

KNIFE SWITCHES

REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers manually operated knife switches per:

KS-5018	KS-5080-01	KS-5329-01
KS-5040	KS-5086	KS-5412
KS-5040-01	KS-5101	KS-5456
KS-5040-02	KS-5147	KS-5457
KS-5047	KS-5147-01	KS-5503
KS-5058	KS-5233	KS-15515
KS-5062	KS-5327	KS-15820
KS-5065	KS-5329	KS-19392
KS-5080		KS-19468

Note: The KS-15820 switch is a rotary knife switch. The KS-19392 is a fuse panel with a transfer switch.

1.02 This section is reissued to:

- Add the KS-19392 fuse panel equipped with a transfer switch
- Add the KS-19468 switch
- Add the KS-20538 meter
- Revise 3.001
- Make reference to Section 030-745-701
- Delete reference to tools no longer available.

This reissue does not affect the Equipment Test List. Since this is a general revision, arrows ordinarily used to indicate changes have been omitted.

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.

1.04 *Asterisk (*)*: Requirements are marked with an asterisk when to check for them would necessitate dismantling or dismounting of apparatus, or would affect the adjustment involved, or other adjustments. No check need be made for these requirements unless the apparatus or part is made accessible for other reasons, or its performance indicates that such a check is advisable.

1.05 The switches as covered in this section are of two general types: those having flat area contacts and those having embossed line contacts.

1.06 Switches may have a high potential while in use. To avoid injury to personnel or damage to equipment, care should be exercised when working on these switches.

1.07 Unless stated to the contrary, the requirements in this section shall be gauged by eye or by feel.

1.08 *Normal operation* may be defined as a condition in which the switch is carrying any load from no load to maximum available load in amperes not exceeding the current rating of the switch, with the temperature of any part of the switch not excessive, and the blades and clips, or tongues, engaging smoothly and positively.

2. REQUIREMENTS

2.01 *Cleaning and Lubrication*: The contact surfaces of switches, clips, tongues, blades, and hinge contacts shall be lubricated annually with petrolatum.

2.02 *Switch Blades*: Blades shall be straight, clean, smooth, and free from rough edges. Multiblade switches shall have their blades parallel.

2.03 *Crossbars* (Multipole Switches): Crossbars shall be securely fastened to the blades or blade blocks. The KS-5412 switches equipped with the so called "floating" blades are designed for a small amount of play between the switch blades and their associated crossbar fittings. These

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crossbar fittings, however, shall be firmly attached to the crossbar.

2.04 Handles: Except where a linkage is used between a separately mounted operating handle and the switch blades, and except on the KS-5147, KS-15820 and KS-19392 switches, the handle shall be securely fastened to the blade, blade-block, or crossbar. KS-5503 switches of the 6000-ampere size have detachable extension handles.

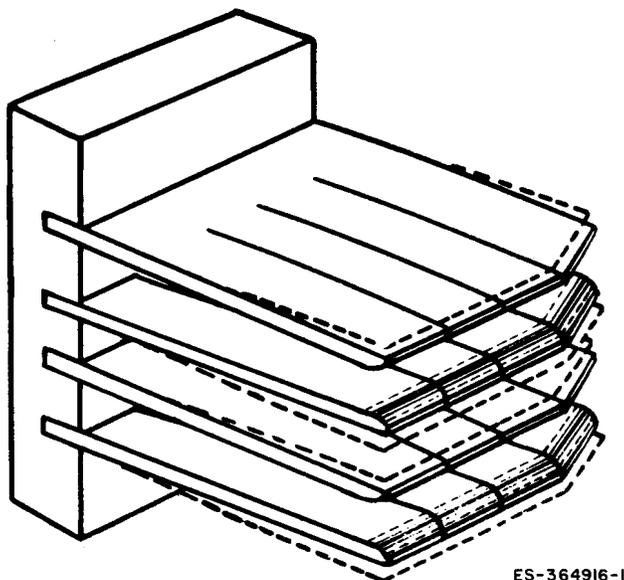
2.05 Mounting of Switches

- (a) All assembly screws and nuts shall be tightened firmly and the switch fastened securely to the panel.
- (b) Corresponding clips or tongues of the same pole and fingers of the same clip shall be in the same horizontal or vertical plane.

2.06 Clips or Tongues

Switches With Flat Area Contacts

- (a) Switch clips and tongues shall be smooth and free from rough edges.
- (b) All clips shall be straight and converging; that is, slightly closer together at the rounded edge where the blade enters as shown in Fig. 1.
- (c) The hinge clip or tongue shall make positive contact but shall not bind.



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Fig. 1—Coverging of Contact Clips

Switches With Embossed Line Contacts

- (d) Switch tongues shall be clean, smooth, and free from any rough edges.
- (e) All tongues shall be straight and sides parallel.
- (f) Blades and tongues shall make positive contact at the hinge but shall not bind.

***2.07 Contact Area**

- (a) Switches of less than 30-ampere capacity shall have a reasonably tight fit between each blade and its associated clip, sufficient to carry the current required for the particular installation.
- (b) On switches of 30-ampere capacity or greater, in the fully closed position, a 0.0015-inch gauge shall not enter at the accessible outer junction line (Fig. 2) to the extent of the following minimum percentages of junction line lengths.

CAPACITY	MIN
30 to 60 Amperes (Inclusive)	50%
100 Amperes and Over	
Copper Contacts	90%
Silver Contacts	50%

Use the KS-6909 gauge.

Switches With Embossed Line Contacts

- (c) On switches with embossed line contacts, (Fig. 3) a 0.0015-inch gauge shall not enter at any accessible point along the contact line.

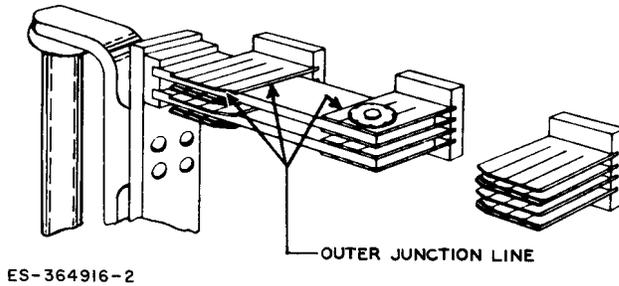
Use the KS-6909 gauge.

- (d) If any question arises as to whether a switch meets requirements (a), (b), or (c), the temperature requirements shall determine the acceptability of the switch provided the other requirements are met.

***2.08 Contact Pressures (Fig. 4)**

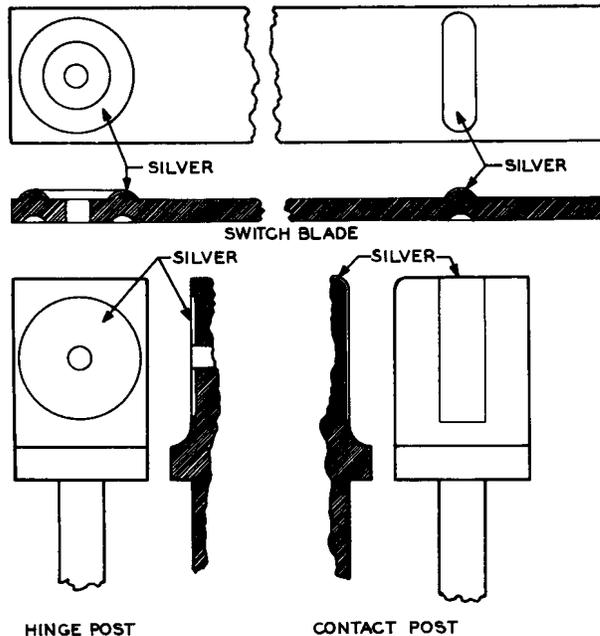
KS-5412 or KS-5329-01 Switches

- (a) With other requirements of this section met, the pounds pull to open any single-pole noncircuit maintaining switch shall be within the



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Fig. 2—Junction Line Between Blade and Clip



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Fig. 3—Embossed Line Contact (Switch With Silvered Contact Surfaces Shown)

limits of the table given below which gives values for single-pole switches only.

- (b) The pounds pull on single-pole switches shall be measured at the base of the handle as near as possible to the crossbar or blade block.
- (c) For switches having more than a single pole, the crossbar of the knife switch holding two or more poles together shall be disconnected, and the pressure check shall be made on each individual blade.
- (d) Any noncircuit maintaining switch carrying full-rated ampere load and having a tendency

to overheat, yet meeting the contact pressure requirements, shall have its contact pressures adjusted close to the **maximum** limit instead of the minimum limit of the values given in the table.

Flat Area Contact Switches

AMPERE RATING	HINGE ONLY TOTAL PULL (Lbs)			COMPLETE SWITCH TOTAL PULL (Lbs)		
	MIN AT TURN-OVER	MIN DURING LIFE	MAX	MIN AT TURN-OVER	MIN DURING LIFE	MAX
30	0.45	0.40	1.7	2.25	1.90	4.0
60	1.30	1.10	2.9	5.00	4.10	7.5
100	1.30	1.10	2.9	5.90	4.90	8.6
200	1.80	1.50	4.6	7.20	6.00	14.0
400	3.60	3.00	6.9	12.60	10.50	21.0
600	5.40	4.50	9.2	18.00	15.00	27.5
800	6.30	5.30	12.5	25.20	21.00	37.0
1200	10.80	9.00	18.5	36.00	30.00	58.0

Embossed Line Contact Switches

AMPERE RATING	HINGE ONLY TOTAL PULL (Lbs)			COMPLETE SWITCH TOTAL PULL (Lbs)		
	MIN AT TURN-OVER	MIN DURING LIFE	MAX	MIN AT TURN-OVER	MIN DURING LIFE	MAX
400	1.40	1.10	2.9	6.30	5.30	10.2
600	2.25	1.90	4.0	9.00	7.50	16.0
800	2.25	1.90	4.0	10.80	9.00	18.5
1200	2.70	2.30	5.8	13.50	11.30	22.0
1600	3.60	3.00	6.9	16.20	13.50	25.5

Use the R-2481 or R-2771 spring balance.

Circuit Maintaining Switches

- (e) Circuit maintaining switches, or switches with auxiliary clips, have no contact pressure requirements.

KS-15820 Switch

- (f) The surfaces of each rotor arm contact shall exert pressure on the stationary contacts to insure good electrical contact on each side of the stationary contacts.

2.09 Voltage Drop: The voltage drop across the hinge and clip studs located in back of the switch panel shall not exceed 25 millivolts dc or rms for full loads and prorated fractions thereof for smaller loads. If studs are not provided for the hinge, the measurement shall be taken between

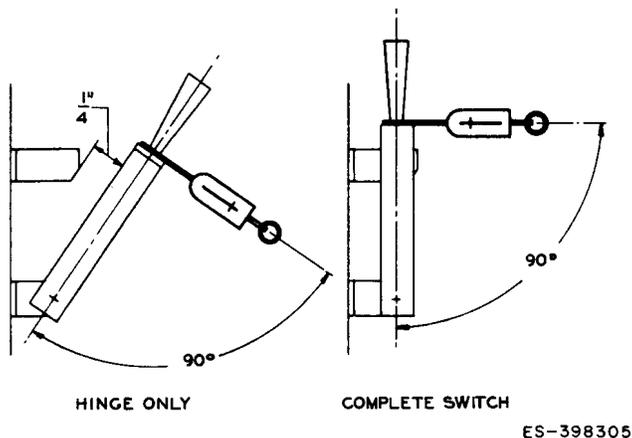


Fig. 4—Measurement of Contact Pressure

the hinge and clip blocks. The voltage drop shall be checked quarterly unless periodic inspections have indicated that local conditions are such that the interval may be extended. For dc measurements, use the KS-8039 volt-milliammeter. For ac measurements use the KS-20538 volt-ohm-milliammeter.

2.10 Linkages: Where a linkage is used between a separately mounted operating handle and the switch blades, for example, in KS-15515 as shown in Fig. 9, the joints in the linkage shall be oiled sparingly with light mineral oil.

***2.11 Temperature:** The temperature of any part of the switch shall not exceed 70°C (158°F). If the temperature is thought to be excessive, measure by thermometer or thermocouple.

2.12 Operation of Rotor (KS-15820, KS-19392, and KS-19468 Switches): The rotor shall move smoothly and positively from one position to another.

2.13 Operation of Microswitch (KS-15820 Switch)

- (a) With the rotary switch operated to either the **BAT OFF** or **BAT** position, there shall be an open circuit between contacts **A** and **C** of the microswitch.

Use 81A test set.

- (b) With the rotary switch operated to either the **GR1** or **GR1 & GR2** position, contacts **A** and **C** of the microswitch shall be closed.

Use the 81A test set.

2.14 Operation of microswitch (KS-19468 Switch): Each microswitch mounting shall be adjusted so that the actuating plunger is engaged by the switchblade as it enters the contact clip. The normally open contacts shall close before the leading edge of the switchblade has entered fully into the clip. The contacts shall open before the switchblade has traveled one quarter the way out of the contact clip.

2.15 Contact Alignment: The rotor arm and stationary contacts shall be so aligned that when in contact the radial center lines are within 1/16 inch of each other.

3. ADJUSTING PROCEDURES

3.001 List of Tools, Gauges, Test Apparatus, and Materials (Equivalents May be Substituted)

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
R-1255	31/32- and 1-1/16-inch Open Double-end Flat Wrench
R-1289	1-5/8-inch Open Single-end Flat Wrench
R-1770	1/2- and 9/16-inch Open Double-end Flat Wrench
R-1842	8-inch Smooth Flat File
R-2512	15/16-inch Adjustable Single-end Wrench
R-2593	7/8- and 1-1/16-inch Open Double-end Flat Wrench
R-8950	Rubber Syringe
R-9430	1-lb Claw Hammer
TP-87697	1/2- and 3/4-inch Open Double-end Flat Wrench
—	Side Cutting Pliers
—	1-5/16-inch Open Single-end Superrench, No. 1008A, J. H. Williams and Company
—	15/16- and 1-inch Open Double-end Flat Wrench, No. 33C, J. H. Williams and Company
—	3/4- and 13/16-inch Open Double-end Flat Wrench, No. 731, J. H. Williams and Company

CODE OR SPEC NO.	DESCRIPTION	CODE OR SPEC NO.	DESCRIPTION
TOOLS			
—	1-7/16- and 1-13/16-inch Open Double-end Flat Wrench, No. 42 J. H. Williams and Company	—	Fiber Board, 10 by 1-3/4 by 1/16 Inch
—	3-inch Cabinet Screwdriver	—	Petrolatum
—	4-inch Regular Screwdriver	—	Rubber Strip, Code No. 33R9, Class 1, Goodyear Sundries and Mechanical Co, Inc
—	5-inch Regular Screwdriver	KS-19578,L1	Trichloroethane
—	5/16 dia. by 5-inch Steel Rod		
—	3/8 dia. by 5-inch Steel Rod		
—	1/8 dia. by 5-inch Steel Rod		
—	Carpenter's Wood Level		
GAUGES			
R-2481	Spring Balance		
R-2771	Spring Balance		
KS-6909	Thickness Gauge Nest		
KS-8039	Volt-milliammeter, DC		
KS-20538	Volt-ohm-milliammeter		
—	Thickness Gauge, 6 Inches Long, 1/4 Inch Wide, 1/32 Inch Thick at One End and 0.025 Inch Thick at Other End (Prepare locally from strip of insulating material such as fiber or bakelite)		
—	-5° to +150°C Thermometer, No. 386KB71, Weksler Instruments Corp		
TEST APPARATUS			
81A	Test Set		
MATERIALS			
KS-6232	Light Mineral Oil		
KS-14666	Cloth		
KS-16736, List 1	Compound		
R-3154	Protective Sheeting		
—	Felt Pad		
—	Abrasive Cloth, 100 Grade		
—	3-inch Cotton Bandage		
			3.002 <i>Caution: Generally, it is not practicable to remove potential from the switch. Live parts should be wrapped with canvas or tape before making any adjustments. Extreme care should be exercised to avoid a short circuit between the live contacts and other metal parts of the switch. However, certain cases may require that the switch be disconnected from the power supply. Such cases should be referred to the supervisor, since it may be necessary to shunt the switch temporarily with a cable or bus bar of adequate capacity to maintain the office load before disconnecting the switch.</i>
			3.003 Care should be exercised when using trichloroethane to provide adequate ventilation. Use the absolute minimum amount of trichloroethane required for the cleaning operation, and keep the container closed when not in use.
			3.01 <i>Lubrication</i> (Reqt 2.01)
			(1) Contact Surfaces: Unless operating experience indicates otherwise, the contact surfaces of motor-driven switches should be cleaned and lubricated semiannually in accordance with the procedure given in Section 030-745-701.
			<i>Caution: Switches should NOT be lubricated with molybdenum disulfide.</i>
			(2) After cleaning, determine the adequacy of the cleaning by visual inspection and measurement of the voltage drops as covered in requirement 2.09.
			3.02 <i>Switch Blades</i> (Reqt 2.02)
			(1) Adjust as outlined in 3.05. It is improbable that multiblade switches will become bent.

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Should it become necessary to straighten single blade switches, remove the blades from the hinge clips, where practicable, as outlined in 3.05. Lay the individual blades upon a clean, smooth, flat surface and straighten with a hammer and fiber block. The fiber block is used so that blades will not be marred during the straightening process.

(2) The end of the hinge bolts on some makes of switches are spun over or riveted over the hinge nut, permanently locking them in place. No attempts should be made to adjust the hinge clips or remove the switch blade on switches of this type. If necessary, remove the blade and hinge clip and replace as a unit.

3.03 *Crossbars* (Reqt 2.03)

(1) Loose crossbars on other than KS-5412 switches with so-called "floating" blades should have their mounting screws or nuts tightened with a screwdriver or wrench of the correct size.

3.04 *Handles* (Reqt 2.04)

(1) On switches having an even number of poles, tighten loose handles by tightening the associated screws or nuts with a screwdriver or wrench of the proper size. Straight handles on switches having an odd number of poles may be tightened by turning the handle itself, holding the mounting screw or bolt from turning if necessary. Spade handles on switches having an odd number of poles may be tightened with a screwdriver or wrench of the proper size.

3.05 *Mounting of Switches* (Reqt 2.05)

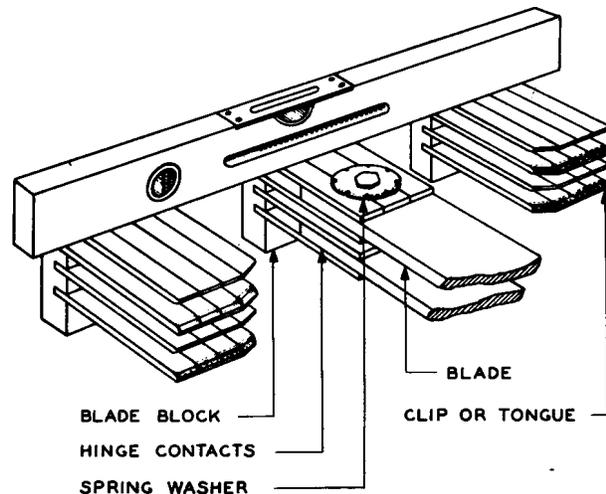
(1) If any part of the switch is loose on the panel, tighten the mounting nuts or screws with a wrench or screwdriver of suitable size. Check the alignment of the switch and clips or tongues with a level having a wooden frame. When necessary, the switches may be aligned in the following manner.

(2) With a wrench or screwdriver, loosen the mounting screws, or nuts, on the switches. Set the hinge contact so that it will be approximately vertical or horizontal (whichever the case may be) and then tighten the mounting screws or nuts on the blade block.

(3) Place a level across the hinge contact as shown in Fig. 5 and align the tongue or clips on the side or sides of the hinge as closely as possible. (When the spring washer interferes with the placing of the level, tilt the top of the level away from the panel, allowing the edge of the level to rest on the hinge.) Tighten the mounting nuts or screws on the studs of the tongue or clips to retain this alignment sufficiently.

(4) Move the switch blade, or blades, over to the clips or tongue and note that the blades of the switch line up in their proper relation to the tongue or clips. If the switch is double throw, do the same with the other side. Adjust as required and tighten all mounting screws or nuts firmly.

(5) Recheck for alignment after the nuts and screws are finally tightened.



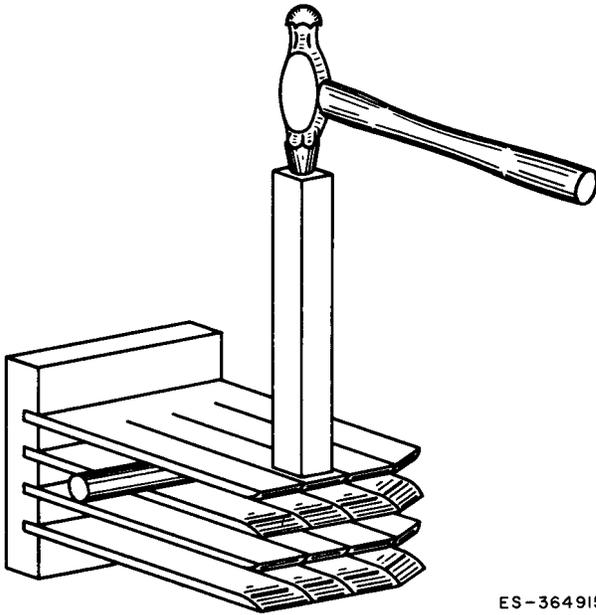
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Fig. 5—Leveling of Contact Clips

3.06 *Clips or Tongues* (Reqt 2.06)

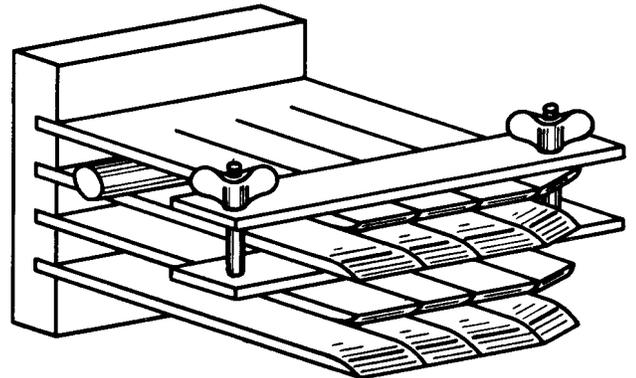
Switches With Multiple Finger Clips

(1) Contact clips, other than those with silvered contacts, that have any slight roughness or burrs should be smoothed with abrasive cloth or a fine file so that the blade engages the clip smoothly and positively. Shape clips as required in accordance with Fig. 6 or 7. Care should be taken to remove a minimum of copper.



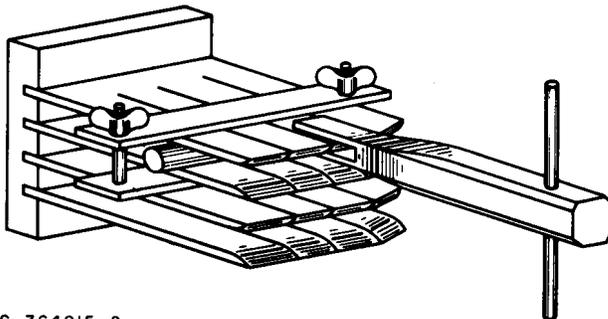
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Fig. 6—Contact Clip Adjustment



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Fig. 8—Contact Clip Adjustment



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Fig. 7—Contact Clip Adjustment

(2) When the amount of adjustment is large, insert a round rod of the proper size between the clips as shown in Fig. 6 and shape the clips in their proper relation with a hammer and fiber or wood block. Remove the round rod and try the clips for contact surface. Repeat this procedure, if necessary, until the desired adjustment has been obtained.

(3) When the amount of adjustment is small, a bending tool constructed on the job similar to the tool in Fig. 7 may be used.

(4) On laminated switches, it will be found that the inner clips can be adjusted by inserting

a round rod of the correct size between the clips; securing a clamp, constructed on the job over the outside of the clips as shown in Fig. 8; and tightening the wing nuts until the clips are properly shaped. No more shaping than is absolutely necessary should be done on the contact clips.

(5) In case the hinge clip binds, adjust the switch, when practicable, as follows: remove the locknut, or setscrew, from the hinge bolt, or nut and remove the switch blade from the switch. See that the individual blades and hinge clips are clean, free from any roughness, and straight. Adjust the clips, if necessary, in a manner similar to that outlined in (3) and (4). Tighten the locknut or setscrews so that the contact between the blades and clips is positive but does not bind.

(6) Should the blades be loose in the hinge clips so that the proper contact is not made, loosen the locknut or setscrews, tighten the nut on the hinge bolt until the required contact is obtained, and lock the nut into place by tightening the locknut or setscrews.

Switches With Tongue Contacts

(7) Abrasive cloth, or a fine file, should be used only on copper surfaces, and then only to remove burrs or rough projections. Do not attempt to use emery or other abrasive to grind the blades into good contact. Such practice generally results in poor contact and overheating. Replace any tongues which are not satisfactory.

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3.07 Contact Area (Reqt 2.07)

Switches With Flat Area Contact

(1) Move the switch blade, or blades, over to the tongue or clips, and be sure the switch blade rests firmly against the blade stop. See that the blades of the switch line are in their proper relation to the tongue or clips by inserting a thickness gauge along the outer junction line between the blades and the tongue or clips. If the switch is double throw, do the same with the other throw. Whenever possible, the switch should be adjusted as outlined in 3.05 so as to have the required contact.

Switches With Embossed Line Contact

(2) Proceed in a similar manner to that outlined in (1) above, by attempting to insert a thickness gauge between the blade laminations and the tongue at all accessible points along the line of contact. Contact is satisfactory if it is impossible to insert the gauge at any point and the contact pressure requirement is met.

3.08 Contact Pressures (Reqt 2.08)

(1) Contact pressure is measured by the pounds pull required to open a switch blade from its contact tongue or to move the blade on its hinge clip after the switch has been opened. To measure the contact pressure, first operate the switch several times and then using a spring balance, or where the pull exceeds the capacity of a single balance, using two in parallel, attach the balance to the switch in the following manner: on single-pole switches, hook the end of the spring balance to the switch handle at the base and as near as possible to the point where the handle attaches to the crossbar or blade. On multipole switches, after the crossbar holding the individual blades together has been removed, the spring balance should be attached to the end of the individual switch blades, or blade block, as near as possible to the point of its normal connection to the crossbar so disconnected. In either case, the spring balance shall be at right angles to the center line of the switch in the plane of travel of the switch blade. Readjust only when the pull required goes outside the maximum or minimum values given in the table or the switch overheats [see 2.07(d)].

(2) To adjust for contact pressure, where the pressure is too little, squeeze the blades of the switch slightly with a knife-switch clamp or pliers at the point where the blades make contact with the tongue, until the distance between the blades is approximately $1/32$ less than the thickness of the tongue. If the pressure is too great, it may be lessened by opening the blades slightly by means of rods and clamps.

(3) Where hinge bolts are present, contact pressure may be adjusted in the hinge by tightening or loosening the hinge bolt in a manner similar to that outlined in 3.05.

(4) For the larger capacity KS-5412 switches, adjustment of pressure is made by tightening or loosening the associated blade block holding nuts uniformly and maintaining the blade laminations parallel with each other and with the contact tongue, until the desired adjustment has been obtained.

3.09 Voltage Drop (Reqt 2.09)

(1) If the requirement is not met, check the temperature of switch parts as covered in requirement 2.11. If requirement 2.11 is met, no action is required.

3.10 Linkages (Reqt 2.10)

(1) On switches having linkage between the operating handle and the switch blade, (Fig. 9) wipe off the joints with a clean cloth to remove accumulated dirt. Apply oil sparingly to the joints and remove excess oil with a clean cloth.

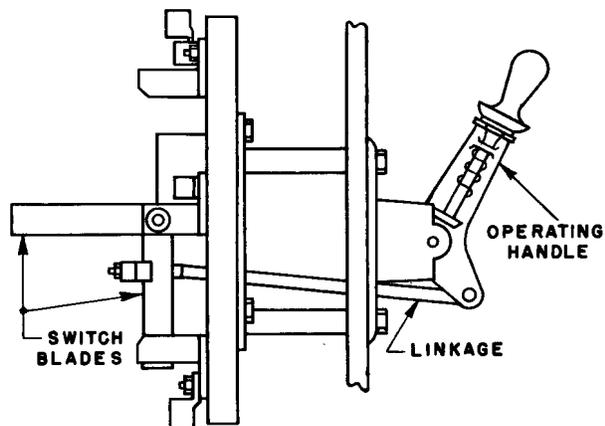


Fig. 9—KS-15515 Switch Showing Operating Handle and Linkage to Switch Blades

3.11 Temperature (Reqt 2.11)

- (1) The temperature of any part may be measured by placing the bulb of the thermometer or thermocouple on the part, covering the exposed portion of the bulb with a piece of felt and observing the highest temperature reading.
- (2) If the temperature of the switch parts exceeds the specified limits, clean and lubricate the switch as covered in 3.01 and recheck the requirement. If the requirement still is not met, determine where the excessive voltage drop occurs as follows. Measure the voltage drop between the hinge block and center of the knife blade. Then, measure the voltage drop between the center of the knife blade and the clip block. If the drop between the knife blade and clip block is excessive, readjust the clip as covered in 3.06. If the drop between the hinge block and center of the knife blade is excessive, refer the matter to the supervisor as it will be necessary to dismantle and clean the hinge contact.

3.12 Operation of Rotor (Reqt 2.12)

- (1) If the detent (Fig. 10) does not permit the rotor to meet the requirement, it should be replaced.

3.13 Operation of Microswitch (Reqt 2.13)

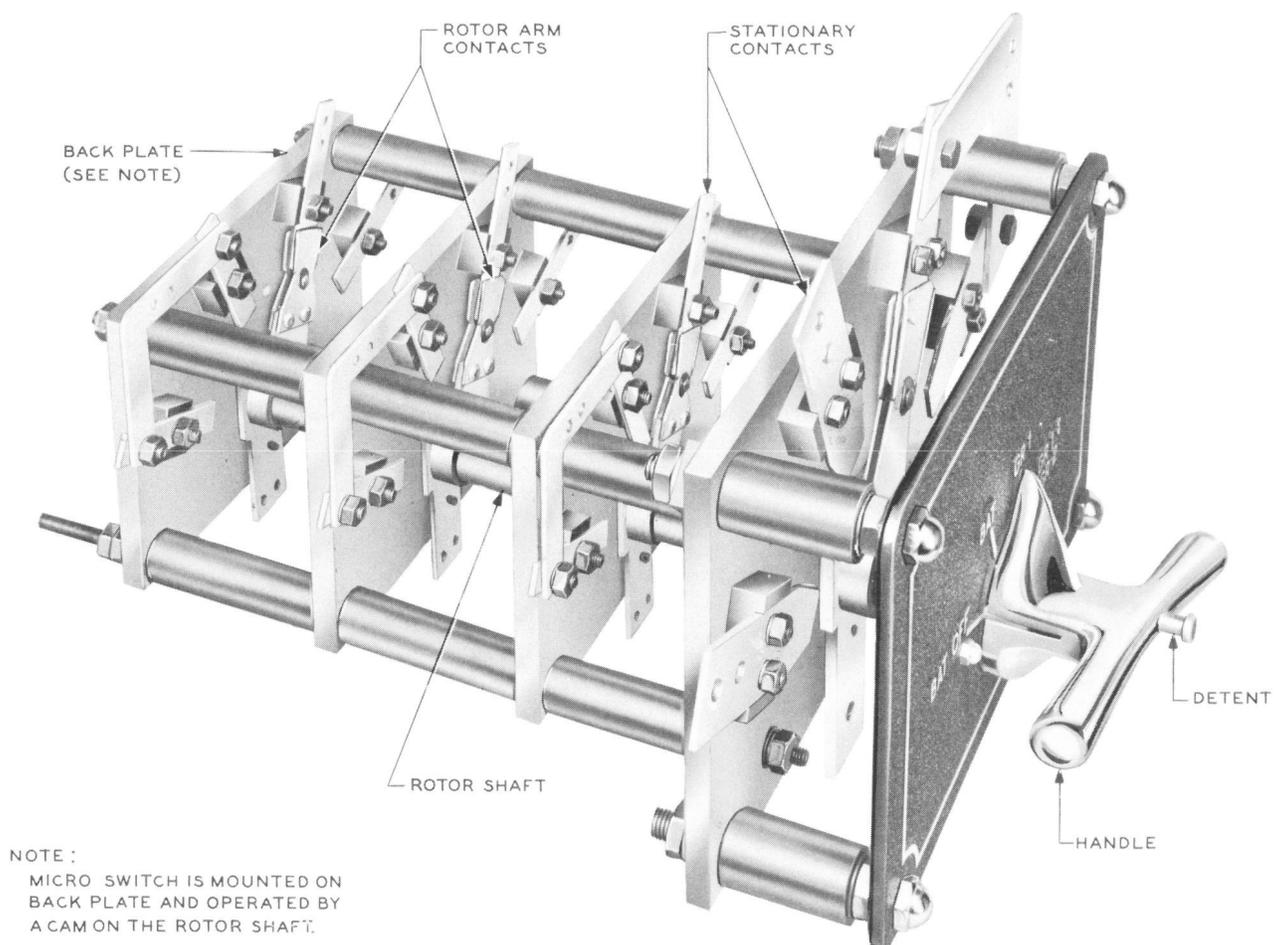
- (1) If the microswitch is defective in any way, replace it.

3.14 Operation of Microswitch (Reqt 2.14)

- (1) If the microswitch is defective in any way, replace it.

3.15 Contact Alignment (Reqt 2.15)

- (1) Misalignment of these contacts is generally due to loose nuts and lockwashers on the stationary contacts. Check that these lockwashers are in place and tighten the nuts.

**Fig. 10—KS-15820 Switch**