerting pressure in a direction opposite to the bow. Adjust the spring in line with its movement to avoid tilting the spring.

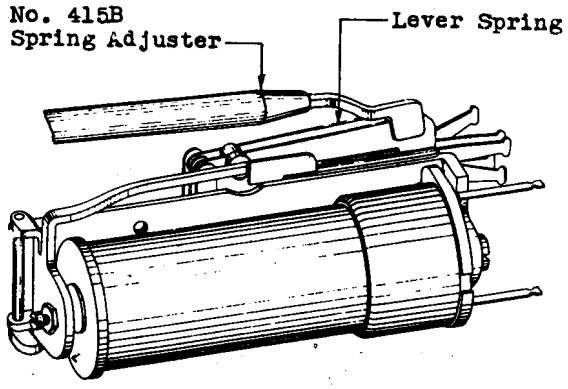


Fig. 29 - Adjusting Lever Spring for Tension

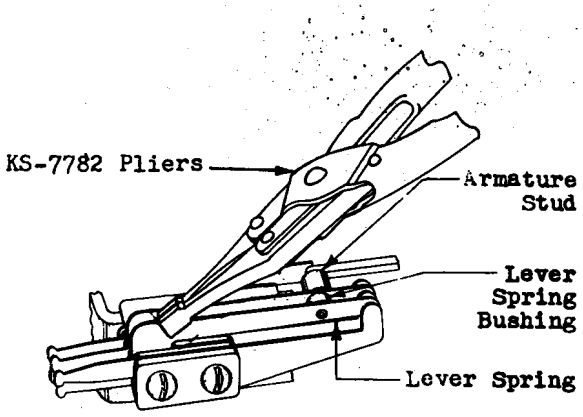


Fig. 30 - Removing Excessive Bow From Spring

(4) To remove a kink in the spring, apply the adjuster or pliers just in front of the kink and carefully bend the spring to remove the kink. Where mounting conditions permit, it is desirable to hold the spring with one tool behind the kink and bend the spring with a second tool.

(5) After straightening the springs check requirement 2.12 and readjust if necessary.

3.12 Spring Gauging (Rq 2.12)

(1) If the requirement is not met, adjust the lever springs as described in (2) and the stationary springs as described in (3). Adjust the springs toward the preferred limit of the spring gauging requirement described in (4). Distribute the spring tension as described in (5).

(2) Adjustment of Lever Springs: To adjust the lever springs proceed as follows:

(a) Place the No. 415B or 416B adjuster on the spring just behind the stud and slide it along to a point near the inner end as shown in Fig. 29. In some cases it may be necessary to use the No. 259 adjuster or the KS-7782 parallel jaw pliers. When using the pliers, apply them to the spring at the point at which the spring adjuster is applied as shown in Fig. 29.

(b) To increase the tension of a spring toward the armature stud, bend the spring toward the stud; to decrease the tension, bend the spring away from the stud. Adjust the spring in line with its movement to avoid tilting. Take care not to disturb adjacent springs. Do not adjust springs any more than necessary, since repeated adjustment may injure a spring.

(c) If sufficient tension (toward the armature stud) cannot be obtained by adjusting the spring as described in (b) without bowing the spring beyond the permissible limit, or reducing the clearance between springs to a point where they may touch, proceed as follows.

(d) Apply the spring adjuster or pliers to the spring just behind the stud and slide the tool along the spring to a point near the inner end as shown in Fig. 29 and 30. Then carefully draw the tool forward the length of the spring, meanwhile applying pressure so that the spring is formed into a slight gradual bow with the concave surface facing the heelpiece. Then move the tool to the inner end of the spring and adjust the spring as described in (b). The magnitude of the bow to be formed in the spring must be learned by experience and should be such that when the final adjustment is made at the inner end of the spring, the spring will be approximately straight.

(e) Adjust the stationary springs of the BCO spring combination of Primary Line Switch B relays with the No. 7066 spring adjuster and the lever springs

with the No. 7066 spring adjuster and KS-7782 pliers as shown in Fig. 31. If difficulty is experienced in meeting the spring gauging requirements for the BCO spring combination, note that the armature backstop is flat against the heelpiece. If it is not, adjust it as outlined in procedure 3.09(9).

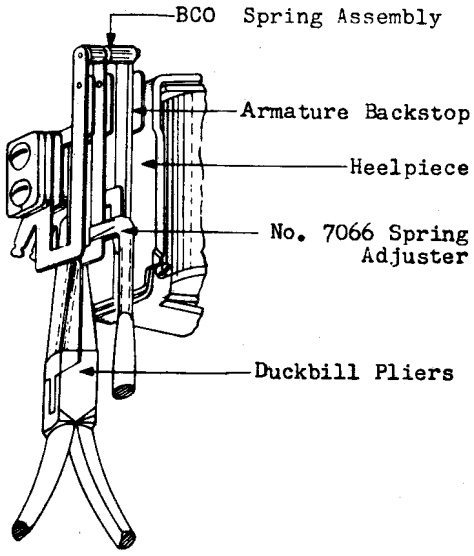


Fig. 31 - B Relay of Primary Line Switch - Method of Adjusting BCO Springs for Spring Gauging

(3) Adjustment of Stationary Springs: To adjust the stationary springs (back or front contact springs) proceed as follows:

(a) Apply the No. 415B or 416B spring adjuster to the slanting edge of the spring near the point where the spring leaves the insulators as shown in Fig. 32. In some cases it may be necessary to use the KS-7782 pliers or the No. 259 spring adjuster.

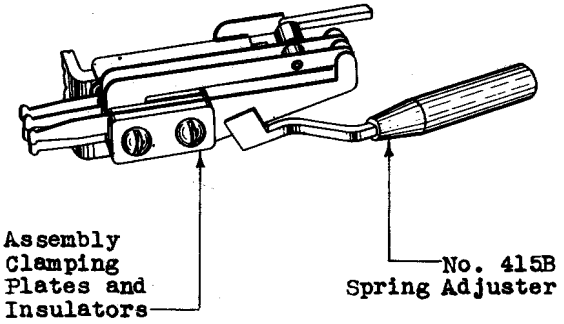


Fig. 32 - Adjusting Spring to Meet the Spring Gauging Requirements

(b) Adjust the spring carefully to the left or right as required to properly position the spring, taking care not to disturb adjacent springs. Take care not to tilt the springs. Do not adjust springs more than necessary, since repeated adjustment may injure a spring.

(c) In the case of Z position relays adjust the stationary springs where mounting conditions permit with the No. 256 spring adjuster applied from the right near the point where the spring leaves the insulators. In some cases it may be necessary to remove the switch from the shelf to properly adjust these relays.

(4) Preferred Adjustments for Spring Gauging Requirements: Adjust the springs toward the preferred limit for spring gauging as follows:

(a) Adjust normally closed contacts (except normally closed contacts of make-before-break spring assemblies) so that they just break with a gauge inserted of a value as near the minimum specified as will insure meeting the sequence of normally closed contacts and normally open contacts.

(b) Adjust the normally closed contacts of make-before-break assemblies so that they break as near the specified maximum gauging value as possible.

(c) Adjust normally open contacts so that they just fail to make with a gauge of the maximum value inserted.

(5) Distribution of Spring Tension: Distribute the tension on springs as follows:

(a) On spring assemblies having more than one normally closed contact, it is advisable to tension the lever springs against the associated normally closed contact springs so that the contact pressure at each normally closed contact is approximately equal, consistent with meeting the electrical requirements. Check for approximate equal distribution of tension, using the KS-6320 orange stick applied to the spring, first removing the tension of the springs which press against the spring being checked. On D position relays of selectors and on similar functioning relays, it may not be possible to evenly distribute the tension and still meet the electrical requirements.

(b) In the case of lever springs associated with normally open contacts only, distribute the tension between the lever springs as equally as possible, consistent with meeting electrical requirements.

(c) In order to meet electrical requirements applying to the preliminary contacts of 2-step operation relays, it may be necessary to tension the lever spring associated with the preliminary contacts to a different value from that of the other lever springs in the spring assembly.

3.13 Electrical Requirements (Rq 2.13)

(1) If a relay fails to meet the dc electrical operate or hold requirement, reduce the tension of the lever springs as covered in 3.12.

(2) If a relay fails to meet the dc electrical nonoperate or release requirement, increase the tension of the lever springs as covered in 3.12.

REASONS FOR REISSUE

1. To revise the title to the section.
2. To revise the paragraph covering the contents of the section (1.01).
3. To add a paragraph covering supplementary information (1.03).
4. To revise the definitions of operate, nonoperate, hold, and release (1.06 to 1.09).
5. To revise the definition of heelpiece airgap (1.10).
6. To revise the definition of residual airgap (1.11).
7. To revise the definition of armature travel (1.12).
8. To add a definition for armature stud gap (1.13).
9. To revise the definition for spring assembly (1.14).
10. To revise the definition for spring combination (1.15).
11. To add a paragraph covering adjustment of relays on switches with normal post springs (1.22).
12. To revise the requirement for relay mounting (2.02).
13. To add a requirement for vertical clearance between relays (2.03).
14. To revise the requirement for contact alignment (2.04).
15. To revise the requirement for armature movement (2.05).
16. To revise the requirement for residual airgap (2.06).
17. To revise the requirement for heelpiece airgap (2.07).
18. To revise the requirement for armature travel (2.08).
19. To revise the requirement for stud gap (2.09).
20. To revise the requirement for spring gauging (2.12).
21. To revise the electrical requirement (2.13).
22. To revise the list of tools (3.001).
23. To omit former paragraphs 3.002 and 3.003.
24. To revise the procedures for contact alignment (3.04).
25. To revise the procedures for armature movement (3.05).
26. To revise the procedures for residual and heelpiece airgaps (3.06 and 3.07).
27. To revise the procedures for armature travel and stud gap (3.08 and 3.09).
28. To revise the procedures for straightness of springs (3.11).
29. To revise the procedures for spring gauging (3.12).
30. To revise the procedures for electrical requirements (3.13).