SWITCHES
300, 301, 302, AND 303 TYPES
REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers 300-, 301-, 302-, and 303-type switches. It also covers D-158890 and D-158891 (5-wire switches equipped with 20 vertical units) and the D-159187 (16-trunk, 6-wire switch equipped with 20 vertical units) switches.

1.02 The section is reissued to revise the procedures covering operating spring pressure, contact separation, front contact make, and clearance between operating springs and adjacent multiple strip to include the use of operating spring stud caps. Detailed reasons for reissue will be found at the end of the section.

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 stops on the associated actuating springs.

1.06 *Operate — Vertical Unit*

(a) ***All Coded Switches and D-158890 and D-158891 Switches:*** A vertical unit is said to ***operate*** if, when current is connected to its associated winding and a selecting finger touches the stop on its associated actuating spring, the following conditions are met.

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

(2) All contacts in a crosspoint are closed.

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

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

(b) ***D-159187 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 and the selecting finger on two levels (0 or 1 and one other level) touches the stop on their associated actuating springs, the following conditions are met.

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

(2) All contacts in both crosspoints are closed.

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

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

1.07 *Normal Position of Holding Armature:* A holding armature is said to be in the normal holding position when the holding armature stud rests against the holding armature backstop and the holding armature rests on the top edge of the lower retaining spring or 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 ***Standard point of measurement*** on a holding magnet is 1/8 inch in 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 and after checking or adjusting for any requirements involving the operation of the holding armature, see that the holding armature is resting on the top edge of the lower retaining spring or armature support lug.

1.13 Before checking or adjusting for any requirements on a switch, if possible take the switch out of service as covered in the appropriate section covering the equipment in which the switch is associated.

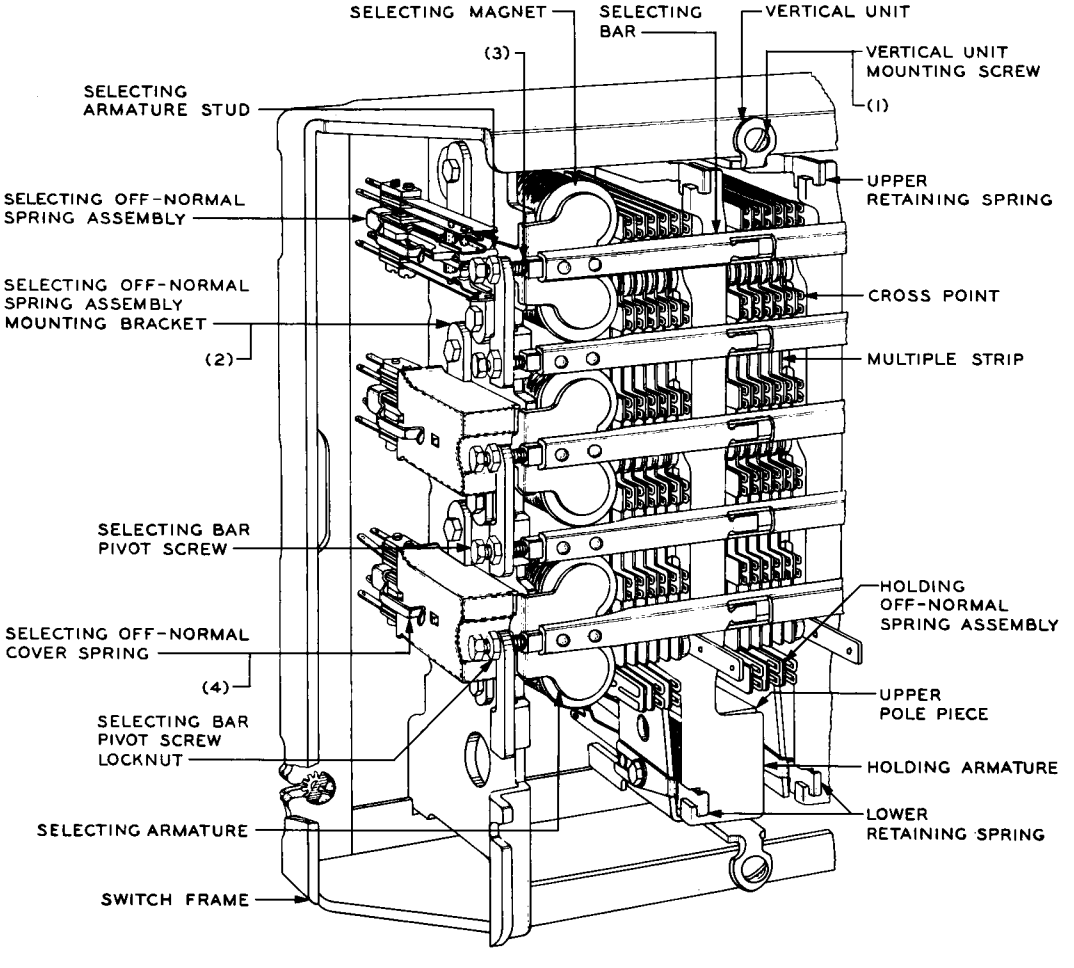


Fig. A — General View of Switch Equipped With Vertical Units Having Upper and Lower Retaining Springs

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

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(d), 2.25(b), 2.40 (Column C), and 2.41(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.

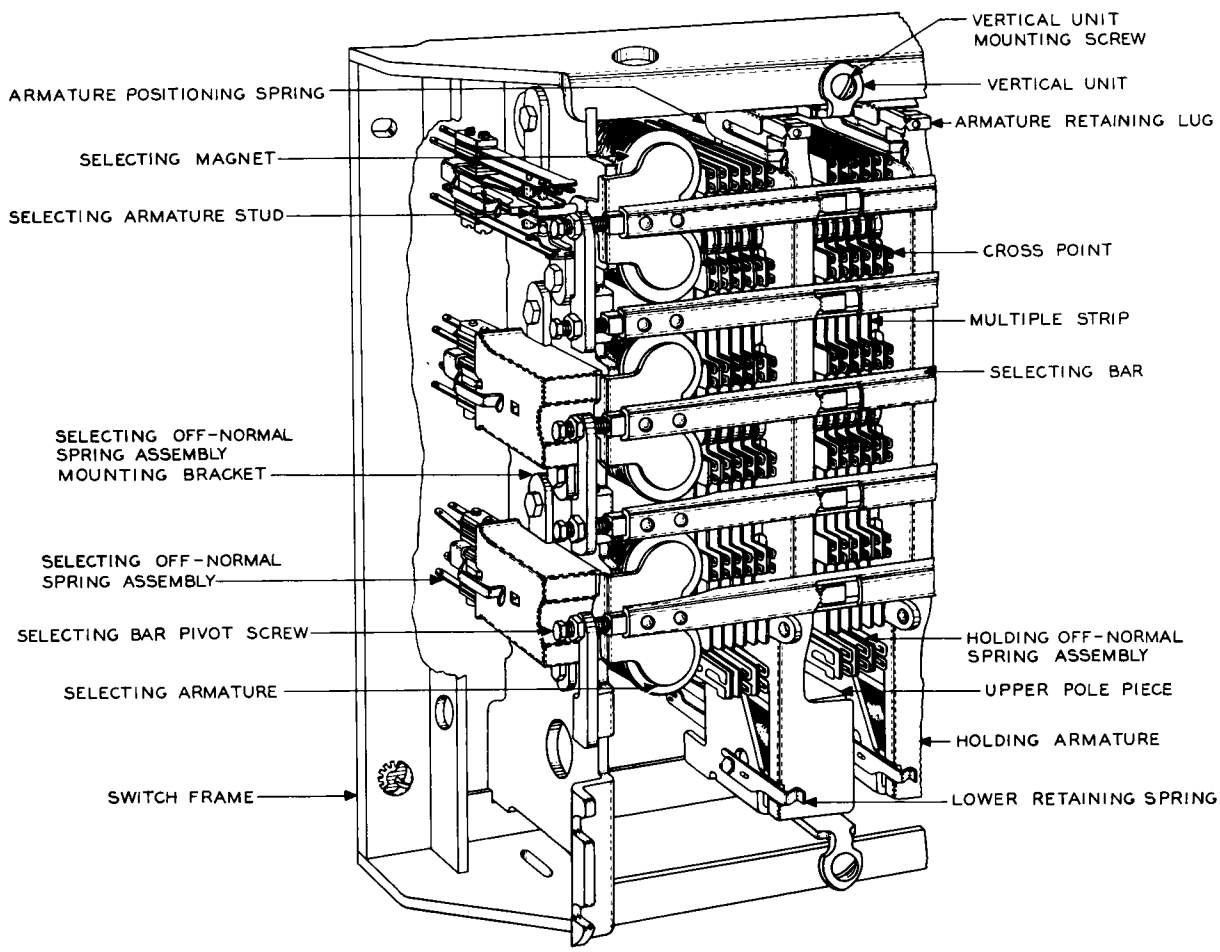


Fig. B — General View of Switch Equipped With Vertical Units Having Armature Retaining Lug

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 move 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.

Gauge by feel.

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

0.012 inch.

Use the No. 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 No. 74D gauge check that the clearance does not exceed 0.012 inch.

Caution: Insert the blade of the No. 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*

(a) Fig. C(1) — 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

Use the No. 139A gauge.

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. Insert the No. 139A gauge from above the armature as shown in Fig. D. Similarly, check the clearance by inserting the gauge from below the armature.

(b) On switches having straight armature extensions (Fig. D), the minimum limit of (a) shall apply the full length of the selecting armature extension inclusive of the wide portion.

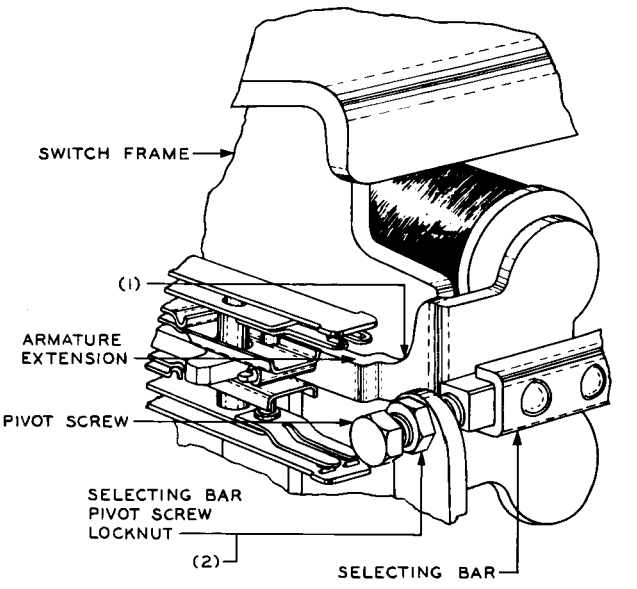


Fig. C — Clearance Between Selecting Armature Extension and Switch Frame

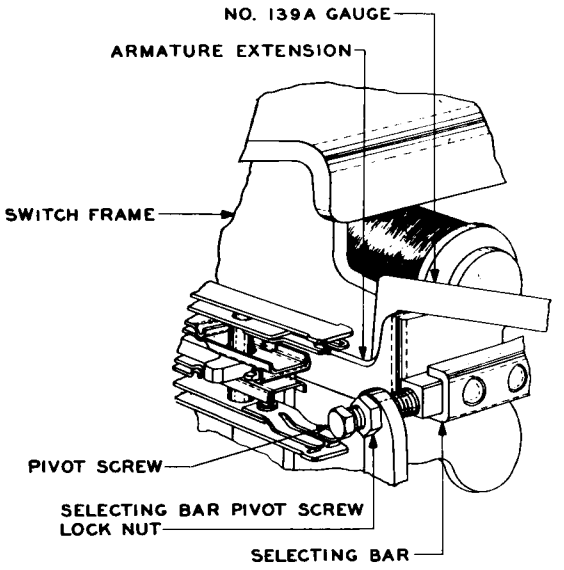


Fig. D – Method of Checking Clearance Between Wide Portion of Selecting Armature Extension and Switch Frame

2.05 ***Tightness of Selecting Bar Pivot Screw Locknuts:*** Fig. C(2) — 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 No. 68B and 70J gauges.

(b) Fig. E(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 No. 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. E(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.

Use the No. 74D gauge.

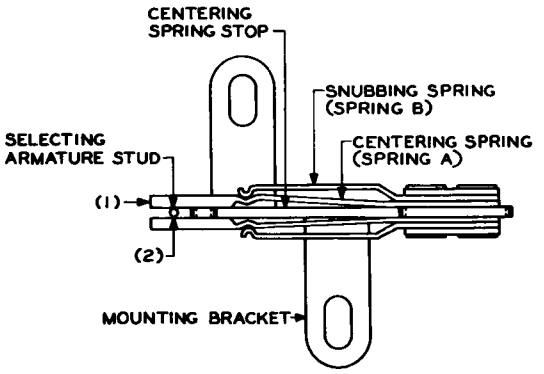


Fig. E – Centering Unit in Normal Position

2.09 ***Armature Travel:*** Fig. F(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 No. 137A gauge as shown in Fig. G.

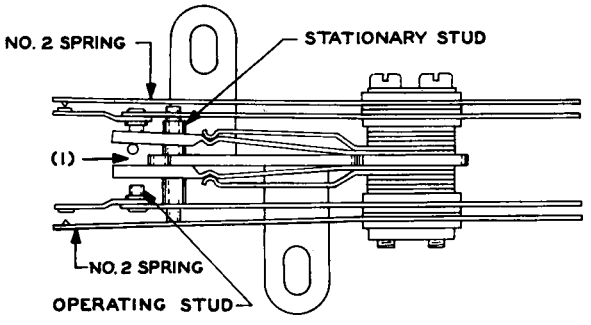


Fig. F – Selecting Off-Normal Spring Assembly With Selecting Unit Operated

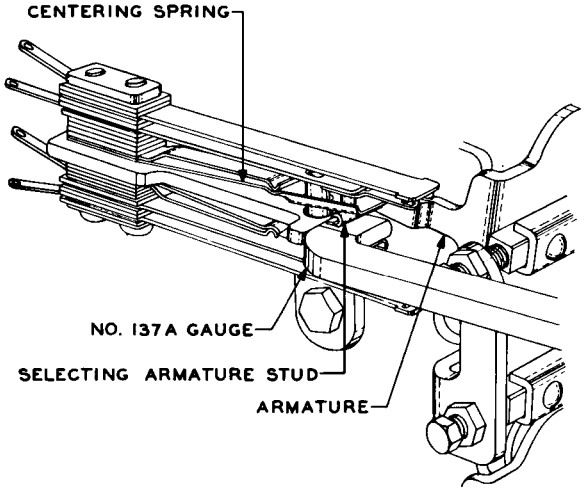


Fig. G – Method of Gauging Armature Travel

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. H(1) — With the holding armature in the normal position and with the end play of the associated selecting bar taken up to the left by grasping the selecting bar near the left end, the selecting fingers shall not touch the holding bars or vertical faces of the actuating spring with the selecting armature in any position.

Gauge by eye.

(b) Fig. H(2) — With the selecting armature electrically operated, each selecting finger shall touch the stop on the associated actuating springs.

Gauge by eye and by feel.

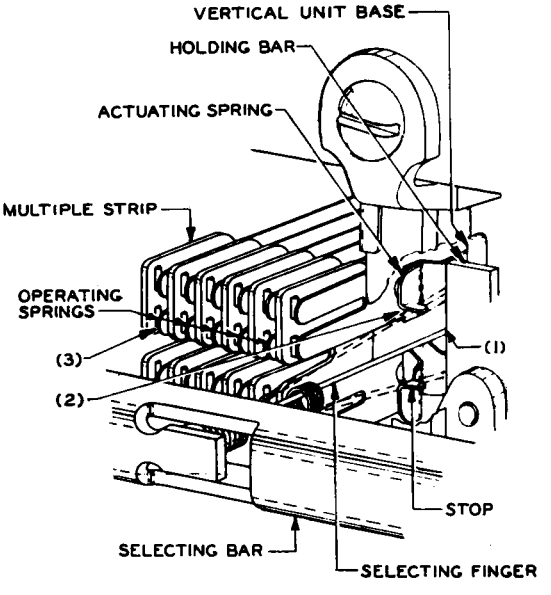


Fig. H – Position of Selecting Finger

(c) Fig. H(2) — With the selecting armature partially operated so that the selecting armature stud is 0.067 inch from the unoperated centering spring and with this centering spring resting against the centering spring stop, no selecting finger shall touch the stop on the associated actuating springs.

Use the No. 136A gauge or No. 164A and 165A gauges as follows.

(d) ***Using No. 136A Gauge:*** To check this requirement, 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.)

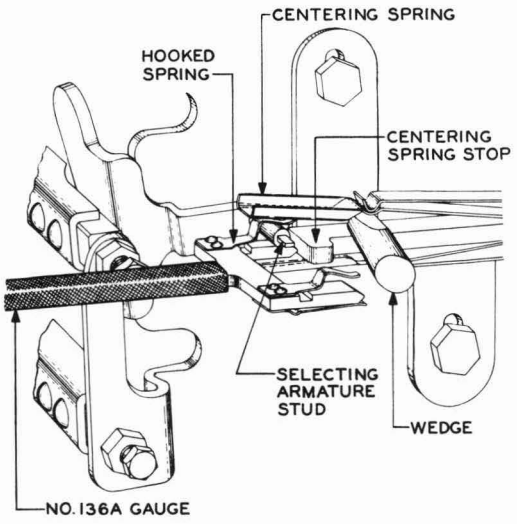


Fig. I – Method of Checking Position of Selecting Finger

Place the No. 136A gauge between the selecting armature stud and the centering spring as shown in Fig. I. In placing the gauge in this position, start the tip of the nonoperated 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. If the selecting finger rests against the actuating spring stop with the gauge in position, press the finger lightly away from the actuating spring stop with the KS-6320 orange stick. Release the finger and note whether the finger resumes its position against the actuating spring stop. If it does not, the requirement is met.

(e) ***Using No. 164A and 165A Gauges:*** Operate the selecting armature and insert a wedge between the operated centering spring and the centering spring stop as covered in (d). Slide the No. 164A gauge over the selecting armature stud and hook the No. 165A weight gauge over the selecting bar as shown in Fig. J. Make sure that the unoperated centering spring rests against the centering spring stop. If the selecting finger rests against the actuating spring stop with the gauges in position, press the finger lightly away from the actuating spring stop with the KS-6320 orange stick. Release the finger and note whether the finger resumes its position against the actuating spring stop. If it does not, the requirement is met.

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

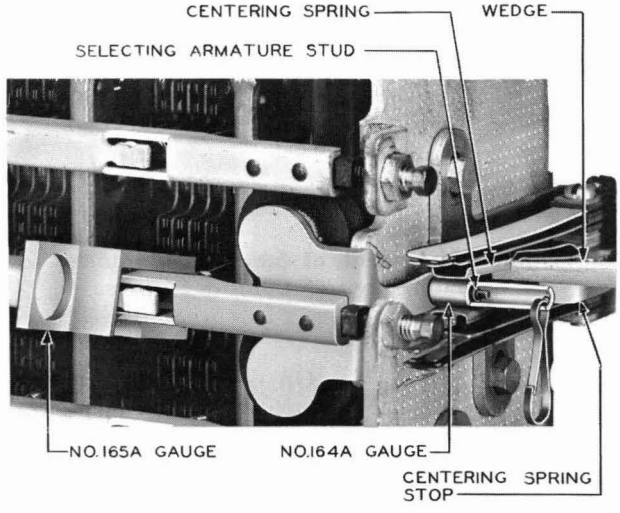


Fig. J – Method of Checking Position of Selecting Finger Using the No. 164A and No. 165A Gauges

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 No. 62B gauge.

This requirement shall be checked with the gauge applied against the straight portion of the spring at the point shown in the figure.

2.14 ***Contact Alignment***

(a) Fig. K(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.

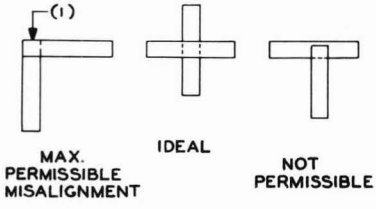


Fig. K — Alignment of Standard Contacts — Plan View of Contact Surfaces

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

Gauge by eye.

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

Gauge by eye and by feel.

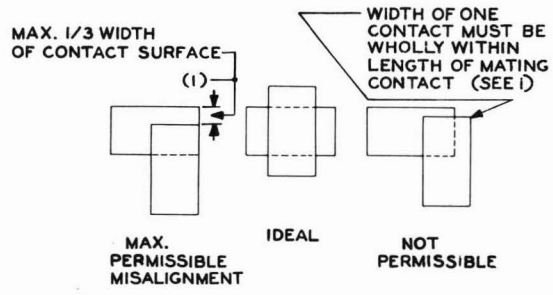


Fig. L — Alignment of Heavy Contacts — Plan View of Contact Surfaces

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. M(2) — There shall be a clearance between adjacent contact springs whether in the operated or the normal position of the selecting unit of

Min 0.010 inch

Gauge by eye.

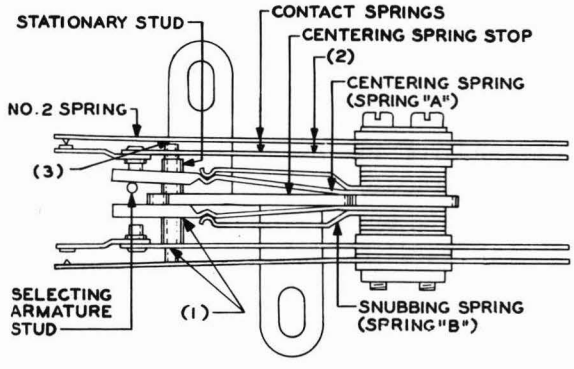


Fig. M — Selecting Off-Normal Spring Assembly With Selecting Unit Operated

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. 101 through 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 spring 1 shall be measured just in front of the operating stud and the tension of spring 2 shall be measured at the end of the spring. The springs shall register the required tension just as the spring leaves the stationary stud.

Use the No. 68B, 70H, and 70J gauges.

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

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

Test Min 0.008 inch
Readjust Min 0.010 inch

Use the No. 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 No. 74D and 139A gauges.

2.20 ***Operating Stud Gap:*** Fig. N(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 No. 300D, 300T, D-97286, and D-97299***

Test Min 0.062 inch
Readjust Min 0.065 inch

Use the No. 145A gauge.

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		

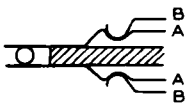


FIG. 102

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

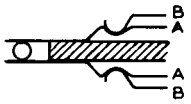


FIG. 103

SPRING TENSION		SPRINGS A+B	1	2
MIN.	T	45	10	60
	R	50	15	65
MAX.	T	65	30	85
	R	60	25	80

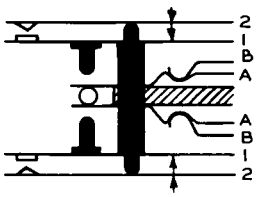
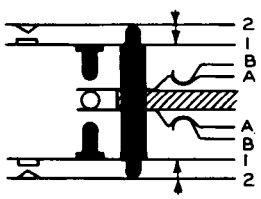


FIG. 104

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



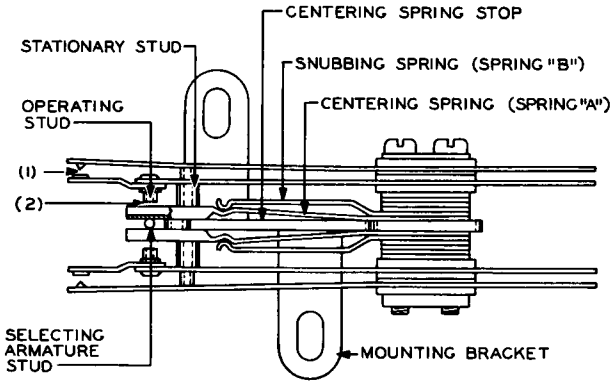


Fig. N – Selecting Off-Normal Spring Assembly With Selecting Unit Normal

(b) ***On No. 300D, 300T, D-97286, and D-97299 switches***

Min 0.065 inch

Use the No. 145A gauge.

2.21 ***Front Contact Make***

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

Gauge by eye.

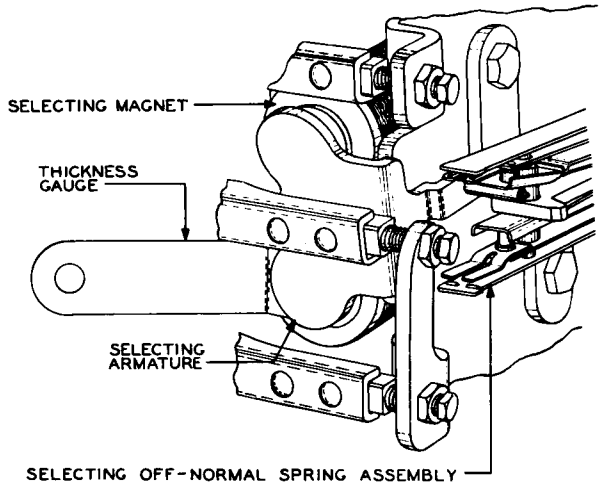


Fig. O – Method of Checking Front Contact Make on Selecting Off-Normal Spring Combination Fig. 104

(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. O.

(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 a contact spring, 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. K(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:*** With the holding armature in its normal position, there shall be follow on all operating springs in the crosspoint when the front end of the associated actuating spring is moved slightly toward the holding bar.

Gauge by eye and by feel.

2.24 ***Contact Separation:*** Fig. H(3) — The contact separation shall be

Test	Min 0.008 inch
Readjust	Min 0.010 inch

Use the No. 74D gauge.

2.25 ***Front Contact Make:*** Contacts shall close as specified below when the holding magnet is electrically energized with the specified thickness gauge inserted at the standard point of measurement and with the selecting finger engaging its associated actuating spring.

Use the No. 148B and 148C gauges as covered in (c).

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

Test	0.015 inch
Readjust	0.025 inch

(b) Both contacts on each bifurcated spring shall close using a thickness gauge of

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 and electrically energize the required holding magnet. Check whether the contact makes as covered in requirement 2.21(d).

2.26 ***Clearance Between Operating Springs and Adjacent Multiple Strips***

(a) Fig. Q(1) — 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 No. 139A gauge.

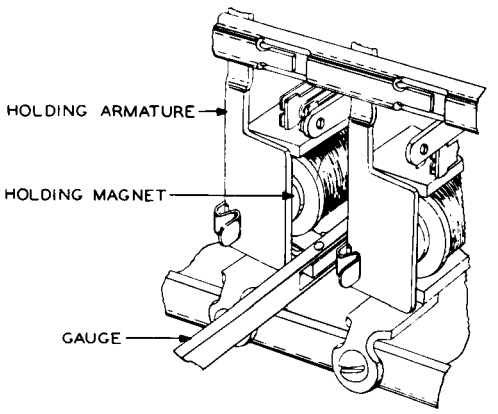


Fig. P — Thickness Gauge in Position at Standard Point of Measurement

(b) Fig. Q(2) — 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.

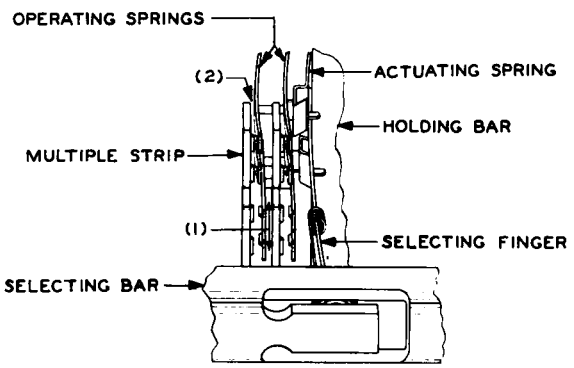


Fig. Q — Spring Clearance Requirements

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***

(a) The balancing spring tension shall be measured in grams at the end of the spring and shall be in accordance with the T (test) or R (readjust) tensions specified in Fig. 1 through 14 on pages 13 through 15. The particular figure to be used is indicated in the BSP Fig. column of the circuit requirement table. Restrain the holding armature from following the balancing spring when measuring its tension.

Use the No. 68B or 70J gauge.

Note: Fig. R(1) — On 2-piece-type balancing springs, the balancing spring tension shall be measured at the crimp in the branch of the spring next to the armature instead of at the end of the spring.

(b) The balancing spring tension shall be measured with the holding armature in its normal position and just as the spring leaves the holding armature stud.

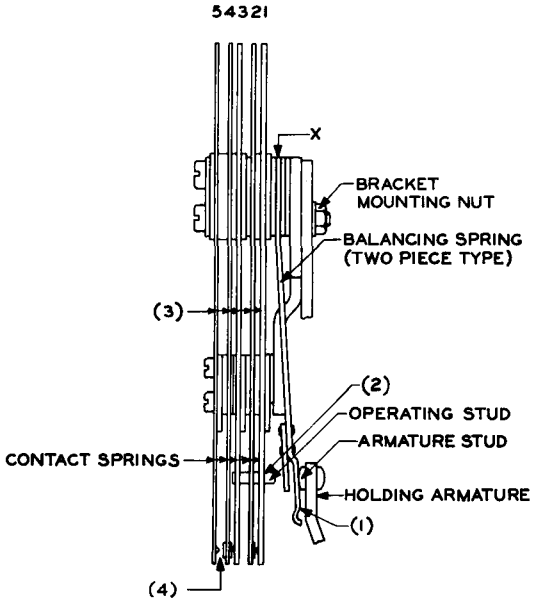


Fig. R — Bracket-Type Holding Off-Normal Spring Assembly

2.29 ***Retaining Spring Tension:*** The retaining spring tension, measured at the end of the spring as the tang leaves the base (switches per Fig. A) or as the spring leaves the base (switches per Fig. B) shall be

Test	Min 87.5 grams
Readjust	Min 100 grams

Use the No. 70J gauge.

On switches per Fig. (A), proceed as follows.

In checking the tension of the lower retaining spring on switches equipped with vertical units having upper and lower retaining springs, raise the armature slightly, if necessary, to insure that the spring is free to move without binding on the armature. Use the P-220366 dental mirror to determine when the tang of the spring leaves the base.

2.30 ***Freedom of Movement of Holding Armature:*** The holding armature shall not bind. This requirement is met if the two following conditions exist with the armature in the normal position.

(a) Play in the up and down direction.

Gauge by eye and by feel.

(b) Play not to exceed 0.010 inch in the left and right and in and out directions at the upper and lower ends of the holding armature. On vertical units having armature retaining lug and armature positioning spring, the play is between the armature and the retaining lug.

Gauge by eye and by feel.

In doubtful cases the minimum limit of (b) is met if the armature drops freely by its own weight after being raised manually. On vertical units with armature positioning spring, the pressure of the spring against the armature shall be removed while making this check.

2.31 ***Overlap of Holding Armature:*** (Applies only to vertical units having upper and lower retaining springs.) With the holding armature in its normal position and with the end play of the armature taken up in the downward direction, the armature shall overlap, or

at least be flush with, the pole pieces over the entire width of the armature.

Gauge by eye.

2.32 ***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 D-159187 switch). For combinations of two crosspoints, level 0, together with each of levels 2 through 9 and level 1, together with each of levels 2 through 9 shall be checked.

Requirements For Holding Off-Normal Contact Springs

2.33 ***Contact Alignment***

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

Gauge by eye.

2.34 ***Operating Stud Clearance:*** Fig. R(2) and S(1) — The springs shall not rub on the operating stud when the holding armature is slowly operated manually.

Gauge by eye and by feel.

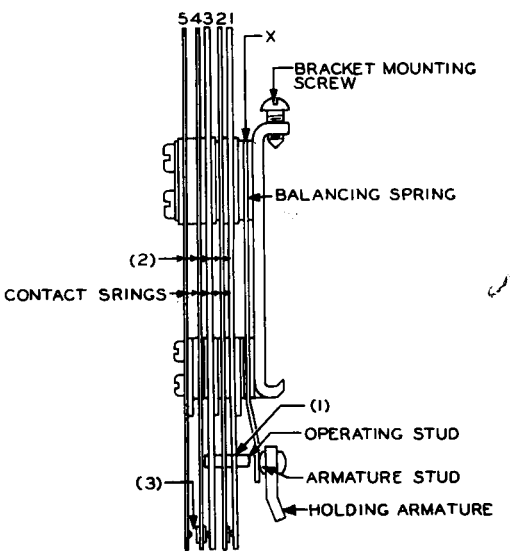


Fig. S — Clamp-Type Holding Off-Normal Spring Assembly

REQUIREMENTS FOR HOLDING OFF-NORMAL CONTACT SPRINGS

FIG. 1

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

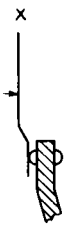
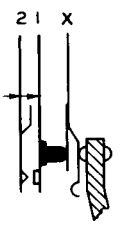


FIG. 2

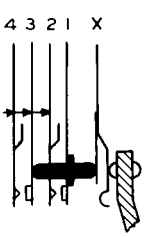
SPRING TENSION		SPRINGS X	1	2
MIN.	T	B	A	30
	R	B	A	35
MAX.	T	B		
	R	B		



A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.37 (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. 3

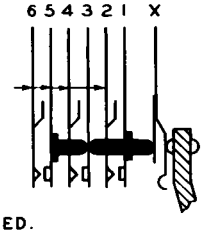
SPRING TENSION		SPRINGS X	1	2	3	4
MIN.	T	B	A	30	A	30
	R	B	A	35	A	35
MAX.	T	B				
	R	B				



A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.37 (c).
B - THE COMBINED TENSION OF SPRING 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

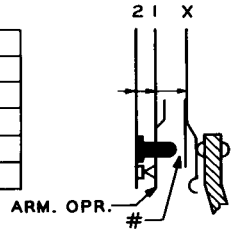
SPRING TENSION		SPRINGS X	1	2	3	4	5	6
MIN.	T	B	A	45	A	45	A	45
	R	B	A	50	A	50	A	50
MAX.	T	B						
	R	B						



A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.37(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

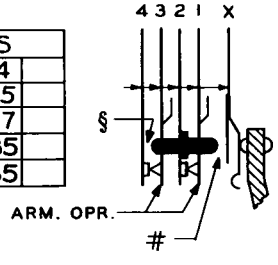
SPRING TENSION		SPRINGS X	1	2			
MIN.	T	40	30	15			
	R	45	35	17			
MAX.	T	60		35			
	R	57		35			



#- STUD GAP - SEE RQ. 2.39(b) - USE NO. 148D GAUGE.

FIG. 6

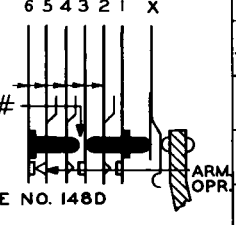
SPRING TENSION		SPRINGS X	1	2	3	4	
MIN.	T	40	30	15	30	15	
	R	45	35	17	35	17	
MAX.	T	60		35		35	
	R	57		35		35	



§ - SEE RQ. 2.39(a).
#- STUD GAP - SEE RQ. 2.39(b) - USE NO. 148E GAUGE.

FIG. 7

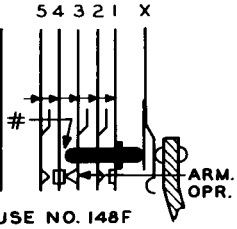
SPRING TENSION		SPRINGS X	1	2	3	4	5	6
MIN.	T	B	A	45	A	45	45	15
	R	B	A	50	A	50	50	17
MAX.	T	B						35
	R	B						35



#- STUD GAP - SEE RQ. 2.39(b) - USE NO. 148D GAUGE.
A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.37(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

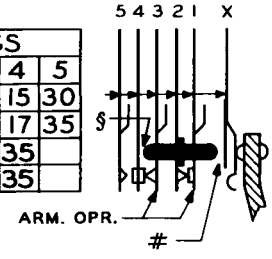
SPRING TENSION		SPRINGS X	1	2	3	4	5
MIN.	T	B	A	30	30	15	30
	R	B	A	35	35	17	35
MAX.	T	B				35	
	R	B				35	



#- STUD GAP - SEE RQ. 2.39(b) - USE NO. 148F GAUGE.
A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.37(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. 9

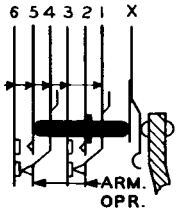
SPRING TENSION		SPRINGS X	1	2	3	4	5
MIN.	T	40	30	15	30	15	30
	R	45	35	17	35	17	35
MAX.	T	60		35		35	
	R	57		35		35	



§ - SEE RQ. 2.39(a)
#- STUD GAP - SEE RQ. 2.39(b) - USE NO. 148F GAUGE

FIG. 10

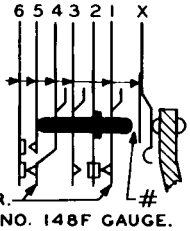
SPRING TENSION		SPRINGS X	1	2	3	4	5	6
MIN.	T	B	30	A	35	30	A	35
	R	B	35	A	40	35	A	40
MAX.	T	B			55			55
	R	B			50			50



A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.37(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

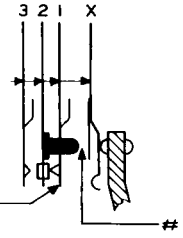
SPRING TENSION		SPRINGS X	1	2	3	4	5	6
MIN.	T	40	30	B	30	30	A	15
	R	45	35	B	35	35	A	17
MAX.	T	60						35
	R	57						35



#- STUD GAP - SEE RQ. 2.39(b) - USE NO. 148F GAUGE.
A - NO DEFINITE TENSION SPECIFIED. SEE RQ. 2.37(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

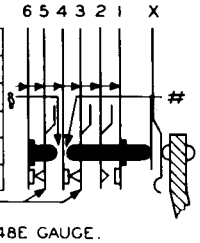
SPRING TENSION		SPRINGS X	1	2	3		
MIN.	T	40	30	15	30		
	R	45	35	17	35		
MAX.	T	60		35			
	R	57		35			



#-STUD GAP-SEE RQ. 2.39(b) - USE NO. 148 F GAUGE.

FIG. 13

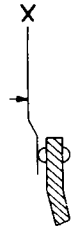
SPRING TENSION		SPRINGS X	1	2	3	4	5	6
MIN.	T	B	A	30	30	15	30	15
	R	B	A	35	35	17	35	17
MAX.	T	B				35		35
	R	B				35		35



§ - SEE RQ. 2.39 (a).
#-STUD GAP-SEE RQ. 2.39 (b) - USE NO. 148E GAUGE.
A-NO DEFINITE TENSION SPECIFIED. SEE RQ.
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	112.5



2.35 ***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.

2.36 ***Contact Spring Clearance:*** Fig. R(3) and S(2) — There shall be a clearance between adjacent contact springs whether in the operated or normal position of the holding armature of

Min 0.010 inch

Gauge by eye.

2.37 ***Contact Spring Tension***

(a) The spring tension shall be measured in grams at the end of the spring and 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 No. 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.

2.38 ***Contact Separation:*** Fig. R(4) and S(3) — The separation between any pair of contacts normally open or between any pair of contacts that are opened when the holding armature is operated shall be

Test Min 0.008 inch
Readjust Min 0.010 inch

Use the No. 74D gauge.

2.39 ***Operating Stud Gap***

(a) On spring combinations shown in Fig. 6, 9, and 13 the clearance between the operating stud and the adjacent spring (labeled §) 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. O.

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

Use the 148-type gauges.

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

Note: This requirement applies in addition to 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).

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

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

Gauge by eye. See 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.

2.42 ***Armature Positioning Spring (vertical units having armature retaining lug)***

(a) When the upper end of the holding armature is pulled forward and released, the armature positioning spring shall cause the

armature to return against the upper knife edge. The 534-type adjuster may be used as a hook.

Gauge by eye and feel.

(b) The armature positioning spring shall not cause the holding armature to assume either the operated or the normal position when checked as follows. Lift the balancing spring from the holding armature stud with the KS-6320 orange stick and manually place the holding armature approximately midway between the operated and the normal positions. Then upon letting go of the holding armature, it shall not assume either the operated or the normal position.

Gauge by eye and feel.

3. ADJUSTING PROCEDURES

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

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
270	Spring Adjuster
416B (2 reqd)	Spring Adjuster
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 No. 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 (2 reqd)	Spring Adjuster
535A	Spring Adjuster
536B	Selecting Bar Holder
538A	9/32-Inch Hex. Offset Socket Wrench
539A	1/4-Inch Hex. Open Double-End Wrench
541A	1/4-Inch 12-Point Double-End Wrench
544A	1/4-Inch Hex. Offset Socket Wrench
549A	Spring Adjuster
579A	Spring Adjuster
711A	Tool
KS-6320	Orange Stick
KS-6320	Orange Stick (modified locally)
KS-14220, L1, L7, and L14	Wrench Consisting of Sliding T-Handle 6-Inch Extension Bar 7/16-Inch Socket
KS-14762	Portable Lamp ←
P-220366	Dental Mirror
R-1051	File ←
—	4-Inch E Screwdriver (or the replaced 4-inch regular screwdriver) ↰
—	5-Inch E Screwdriver (or the replaced 5-inch regular screwdriver) ↲

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	6-Inch Tweezers, American Piano Supply Co, No. 91 (modified, see 3.008)
GAUGES	
62B	0- to 700-Gram Gauge
68B	70-0-70-Gram Gauge
70H	0- to 30-Gram Gauge
70J	0- to 150-Gram Gauge
74D	Thickness Gauge Nest
136A	0.067-Inch Thickness Gauge
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
164A	Selecting Finger Positioning Gauge
165A	Selecting Finger Positioning Gauge
P-243665	0.003-Inch Feeler Gauge (part of KS-6909 thickness gauge nest)
GAUGES	
P-243666	0.004-Inch Feeler Gauge (part of KS-6909 thickness gauge nest)
MATERIALS	
KS-7860	Petroleum Spirits
KS-14666	Cloth
KS-16832, L1	Lubricant
P-10F136	0.006-Inch Cap (operating spring stud cap)
—	Single-Edge Razor Blade
—	No. 22 Bare Tinned Copper Wire
—	Toothpicks, Hardwood, Flat at One End and Pointed at the Other
—	Electrical Tape, Scotch No. 33
TEST APPARATUS	
35-Type	Test Set

3.002 ***Use of Test Lamp:*** The No. 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 No. 418A or the No. 539A wrench, depending upon whether 5/16- or 1/4-inch nuts are used. Turn the pivot screws out with the No. 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 mounted in the positions from which they were removed.

3.004 ***Remounting of Selecting Bars in the Switch Frame:*** In remounting the selecting bars, take care that they are assembled 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 actuating springs and holding bar. 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 Holding Armature:*** To remove a holding armature, press the lower retaining spring to the left, taking care not to distort the spring. At the same time draw the lower end of the armature forward until it is free of the retaining spring and move the armature forward and downward until it is free of the vertical unit. On 6-wire switches it may be necessary to remove the lower selecting bar as covered in 3.003 to obtain sufficient clearance for removing and reassembling the holding armature.

3.006 ***Remounting Holding Armature:*** To remount a holding armature proceed as follows. Grasp the bottom right corner of the armature and insert the top end of the armature under the upper retaining (or armature positioning) spring, taking care that the armature does not catch on the selecting fingers or actuating springs. Then rotate the armature to the left so that it will clear the actuating springs 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 actuating springs. At the same time, position the armature on the armature support lug with the armature stud between the balancing spring and the back stop lug. If necessary, press the lower retaining spring to the left with the other hand to facilitate positioning the armature. When more than one holding armature is removed from the switch, take care to remount the armatures on the same vertical units from which they were removed. If the armatures are interchanged, there is a hazard of changing the adjustments on the operating springs. In some cases difficulty may be experienced in reassembling the holding armature on 6-wire switches because of interference of the actuating springs. In this case, with the 4-inch E screwdriver, loosen the vertical unit mounting screws of the vertical unit on which the armature is being remounted. 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 placed in position. 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.

3.007 When adjusting 301-, 302-, and 303-type switches, it may be necessary to remove the selecting bar guard to gain access to the parts.

3.008 Modify the 6-inch tweezers by filing both legs of the tweezers in accordance with Fig. T using the R-1051 file. Exercise care to file parallel to the longitudinal axis of the tweezers. Then insulate the tweezers by applying electrical tape to the outer surfaces as shown in the figure. Form the tape to the contours of the tweezers and remove excess tape with a single-edge razor blade.

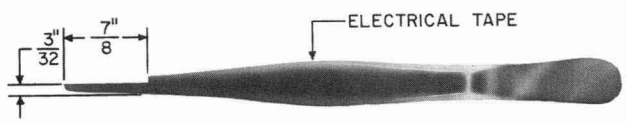


Fig. T – Modified 6-Inch Tweezers

General Procedures

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

(1) Clean the contacts in accordance with the approved 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 vertical unit mounting screws with the 4-inch E screwdriver. Recheck requirement 2.11.

(4) Tighten the selecting off-normal spring assembly bracket mounting screws with the No. 538A or the 544A wrench, depending upon whether 9/32- or 1/4-inch head screws are used.

(5) Tighten the holding off-normal spring assembly bracket mounting screws with the 4-inch E screwdriver.

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 No. 533A bearing lug adjuster applied as shown in Fig. U.

(3) ***Dirt and Grit in the Pivot Bearings, Imperfect Pivot Screws, and Selecting Bar Bearings:*** Loosen the pivot screw locknuts with the No. 539A or 418A wrench, depending upon whether 1/4- or 5/16-inch nuts are used. 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 No. 476A or 544A wrench, 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 with a new one. Examine the pivot screws and, if bent or otherwise defective, replace them with new ones. If they are dirty, clean them with a KS-14666 cloth saturated with KS-7860 petroleum spirits. At this time examine the selecting bar bearings and, if they are burred, replace the selecting bar with a new one. If the bearings are dirty, flush them out with petrolum spirits applied with a clean toothpick. After the parts have become thoroughly dry, lubricate each bearing by applying one drop of KS-16832,L1 lubricant in the bearing hole with a piece of No. 22 bare

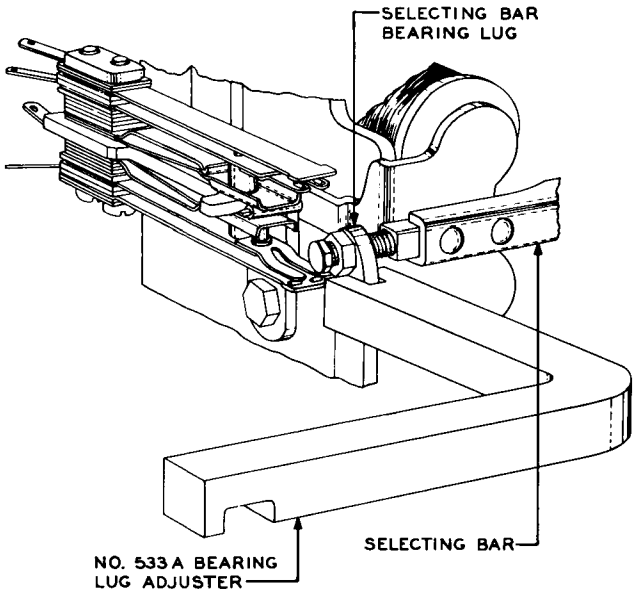


Fig. U –Method of Adjusting Selecting Bar Bearing Lug to Eliminate Bind

tinned copper wire which has been dipped into the oil to a depth of 3/8-inch and quickly removed. 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 No. 539A or 418A wrench and turn the pivot screws at each end out slightly. Insert the 0.010-inch blade of the No. 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 finger-tight. 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 No. 476A or 544A wrench depending upon whether 3/16- or 1/4-inch head screws are used, and tighten the locknut with the No. 418A or 539A 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, 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 No. 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 No. 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 No. 549A spring adjuster to the spring from the front as shown in Fig. V and adjust the end of the centering spring up or down as required. Any change made in this adjustment may affect the armature travel. Recheck requirements 2.07 and 2.20.

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 No. 538A or 544A wrench, depending upon whether 9/32- or 1/4-inch head screws are used, and shift the bracket up or down as required so as 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.

(3) If the armature travel is unsatisfactory at both magnets, adjust the selecting bar bearing lug in or out slightly with the No. 533A bearing lug adjuster as shown in Fig. W. Recheck requirements 2.03 and 2.11.

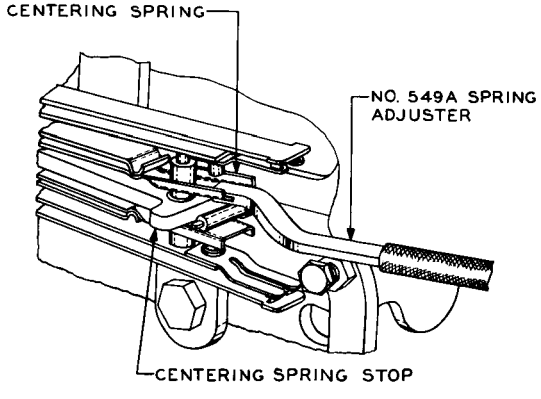


Fig. V – Method of Adjusting Centering Spring

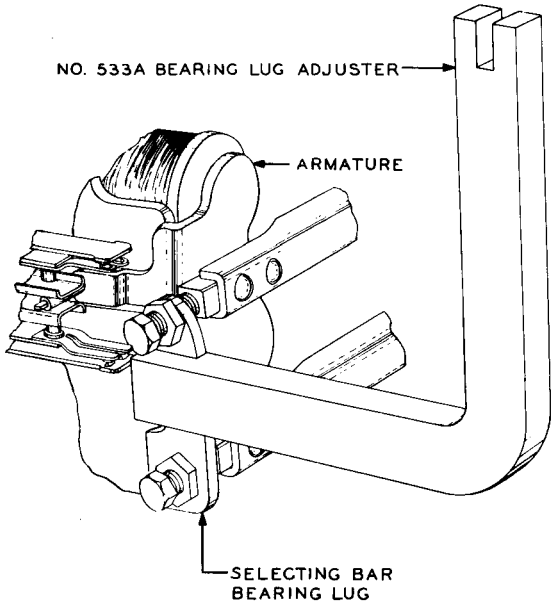


Fig. W – Method of Adjusting Selecting Bar Bearing Lug for Armature Travel

3.10 ***Straightness of Selecting Finger*** (Reqt 2.10)
3.11 ***Position of Selecting Finger*** (Reqt 2.11)

Straightness of Selecting Finger

(1) If the selecting finger is kinked or bent, straighten it with the No. 485A smooth-jaw pliers.

Clearance Between Selecting Finger and the Holding Bar and Actuating Springs

(2) If the selecting fingers do not clear the holding bars and actuating springs, 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 using the No. 539A or 418A wrench, depending upon whether 1/4- or 5/16-inch nuts are used. Turn the pivot screws, using the No. 476A wrench, so as to move the selecting bar horizontally to correct the condition. Retighten the pivot screw locknuts as covered in 3.03 through 3.05.

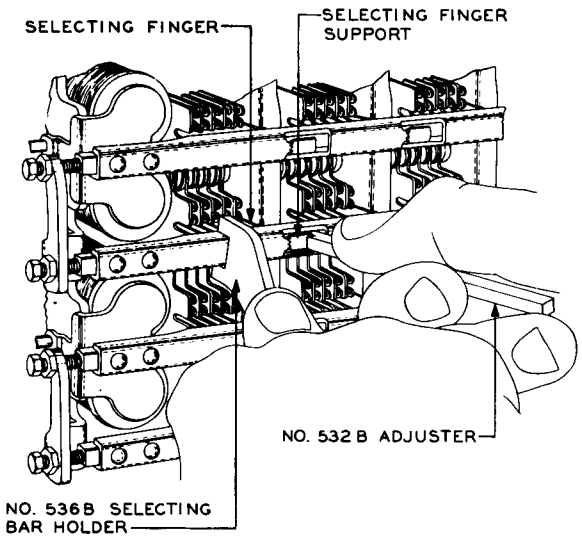


Fig. X – Method of Adjusting Selecting Finger Support

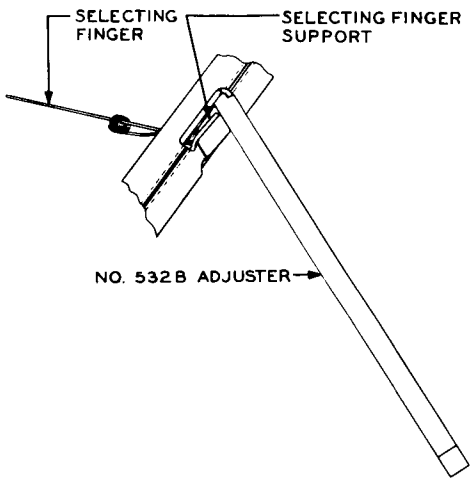


Fig. Y – Method of Adjusting Selecting Finger to Left

To change the position of an individual selecting finger, hold the selecting bar with the No. 536B selecting bar holder and adjust as required with the No. 532B adjuster as shown in Fig. X.

(3) Where the front edge of the selecting finger support is rounded slightly, the No. 532B adjuster may slip off the finger support when adjusting the selecting finger to the left as shown in Fig. X. In this case use the tool as a lever by inserting the small end between the selecting bar and the selecting finger support as shown in Fig. Y, and prying the support so that the finger moves to the left.

Engagement of Actuating Springs by Selecting Finger

(4) Operate the selecting armature and check that the selecting finger touches the stop on its associated actuating spring.

(5) If the requirements are not met, first determine whether the condition 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 covered 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 No. 532B adjuster and No. 536B selecting bar holder as shown in Fig. X.

(6) If the springs of the No. 136A gauge require readjusting, use the No. 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 No. 534D spring adjuster applied to the spring as near to the insulators as possible. Remount the cover and recheck that the requirement is met.

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 with a new one as covered in Section 030-715-801.

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 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 No. 416B spring adjuster to the spring just back of the bow or bend as shown in Fig. Z 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.

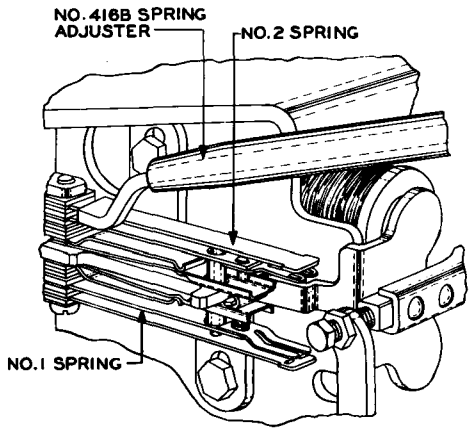


Fig. Z – Method of Adjusting Springs for Straightness and Clearance

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 No. 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 No. 416B spring adjuster on the spring just 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 outlined in (3) without bowing the spring beyond its permissible limit or reducing the clearance between the springs below the specified minimum, apply the No. 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. Z. 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 No. 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 No. 416B spring adjuster just behind the stationary stud, and adjust the spring up or down, as required, with another No. 416B spring adjuster applied just in front of the stationary stud as shown in Fig. AA. In no case should the bend

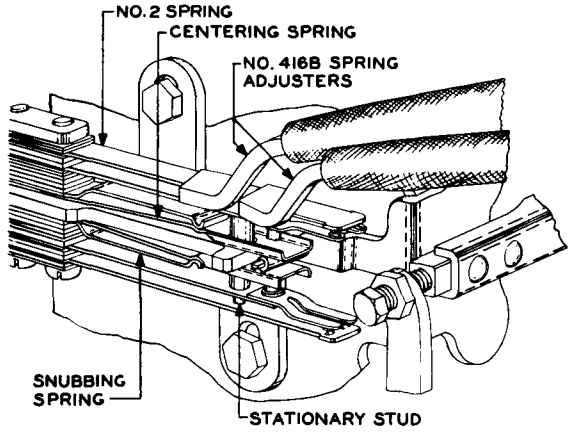


Fig. AA – Method of Adjusting No. 2 Spring for Contact Separation and Front Contact Make

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).

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 Adjacent Multiple Strips*** (Reqt 2.26)

Operating Spring Pressure and Clearance Between Operating Springs and Rear of Adjacent Multiple Strips 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 No. 579A spring adjuster on the multiple strip in back of the contacts and while firmly holding the multiple strip with the No. 485A smooth-jaw pliers as shown in Fig. AB, adjust the multiple strip as required. Exercise care not to mutilate the contact when placing the No. 579A spring adjuster on the multiple strip or when removing it.

(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 No. 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.

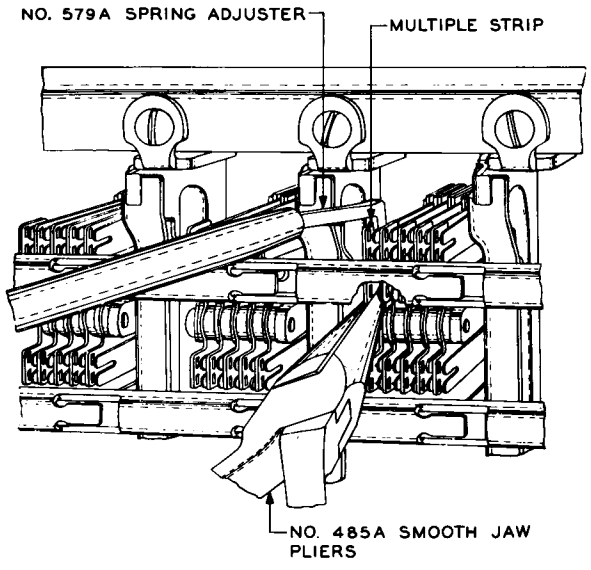


Fig. AB – Method of Adjusting Contact Multiple

(5) After making adjustments covered above, 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 Springs and Front of Adjacent Multiple Strips to the Right

(6) Failure to meet these requirements may be due to wear of contacts, operating spring studs, or holding bar. Several methods are available to compensate for these conditions, as follows.

(a) Use of operating spring stud caps, as covered in (7).

(b) Adjustment of upper armature support lug, as covered in (8).

(c) Repositioning the holding bar, as covered in (9).

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

The following considerations will aid in determining the most suitable method of correcting the condition. Beginning at the top, examine, successively, the operation of each crosspoint in the vertical unit. If failure to meet the requirements occurs on most of the crosspoints or crosspoints near both the top and bottom, use spring stud caps to correct the condition as covered in (7). If failure to meet the requirements occurs only on crosspoints in the upper part of the unit, adjust the upper armature support lug as covered in (8). If sufficient adjustment cannot be obtained using these methods and the holding bar is not excessively worn at points of contact with the selecting fingers, reposition the holding bar as covered in (9). If the holding bar is excessively worn, replace the armature.

(7) ***Mounting Operating Spring Stud Caps***

(a) Use the KS-14762 portable lamp as shown in Fig. AC to facilitate mounting the cap.

(b) Referring to Fig. AC, hold the modified tweezers in the left hand and position the P-10F136 operating spring stud cap (0.006 inch thick) in the tweezers so that the open end of the cap will be toward the stud on which the cap is to be mounted. Hold the KS-6320 orange stick in the right hand, apply the tip of the orange stick to the outer end of the actuating spring, and carefully move the spring toward the armature. Position the cap on the stud and slowly move the orange stick to the left permitting the actuating spring to bear against the cap. Remove the tweezers and orange stick and check that the cap is seated on the stud.

(c) If after mounting an operating spring stud cap, slight additional adjustment of the springs is required, adjust the individual springs using the No. 535A spring adjuster applied as close to the stud as possible. Take care not to kink the spring.

Caution: Do not attempt to adjust the actuating spring because this might adversely affect operation of the crosspoint springs.

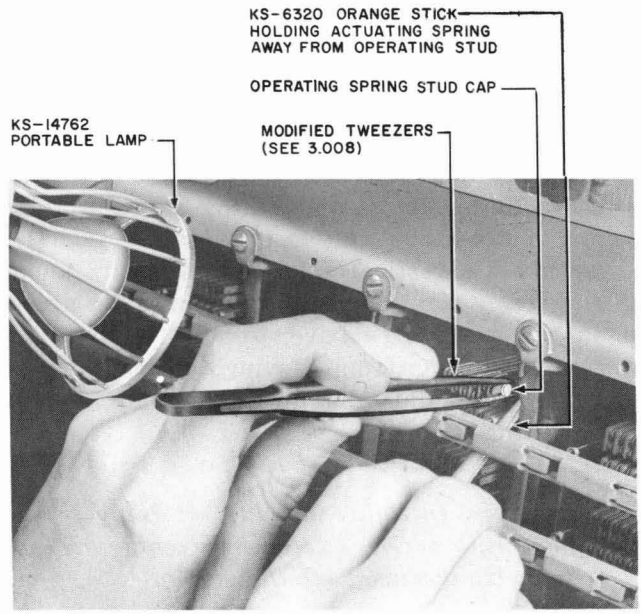


Fig. AC – Method of Mounting Operating Stud Cap

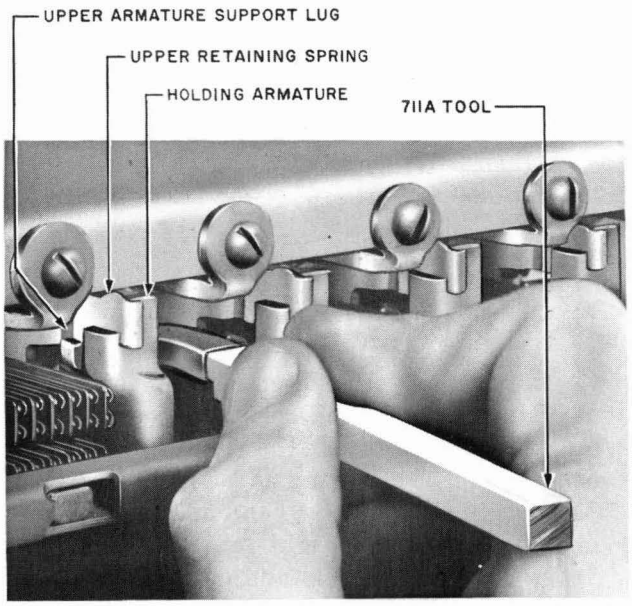


Fig. AD – Method of Adjusting Upper Armature Support Lug

(8) ***Adjusting Upper Armature Support Lug***

(a) Apply the No. 711A tool to the bottom of the upper armature support lug as follows. 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. AD.

(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.

(9) ***Repositioning Holding Bar***

(a) Remove any operating spring stud caps in reverse order of mounting as covered in (7).

(b) Remove the holding armature as covered in 3.005.

(c) Using the 3-inch C screwdriver, loosen the holding bar mounting screws just enough to permit slight shifting of the position of the bar. Slightly move the bar in the direction of the actuating springs, shifting the bar parallel to its original position unless failure to meet the contact make requirement is more prevalent at the upper or lower portions of the vertical unit. In this case, tilt the bar slightly to compensate for this difference. Securely tighten the holding bar mounting screws.

(d) Remount the armature as covered in 3.006.

(e) Check requirements 2.11 (position of selecting finger), 2.24 (contact separation), 2.25 (front contact make), and 2.26 (clearance between operating springs and adjacent multiple strips).

(f) If the clearance between operating springs and adjacent multiple strips or the front contact make requirements on individual crosspoints are not met, adjust the operating springs as covered in (7) (c), or use the caps as covered in (7) (b).

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 No. 534B or 534C 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 No. 534A spring adjuster.

Balancing Spring Tension

(2) Place the No. 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 No. 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 No. 541A wrench. On vertical units equipped with upper and lower retaining springs, it may be necessary to use a screwdriver to hold the lower retaining spring from moving with the screw when tightening the lower retaining spring mounting screw.

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 No. 541A wrench, taking care not to turn the screw out because difficulty may be experienced in reassembling 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 No. 416B spring adjuster. Do the adjusting on the straight portion of the spring in front of the mounting screw. Remount the spring and partially tighten the spring mounting screw. Make sure that requirements 2.30 and 2.31 are met and then securely retighten the retaining spring mounting screw as covered in (1).

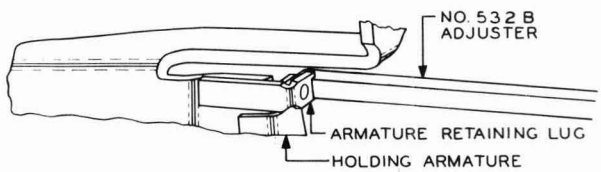


Fig. AE – Method of Adjusting Armature Retaining Lug of Vertical Units Having Lower Retaining Springs Only

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

Vertical Units Having Lower Retaining Springs Only

(1) If there is insufficient play at the top of the armature, adjust the armature retaining lug as required with the No. 532B adjuster as shown in Fig. AE.

(2) If the sideplay at the bottom is not satisfactory, remove the retaining spring as covered in 3.29 and remove the armature as covered in 3.005. Adjust the armature support lug very slightly using the No. 485A smooth-jaw pliers as shown in Fig. AF. Set the armature in place and recheck the sideplay. Remount the retaining spring and partially retighten the retaining spring mounting screw. Make sure that the in and out play is satisfactory and then securely tighten the retaining spring mounting screw as covered in 3.29.

Vertical Units Having Upper and Lower Retaining Springs

(3) 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 No. 416B adjuster. In making this adjustment, hold 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 3.29.

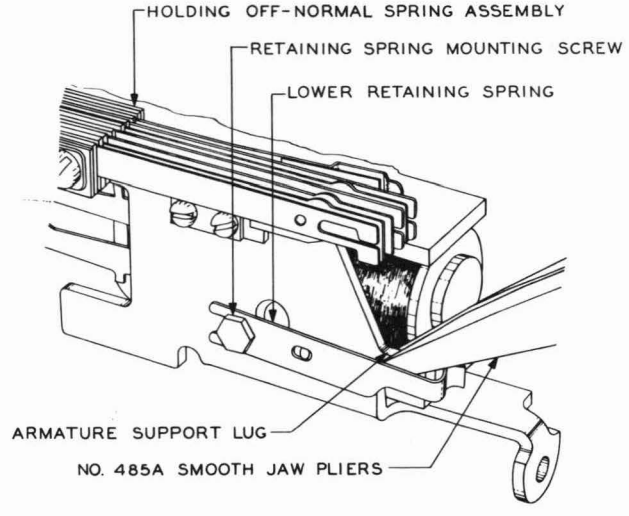


Fig. AF – Method of Adjusting Lower Armature Support Lug

3.31 ***Overlap of Holding Armature*** (Reqt 2.31)

(1) If necessary, loosen the retaining spring mounting screws as covered in 3.29 and position the springs as required. Securely retighten the retaining spring mounting screw as covered in 3.29, making sure that requirement 2.30 is met.

3.32 ***Electrical Requirements*** (Reqt 2.32)

(1) If the electrical requirements are not met, recheck requirements 2.29, 2.30, and 2.31.

(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 3.35 through 3.41.

Procedures for Holding Off-Normal Contact Springs

3.33 ***Contact Alignment*** (Reqt 2.33)
3.34 ***Operating Stud Clearance*** (Reqt 2.34)

(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 with a new one as covered in Section 030-715-801.

3.35 ***Straightness of Springs*** (Reqt 2.35)
3.36 ***Contact Spring Clearance*** (Reqt 2.36)
3.37 ***Contact Spring Tension*** (Reqt 2.37)
3.38 ***Contact Separation*** (Reqt 2.38)
3.39 ***Operating Stud Gap*** (Reqt 2.39)
3.40 ***Front Contact Make*** (Reqt 2.40)
3.41 ***Back Contact Make*** (Reqt 2.41)

General

(1) The No. 534A, 534B, 534C, and 534D spring adjusters are used for adjusting the holding off-normal springs. In making the following adjustments select the adjuster 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 2.34.

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) If the balancing spring is of the 2-piece type (Fig. R), adjust the prongs of the spring as required, using the No. 534C adjuster to spread the prongs or the No. 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) If the balancing spring is of the 1-piece type (Fig. S), readjust for these requirements by changing the position of the tangs as required, applying the proper spring adjuster close to the backstop assembly to hold the spring and using a No. 534D spring adjuster to adjust the tang. 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 screw on the terminal side of the switch with the 4-inch E screwdriver or the No. 541A wrench, depending on whether a roundhead screw or a hexagonal nut is to be loosened. Unsolder the wires and withdraw the spring assembly. Then adjust the springs as outlined above. Remount the spring assembly and resolder the wires.

3.42 ***Armature Positioning Spring (vertical units having armature retaining lug)*** (Reqt 2.42)

(1) If trouble is experienced with the armature locking partially operated, check the armature positioning spring and readjust it as required, as follows.

(2) If part (a) of the requirement is not met, adjust the armature positioning spring with the No. 270 spring adjuster so that the point of contact between the spring and the holding armature is brought forward consistent with meeting part (b) of the requirement.

(3) If part (a) of the requirement is still not met, remove the armature positioning spring as covered in (4) and adjust the offset using the No. 485A smooth-jaw pliers to increase the spring tension.

(4) To remove the armature positioning spring, grasp the tab which is to the right of the vertical unit mounting lug with the smooth-jaw pliers as shown in Fig. AG. Then twist the tab slightly to the right to clear the vertical unit mounting lug and at the same time pull the spring forward until clear of the vertical unit. When removing the armature positioning spring from the vertical unit mounted behind the selecting bar guard, exercise care not to damage the spring by snagging it on the guard.

(5) To mount the armature positioning spring, grasp it with the smooth-jaw pliers as shown in Fig. AH and push it straight onto the vertical unit until the notched portion of the spring engages the frame of the vertical unit and the tab locks behind the vertical unit mounting lug. Then while still grasping the spring with the pliers, check whether it is locked on the vertical unit by attempting to pull the spring forward. If properly locked the spring will stay on the vertical unit. In some cases the spring may bind against the vertical unit mounting lug at the point Fig. AH(A). When this occurs, do not attempt to force the spring into place, but shift the pliers to the tab as shown in Fig. AG and press the tab

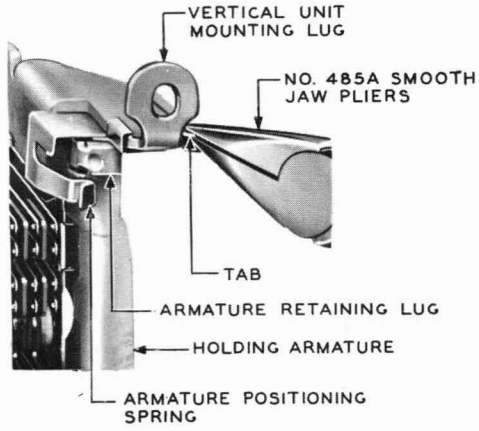


Fig. AG – Method of Removing Armature Positioning Spring

inward and twist it slightly to the left. Then check as above to determine whether the spring is properly locked on the vertical unit.

(6) Recheck part (a) of the requirement and if it is met, check part (b) of the requirement.

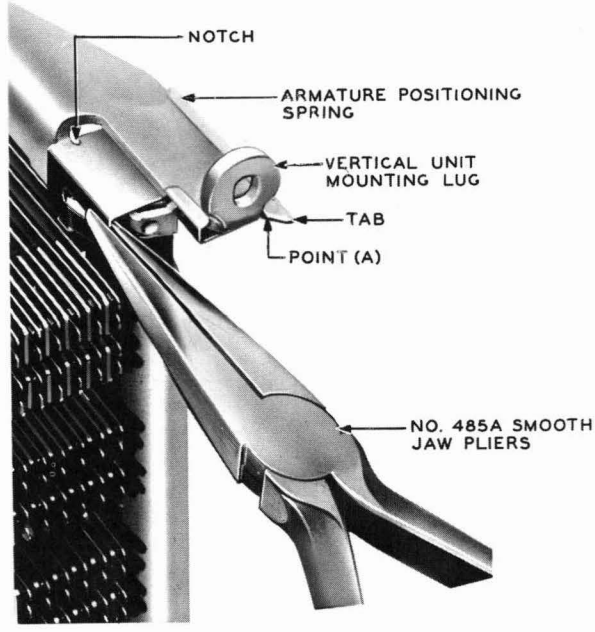


Fig. AH – Method of Mounting Armature Positioning Spring

(7) If part (a) of the requirement is met and part (b) is not met, adjust the armature positioning spring with the No. 270 spring adjuster so that the point of contact between the spring and the holding armature is moved back just enough to meet part (b) of the requirement.

(8) Recheck part (a) of the requirement.

REASONS FOR REISSUE

1. To reword operate-vertical unit definition (1.06).

2. To delete the contact spring definition (1.10 of previous issue).

3. To revise the list of tools, gauges, materials, and test apparatus (3.001).

4. To add procedure for modifying 6-inch tweezers (3.008).

5. To add Fig. T.

6. To revise procedures covering operating spring pressure, contact separation, front contact make, and clearance between operating springs and adjacent multiple strip (3.23 through 3.26).

7. To add Fig. AC.

8. To add Fig. AD.