SWITCHES

304, 305, 306, 307, 308, 314, 315, AND 318 TYPES

REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers 304-, 305-, 306-, 307-, 308-, 314-, 315-, and 318-type switches.

1.02 This section is reissued to:

- Incorporate the information contained in Addendum.
- Cover the use of the P13F206 shim which is used for repairing worn holding armatures and bringing contact follow tolerances to an acceptable limit.
- Add the P-13F206 shim to the List of Materials.
- Add a new Fig. Z.
- Add (e) to 3.25.

1.03 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.

Definitions

1.04 ***Selecting Armature:*** For the purpose of this section, a selecting armature is either the upper or the lower part of the double armature attached to the selecting bar.

1.05 ***Operate-Selecting Unit:*** A selecting unit is said to ***operate*** if, when current is connected to its associated winding, the armature moves until the stop disc touches the core, all contacts in the associated selecting off-normal spring assembly are closed, and the associated selecting fingers touch the stop surface of the associated operating card.

1.06 ***Operate-Vertical Unit***

(a) ***All Switches Except 308A Switch:*** A vertical unit is said to ***operate*** if, when current is connected to its associated winding, the following conditions are met.

(1) Holding armature moves until its stop plate touches the bottom pole piece.

(2) A selecting finger touches the stop surface of the associated operating card.

(3) All contacts in a crosspoint are closed.

(4) All normally open contacts in the holding off-normal spring assembly are closed.

(5) All normally closed contacts in the holding off-normal spring assembly are open.

(b) ***308A Switch (Two crosspoints on the same vertical unit operated at the same time):*** A vertical unit is said to ***operate*** if, when current is connected to its associated winding the following conditions are met.

(1) Holding armature moves until its stop plate touches the bottom pole piece.

(2) Selecting fingers on two levels (0 or 1 and one other level) touch the stop surface of their associated operating cards.

(3) All contacts in both crosspoints are closed.

(4) All normally open contacts in the holding off-normal spring assembly are closed.

(5) All normally closed contacts in the holding off-normal spring assembly are open.

1.07 ***Normal Position of Holding Armature:*** A holding armature is said to be in the ***normal position*** when the holding armature stud rests against the holding armature backstop and

the holding armature rests on the top edge of the armature support lug.

1.08 ***Crosspoint:*** A crosspoint includes only those vertical unit springs, exclusive of off-normal springs, operated when a selecting unit and a vertical unit operate.

1.09 ***The standard point of measurement*** on the holding magnet is 1/8 inch from the right side of the lower pole piece. This position is obtained automatically when the specified gauges are used (see Fig. P).

1.10 ***A pair of contacts,*** as referred to in this section, consists of a single contact bar on one contact spring and the corresponding contact bar on the opposing contact spring.

1.11 ***The terms make contact or break contact*** apply to the electrical circuit between the two springs. Contact make may involve only one pair of the two parallel pairs of contacts. Contact break involves the opening of both parallel pairs of contacts.

General Information

1.12 Before checking or adjusting for any requirements on a switch or removing a holding armature, if possible take the switch out of service in the approved manner.

1.13 Except where otherwise specified, the parts of the switch may be operated either manually or electrically in order to check the requirements.

1.14 ***Preparation of KS-16832 L2 Lubricant:*** This lubricant is provided in 2-ounce and 1-pint containers. A small wide-mouth container, such as the 2-ounce jar in which the lubricant is available, should be used as a receptacle from which to dispense the lubricant. If allowed to stand more than 1 day without agitation, the lubricant ingredients tend to separate; therefore, each day before using, shake the container of lubricant for approximately 30 seconds to ensure mixing of the ingredients. The proper method of shaking the lubricant consists of repeated, rapid turning of the container to an upside down position and back to the upright position. If the lubricant from a 1-pint container is to be used, the lubricant must be mixed as just described before it is poured into the smaller container. Under storage conditions, the cover should be tight on the container.

2. REQUIREMENTS

General Requirements

2.01 ***Cleaning***

(a) Contacts shall be cleaned, when necessary, in accordance with approved procedures. After cleaning any contact, a check should be made to see that both contacts on the bifurcated spring involved close as specified in requirements 2.21(c), 2.25(b), 2.39(column C), and 2.40(b).

(b) Loose dust and dirt shall be removed, when necessary, in accordance with approved procedures.

2.02 ***Mounting of Switch and Switch Parts***

(a) Fig. A(1)—The screws mounting the switch on the framework and the screws mounting the vertical units on the switch frame shall be tight.

Gauge by feel.

(b) Fig. A(2)—The magnets, selecting off-normal spring assembly, or centering unit mounting brackets and the holding off-normal spring assembly mounting brackets shall be mounted securely.

Gauge by feel.

Requirements for Selecting Unit Exclusive of Selecting Off-Normal Contact Springs

2.03 ***Freedom of Movement of Selecting Bar:*** Fig. A(3)

(a) The selecting bar shall rotate freely in its bearing.

To check this requirement, use the KS-6320 orange stick to remove the pressure of the centering springs on the selecting armature stud and gauge by feel.

(b) The selecting bar shall have end play but this end play shall not exceed

0.012 inch

Use the 74D gauge and gauge by feel.

To check the minimum end play, gauge by feel. If end play is not felt, hold the bar lightly near the more rigid bearing with the thumb and forefinger of one hand and attempt to move it back and forth endwise while the forefinger of the other hand is used to feel for play between the opposite end of the selecting bar and the less rigid bearing.

To check whether the end play is excessive, take up the end play of the selecting bar to give the maximum clearance between the end of the selecting bar and the shoulder on the pivot screw. With the 74D gauge, check that the clearance does not exceed 0.012 inch.

Caution: Insert the blade of the 74D gauge between the end of the selecting bar and the shoulder on the pivot screw carefully because deflection of the selecting bar bearing lug may cause false indications if the gauge is forced slightly.

2.04 ***Clearance Between Armature Extension and Side of Switch Frame:*** The clearance at the closest point between the wide portion of the selecting armature extension and the side of the switch frame shall be

Test — Min 0.005 inch
Max 0.025 inch

Readjust — Min 0.010 inch
Max 0.022 inch

The minimum limit shall be checked with the end play of the selecting bar taken up to give the minimum clearance and the maximum limit shall be checked with the end play of the selecting bar taken up to give the maximum clearance.

Use the 139A gauge.

To check this requirement, first insert the 139A gauge from above the armature as shown in Fig. B. Then similarly insert the gauge from below the armature.

2.05 ***Tightness of Selecting Bar Pivot Screw Locknuts:*** Fig. B(1)—The locknuts shall be sufficiently tight to hold the respective screws in their adjusted positions.

Gauge by feel.

2.06 ***Straightness of Centering Springs:*** The centering springs shall be free of sharp bends or kinks due to adjustment. A gradual bow in a spring or a slight kink due to tensioning at the point where the spring leaves the assembly clamping plates or insulators is permissible.

Gauge by eye.

2.07 ***Centering Spring Tension***

(a) With the selecting armature in the normal position, the spring tension, measured in grams, shall be in accordance with the T (test) and R (readjust) values given in Fig. 101 through 104. The particular figure to be used is indicated in the BSP Fig. column of the circuit requirement table.

Use the 68B and 70J gauges.

(b) Fig. C(1)—The snubbing spring (spring B) shall be tensioned against the centering spring (spring A) and the combined tension of the two springs against the centering spring stop shall be measured at the end of the centering spring.

Use the 68B and 70J gauges.

Note: With the snubbing spring lifted away from the centering spring, the centering spring may or may not rest against the centering spring stop. If it does rest against the centering spring stop, the tension shall be no more than 15 grams.

In checking this requirement on the lower centering spring of an individual assembly, hold the selecting armature stud from following the spring.

2.08 ***Clearance Between Selecting Armature Stud and Centering Spring:*** Fig. C(2)—With the selecting armature in its normal position and with the selecting armature stud resting against a centering spring, the clearance, if any, between the selecting armature stud and the other centering spring at the closest point shall not exceed 0.003 inch.

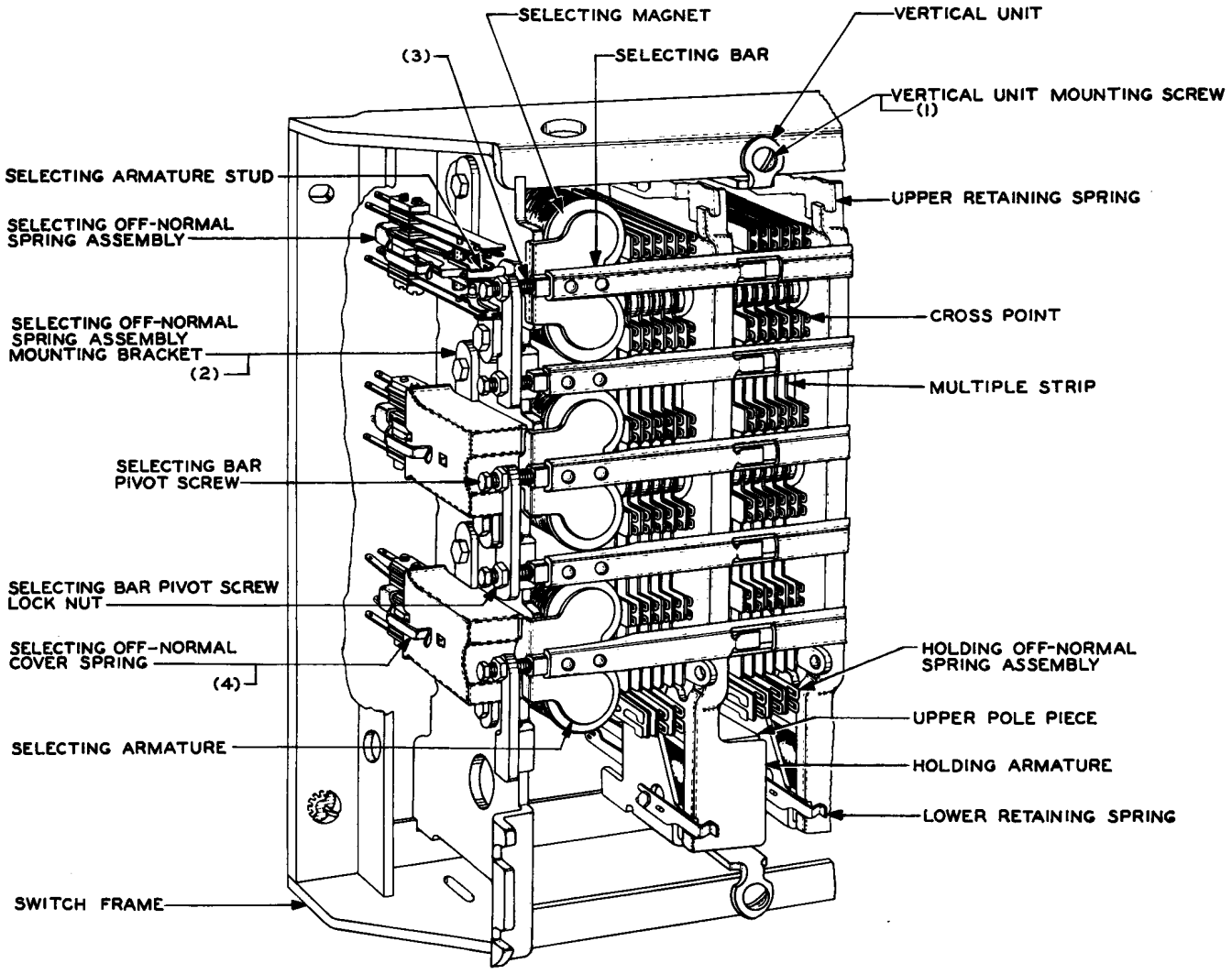


Fig. A—General View of Switch

Use the 74D gauge.

2.09 ***Armature Travel:*** Fig. D(1)—With the selecting magnet electrically operated, the clearance between the closest point on the selecting armature stud and the nonoperated centering spring shall be

Min 0.100 inch
Max 0.118 inch

Use the 137A gauge as shown in Fig. E.

2.10 ***Straightness of Selecting Finger:*** The selecting finger shall be free of sharp bends or kinks. A gradual bow is permissible.

Gauge by eye.

2.11 ***Position of Selecting Finger***

(a) Fig. F(1) and (2)—With the holding armature in the normal position and with the end play of each selecting bar taken up to the left, the following condition shall be met. The selecting finger shall not touch the holding armature or the operating faces of the operating cards except at the two stop surfaces while the selecting

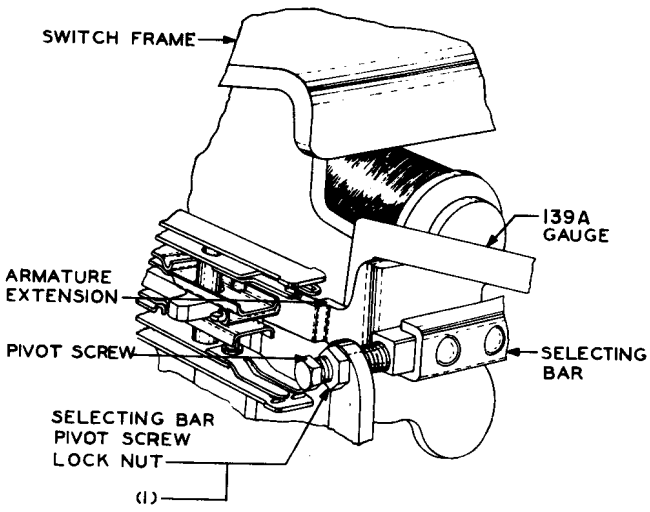


Fig. B—Method of Checking Clearance Between Wide Portion of Selecting Armature Extension and Switch Frame

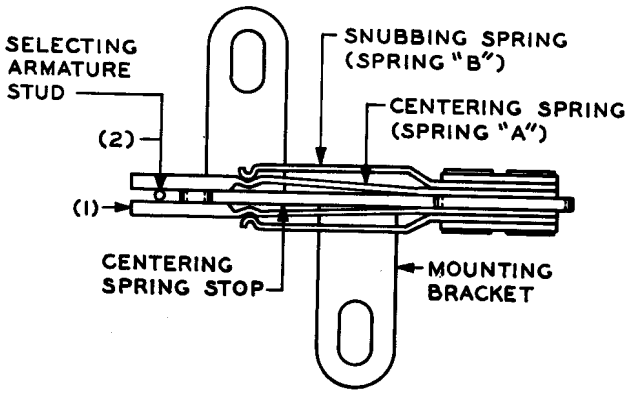


Fig. C—Centering Unit in Normal Position

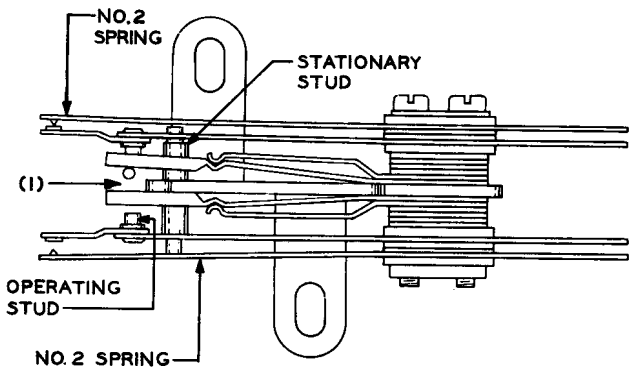


Fig. D—Selecting Off-Normal Spring Assembly With Selecting Unit Operated

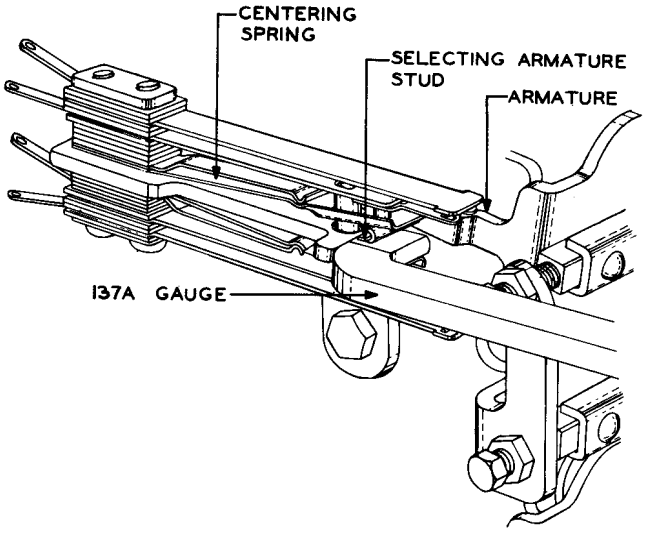


Fig. E—Method of Gauging Armature Travel

armature is moved manually to the fully operated position in both directions.

Gauge by eye.

Caution: Do not bow the selecting bar or spring the selecting bar bearing lug while checking for this requirement.

To check this requirement, proceed as follows.

(1) Grasp the selecting bar near the left end and take up the end play toward the left.

(2) Move the selecting armature to the fully operated position in one direction observing whether the requirement is met.

(3) Repeat this check moving the selecting armature to the fully operated position in the opposite direction.

(b) Fig. F(3)—With the selecting armature electrically operated on the specified operate current, each selecting finger shall touch the stop surface of the operating card. This requirement shall be met in both the upper and lower positions of the selecting finger.

Gauge by eye.

(c) Fig. F(4)—With the selecting armature partially operated so that the selecting armature stud is 0.040 inch from the unoperated

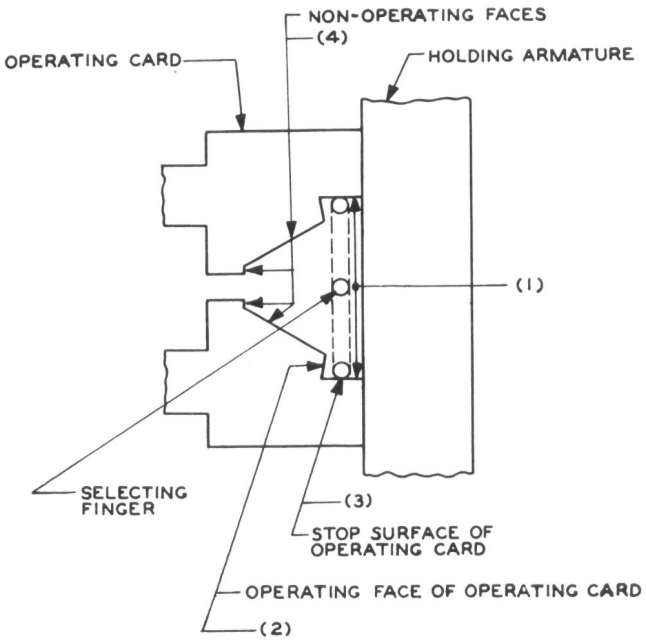


Fig. F—Position of Selecting Finger

centering spring and with this centering spring resting against the centering spring stop, the selecting finger shall engage the nonoperating faces of the card when the holding armature is slowly moved manually until the finger touches the card. This requirement shall be met in both the upper and lower positions of the selecting finger.

Note: If the finger does not move laterally far enough to engage the card, the vertical position of the finger shall be such that if its lateral movement were to be extended, the finger would engage the nonoperating faces of the card.

Use the 164B and 165A gauges or the 136B gauge as follows.

(d) ***Using the 164B and 165A Gauges***

(1) Operate the selecting armature and insert a wedge between the operated centering spring and the centering spring stop. To avoid overstressing the spring, insert the wedge just far enough to hold the springs in about the position they assume when normally operated. (A suitable wedge can be made by cutting about 1-1/2 inches from one end of a KS-6320 orange stick.) Slide the 164B gauge over the selecting armature stud and hook the 165A gauge over the selecting bar as shown in Fig. G. Make sure that the unoperated centering spring rests against the centering spring stop. Slowly move the holding armature manually and note the position of the selecting finger. If it touches or approaches [as defined in (c)] the nonoperating faces of the card, the requirement is met. Do not continue to move the holding armature beyond the point where the selecting finger first touches the card.

Note: When the lower position of the selecting finger is being checked, the position of the 165A gauge should be the reverse of that shown in Fig. G and the wedge should be between the lower centering spring and the spring stop.

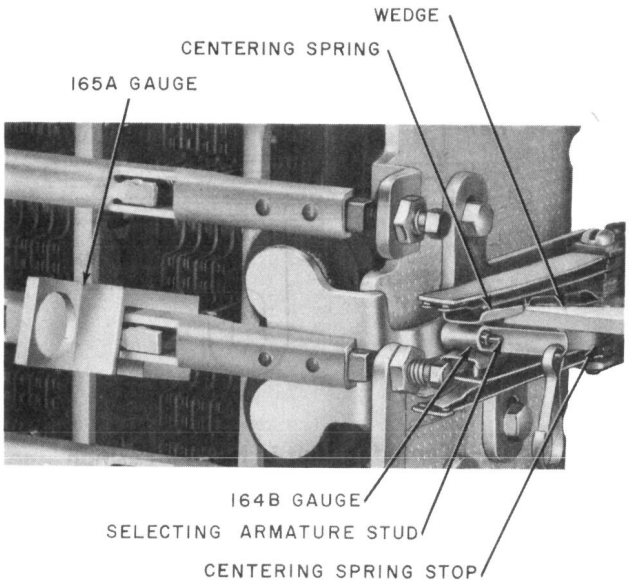


Fig. G—Method of Checking Position of Selecting Finger Using the 164B and 165A Gauges

(e) ***Using the 136B Gauge***

(1) Operate the selecting armature and insert a wedge between the operated centering spring and the centering spring stop. To avoid overstressing the spring, insert the wedge just far enough to hold the springs in

about the position they assume when normally operated. (A suitable wedge can be made by cutting about 1-1/2 inches from one end of a KS-6320 orange stick.)

(2) Place the 136B gauge between the selecting armature stud and the centering spring as shown in Fig. H. In placing the gauge in this position, start the tip of the unoperated centering spring between the flat spring and the thick portion of the gauge. Partially release the selecting armature so that the selecting armature stud is directly in front of the opening between the thick portion of the gauge and the hooked spring of the gauge. Carefully push the gauge back as far as permitted by the stop of the gauge, taking care that the selecting armature stud enters between the thick portion of the gauge and the hooked spring. Make sure that the blocked centering spring does not rest against the hooked spring. Also make sure that the unoperated centering spring rests against the centering spring stop, and, if necessary, press the spring against the stop with the KS-6320 orange stick at the point just back of the front end of the stop, taking care not to press against the centering spring with sufficient pressure to distort it.

(3) Slowly move the holding armature manually and note the position of the selecting finger. If it touches [or approaches as defined in (c)] the nonoperating faces of the card, the requirement is met. Do not continue to move the holding magnet armature beyond the point where the selecting finger first touches the card.

2.12 ***Electrical Requirements:*** The selecting units shall meet the electrical requirements specified on the circuit requirement table.

Requirements For Selecting Off-Normal Contact Springs

2.13 ***Selecting Off-Normal Cover Spring Tension:*** Fig. A(4)—The selecting off-normal cover spring shall bear against the selecting off-normal cover with a pressure of

Min 75 grams

Use the 62B gauge.

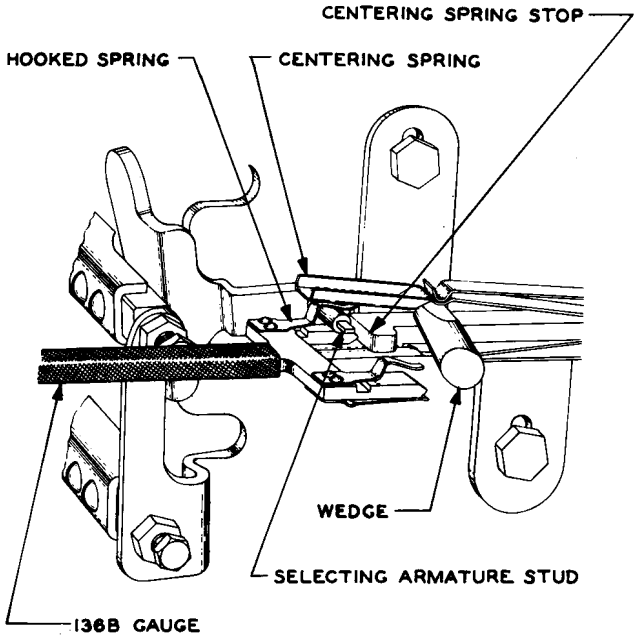


Fig. H—Method of Checking Position of Selecting Finger Using the 136B Gauge

This requirement shall be checked with the gauge applied against the straight portion of the spring as near the bend for the V as possible.

2.14 ***Contact Alignment***

(a) Fig. I(1)—On selecting off-normal spring assemblies equipped with standard contacts, the contacts shall line up so that the width of the contact surface of each contact bar falls wholly within the length of its mating bar.

Gauge by eye.

(b) Fig. J(1)—On selecting off-normal spring assemblies equipped with heavy contacts, the contact alignment shall be within the limits indicated in Fig. J.

Gauge by eye.

2.15 ***Stationary Stud Clearance:*** Fig. K(1)—The contact and centering springs shall not rub on the stationary studs when the selecting armature is slowly moved manually until the stop disc touches the core.

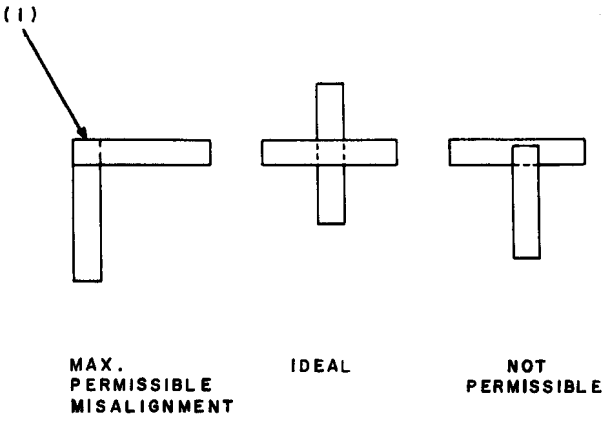


Fig. I—Alignment of Standard Contacts—Plan View of Contact Surfaces

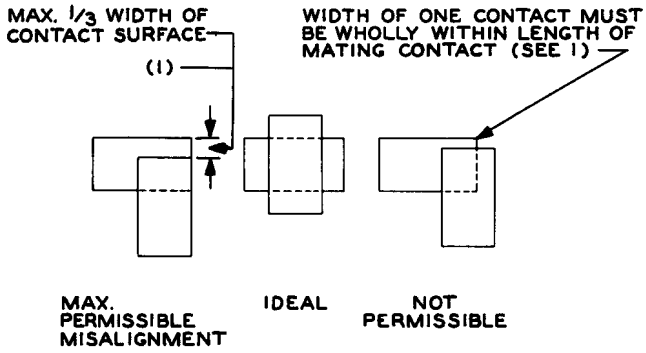


Fig. J—Alignment of Heavy Contacts—Plan View of Contact Surfaces

Gauge by eye and feel.

To check this requirement, lift the No. 2 spring slightly with the KS-6320 orange stick to prevent closure of the contacts during the check.

2.16 ***Straightness of Springs:*** The contact springs shall be free of sharp bends or kinks due to adjustment. A gradual bow in a spring or a slight kink due to tensioning at the point where the spring leaves the assembly clamping plates and insulators is permissible.

Gauge by eye.

2.17 ***Contact Spring Clearance:*** Fig. K(2)—There shall be a clearance between adjacent contact

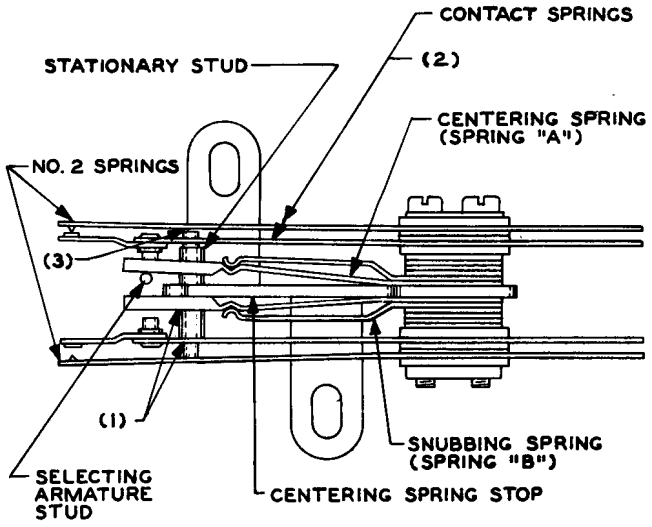


Fig. K—Selecting Off-Normal Spring Assembly With Selecting Unit Operated

springs whether in the operated or the normal position of the selecting unit of

Min 0.010 inch

Gauge by eye.

2.18 ***Contact Spring Tension***

(a) With the selecting armature in the normal position, the spring tension, measured in grams, shall be in accordance with the T (test) and R (readjust) values given in Fig. 103 and 104. The particular figure to be used is indicated in the BSP Fig. column of the circuit requirement table.

(b) The springs shall be tensioned in the direction indicated by the arrows in the figures. The tension of No. 1 spring shall be measured just in front of the operating stud and the tension of No. 2 spring shall be measured at the end of the spring. The spring shall register the required tension just as the spring leaves the stationary stud.

Use the 68B, 70H, and 70J gauges.

2.19 ***Contact Separation***—Fig. L(1)

(a) Fig. 103—The contact separation shall be

Test —Min 0.008 inch

Readjust —Min 0.010 inch

Use the 74D gauge.

(b) Fig. 104—The contact separation shall be

Test — Min 0.008 inch
Max 0.025 inch

Readjust — Min 0.010 inch
Max 0.025 inch

Use the 74D and 139A gauges.

2.20 ***Operating Stud Gap:*** Fig. L(2)—The gap between the centering spring and the operating stud when the selecting armature is in its normal position shall be

(a) ***On All Switches Equipped With Selecting Off-Normal Springs Except 304C and 304L Switches:***

Test — Min 0.062 inch

Readjust — Min 0.065 inch

Use the 145A gauge.

(b) ***On 304C and 304L Switches:***

Min 0.065 inch

Use the 145A gauge.

2.21 ***Front Contact Make***

(a) Fig. 103 and K(3)—With the selecting unit electrically operated, the operated No. 2 spring shall not touch the stationary stud.

Gauge by eye.

(b) Fig. 104—At least one contact on each bifurcated spring shall make with its associated contact when the selecting magnet is electrically energized with a 0.004-inch thickness gauge inserted between the selecting armature stop disc and the core.

Use the P-243666 gauge as shown in Fig. M.

REQUIREMENTS FOR CENTERING UNITS AND SELECTING OFF-NORMAL SPRING COMBINATIONS

FIG. 101

SPRING TENSION		SPRINGS A+B		
MIN.	T	45		
	R	50		
MAX.	T	65		
	R	60		

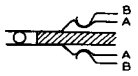


FIG. 102

SPRING TENSION		SPRINGS A+B		
MIN.	T	85		
	R	90		
MAX.	T	105		
	R	100		

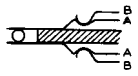


FIG. 103

SPRING TENSION		SPRINGS A+B	1	2
MIN.	T	45	10	60
	R	50	15	65
MAX.	T	65	30	85
	R	60	27	80

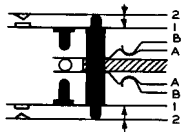
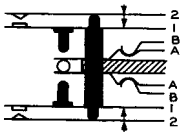


FIG. 104

SPRING TENSION		SPRINGS A+B	1	2
MIN.	T	75	10	85
	R	80	15	90
MAX.	T	90	25	100
	R	90	25	100



(c) Fig. 103 and 104 (readjust only)

(1) Both contacts on each bifurcated spring shall make with their associated contacts when the selecting unit is in the operated position.

Gauge by eye.

(2) Whenever a particular contact requires cleaning or build-up removal, or when readjustments are made on contact spring,

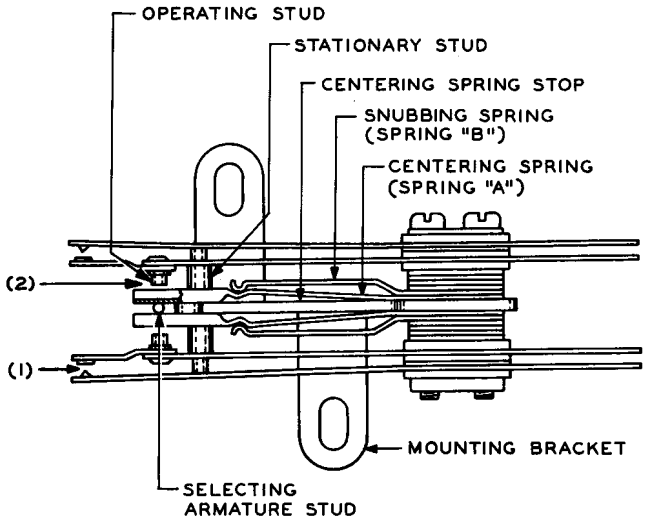


Fig. L—Selecting Off-Normal Spring Assembly With Selecting Unit Normal

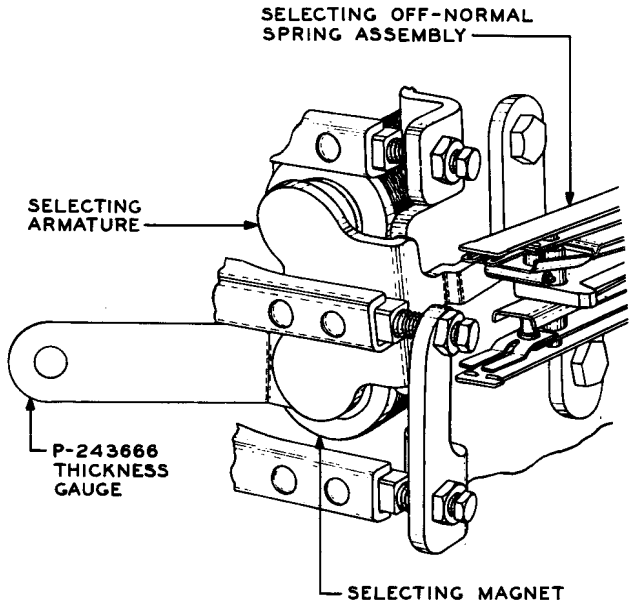


Fig. M—Method of Checking Front Contact Make on Selecting Off-Normal Spring Combination Fig. 104

both contacts on the bifurcated spring involved shall make with their associated contacts when the selecting magnet is electrically energized with a 0.003-inch thickness gauge inserted between the selecting armature stop disc and the core.

Use the P-243665 gauge.

(d) To check whether a contact makes, use the KS-6320 orange stick applied to the tip of the solid spring and attempt to move the contact toward its associated spring. A movement of the solid spring without a corresponding movement of the bifurcated spring indicates that the contact is not closed.

Requirements for Vertical Unit Exclusive of Holding Off-Normal Contact Springs

2.22 ***Contact Alignment:*** Fig. I(1)—The contacts shall line up so that the width of the contact surface of one contact bar falls wholly within the length of its mating bar.

Gauge by eye.

2.23 ***Operating Spring Pressure***

(a) The operating springs shall bear against the operating card with sufficient pressure to cause the springs to follow the operating card when the tab on the multiple strip farthest from the holding armature is depressed slightly to the right.

Gauge by eye.

To check this requirement, apply the 574A tab depressor to the multiple strip farthest from the holding armature as shown in Fig. N. Press the handle of the tool gently to the left just sufficiently to permit movement of the operating springs, taking care not to bend or deform the tab. If each of the associated operating springs moves, the requirement is met.

2.24 ***Contact Separation:*** Fig. O(1)—The contact separation shall be

Test — Min 0.008 inch

Readjust — Min 0.010 inch

Use the 74D gauge.

2.25 ***Front Contact Make:*** Fig. P(1)—With any selecting bar fully operated (either manually or electrically), and with a selecting finger engaging its associated operating card, the contacts shall close as specified below when the holding magnet is electrically energized with the specified

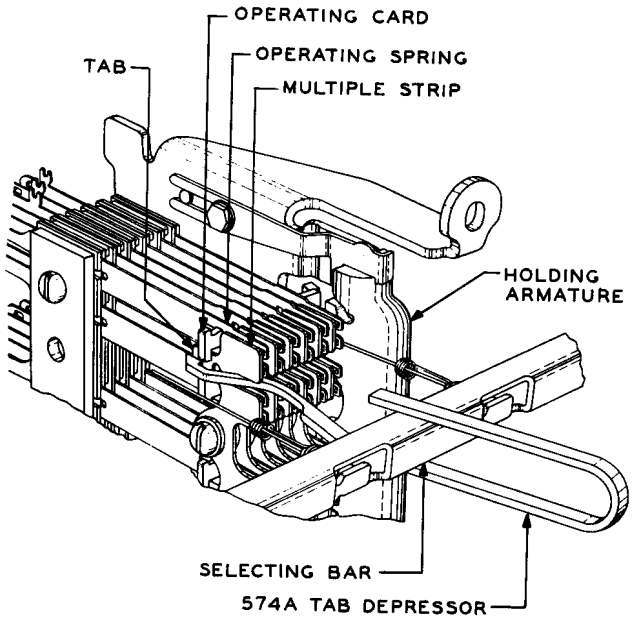


Fig. N—Method of Checking Operating Spring Pressure

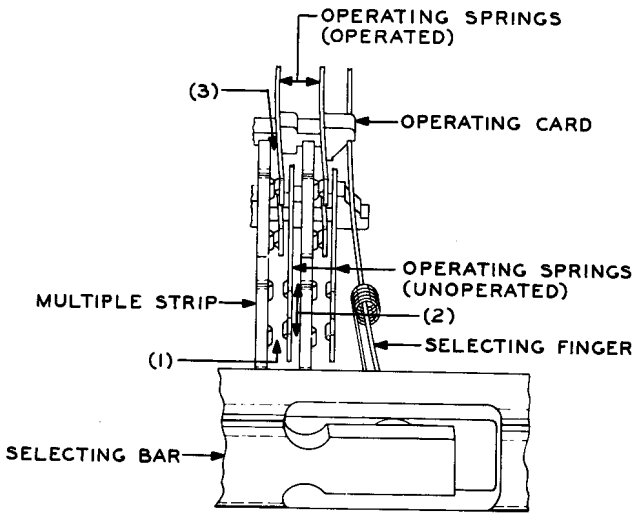


Fig. O—Clearance Between Operating Springs and Multiple Strip (Holding Armature Not Shown)

thickness gauge inserted at the standard point measurement.

Use the 148B and 148C gauges, as covered in (c).

(a) At least one contact of each bifurcated spring shall close on

Test — Min 0.015 inch

Readjust—Min 0.025 inch

(b) Both contacts on each bifurcated spring shall close on

Readjust only 0.015 inch

(c) To check this requirement, engage a selecting finger by operating the required selecting magnet manually. Insert the specified thickness gauge at the standard point of measurement as shown in Fig. P. Slowly operate the holding armature manually and note whether there is further movement of the armature after all contacts are made and before the armature touches the gauge. In operating the holding armature, take care to hold it against the knife edges. In case of doubt, operate the holding armature electrically and check whether the contact makes as covered in requirement 2.21(d).

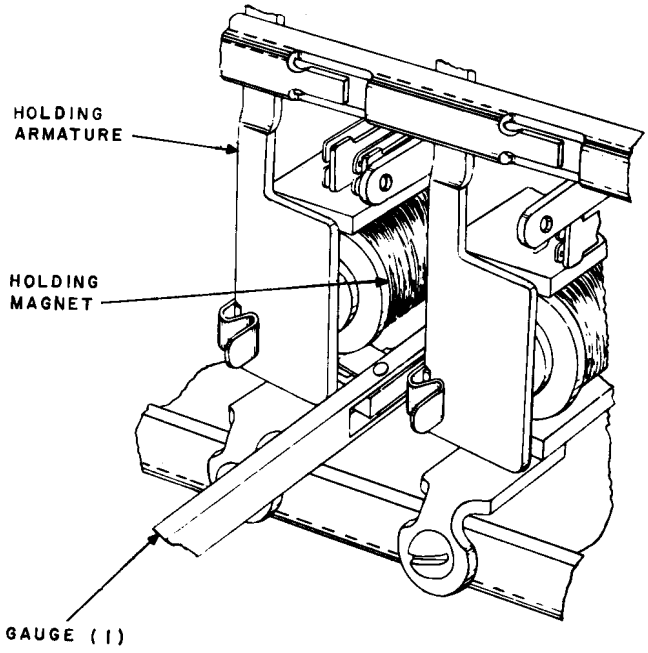


Fig. P—Method of Checking for Front Contact Make

2.26 *Clearance Between Operating Springs and Adjacent Multiple Strips*

(a) Fig. O(2)—With the holding armature in its normal position, the clearance between each operating spring and the adjacent multiple strip

to the right, measured at the tip of the operating spring, shall be

Test —Min 0.015 inch

Readjust —Min 0.020 inch

Use the 139A gauge.

(b) Fig. O(3)—With the vertical unit in the operated position, no operating spring in an associated crosspoint shall touch the rear edge of its adjacent multiple strip to the left.

Gauge by eye.

2.27 ***Straightness of Balancing Springs:*** Balancing springs (spring X) shall be free of sharp bends or kinks due to adjustment. A gradual bow in a spring or a slight kink due to tensioning at the point where the spring leaves the assembly clamping plates and insulators is permissible.

Gauge by eye.

2.28 ***Balancing Spring Tension:*** Fig. Q(1)—The balancing spring tension, measured in grams at the crimp in the spring, shall be in accordance with the T (test) or R (readjust) tensions specified in Fig. 1 through 14. The particular figure to be used is indicated in the BSP Fig. column of the circuit requirement table. Restrain the holding armature from the balancing spring when measuring its tension.

Use the 68B or 70J gauge as follows:

Apply the proper gauge at the crimp at the end of the balancing spring. Measure the spring tension with the holding armature in its normal position and just as the spring leaves the holding armature stud.

2.29 ***Retaining Spring Tension:*** The retaining spring tension, measured at the end of the spring as the spring leaves the base shall be

Test —Min 87.5 grams

Readjust — Min 100 grams

Use the 70J gauge.

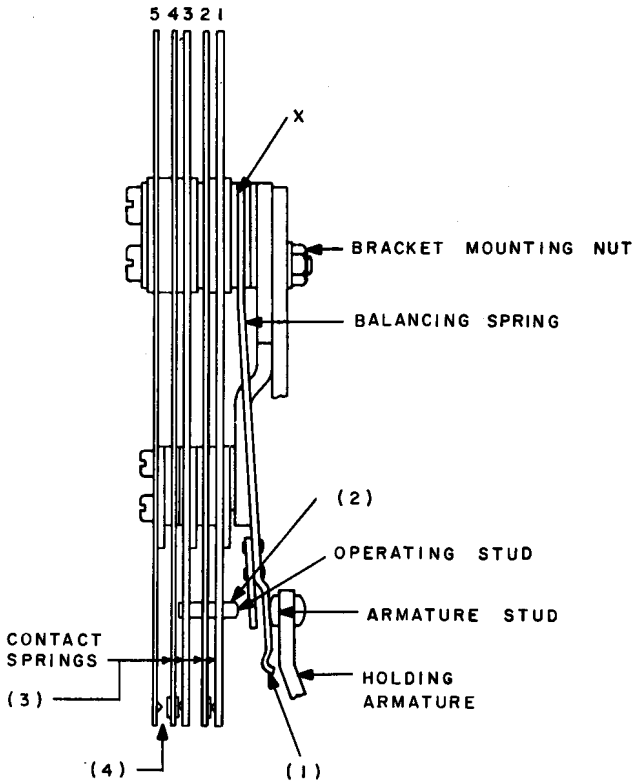


Fig. Q—Holding Off-Normal Spring Assembly

2.30 ***Freedom of Movement of Holding Armature:*** With the holding armature in the normal position

(a) There shall be play in the up and down direction.

Gauge by eye and feel.

To check this requirement, attempt to raise and lower the armature manually.

(b) There shall be play not to exceed 0.010 inch in the in and out direction at the upper retaining spring.

Gauge by eye and feel.

(c) There shall be play not to exceed 0.010 inch in the left and right direction at the upper and lower retaining springs and in the in and out direction at the lower retaining spring.

Gauge by eye and feel.

In case of doubt whether there is play, use the method covered in (d).

(d) If there is no perceptible play as covered in (c), raise the armature manually. If it drops of its own weight, (c) is considered as having been met.

Note: If there is perceptible play, the armature need not drop.

2.31 ***Electrical Requirements:*** The vertical unit shall operate (see 1.06) on the current flow values specified on the circuit requirement table. This requirement shall apply to each crosspoint (or combination of two crosspoints on the 308A switch). For combinations of two crosspoints, level 0, together with each of levels 2 to 9 inclusive, and level 1, together with each of levels 2 to 9 inclusive, shall be checked. The selecting bars in any case may be operated manually or electrically.

Requirements for Holding Off-Normal Contact Springs

2.32 ***Contact Alignment***

(a) Fig. I(1)—On holding off-normal spring assemblies equipped with standard contacts, the contacts shall line up so that the width of the contact surface of one contact bar falls wholly within the length of its mating bar.

Gauge by eye.

(b) Fig. J(1)—On holding off-normal spring assemblies equipped with heavy contacts, the contact alignment shall be within the limits indicated in Fig. J.

Gauge by eye.

2.33 ***Operating Stud Clearance:*** Fig. Q(2)—The springs shall not rub on the operating stud when the holding armature is slowly operated manually.

Gauge by eye and feel.

2.34 ***Straightness of Springs:*** All springs shall be free of sharp bends or kinks due to adjustment. A gradual bow in a spring or a slight kink due to tensioning at the point where the spring leaves the assembly clamping plates and insulators is permissible.

Gauge by eye.

2.35 ***Contact Spring Clearance:*** Fig. Q(3)—There shall be a clearance between adjacent springs whether in the operated or normal position of the holding armature of

Min 0.010 inch

Gauge by eye.

2.36 ***Contact Spring Tension***

(a) The spring tension, measured in grams at the end of the spring, shall be in accordance with the T (test) or R (readjust) tensions specified in Fig. 2 through 13. The particular figure to be used is indicated in the BSP Fig. column of the circuit requirement table.

Use the 68B gauge.

(b) The springs shall be tensioned in the direction indicated by the arrows in the figure. Where no arrow is shown on a spring, it is not necessary to check the tension of that spring individually. Unless the abbreviation Arm. Opr. is shown associated with an arrow mark leading to a spring, the tension shall be measured with the holding armature in its normal position. Springs tensioned against studs or supports shall register the required tension just as the spring leaves the stud or support, respectively. Springs whose contacts are tensioned against the contacts of an opposing spring shall register the required tension when contact between the springs is broken.

(c) Where the letter A appears in the spring tension column it means that no individual spring tension is specified but that

(1) For Fig. 2, 3, 7, 8, 10, and 13, the operating stud shall rest firmly against the balancing spring.

Gauge by feel.

(2) For Fig. 4 and 4A, the operating stud shall rest firmly against the balancing

spring and the stud on spring 5 shall rest firmly against spring 3.

Gauge by feel.

(3) For Fig. 11, spring 5 shall rest firmly against the operating stud.

Gauge by feel.

(d) When measuring contact pressure of bifurcated springs, apply the gauge so that the tip of the gauge engages both prongs of the bifurcated spring.

2.37 ***Contact Separation:*** Fig. Q(4)—The separation between any pair of contacts normally open or between any pair of contacts that are open when the holding armature is operated shall be

Test — Min 0.008 inch

Readjust — Min 0.010 inch

Use the 74D gauge.

2.38 ***Operating Stud Gap***

(a) The gap (labeled §) between the operating stud and the adjacent spring shall be

Min 0.002 inch

Gauge by eye.

This gap shall be measured with the holding armature in the normal position.

(b) The gap (labeled #) between the stud and the adjacent spring shall not close with the holding magnet electrically energized with the specified thickness gauge inserted at the standard point of measurement (see 1.09) as shown in Fig. P.

2.39 ***Front Contact Make:*** With the holding magnet electrically energized against a gauge of the thickness indicated in the table below, inserted at the standard point of measurement (see 1.09) normally open contacts shall meet the following conditions.

Use the 148-type gauges.

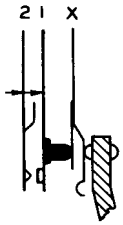
REQUIREMENTS FOR BALANCING SPRINGS AND HOLDING OFF - NORMAL CONTACT SPRINGS

FIG. 1

SPRING TENSION		SPRINGS X
MIN.	T	40
	R	45
MAX.	T	60
	R	57

FIG. 2

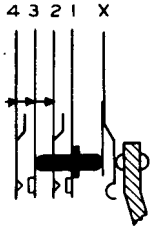
SPRING TENSION		SPRINGS X	1	2
MIN.	T	B	A	30
	R	B	A	35
MAX.	T	B		
	R	B		



A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.36 (C).
B - THE COMBINED TENSION OF SPRINGS X AND 1 MESURED ON SPRING X, SHALL BE
TEST - MIN. 40 GRAMS, MAX. 60 GRAMS
READJUST - MIN. 45 GRAMS, MAX. 57 GRAMS

FIG. 3

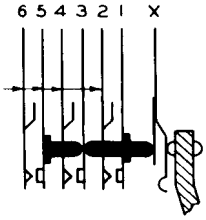
SPRING TENSION		SPRINGS X	1	2	3	4
MIN.	T	B	A	30	A	30
	R	B	A	35	A	35
MAX.	T	B				
	R	B				



A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.36 (C).
B - THE COMBINED TENSION OF SPRINGS X, 1 AND 3, MEASURED ON SPRING X, SHALL BE
TEST - MIN. 40 GRAMS, MAX. 60 GRAMS
READJUST - MIN. 45 GRAMS, MAX. 57 GRAMS

FIGS. 4 & 4A

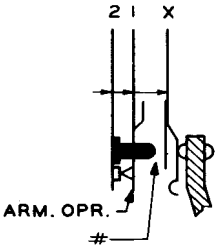
SPRING TENSION		SPRINGS X	1	2	3	4	5	6
MIN.	T	B	A	45	A	45	A	45
	R	B	A	50	A	50	A	50
MAX.	T	B						
	R	B						



A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.36 (C)
B - THE COMBINED TENSION OF SPRINGS X, 1, 3 AND 5, MEASURED ON SPRING X, SHALL BE
TEST - MIN. 40 GRAMS, MAX. 60 GRAMS
READJUST - MIN. 45 GRAMS, MAX. 57 GRAMS

FIG. 5

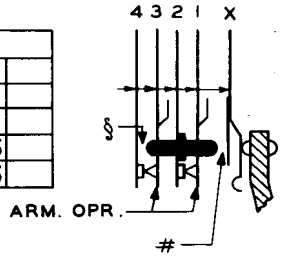
SPRING TENSION		SPRINGS X	1	2
MIN.	T	40	30	15
	R	45	35	17
MAX.	T	60		35
	R	57		35



- STUD GAP - SEE RQ. 2.38 (b) - USE 148D GAUGE.

FIG. 6

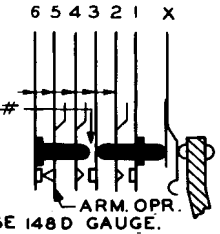
SPRING TENSION		SPRINGS X	1	2	3	4
MIN.	T	40	30	15	30	15
	R	45	35	17	35	17
MAX.	T	60		35		35
	R	57		35		35



§ - SEE RQ. 2.38(a)
# - STUD GAP - SEE RQ. 2.38 (b) - USE 148E GAUGE.

FIG. 7

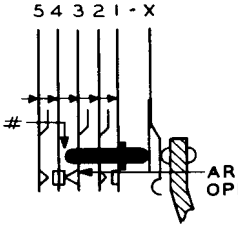
SPRING TENSION		SPRINGS X	1	2	3	4	5	6
MIN.	T	B	A	45	A	45	45	15
	R	B	A	50	A	50	50	17
MAX.	T	B						35
	R	B						35



#- STUD GAP- SEE RQ. 2.38(b)- USE 148D GAUGE.
A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.36(C).
B - THE COMBINED TENSION OF SPRINGS X, 1 AND 3, MEASURED ON SPRING X, SHALL BE
TEST - MIN. 40 GRAMS, MAX. 60 GRAMS
READJUST - MIN. 45 GRAMS, MAX. 57 GRAMS

FIG. 8

SPRING TENSION		SPRINGS X	1	2	3	4	5
MIN.	T	B	A	30	30	15	30
	R	B	A	35	35	17	35
MAX.	T	B				35	
	R	B				35	

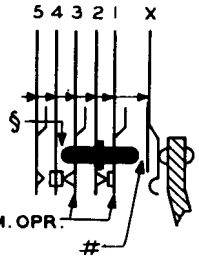


- STUD GAP - SEE RQ. 2.38 (b) - USE 148F GAUGE
A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.36 (C).
B - THE COMBINED TENSION OF SPRINGS X AND 1, MEASURED ON SPRING X, SHALL BE
TEST - MIN. 40 GRAMS, MAX. 60 GRAMS
READJUST - MIN. 45 GRAMS, MAX. 57 GRAMS

REQUIREMENTS FOR BALANCING SPRINGS AND HOLDING OFF - NORMAL CONTACT SPRINGS

FIG. 9

SPRING TENSION		SPRINGS X	1	2	3	4	5
MIN.	T	40	30	15	30	15	30
	R	45	35	17	35	17	35
MAX.	T	60		35		35	
	R	57		35		35	

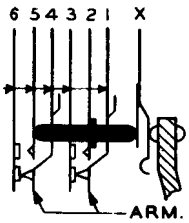


§ - SEE 2.38 (a)

- STUD GAP - SEE RQ. 2.38 (b) - USE 148F GAUGE

FIG. 10

SPRING TENSION		SPRINGS X	1	2	3	4	5	6
MIN.	T	B	30	A	35	30	A	35
	R	B	35	A	40	35	A	40
MAX.	T	B			55			55
	R	B			50			50

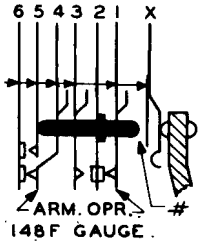


A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.36 (C).

B - THE COMBINED TENSION OF SPRINGS X, 2 AND 5, MEASURED ON SPRING X, SHALL BE
TEST - MIN. 40 GRAMS, MAX. 60 GRAMS
READJUST - MIN. 45 GRAMS, MAX. 57 GRAMS

FIG. 11

SPRING TENSION		SPRINGS X	1	2	3	4	5	6
MIN.	T	40	30	B	30	30	A	15
	R	45	35	B	35	35	A	17
MAX.	T	60						35
	R	57						35



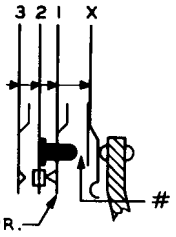
STUD GAP - SEE RQ. 2.38(b) - USE 148F GAUGE.

A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.36 (C)

B - THE COMBINED TENSION OF SPRINGS 2 AND 5, MEASURED ON SPRING 2, SHALL BE
TEST - MIN. 15 GRAMS, MAX. 35 GRAMS
READJUST - MIN. 17 GRAMS, MAX. 35 GRAMS

FIG. 12

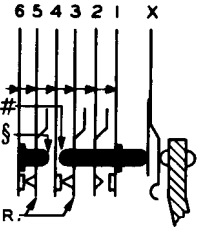
SPRING ENSION		SPRINGS X	1	2	3		
MIN.	T	40	30	15	30		
	R	45	35	17	35		
MAX.	T	60		35			
	R	57		35			



- STUD GAP - SEE RQ. 2.38 (b) - USE 148F GAUGE.

FIG. 13

SPRING TENSION		SPRINGS X	1	2	3	4	5	6
MIN.	T	B	A	30	30	15	30	15
	R	B	A	35	35	17	35	17
MAX.	T	B				35		35
	R	B				35		35



§ - SEE RQ. 2.38 (a)

- STUD GAP - SEE RQ. 2.38 (b) - USE 148E GAUGE.

A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.36 (c)

B - THE COMBINED TENSION OF SPRINGS X AND 1 MEASURED ON SPRING X SHALL BE
TEST - MIN. 40 GRAMS, MAX. 60 GRAMS
READJUST - MIN. 45 GRAMS, MAX. 57 GRAMS

FIG. 14

SPRING TENSION		SPRINGS X				
MIN.	T	87.5				
	R	94				
MAX.	T	119				
	R	112				

SPRING COMB. NO.		A CONTACTS SHALL NOT MAKE	B AT LEAST ONE CONTACT SHALL MAKE	C BOTH CONTACTS SHALL MAKE (see note)
		INCHES	INCHES	INCHES
2,3,8	Test	0.025	0.012	—
9 & 12	Readj	0.025	0.015	0.009
4,4A,	Test	0.065	0.050	—
and 7	Readj	0.065	0.055	0.025
10	Test	0.050	—	—
	Readj	0.050	—	—
11	Test	0.025	0.012	—
(springs	Readj	0.025	0.015	0.009
2 & 3)				
11	Test	—	—	—
(springs	Readj	—	—	—
5 & 6)				
13	Test	0.025	0.012	—
(springs	Readj	0.025	0.015	0.009
1 & 2)				

Note: The requirement in column C applies in addition to the requirement in column B whenever a particular contact requires cleaning or build-up removal or where readjustments are made on a contact spring. Check whether the contact makes as covered in requirement 2.21(d).

2.40 ***Back Contact Make*** (readjust only)

(a) With the holding armature in its normal position, both contacts on each bifurcated spring shall close.

Gauge by eye as covered in requirement 2.21(d).

(b) Whenever a particular contact requires cleaning or build-up removal or when readjustments are made on a contact spring, both contacts on the bifurcated spring involved shall break at approximately the same time.

Gauge by eye.

3. ADJUSTING PROCEDURES

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

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
416B	Spring Adjuster (2 reqd)
418A	5/16- and 7/32-Inch Hex. Open Double-End Flat Wrench
476A	3/16-Inch Offset Socket Wrench
485A	Smooth-Jaw Pliers
510C	Test Lamp [must be equipped with 561A tool (straight tip) and W2CB (24V) or W2BL (48V) cord.*!*
532B	Adjuster
533A	Bearing Lug Adjuster
534A	Spring Adjuster
534B	Spring Adjuster
534C	Spring Adjuster
534D	Spring Adjuster
534E	Spring Adjuster
535A	Spring Adjuster
536B	Selecting Bar Holder
541A	1/4-Inch 12-Point Double-End Wrench
544A	1/4-Inch Hex. Offset Socket Wrench
549A	Spring Adjuster
574A	Tab Depressor
579A	Spring Adjuster
711A	Adjuster
KS-6320	Orange Stick (modified)
KS-14220 L1, L7, L14	Wrench consisting of Sliding T-Handle 6-Inch Extension Bar 7/16-Inch Socket
—	4-Inch E Screwdriver

—	5-Inch E Screwdriver

GAUGES

62B	0-700 Gram Gauge
68B	70-0-70 Gram Gauge
70H	0-30 Gram Gauge
70J	0-150 Gram Gauge
74D	Thickness Gauge Nest
137A	0.100- and 0.118-Inch Thickness Gauge
139A	Thickness Gauge Nest
145A	0.062- and 0.065-Inch Thickness Gauge
148A	0.012-Inch Thickness Gauge
148B	0.015-Inch Thickness Gauge
148C	0.025-Inch Thickness Gauge
148D	0.050-Inch Thickness Gauge
148E	0.055-Inch Thickness Gauge
148F	0.065-Inch Thickness Gauge
148G	0.009-Inch Thickness Gauge
164B and 165A	Selecting Finger Positioning Gauges
P-243665	0.003-Inch Feeler (part of KS-6909 thickness gauge nest)
P-243666	0.004-Inch Feeler (part of KS-6909 thickness gauge nest)

MATERIALS

KS-7860	Petroleum Spirits
KS-14666	Cloth
KS-16832 L2	Lubricant
—	22-Gauge Bare-Tinned Copper Wire
—	Toothpicks, Hardwood, Flat at One End and Pointed at the Other
P-13F206	Shim (5 per each holding armature)

TEST APPARATUS

35 Type	Test Set

3.002 ***Use of Test Lamp:*** The 510C test lamp may be used in connection with the visual inspections specified in Part 2. In using the test lamp, make sure that the proper cord is being used with the lamp for the available voltage.

3.003 ***Removal of Selecting Bars From The Switch Frame:*** If the switch is equipped with a selecting bar guard, remove it. Loosen the pivot screw locknuts at the armature end of the selecting bars with the 418A wrench. Turn the pivot screws out with the 476A or 544A wrench sufficiently to disengage and remove the selecting bars. If more than two adjacent selecting bars are removed, label them so that they can be replaced in the positions from which they were removed.

3.004 ***Remounting Selecting Bars in the Switch Frame:*** In remounting the selecting bars, take care that they are mounted on the same horizontal positions from which they were removed. To remount a selecting bar, hold it so that each selecting finger will enter between the proper operating cards and holding armature. Gently move the selecting bar toward the switch until in position, taking care that the selecting armature stud enters between the centering springs of the selecting off-normal spring assembly. Position the selecting bar in accordance with requirements 2.03 through 2.05. Recheck requirement 2.11.

3.005 ***Removing and Remounting Holding Armatures***

General

(1) In removing and remounting the holding armature, it will be necessary to exercise care to avoid damaging the operating cards.

(2) When more than one holding armature is removed from the switch, take care to reassemble the armatures on the same vertical units from which they were removed. Where the armatures are interchanged there is a hazard

of changing the adjustments on the operating springs. In some cases where vertical units are mounted on close centers, difficulty may be experienced in removing and remounting the holding armature because of interference between operating cards on adjacent vertical units. In this case, with the 4-inch E screwdriver, loosen the mounting screws of the vertical unit in which the armature is being removed. Also loosen the mounting screws of the vertical unit to the right and move the vertical units away from each other, after which the armature can be removed and remounted as covered in (3) and (4) below. Then shift the vertical units back into position, taking care to leave at least 1/32-inch clearance between all parts of adjacent vertical units. Also check that requirement 2.11 is met at all crosspoints on the vertical units which were moved.

Removing Holding Armature

(3) Grasp the armature in such a way as to keep it in an unoperated position. Taking care not to affect the lower retaining spring adjustment, press the spring to the left far enough to permit the armature to be pulled forward. In some cases, it may be necessary to rock the armature to free it as it is being pulled forward. After the armature has been pulled forward sufficiently to clear the armature support lug (about 3/32 inch), rotate the armature to the left to clear the operating cards before removing it from the vertical unit.

Remounting Holding Armature

(4) Grasp the bottom right corner of the armature and insert the top end of the armature under the retaining spring, taking care that the armature does not catch on the selecting fingers or operating cards. Then rotate the armature to the left so that it will clear the operating cards and place the armature against the tip of the lower retaining spring. Press the armature to the left, being careful to maintain the clearance between it and the operating cards. At the same time, position the armature on the armature support lug with the armature stud between the balancing spring and the backstop lug. If necessary, press the retaining spring to the left with the other hand to facilitate positioning the armature.

3.006 When adjusting 305-, 306-, 307-, 308-, 314-, 315-, and 318-type switches, it may be necessary to remove the selecting bar guard to gain access to the parts.

General Procedures

3.01 ***Cleaning*** (Reqt 2.01)

(1) Clean the contacts in accordance with the section covering cleaning and reconditioning relay contacts.

(2) Clean the switch in accordance with approved procedures.

3.02 ***Mounting of Switch and Switch Parts*** (Reqt 2.02)

(1) Tighten the switch mounting screws with the 5-inch E screwdriver.

(2) Tighten the magnet clamping nuts with the KS-14220 7/16-inch T-handle socket wrench, exercising care to align the coils so that there is a clearance between the frame and the winding terminals.

(3) Tighten the holding magnet mounting screw with the 541A wrench.

(4) Tighten the vertical unit mounting screws with the 4-inch E screwdriver. Recheck requirement 2.11.

(5) Tighten the selecting off-normal spring assembly bracket mounting screws with the 544A wrench.

(6) Tighten the holding off-normal spring assembly bracket mounting nut with the 541A wrench.

Procedures for Selecting Unit Exclusive of Selecting Off-Normal Contact Springs

3.03 ***Freedom of Movement of Selecting Bar*** (Reqt 2.03)

3.04 ***Clearance Between Armature Extension and Side of Switch Frame*** (Reqt 2.04)

3.05 ***Tightness of Selecting Bar Pivot Screw Locknuts*** (Reqt 2.05)

(1) ***Freedom of Movement of Selecting Bar:*** A binding selecting bar is attributable to one or more of the following conditions.

(a) Pivot screws being set too tightly (lack of end play)

(b) Dirt and grit in the pivot bearings

(c) Imperfect pivot screws

(d) A bent bearing lug

(e) Burred or imperfect selecting bar bearings

(f) Improper clearance between the armature extension and the switch frame

(g) Bowed selecting bar.

In general, the trouble will be due to either or both of the first two conditions. The first will probably manifest itself by producing a uniform bind throughout the angle of rotation. Dirt and grit in the bearings will usually produce an intermittent binding condition when the selecting bar is rotated.

(2) ***Bent Selecting Bar Bearing Lug:*** If the selecting bar bearing lug is bent so that the pivot screw does not enter the selecting bar bearing squarely, binding will result. In this case, adjust the bearing lug slightly with the 533A bearing lug adjuster applied as shown in Fig. R.

(3) ***Dirt and Grit in the Pivot Bearings, Bowed or Bent Selecting Bar, Imperfect Pivot Screws, and Selecting Bar Bearings:*** Loosen the pivot screw locknut at the armature end of the selecting bar with the 418A wrench. If the switch is equipped with a selecting bar guard, remove the mounting screws using the 4-inch E screwdriver and remove the guard. Then using the 476A or 544A wrench, depending upon whether 3/16- or 1/4-inch head screws are used, turn the pivot screw out sufficiently to disengage the selecting bar and then remove the bar. Check the selecting bar and if it is bent or bowed straighten it by hand. If this cannot be done satisfactorily, replace the selecting bar. Examine the pivot screws and, if bent or otherwise defective, replace them. If they are dirty, clean them with a KS-14666 cloth saturated

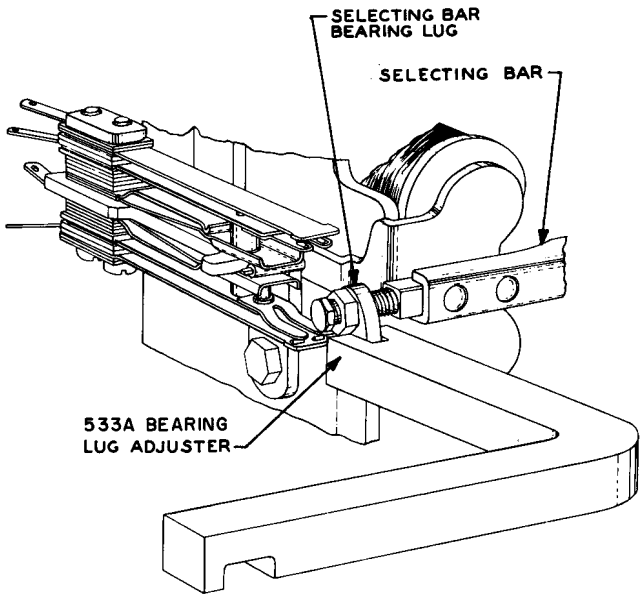


Fig. R—Method of Adjusting Selecting Bar Bearing Lug to Eliminate Bind

with KS-7860 petroleum spirits. At this time examine the selecting bar bearings and, if they are burred, replace the selecting bar. If the bearings are dirty, flush them out with petroleum spirits applied with a clean toothpick. After the parts have become thoroughly dry, lubricate each bearing by applying one drop of KS-16832 L2 lubricant in the bearing hole with a piece of 22-gauge bare-tinned copper wire which has been dipped into the oil to a depth of 3/8 inch and quickly removed. Make sure the container of lubricant has been shaken as covered in 1.14. Remount the selecting bar as outlined in 3.004. Then position the pivot screws as outlined in (4). Wipe off any excess oil that may have crept out of the bearing.

(4) ***Adjustment for End Play and Clearance Between the Armature Extension and Side of Switch Frame:*** Loosen both locknuts with the 418A wrench and turn the pivot screws at each end out slightly. Insert the 0.010-inch blade of the 139A gauge between the wide portion of the selecting armature extension and the side of the switch frame. Press the armature extension against the blade and then tighten the pivot screw further from the armature fingertight. Remove the gauge and tighten the other pivot screw until all of the end play of the selecting

bar is taken up. Then back off the screw approximately 1/6 turn to allow for end play. Check the clearance between the wide portion of the armature extension and the side of the switch frame. Tighten the locknuts as covered in (5).

(5) ***Tightening of Pivot Screw Locknuts:*** Hold the pivot screw with a 476A or 544A wrench and tighten the locknut with the 418A wrench.

(6) ***Rechecking Other Requirements:*** If the selecting bar bearing lug has been adjusted in accordance with (2) above, or if the selecting bar has been removed, adjusted, or replaced in accordance with (3), check requirements 2.09, 2.11, 2.12, and 2.21. If any adjustments are made, recheck requirement 2.12.

3.06 ***Straightness of Centering Springs*** (Reqt 2.06)

3.07 ***Centering Spring Tension*** (Reqt 2.07)

(1) ***Straightness of Centering Springs:*** If the spring is excessively bowed or bent, straighten the spring before adjusting to meet the spring tension requirement. To straighten the spring, apply the 416B spring adjuster to the spring just back of the bow or bend and, while exerting pressure up or down as required, draw the spring adjuster forward the length of the bow. Repeat this operation as required until the spring is approximately straight. Take care when adjusting the springs to adjust them in line with their movement and to avoid tilting the spring.

(2) ***Centering Spring Tension:*** If the centering spring tension requirement is not met, apply the 416B spring adjuster near the base of the springs and adjust them up or down as required, taking care not to disturb adjacent springs. Tension the centering spring so that it rests against the centering spring stop with a pressure of not more than 15 grams and then tension the snubbing spring so that the combined tension requirement is met. Make sure that requirement 2.08 is met.

3.08 ***Clearance Between Selecting Armature Stud and Centering Spring*** (Reqt 2.08)

3.09 ***Armature Travel*** (Reqt 2.09)

Clearance Between Selecting Armature Stud and Centering Spring

(1) If necessary to adjust for this requirement, apply the 549A spring adjuster to the spring from the front as shown in Fig. S and adjust the end of the centering spring up or down as required. Any change made in this adjustment may affect the armature travel. Also check requirements 2.07 and 2.20.

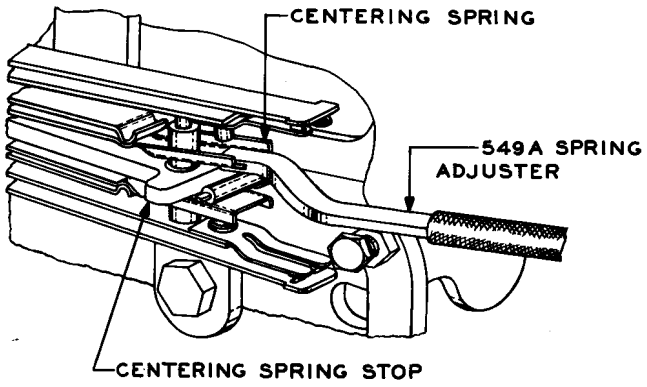


Fig. S—Method of Adjusting Centering Spring

Armature Travel

(2) If the requirement is met at one side but not at the other, loosen the selecting off-normal spring assembly bracket mounting screws with the 544A wrench, and shift the bracket up or down as required to equalize the armature travel. Securely tighten the bracket mounting screws. At this time make sure that the centering springs are positioned correctly and that the selecting armature stud is in approximate alignment with the centering spring stop. Recheck requirement 2.11.

(3) If the armature travel is unsatisfactory at both magnets, adjust the selecting bar bearing lug in or out slightly with the 533A bearing lug adjuster as shown in Fig. T. Recheck requirements 2.03 and 2.11.

3.10 ***Straightness of Selecting Finger*** (Reqt 2.10)

3.11 ***Position of Selecting Finger*** (Reqt 2.11)

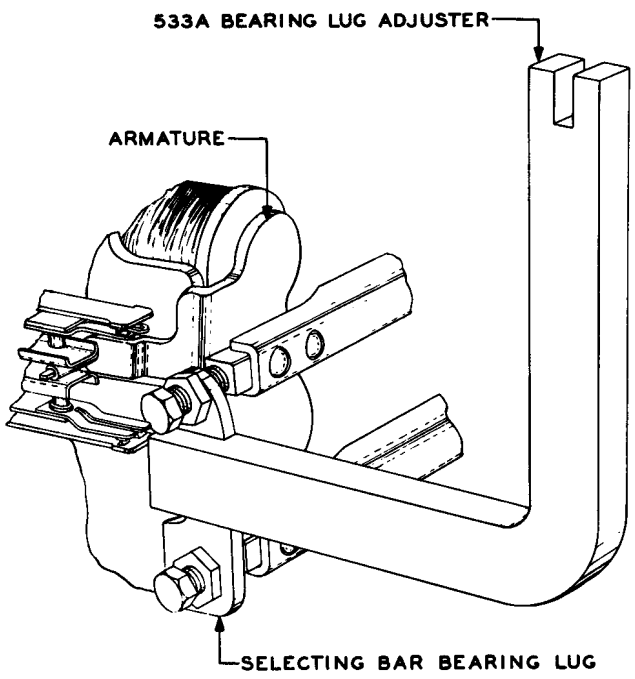


Fig. T—Method of Adjusting Selecting Bar Bearing Lug for Armature Travel

Straightness of Selecting Finger

(1) If the selecting finger is kinked or bent, straighten it with the 485A smooth-jaw pliers.

Clearance Between Selecting Finger and the Holding Armature and Operating Cards

(2) If the selecting fingers do not clear the holding armature and operating cards, determine whether the condition is general for all selecting fingers on the selecting bar. If such a condition exists and if the limits of requirements 2.03 and 2.04 will permit, loosen the selecting bar pivot screw locknuts with the 418A wrench. Turn the pivot screws so as to move the selecting bar horizontally to correct the condition. Retighten the pivot screw locknuts as covered in 3.03 to 3.05. To change the position of an individual selecting finger, hold the selecting bar with the 536B selecting bar holder and adjust as required with the 532B adjuster as shown in Fig. U.

(3) Where the front edge of the selecting finger support is rounded slightly, the 532B adjuster

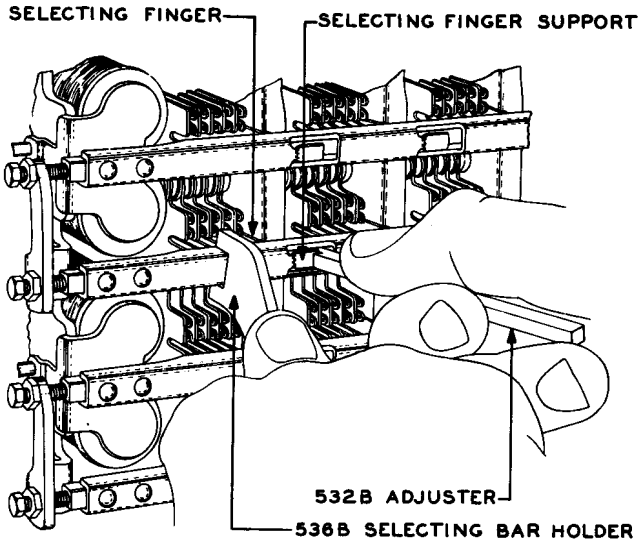


Fig. U—Method of Adjusting Selecting Finger Support

may slip off the finger support when adjusting the selecting finger to the left as shown in Fig. U. In this case use the tool as a lever by inserting the small end between the selcting bar and the selecting finger support as shown in Fig. V and prying the support so that the finger moves to the left.

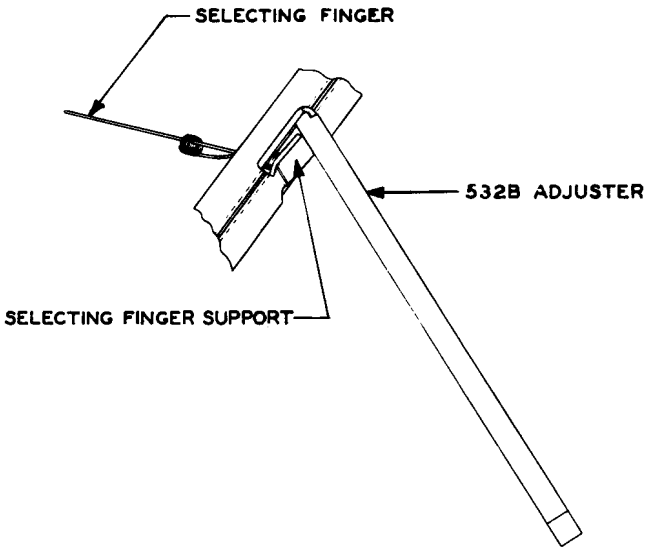


Fig. V—Method of Adjusting Selecting Finger to Left

Engagement of Operating Card by Selecting Finger

(4) First determine whether failure to meet requirement 2.11(c) is general for all selecting fingers on the selecting bar and if it is, determine whether the two armature airgaps of the associated magnets are approximately equal. If they are not, adjust as outlined in 3.08 and 3.09. If necessary to adjust one or two fingers which are out of adjustment, adjust the position of the individual selecting finger support up or down as required with the 532B adjuster and 536B selecting bar holder as shown in Fig. U.

(5) If the springs of the 136B gauge require readjusting, use the 535A spring adjuster for this purpose.

3.12 ***Electrical Requirements*** (Reqt 2.12)

(1) Failure of the selecting unit to meet the electrical requirements usually indicates improper centering spring tension or improper armature travel. Check the combined tension of the centering and snubbing springs and, if it is not within the limits, readjust them as outlined in 3.06 and 3.07. Decreasing the tension will aid in meeting the operate requirement. If the spring tension is satisfactory, but the switch still fails to meet the requirement, check the armature travel and, if necessary, readjust as outlined in 3.08 and 3.09. An armature travel in excess of the maximum may result in failure of the switch to meet its operate requirement.

Procedures for Selecting Off-Normal Contact Springs

3.13 ***Selecting Off-Normal Cover Spring Tension*** (Reqt 2.13)

(1) If the selecting off-normal cover spring is not tensioned satisfactorily, remove the cover and adjust the spring with the 534D spring adjuster applied to the spring as near to the insulators as possible. Remount the cover and recheck the requirement.

Caution: Take care when removing and remounting a cover that the spring is not flexed enough to reduce the tension of the spring below the specified minimum.

3.14 ***Contact Alignment*** (Reqt 2.14)

3.15 ***Stationary Stud Clearance*** (Reqt 2.15)

(1) If the contacts do not line up from right to left or if the spring rubs on the stud, replace the selecting off-normal spring assembly as covered in Section 030-717-801.

3.16 ***Straightness of Springs*** (Reqt 2.16)

3.17 ***Contact Spring Clearance*** (Reqt 2.17)

3.18 ***Contact Spring Tension*** (Reqt 2.18)

3.19 ***Contact Separation*** (Reqt 2.19)

3.20 ***Operating Stud Gap*** (Reqt 2.20)

3.21 ***Front Contact Make*** (Reqt 2.21)

Straightness of Springs and Contact Spring Clearance

(1) If the spring is excessively bowed or bent or if there is not the proper clearance between springs, straighten the spring before adjusting to meet the spring tension requirement. To straighten the spring, apply the 416B spring adjuster to the spring just back of the bow or bend as shown in Fig. W and, while exerting pressure up or down as required, draw the spring adjuster forward the length of the bow. Repeat this operation as required until the spring is approximately straight. Take care when adjusting the springs to adjust them in line with their movement and to avoid tilting the spring. Tilted springs cause unequal contact separation of the two pairs of contacts and may result in the failure of one of the contacts on the bifurcated spring to close.

Operating Stud Gap

(2) If the stud gap is not satisfactory and requirement 2.08 is met, adjust the No. 1 contact spring slightly away from the centering springs, using the 416B spring adjuster applied at a point just back of the stationary stud. Make sure that the contact separation requirement is met.

Contact Spring Tension, Contact Separation, and Front Contact Make

(3) To change the tension of the springs, place the 416B spring adjuster on the spring just

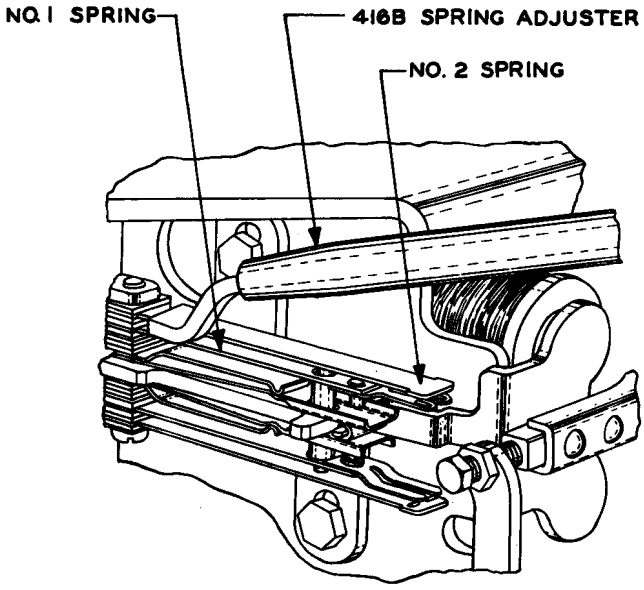


Fig. W—Method of Adjusting Springs for Straightness and Clearance

back of the stationary stud and slide it back to the base of the spring. Adjust the spring up or down as required, exercising care not to disturb adjacent springs.

(4) If the desired tension cannot be obtained by adjusting as covered in (3) without bowing the spring beyond its permissible limit or reducing the clearance between the springs below the specified minimum, apply the 416B spring adjuster to the spring just back of the stationary stud and slide it back to the base of the spring as indicated in Fig. W. Draw the adjuster forward the length of the spring, meanwhile applying pressure as required so that the spring is formed into a slight gradual bow with the concave surface facing the centering spring stop. The magnitude of the bow to be formed in the spring must be learned by experience and should be such that when the final tension adjustment is made at the base, the spring will be approximately straight. Move the adjuster to the base of the spring and adjust as covered in (3).

(5) Do not straighten kinked springs unless the kink interferes with proper adjustment of the spring assembly. Removing kinks tends to weaken the spring and to shorten its life. Normally straight springs that have been adjusted should have no sharp bends due to adjustment. A gradual bow, however, is permissible.

(6) Where the bifurcated springs are not in approximate alignment, readjust the individual members as required with the 535A spring adjuster.

(7) If the contact separation or front contact make cannot be met by adjusting the springs back of the stationary stud, hold the No. 2 spring firmly with a 416B spring adjuster just behind the stationary stud, and adjust the spring up or down as required with another 416B spring adjuster applied just in front of the stationary stud as shown in Fig. X. In no case should the bend be enough to make a visible kink in the spring. In making this adjustment, it may be necessary to readjust the tension as outlined in (3).

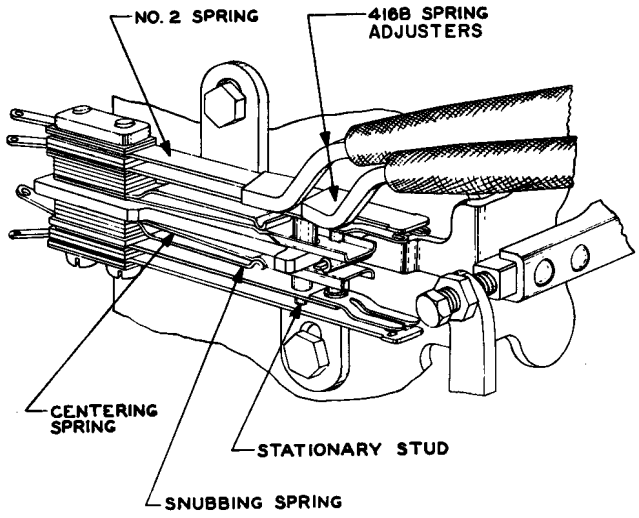


Fig. X—Method of Adjusting No. 2 Spring for Contact Separation and Front Contact Make

Procedures for Vertical Unit Exclusive of Holding Off-Normal Contact Springs

3.22 ***Contact Alignment*** (Reqt 2.22)

(1) If the contacts are not properly aligned, refer the matter to the supervisor.

3.23 ***Operating Spring Pressure*** (Reqt 2.23)

3.24 ***Contact Separation*** (Reqt 2.24)

3.25 ***Front Contact Make*** (Reqt 2.25)

3.26 ***Clearance Between Operating Springs and Adjustment Multiple Strip*** (Reqt 2.26)

Operating Spring Pressure and Clearance Between Operating Spring and Rear of Adjacent Multiple Strip to the Left

(1) If these requirements are not met, refer the matter to the supervisor.

Contact Separation

(2) Failure to meet this requirement may be due to a deformed multiple strip or misalignment of bifurcated tips of individual operating springs. To correct these conditions, proceed as covered in (3), (4), and (5).

(3) ***Deformed Multiple Strip:*** Place the 579A spring adjuster on the multiple strip in back of the contacts and while firmly holding the multiple strip with the 485A smooth-jaw pliers as shown in Fig. Y, adjust the multiple strip as required. Exercise care not to mutilate the contact when placing the 579A spring adjuster on the multiple strip or when removing it.

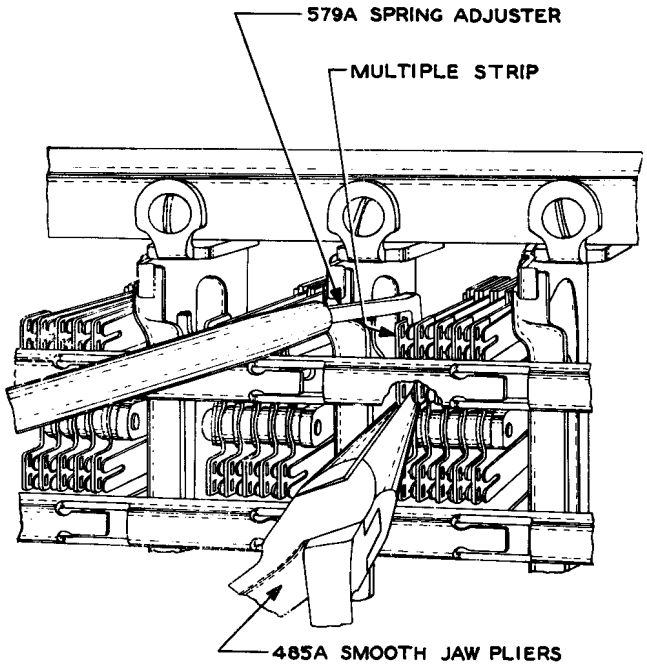


Fig. Y--Method of Adjusting Contact Multiple

(4) ***Misalignment of Bifurcated Tips of Operating Springs:*** If the bifurcated tips of the operating springs are not in approximate alignment with each other or with the remainder of the springs, adjust the individual tips as required with the 535A spring adjuster taking care that the contact separation of the two tips is approximately equal. In making these adjustments, always adjust the contact separation toward the minimum permissible amount.

(5) After making adjustments covered in (3) and (4), check requirements 2.24 (contact separation), 2.25 (front contact make), and 2.26 (clearance between operating springs and adjacent multiple strips).

Front Contact Make and Clearance Between Operating Spring and Front of Adjacent Multiple Strip to the Right

(6) Failure to meet these requirements may be due to wear of contacts, operating cards, holding armature, or upper armature support lug. The following methods, which can be used individually or in combination as required, are available to compensate for these conditions.

(a) Replacement of individual contacts as covered in the section covering replacing contacts on crossbar switches.

(b) Adjustment of individual operating springs.

(c) Adjustment of upper armature support lug.

(d) Replacement of operating cards or holding armature is covered in Section 030-717-801.

(e) ◗Placement of P-13F206 shims on holding armature as shown in Fig. Z.◖

(7) The following considerations will aid in determining the most suitable method of correcting the condition. First check that the armature retaining springs meet requirements 2.29 and 2.30. If the springs do not meet the requirements, adjust them as covered in 3.29 and 3.30. Then, if the requirements are still not met, examine successively the operation of each crosspoint starting at the top of the unit.

(8) If failure to meet the requirements occurs on crosspoints in the upper part of the vertical unit, adjust the upper armature support

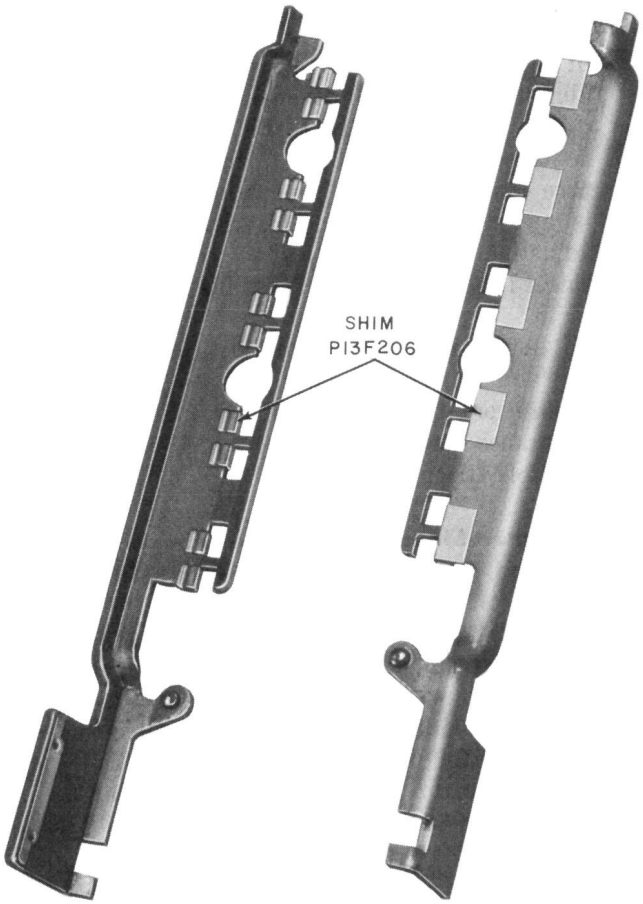


Fig. Z—P13F206 Shim In Place on Holding Armature

lug without removing the holding armature, as follows.

(a) Apply the 711A tool to the bottom of the upper armature support lug. Hold the tool parallel to the lug and tilt the slotted portion of the tool downward. Start the slotted portion of the tool on the bottom of the lug as close to the armature as possible. Then rotate the tool so that the bottom of the slot in the tool is against the bottom of the lug. Slide the tool outward against the armature as shown in Fig. AA.

(b) Slightly bend the lug to the left. Recheck the requirement and make additional adjustments to the left or right as necessary taking care not to damage adjacent springs.

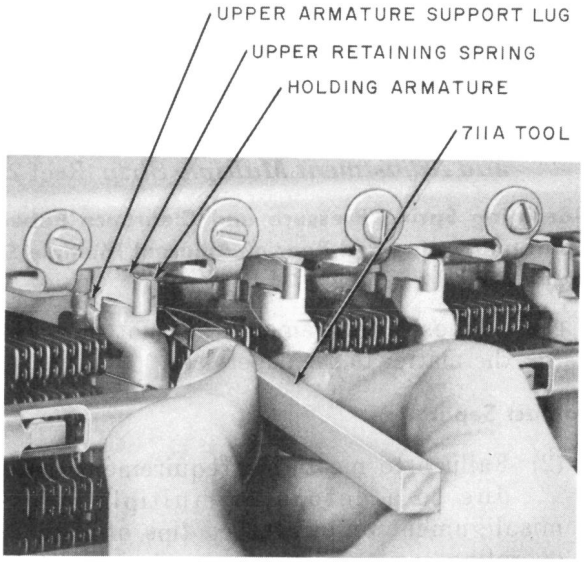


Fig. AA—Method of Adjusting Upper Armature Support Lug

(9) If failure to meet the requirements occurs on only a few crosspoints throughout the unit, check the following conditions.

(a) Wear of contacts. Replace worn contacts, if necessary, as covered in the section covering replacing contacts on crossbar switches.

(b) Wear of operating card and/or armature at the point of contact with the selecting finger. Replace worn cards, as required. Replace the armature if a groove or worn spot is found on the armature at the point of contact with the selecting finger ▶or apply shim P13F206 to those points which show card and armature grooves. Recheck for requirements in 2.11.◀

(c) If the parts covered in (a) and (b) are not excessively worn, adjust individual operating springs as required, using the 535A spring adjuster. Apply the adjuster as close to the operating card as possible. Take care not to kink the spring. If parts were replaced, it may be necessary to adjust individual springs to meet the requirement.

(10) If failure to meet the requirements occurs on most of the crosspoints, check for wear of the holding armature bearing surfaces.

(a) Remove the armature, as covered in 3.005. If the bearing surfaces are worn, replace the armature. Recheck the requirement, adjusting individual operating springs, if necessary, as covered in (9)(c).

3.27 ***Straightness of Balancing Springs*** (Reqt 2.27)

3.28 ***Balancing Spring Tension*** (Reqt 2.28)

Straightness of Balancing Springs

(1) If the spring is excessively bowed or bent or if there is not the proper clearance between springs straighten the spring before adjusting to meet the spring tension requirement. To straighten the spring apply the 534B spring adjuster to the spring just back of the bow or bend and, while exerting pressure to the right or left as required, draw the spring adjuster forward the length of the bow. Repeat this operation as required until the spring is approximately straight. In cases where the balancing spring is a thin spring, use the 534A spring adjuster.

Balancing Spring Tension

(2) Place the 534B spring adjuster on the spring just back of the operating stud and slide it back to the base of the spring. Adjust the spring to the right or to the left as required, exercising care not to disturb adjacent springs.

(3) If the desired tension cannot be obtained by adjusting as covered in (2) without bowing the spring beyond its permissible limit or reducing the clearance between the springs below the specified minimum, apply the 534B spring adjuster to the spring just back of the operating stud and slide it back to the base of the spring. Draw the adjuster forward the length of the spring meanwhile applying pressure as required so that the spring is formed into a slight gradual bow with the concave surface facing the armature. The magnitude of the bow to be formed in the spring must be learned by experience and should be such that when the final tension adjustment is made at the base, the spring will be approximately straight. Move the adjuster to the base of the spring and adjust as covered in (2).

3.29 ***Retaining Spring Tension*** (Reqt 2.29)

(1) If the retaining spring does not meet the tension requirement, first make sure that the retaining spring mounting screw is tight and if necessary tighten it with the 541A wrench.

Caution: In tightening the retaining spring mounting screw, exercise extreme care not to twist the head off the screw.

(2) If this does not relieve the condition, loosen the retaining spring mounting screw with the 541A wrench, taking care not to turn the screw out because difficulty may be experienced in reinserting the screw in the hole. In some cases it may be necessary to remove the top selecting bar as covered in 3.003 to obtain better movement of the wrench. Remove the spring and adjust it as required with the 416B spring adjuster. Do the adjusting on the straight portion of the spring in front of the mounting screw slot. Remount the spring and partially tighten the spring mounting screw. Make sure that requirement 2.30 is met and then securely tighten the screw as covered in (1).

3.30 ***Freedom of Movement of Holding Armature*** (reqt 2.30)

Lower End of Holding Armature

(1) If the sideplay at the lower end of the holding armature is not satisfactory, remove the armature as covered in 3.005. Adjust the armature support lug very slightly using the 485A smooth-jaw pliers as shown in Fig. BB. Remount the armature and recheck the sideplay. Make sure that the in and out play is satisfactory and if not, loosen the retaining spring mounting screw as covered in 3.29 and reposition the retaining spring as required. Retighten the retaining spring mounting screw as covered in 3.29 making sure that requirement 2.29 is met.

Upper End of Holding Armature

(2) If the holding armature does not have the specified sideplay, it is an indication that the portion of the retaining spring adjacent to the knife edge of the armature is either too close or too far away from the knife edge. Remove the holding armature as covered in 3.005 and adjust the straight portion of the retaining spring in front of the tang with the 416B adjuster. In making this adjustment, hold

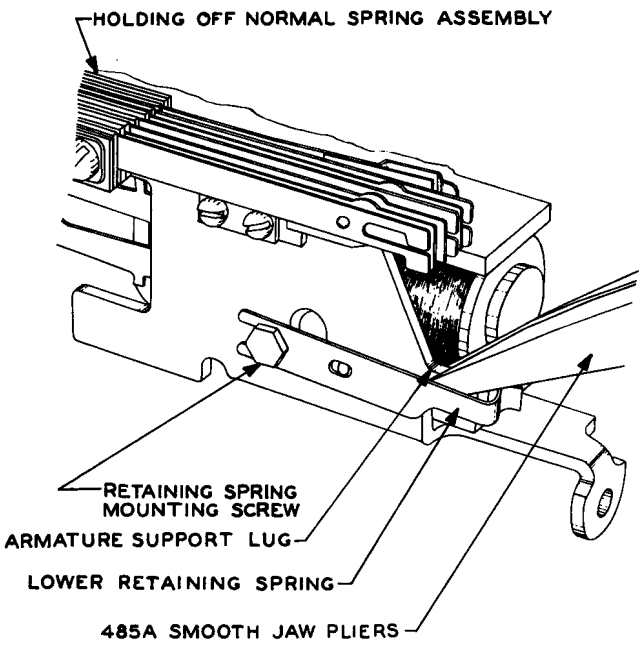


Fig. BB—Method of Adjusting Lower Armature Support Lug

the spring firmly so that all adjusting will be done in front of the tang and thereby avoid affecting the retaining spring tension. Adjust the in and out play by positioning the retaining spring as covered in (1).

3.31 ***Electrical Requirements*** (Reqt 2.31)

(1) If the electrical requirements are not met, recheck requirements 2.29 and 2.30.

(2) If the operate requirement is not met and the retaining spring tension and position is satisfactory, the trouble may be due to excessive balancing or holding off-normal spring tension or improperly adjusted crosspoint springs or both. In any case, correct the condition as covered in 3.23 through 3.28 and 3.34 through 3.40.

Procedures for Holding Off-Normal Contact Springs

3.32 ***Contact Alignment*** (Reqt 2.32)

3.33 ***Operating Stud Clearance*** (Reqt 2.33)

(1) If the contacts do not line up from top to bottom or if the stud rubs on the spring, replace the holding off-normal spring assembly as covered in Section 030-717-801.

3.34 ***Straightness of Springs*** (Reqt 2.34)

3.35 ***Contact Spring Clearance*** (Reqt 2.35)

3.36 ***Contact Spring Tension*** (Reqt 2.36)

3.37 ***Contact Separation*** (Reqt 2.37)

3.38 ***Operating Stud Gap*** (Reqt 2.38)

3.39 ***Front Contact Make*** (Reqt 2.39)

3.40 ***Back Contact Make*** (Reqt 2.40)

General

(1) The 534A, 534B, 534C, 534D, and 534E spring adjusters are used for adjusting the holding off-normal springs. In making the following adjustments select the adjustment which will fit the particular spring to be adjusted. Take care when adjusting the springs to adjust them in line with their movement and to avoid tilting the springs. Tilted springs cause unequal contact separation of the two pairs of contacts and may result in failure of one of the contacts on the bifurcated spring to close or they may result in failure to meet requirement 2.33.

Straightness of Springs and Contact Spring Clearance

(2) If the spring is excessively bowed or bent or if there is not the proper clearance between springs, straighten the spring before adjusting to meet the spring tension requirement. To straighten the spring, apply the proper spring adjuster to the spring just back of the bow or bend and, while exerting pressure to the right or left as required, draw the spring adjuster forward the length of the bow. Repeat this operation as required until the spring is approximately straight.

Contact Spring Tension

(3) Place the spring adjuster on the spring just back of the operating stud and slide it back to the base of the spring. Adjust the spring to the right or to the left as required exercising care not to disturb adjacent springs .

(4) If the desired tension cannot be obtained by adjusting as outlined in (3) without bowing the spring beyond its permissible limit or reducing the clearance between the springs below the specified minimum, apply the proper spring adjuster to the spring just back of the operating stud and slide it back to the base of the spring. Draw the adjuster forward the length of the spring meanwhile applying pressure as required so that the spring is formed into a slight gradual bow with the concave surface facing the holding armature. The magnitude of the bow to be formed in the spring must be learned by experience and should be such that when the final tension adjustment is made at the base, the spring will be approximately straight. Move the adjuster to the base of the spring and adjust as covered in (3). When adjusting the combined tension of two or more springs, distribute the tension between the individual springs.

(5) Do not straighten kinked springs unless the kink interferes with proper adjustment of the spring assembly. Removing kinks tends to weaken the spring and to shorten its life. Normally straight springs that have been adjusted should have no sharp bends due to adjustment. A gradual bow, however, is permissible.

Contact Separation, Operating Stud Gap, and Front Contact Make

(6) Adjust the prongs of the balancing spring as required, using the 534C adjuster to spread the prongs or the 485A smooth-jaw pliers to force them together. In some cases it may be necessary to remove the holding armature as covered in 3.005 to make this adjustment. If the requirements are not met on individual springs, change the position of the tangs as covered in (7).

(7) Hold the balancing spring with the proper spring adjuster applied as close as possible to the tang. Then adjust the tang to the right or left as required using a 534D spring adjuster. In making these adjustments on normally open contacts, always adjust the contact separation toward the minimum permissible amount.

(8) If enough relief is not provided, loosen the holding off-normal spring assembly bracket mounting nut with the 541A wrench. Unsolder the leads and withdraw the spring assembly. Then adjust the springs as outlined above. Remount the spring assembly and resolder the leads.