KS-15610 AND KS-15624
SWITCH PANELS
SINGLE MOTOR-DRIVEN TYPE
REQUIREMENTS AND ADJUSTING PROCEDURES

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1. GENERAL

1.01 This section covers the requirement and adjustment procedures for the KS-15610 and KS-15624 type single motor-driven switch panels.

1.02 This section is reissued for the following reasons:

(1) To delete use of the KS-16736, L1, compound

(2) To add an Index

(3) To revise the List of Tools, Gauges, Materials, and Test Apparatus

(4) To rate the 81A Test Set Mfr Disc., replaced by the 139A Test Set.

Revision arrows are used to emphasize the more significant changes. This reissue affects the Equipment Test List.

1.03 The following Bell System Practices are referenced within this section:

SECTION	TITLE
020-010-711	Apparatus—General Requirements and Definitions
030-785-801	Switch Panels—Single Motor-Driven Type, KS-15610 and KS-15624 Replacement Parts and Procedures

SECTION	TITLE
171-110-701	Commutators, Collector Rings, Interrupters, and Brushes—Maintenance Requirements and Procedures
171-110-801	Commutator and Collector Rings—Maintenance Procedures◀

1.04 ***Phi (ϕ):*** Requirements are marked with a phi when they are not required to be checked before turnover.

1.05 ***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 performance indicates that such a check is advisable.

1.06 ***Asterisk (**):*** Requirements marked with a double asterisk should be checked annually unless performance indicates otherwise.

Caution 1: During normal maintenance operations, it is not advisable to move the bridging slider of a 3-position switch from the normal position beyond the Group 1 position except as recommended in paragraph 4.01 since this may cause an excessive increase in plant voltage.

Caution 2: When working on the switch panel, take care to maintain office voltage. Before doing any work on the switch panel, the main contacts should be fully engaged in the normal position. Unless power is needed for the procedure being performed, remove the motor fuse and control circuit fuse for the switch on the associated plant control panel to prevent unexpected automatic switch operation while working on the switch panel and replace them when the work is done. Requirements should be checked preferably during a period when they will cause the least unfavorable service reaction.

Caution 3: Extreme care should be exercised when working on the switch panel since switch parts are live with high-power capability.

1.07 ***Successful commutation*** for the purpose of this section is considered to have been obtained if neither the brushes nor the commutator is injured in normal service to such an extent that abnormal maintenance is required. The presence of some visible sparking is not necessarily evidence of unsuccessful commutation.

1.08 ***Normal operation*** may be defined as the 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 and motor not excessive, the contacts and clips of the switch engaging smoothly and positively, and the switch-actuating motor and drive mechanism operating satisfactorily.

1.09 ▶The motor-driven portion of the switch panel is protected by a metal or fiberglass cover. To inspect or work on the mechanism, remove the four acorn nuts at the corners of the metal cover with the R-1542 adjustable wrench and pull the cover outward to remove it. Fiberglass covers are not secured by nuts and may be removed by slightly lifting the cover and then pulling it outward. The cover is somewhat heavy and should be grasped firmly to avoid dropping it.

Caution 1: If 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.

Caution 2:When working on the switch, do not simultaneously touch current carrying parts and ground with the hands or tools.◀

2. INDEX

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3. APPARATUS

3.01 ***List of Tools, Gauges, Materials, and Test Apparatus:***

TOOLS	DESCRIPTION
141	Cord tip (2 required)
207	Tool (90-degree offset screwdriver)
485A	Smooth jaw pliers (KS-7665)
KS-6278	Connecting clip (2 required)

TOOLS	DESCRIPTION
KS-6320	Orange stick
R-1324	Screwdriver
R-1542	3/4-inch adjustable wrench
R-2512	15/16-inch adjustable wrench
R-3094	Handle (Det 2)
R-3094	Extension (Det 5)
R-3094	Universal joint (Det 8)
R-3094	5/16-inch socket wrench
R-3094	3/8-inch socket wrench (Det 16)
R-3094	1/2-inch socket wrench (Det 18)
R-3193	9/32- and 11/32-inch hex open double-end wrench
◗AT-7329◖	1-pound ball peen hammer
◗AT-7860◖	B long-noise pliers
◗AT-7825◖	3-inch C screwdriver
◗AT-7825◖	4-inch E screwdriver
—	Platform-type scale 0-10 pounds
—	Angle bracket
GAUGES	
KS-3008	Stopwatch
KS-6909	Thickness gauge nest

Note: Where requirements say "Gauge by sight," observe thickness gauge before making gauging by sight.

R-1032	Thermometer (Det 1)
MATERIALS	
KS-7860	Petroleum spirits
KS-14666	Cloth
KS-19578, L1	Trichloroethane
◗KS-13148, L1◖	Abrasive paper—Garnet, 4/0
—	Cotton bandage, 3-inch
—	Felt pad or equivalent
—	Petrolatum
◗KS-7471◖	260-300P grease
—	3/4- by 4- by 6-inch hardwood block
—	1/16- by 1-3/4 by 10-inch fiberboard
—	Electrical tape, Scotch* No. 33
—	Modeling clay, sculpture house or equivalent (purchased locally)
—	1/4- by 1/2- by 4-inch wood block (made locally)
TEST APPARATUS	
1W13B	Test cord (2 required)
◗139A◖	Test set
KS-20599, L4	Digital Multimeter (KS-8039 Voltmilliammeter, Alternate)
—	Test cord, Weston Electrical Instrument Company, No. D-79650 (2 required)

4. REQUIREMENTS

4.01 ***Operation:*** For operations of the switch, proceed as follows:

(a) ***Automatic Operation of Switch:*** Turn off all the charging units in the plant associated with the switch, as covered in the BSP section for the plant. After a short interval, the bridging slider will move from the normal position to the Group 1 position. Operate the MAN-AUTO key on the plant control panel to MAN to prevent further movement of the bridging slider.

(b) To return the bridging slider to the normal position, restore the charging units in the

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plant to service, as covered in the BSP section for the plant, and operate the MAN-AUTO key to AUTO. When batteries associated with the plant are charged to their proper voltage, the bridging slider will return to the normal position.

Caution: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

Note: Operation of the 3-position switch to the Group 2 position should be performed annually to assure reliable performance. This may be accomplished by allowing the switch to move to the Group 2 position, using requirements (a) through (f). Other checks or adjustments associated with the Group 2 position should also be performed at this time. These checks should be performed during a period which will cause the least unfavorable service reaction.

(c) ***Operation of Switch Using RAISE and LOWER Keys.*** Operate the MAN-AUTO key on the plant control panel to MAN. Turn off all the charging units in the plant, as covered in the BSP section for the plant. When the RC relay in the battery control circuit of the plant operates, press the RAISE key on the plant control panel and hold the key operated momentarily. This will move the bridging slider to the Group 1 position.

(d) To return the bridging slider to the normal position, restore the charging units in the plant to service, as covered in the BSP section for the plant. When the LC relay in the battery control circuit of the plant operates, press the LOWER key on the plant control panel and hold the key operated momentarily. This will return the bridging slider to the normal position. After maintenance operations are completed, operate the MAN-AUTO key on the plant control panel to AUTO.

Caution: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

(e) ***Manual Operation of Switch:*** Remove the motor fuse for the switch on the associated plant control panel. Turn off all charging units in the plant, as covered in the BSP section for the plant. When the RC relay in the battery control circuit of the plant operates, use the hand crank furnished with the switch to move the bridging slider to the Group 1 position as follows. Place the crank on the cranking shaft at the top of the switch, and turn the crank rapidly counterclockwise until the main contacts on the bridging slider are fully engaged in the Group 1 position. Do not stop cranking until the main contacts are fully engaged. Stopping the bridging slider between positions may cause damage to the current limiting resistors on the rear of the switch.

(f) To return the bridging slider to the normal position, restore the charging units in the plant to service, as covered in the BSP section for the plant. When the LC relay in the battery control circuit for the plant operates, turn the crank rapidly clockwise until the main contacts on the bridging slider are fully engaged in the normal position. Do not stop cranking until the main contacts are fully engaged. Stopping the bridging slider between positions may cause damage to the current limiting resistors on the rear of the switch. After work is completed, remount the motor fuse.

Caution: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

4.02 ***Lubrication:*** To check the lubrication requirements, proceed as follows:

Caution: Care should be exercised when using petroleum spirits in power rooms where there are dc machines since commutation may be adversely affected by softening of commutator film by the fumes. To avoid the need for burnishing the commutators of dc machines after doing any cleaning called for in this section, provide adequate ventilation. Use the absolute minimum amount of petroleum spirits required for the cleaning operation, and keep the container closed when not in use.

(a) ***Contact Surfaces of Main Contacts, Auxiliary Contacts, and Knife Switch Contacts:*** Fig. 1 and 2—The contact surfaces of the main contacts, auxiliary contacts, and where provided, the knife switch contacts shall be

cleaned and then lubricated with a thin film of petrolatum. These surfaces should be cleaned and relubricated every 6 months unless examination indicates interval may be extended. See requirement 4.01.

(b) ***Driving Screws and Exposed Gears:*** The driving screws and the teeth and accessible surfaces of exposed gears shall be cleaned and lubricated with a small amount of 260-300P grease.

4.03 ***Condition of Bearings:*** All bearings shall be free from excessive wear. If the switch operates satisfactorily under all conditions of normal operation (paragraph 1.08) and meets requirement 4.11, the bearings shall be considered to be in satisfactory condition.

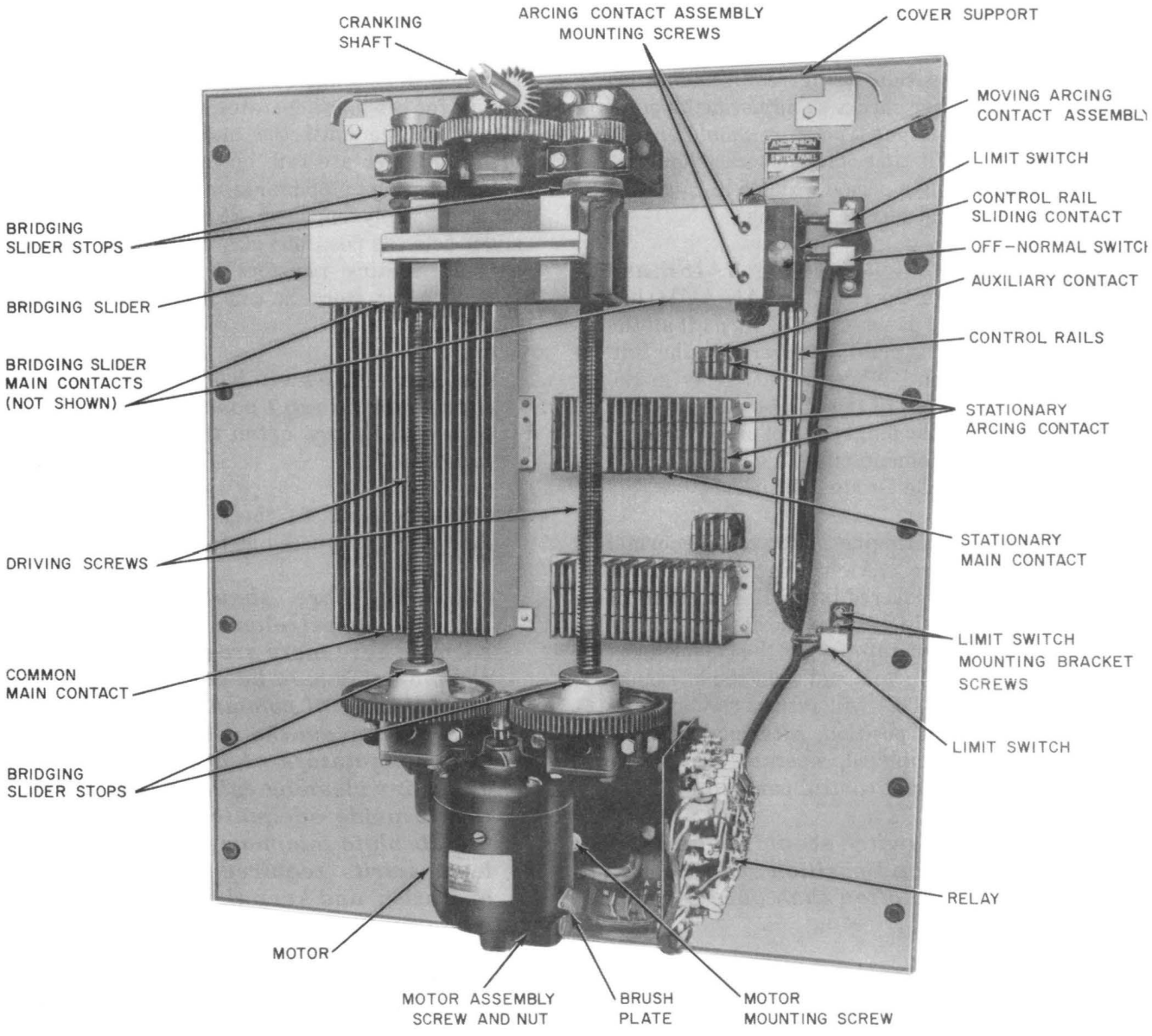

Fig. 1—KS-15624, L4, Switch Panel (Cover Removed)

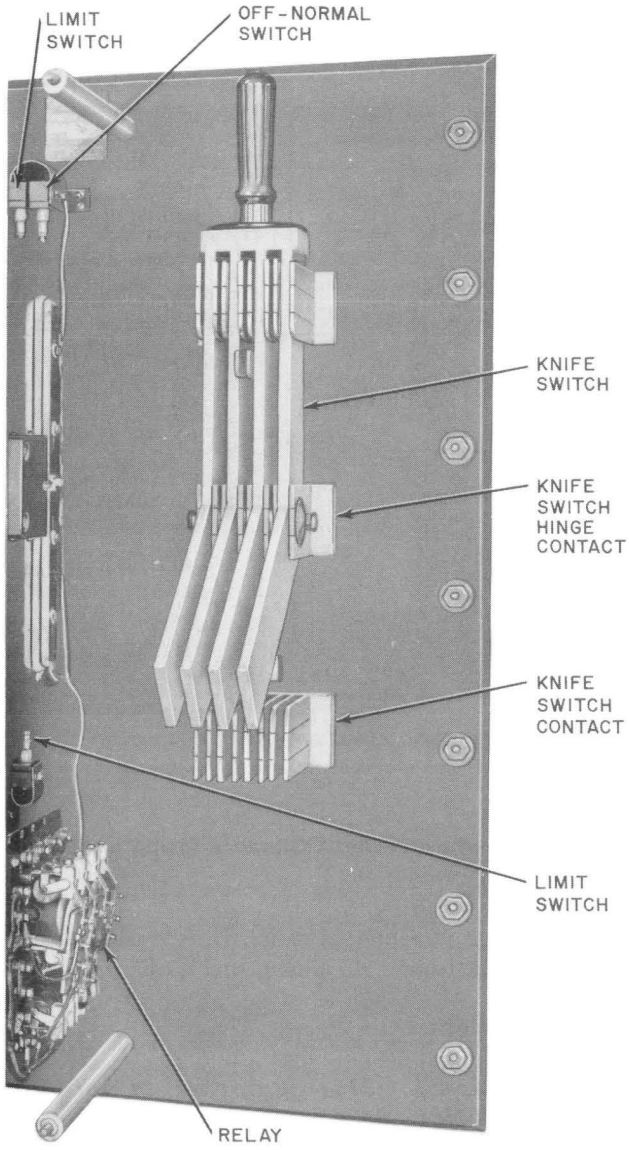

Fig. 2— Portion of the KS-15610, L4, Switch Panel Showing Knife Switch and Vertical Mounted Limit and Off-Normal Switches

Note: Abnormal noise from a bearing is an indication of excessive wear.

4.04 ***Mounting of Contacts (Fig. 1 and 2):*** All contacts shall be securely fastened to their mounting.

Gauge by sight and feel.

(a) Check the requirement for the stationary main and auxiliary contacts as follows. Operate the switch to move the bridging slider to the Group 1 position and return it to the normal position, as covered in requirement 4.01(a). There should be no movement at the mounting base of the contacts when the bridging slider main contacts just make or break with the main or auxiliary stationary or auxiliary contacts.

Caution 1: During normal maintenance operations, it is not advisable to move the bridging slider of a 3-position switch from the normal position beyond the Group 1 position except as recommended in requirement 4.01 since this may cause an excessive increase in plant voltage.

Caution 2: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

(b) Check the requirement for the knife switch contacts as follows. Operate the knife switch. There should be no movement at the mounting base of the stationary contacts when the blades just make or break contact.

(c) Check the requirement for the stationary arcing contacts by checking secureness of fastening screws.

4.05 ***Condition of Contacts, Clips, and Blades:*** To check condition of contact, clips, and blades, proceed as follows: (Fig. 1 and 2)

(a) The arcing contact should be clean and without excessive wear, deformation, or pitting.

Gauge by sight and insulated straight edge.

(b) The main contacts including edges should be clean and smooth.

Gauge by sight.

(c) The main and auxiliary contact blades should converge slightly toward the front.

Gauge by sight.

(d) The fingers of the same contact clip should be in line with each other.

Gauge by sight.

4.06 ***Engagement of Movable and Stationary Main and Knife Switch Contacts* (Fig. 1 and 2):

(a) With the contacts in the fully made position, a 0.0015-inch thickness gauge shall not enter between the contacts at minimum 90 percent of the accessible outer junction line.

Use the 0.0015-inch blade of the KS-6909 thickness gauge nest.

(b) The knife switch hinge contact clips shall make positive contact with the blades but shall not bind.

Gauge by sight and feel.

4.07 ***Arcing Contact Follow* (Fig. 3 and 4): The follow of the moving arcing contacts shall be 1/32 inch. Measure, as shown in Fig. 4, using insulated straight edge.

Gauge by sight.

Check the requirement as covered in requirement 4.08.

4.08 ***Arcing Contact Clearance* (Fig. 3 and 5): The clearance between the moving arcing contacts and the base of the stationary arcing contacts when the contacts are open shall be minimum 1/16 ±1/32 inch. Measure, as shown in Fig. 5, using insulated straight edge.

Gauge by sight.

To check requirements 4.07, 4.08, and 4.09, operate the switch to move the bridging slider from the normal to the Group 1 position, as covered in requirement 4.01(a). Observe the clearance and alignment between the lower row of moving arcing contacts and the base of the successive rows of stationary arcing contacts just before the moving contacts make with the stationary contacts. Observe the follow of the moving contacts after they break with the stationary contacts. Return the bridging slider to the normal position, as covered in requirement 4.01(a), and similarly check the clearance and follow of the upper set of moving arcing contacts.

4.09 ***Arcing Contact Alignment* (Fig. 6): The arcing contacts shall be in alignment when

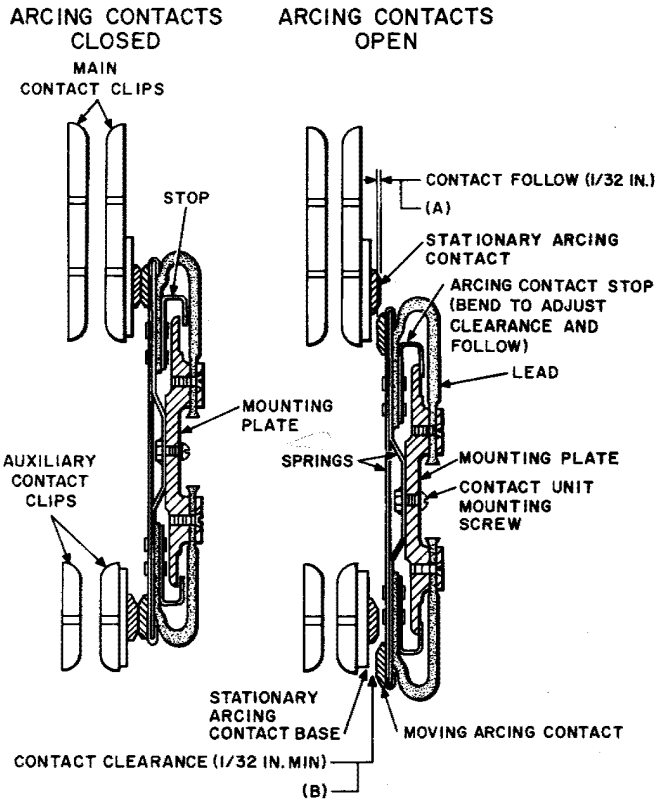

Fig. 3—Moving and Stationary Arcing Contacts

the contacts are nonoperated. Check with an insulated straight edge, as shown in Fig. 6.

Gauge by sight.

Caution 1: During normal maintenance operations, it is not advisable to move the bridging slider of a 3-position switch from the normal position beyond the Group 1 position except as recommended in requirement 4.01 since this may cause excessive increase in plant voltage.

Caution 2: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

4.10 ***Voltage Drop Across Main Contacts:* The voltage drop across the main contacts with the switch in the normal position shall be as follows:

Full load—Maximum 25 millivolts

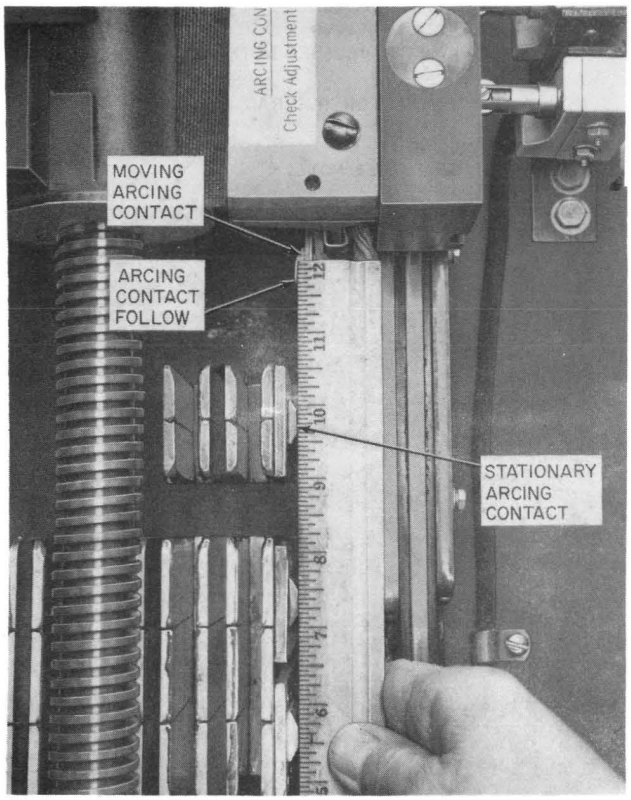

Fig. 4—Method of Measuring Arcing Contact Follows

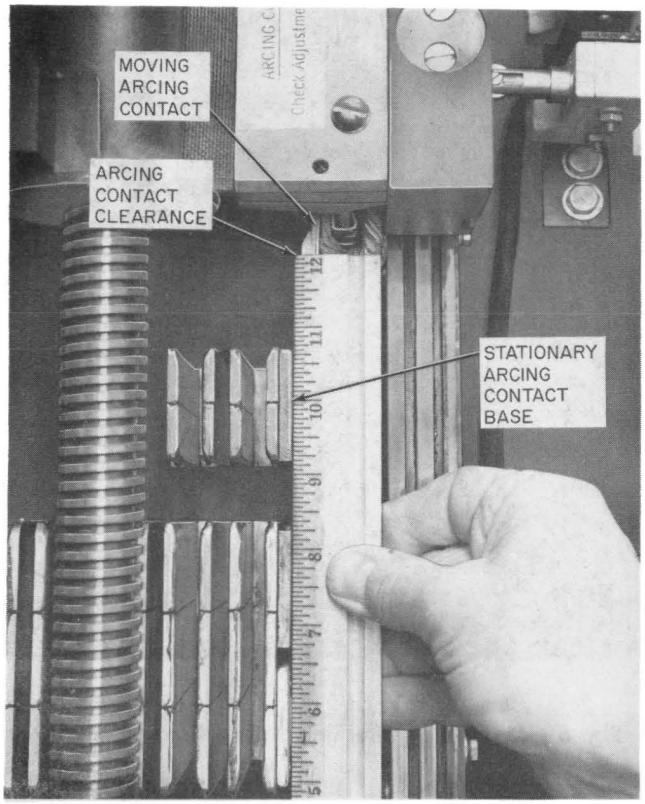

Fig. 5—Method of Measuring Arcing Contact Clearance

Partial loads—Prorated fractions of full-load voltage drop

Use the 50-millivolt scale of the KS-20599, L4, multimeter equipped with Weston (D-79650) test cords.

To check the requirement, apply the meter leads to points on the laminated studs adjacent to the rear of the switch panel as follows. Apply the positive lead of the meter to the laminated stud at the right (common main contact stud) and the negative lead to the top stud of the three laminated studs immediately to the left (stud for normal position of switch).

4.11 ***Noise and Vibration:*** The noise and vibration of the motor and associated mechanism under all conditions of normal operation shall not be excessive.

Gauge by sound and feel.

4.12** ***Voltage and Current of Motor: Except during starting, the total ampere input to the motor shall not exceed the value marked on the motor nameplate by more than 50 percent for KS-15610 or 100 percent for KS-15624 switches when the voltage is within the allowable nameplate limits.

Use the KS-20599, L4, multimeter, equipped with Weston (D-79650) test cords and a dc ammeter capable of reading 500 percent of the nameplate rated full-load motor current.

4.13 ***Motor Torque:*** The motor shall develop sufficient torque to start and move the bridging slider from one position to another within 7 seconds.

Gauge by sight.

Use the KS-3008 stopwatch.

* ***4.14 Condition of Motor Commutator Surface:*** The motor commutator surface shall be clean and free from scares, pits, or other deforma-

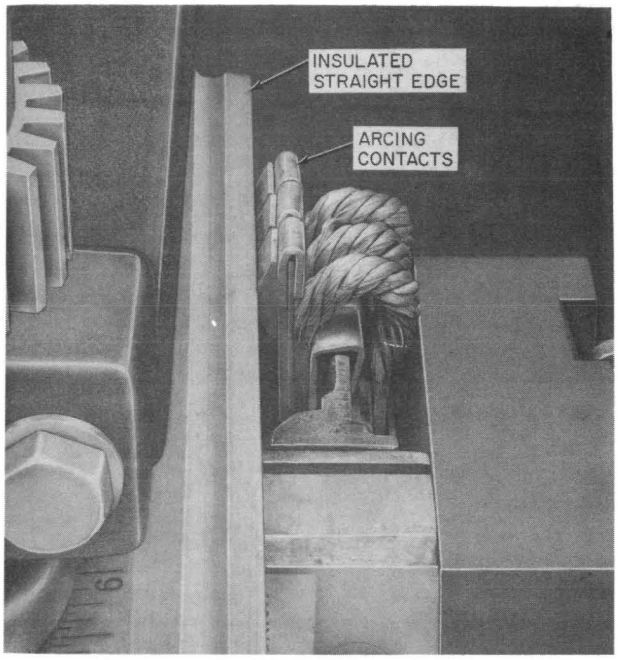

Fig. 6—Method of Checking Arcing Contact Alignment

tions of the surface or structure except those caused by normal wear.

Gauge by sight and feel.

*ϕ**4.15** ***Commutation:*** The motor shall commutate successfully under all conditions of normal operation. (See paragraphs 1.07 and 1.08.)

4.16 ***Brushes:*** The brushes shall be free in their holders and shall fit so as to ensure successful commutation.

Gauge by sight and feel.

*ϕ**4.17** ***Position of Control Rails*** (Fig. 7): The rail controlling the travel of the bridging slider in each direction shall be positioned to:

(a) Break contact with its associated sliding contact on the bridging slider after contact has been broken between the rail controlling travel in the opposite direction and its associated contact.

Gauge by sight.

To check the requirement, operate the switch to move the bridging slider from the normal to the

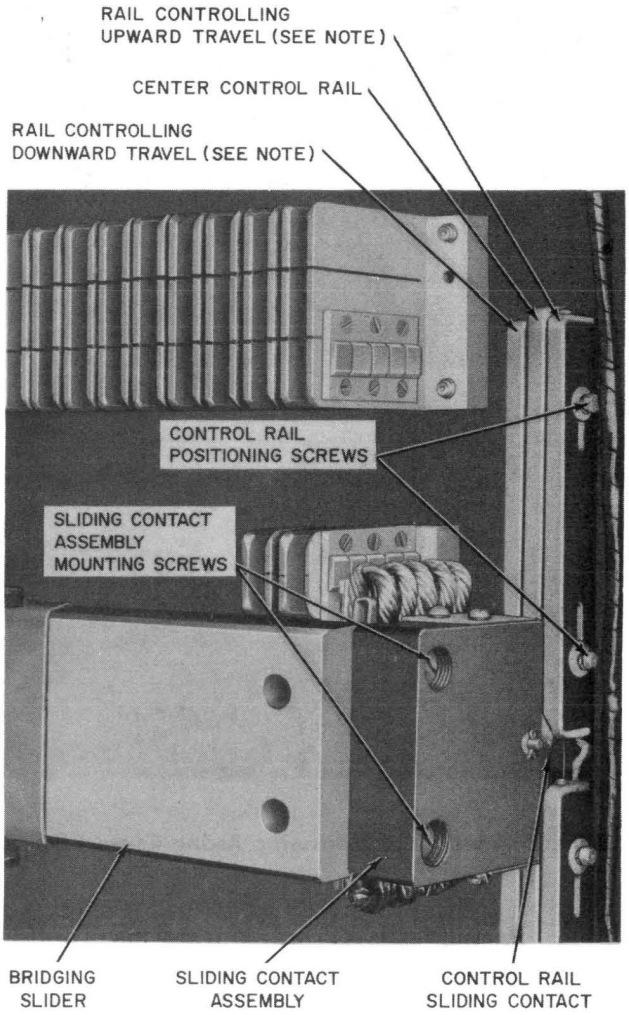

Fig. 7—KS-15610 and KS-15624 Type Switches—Bridging Slider and Control Rails

Group 1 position, as covered in requirement 4.01(e). Observe the sequence in which contact is broken between the control rails and their associated sliding contacts on the bridging slider as the bridging slider approaches the Group 1 position. Then return the bridging slider to the normal position, as covered in requirement 4.01(f), and observe the sequence in which contact is broken as the bridging slider approaches this position.

Caution 1: During normal maintenance operations, it is not advisable to move the bridging slider of a 3-position switch from the normal position beyond the Group 1 position except as recommended in requirement 4.01 since this may cause an excessive increase in plant voltage.

Caution 2: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

(b) Extend maximum 1/4 inch beyond the rail controlling the travel in the opposite direction and to stop the bridging slider minimum 1/4 inch from the stops at each end of travel.

Gauge by sight.

To check the requirement, operate the switch to move the bridging slider from the normal to the Group 1 position, as covered in requirement 4.01(a). On 2-position switches, observe the clearance between the bridging slider and the stops at the bottom of the switch. Then return the bridging slider to the normal position, as covered in requirement 4.01(b), and observe the clearance between the bridging slider and the stops at the top of the switch on both 2- and 3-position switches.

Caution 1: During normal maintenance operations, it is not advisable to move the bridging slider of a 3-position switch from the normal position beyond the Group 1 position except as recommended in requirement 4.01 since this may cause an excessive increase in plant voltage.

Caution 2: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

(c) Stop the bridging slider at each end of the travel so the vertical misalignment of the bridging slider main contacts with the stationary main contacts is 3/8 inch maximum.

Gauge by sight.

To check the requirement, operate the switch to move the bridging slider from the normal to the Group 1 position, as covered in requirement 4.01(a). Observe the misalignment of the top edges of the contacts. Then return the bridging slider to the normal position, as covered in requirement 4.01(b), and observe the misalignment in this position on both 2- and 3-position switches.

Caution 1: During normal maintenance operations, it is not advisable to move the bridging slider of a 3-position switch from the normal position beyond the Group 1 position except as recommended in requirement 4.01 since this may cause an excessive increase in plant voltage.

Caution 2: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

(d) Automatically recenter the bridging slider at the Group 1 position of 3-position switches when the vertical misalignment of the bridging slider main contacts with the stationary main contacts reaches 3/8 inch.

Gauge by sight.

To check the requirement, operate the switch to move the bridging slider from the normal to the Group 1 position, as covered in requirement 4.01(a). Observe the misalignment of the top edges of the main contacts just as the bridging slider stops its downward travel. Observe whether the bridging slider automatically recenters. Return the bridging slider to the normal position, as covered in requirement 4.01(b).

Caution: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

****4.18** ***Condition and Alignment of Control Rails and Control Brush Sliding Contacts*** (Fig. 7): The contact surfaces of the control rails and the control brush sliding contacts shall be clean and smooth, and the overlap between rails and brush contacts shall be 1/32 inch maximum.

Gauge by sight.

ϕ **4.19 ***Contact Pressure and Freedom of Movement of Control Contacts—Brush*** (Fig. 7):

(a) The control brush contacts shall be free to move in the holder without bind.

Gauge by sight and feel.

To check the requirement, remove the motor fuse and control circuit fuse for the switch on the associated plant control panel. Check the two outer contacts by first rotating them as far as possible in each direction, and then pushing them into the holder. The contacts should return to their normal position without bind. Remount the fuses. To check the center contact, operate the switch to move the bridging slider to the Group 1 position and return it to the normal position, as covered in requirment 4.01(a). The center contact should swing from one side of its Group 1 position to the other side when the direction of travel is reversed.

(b) The pressure required to move a brush vertically shall be between 4 pounds minimum and 6 pounds maximum. Check by using a platform-type spring scale. The clearance between the side of the brush holder and the brushes shall be 0.020 inch minimum. Use the KS-6909 gauge. The condition of brush assembly parts, springs, brushes, push rods, housing, etc, should be examined for indications of corrosion, abrasion, deformation, etc.

Gauge by sight and feel.

To check this requirement, the motor and control fuses must be removed and the control brush assembly removed from the switch.

Caution 1: During normal maintenance operations, it is not advisable to move the bridging slider of a 3-position switch from the normal position beyond the Group 1 position except as recommended in paragraph 4.01 since this may cause an excessive increase in plant voltage.

Caution 2: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

****4.20** ***Mounting of Limit Switches and OFF-NORMAL Switch*** (Fig. 1 and 2): The limit switches and OFF-NORMAL switch shall be securely fastened to the mounting bracket, and the bracket securely fastened to the switch panel.

Gauge by feel.

** ***4.21 Operation of Limit Switches:*** To check the operation of the limit switches, proceed as follows (Fig. 1 and 2):

(a) The limit switches shall operate (open the contacts) immediately after contact is broken between the rail controlling the travel and the associated sliding contact on the bridging slider at each end of travel. Use the 139A test set with the two 1W13B cords each equipped with a 141 cord tip on one end and a KS-6278 connecting clip on the other end.

To check the requirement, remove the motor fuse and control circuit fuse for the switch on the associated plant control panel. On 2-position switches, start the check with the bridging slider in the position opposite that of the limit switch to be checked. Move the bridging slider as required in accordance with requirement 4.01(e). With the test set switch in the OFF position, connect the test set across the terminals of the limit switch to be checked. Move the test set switch to C. The buzzer should sound indicating that the limit switch contacts are closed. Move the bridging slider, as covered in requirement 4.01(e), toward the limit switch to be checked, noting whether the limit switch contacts open just after contact is broken between the rail controlling the travel (Fig. 7) and its associated sliding contact. On 3-position switches, start the check with the bridging slider at the Group 1 position to check the limit switch at the normal position, as covered above.

Caution 1: During normal maintenance operations, it is not advisable to move the bridging slider of a 3-position switch from the normal position beyond the Group 1 position except as recommended in requirement 4.01 since this may cause an excessive increase in plant voltage.

Caution 2: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

(b) When the switch is being operated by the RAISE or LOWER key on the associated plant

control panel, operation of the limit switch shall cause the bridging slider to stop before it touches its stops at each end of travel. On 3-position switches, this requirement shall be checked only for the limit switch at the normal position of the bridging slider. Check clearance as shown in Fig. 8 and 9.

Gauge by sight.

To check the requirement on 2-position switches, start the check with the bridging slider in the position opposite to that of the limit switch to be checked. Move the bridging slider as required in accordance with requirement 4.01(a). Then, using the RAISE or LOWER key, move the bridging slider, as covered in requirement 4.01(c), toward the limit switch to be checked and continue to hold the key operated until the bridging slider is stopped by the operation of the limit switch. Observe whether the bridging slider touches its stops. On 3-position switches, start the check with the bridging slider at the Group 1 position to check the limit switch at the normal position, as covered above. Check clearance as shown in Fig. 8 and 9.

Caution 1: During normal maintenance operations, it is not advisable to move the bridging slider of a 3-position switch from the normal position beyond the Group 1 position except as recommended in requirement 4.01 since this may cause an excessive increase in plant voltage.

Caution 2: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

ϕ4.22 *Operation of OFF-NORMAL Switch*** (Fig. 1 and 2): The OFF-NORMAL switch shall operate (close the contacts) just before or when contact is made between the rail controlling the downward travel and the associated sliding contact on the bridging slider as the bridging slider starts to travel downward from the normal position. Use the 139A test set with the two 1W13B cords each

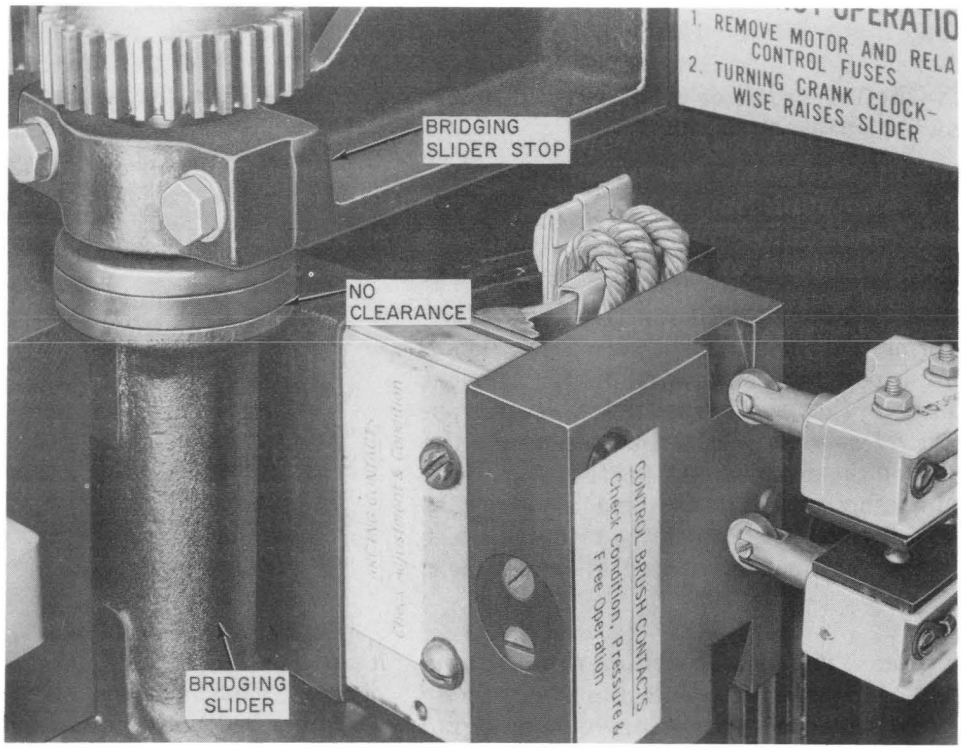

Fig. 8—Improper Adjustment of Limit Switches

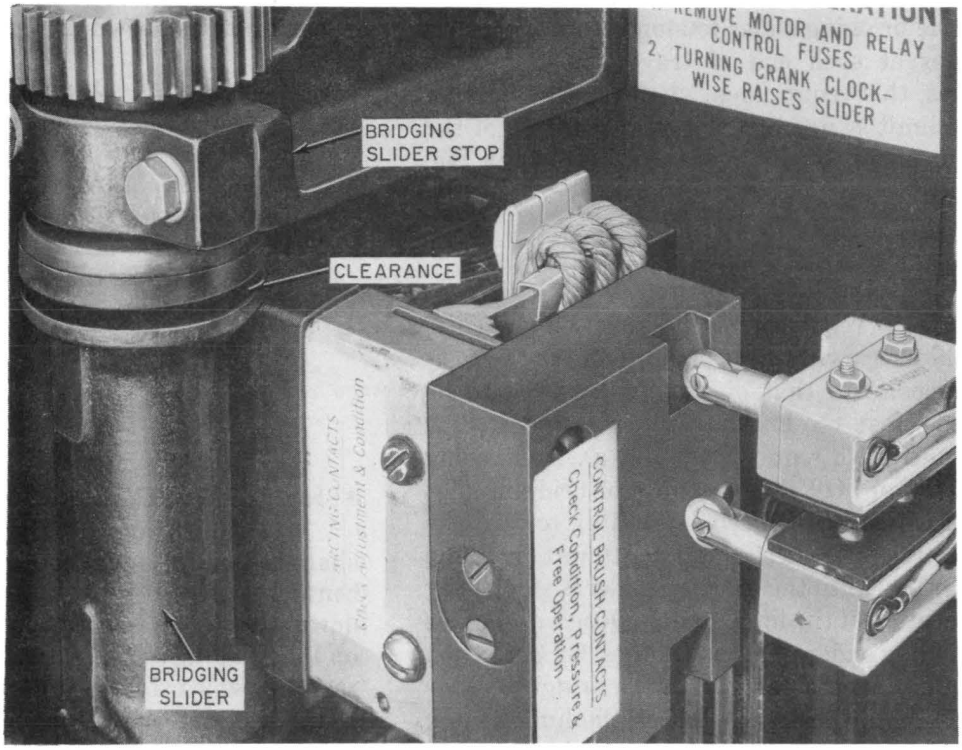

Fig. 9—Proper Adjustment of Limit Switches

equipped with a 141 cord tip on one end and a KS-6278 connecting clip on the other end.

To check the requirement, first remove the motor fuse and control circuit fuse for the switch on the associated plant control panel. With the 139A test set switch in the C position, connect the test set across the terminals of the OFF-NORMAL switch. Then move the bridging slider from the normal position to the Group 1 position, as covered in requirement 4.01(e). Observe when the OFF-NORMAL switch operates with reference to contact make between the rail controlling the downward travel (Fig. 7) and the associated sliding contact on the bridging slider, as indicated by the test set. Return the bridging slider to the normal position, as covered in requirement 4.01(f).

Caution: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

****4.23** ***Struthers-Dunn 166BXB100 Relay:*** The Struthers-Dunn 166BXB100 relay shall meet the applicable requirements as covered in the appropriate section in Division 040.

****4.24** ***Resistors:*** The condition of the cell shorting (current limiting) resistors (rear panel) and connection areas should be checked for defects and evidence of excessive temperatures. Blackened resistors indicate improper switch operation—too frequent or too slow. Connections of blackened resistors should be examined for cleanliness of contact surfaces and secureness of fastening. Partially blackened resistors (center area only) need not be replaced.

Gauge by sight and feel.

4.25 ***Temperature:*** Under normal operating conditions (paragraph 1.08), the temperature shall not exceed:

	MAX
Motor frame	95° C (203°F)
Switch blades, contacts, and terminal studs	70° C (158°F)

Use the R-1032, Detail 1 thermometer.

To check the requirement, proceed as follows. If the surface of the part to be checked is inaccessible with the switch cover on, remove the cover in accordance with paragraph 1.09. Apply the bulb of the thermometer to various spots on the surface to be checked to find the hottest spot. Cover the side of the bulb not in contact with the surface with a small amount of clay and cover the clay with a small felt pad. Take care not to touch any of the hot surfaces with the fingers. The temperature of the parts normally protected by the cover should be somewhat below the maximum temperature specified above. A high-temperature reading is an indication that the temperature of the part may exceed the specified limit when the cover is mounted. If the temperature is high, apply the thermometer to the surface to be checked and tape the thermometer and felt in place in such a way so as not to interfere with the operation of the switch. Then remount the cover. After an interval of approximately 1 hour, remove the cover and observe the temperature indication.

5. ADJUSTING PROCEDURES

5.01 ***Operation:*** (Reqt 4.01)If either requirement is not met, check all other requirements. Then recheck requirement 4.01.

5.02 ***Lubrication:*** (Reqt 4.02)

(a) ***Contact Surfaces of Main Contacts, Auxiliary Contacts, Knife Switch Blades, and Knife Switch Contacts:***

General

(1) Prior to lubrication, clean the contact surfaces as covered in (4) through (6); then lubricate the contact surfaces as covered in (7) and (8).

(2) After cleaning, determine the adequacy of the cleaning by visual inspection and measurement of the voltage drops as covered in requirement 4.10.

(3) For cleaning and lubricating the contact surfaces, prepare several paddles as follows. Wrap several layers of 3-inch cotton bandage around a fiberboard approximately 10 inches long, 1-3/4 inches wide, and 1/16 inch thick. Tie the bandage to the paddle with cord at each end and at the middle of the bandage.

Caution 1: During normal maintenance operations, it is not advisable to move the bridging slider of a 3-position switch from the normal position beyond the Group 1 position except as recommended in requirement 4.01 since this may cause an excessive increase in plant voltage.

Caution 2: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

(4) ***Cleaning Silver-Plated Contact Surfaces:*** Moisten the bandage on one of the paddles prepared, as covered in (3), with KS-7860 petroleum spirits and wipe clean all accessible surfaces and edges of contacts and knife blades, removing any accumulated dirt and old lubricant. Use a paddle with a clean bandage when the bandage gets dirty.

(5) Move the bridging slider from the normal to the Group 1 position, as covered in requirement 4.01(a). Movement of the bridging slider will apply the petroleum spirits to the bridging slider main contacts. Operate the knife switch to its other position. Similarly clean the contact and knife blade surfaces and edges which were previously inaccessible.

(6) Return the bridging slider to the normal position, as covered in requirement 4.01(a), and again clean the surfaces which were in contact with the bridging slider main contacts. Continue operating the switch and cleaning the contact surfaces until the contact surfaces are clean. Wipe dry using a paddle with a clean, dry bandage.

(7) ***Lubricating Contact Surfaces:*** With the bridging slider in the normal position

and the knife switch engaged in the top position, wipe a thin film of petrolatum on the accessible contact and knife blade surfaces and edges using a paddle prepared as covered in (3). Operate the switch to move the bridging slider to the Group 1 position, as covered in requirement 4.01(a). Operate the knife switch to its other position. Similarly lubricate the contact and knife blade surfaces and edges which were inaccessible with the switch in the normal position. Return the bridging slider to the normal position, as covered in requirement 4.01(a). Engage the knife switch in the top position. Apply a thin film of petrolatum on the contact surfaces to replace petrolatum removed by the bridging slider.

(8) Avoid an excess of petrolatum as it will collect dust and dirt. If insufficient petrolatum is used, the thin film which protects the contact surfaces from tarnish will soon be destroyed, resulting in possible overheating of the switch.

(b) ***Driving Screws and Exposed Gears:*** To lubricate the driving screws and exposed gears, proceed as follows:

(1) Before lubricating the driving screws and exposed gears, wipe off as much of the old grease as possible using a clean KS-14666 cloth moistened with KS-7860 petroleum spirits. If necessary, remove hardened grease with the KS-6320 orange stick. Wipe dry with a clean KS-14666 cloth. Operate the switch to move the bridging slider from the normal position to the Group 1 position, as covered in requirement 4.01(a), and similarly clean the portions of the driving screws and all exposed gears which were inaccessible with the bridging slider in the normal position.

(2) Apply a ***thin*** film of fresh 260-300P grease to the driving screws and the teeth and accessible surfaces of the gears. Return the bridging slider to the normal position, as covered in requirement 4.01(b), and apply the grease to the portions of the driving screws and the teeth and surfaces of gears which were previously inaccessible. Operate the switch several times, as covered in requirement 4.01(a), to distribute the grease along the threads of the screws and the teeth of the gears.

Caution 1: During normal maintenance operations, it is not advisable to move the bridging slider of a 3-position switch from the normal position beyond the Group 1 position except as recommended in requirement 4.01 since this may cause an excessive increase in plant voltage.

Caution 2: The switch should not be operated to the Group 1 position and returned to normal more often than once every 5 minutes.

5.03 ***Condition of Bearings:*** (Reqt 4.03)—If a bearing is in unsatisfactory condition, replace it as covered in Section 030-785-801.

5.04 ***Mounting of Contacts:*** (Reqt 4.04)

(a) If any of the main contacts, auxiliary contacts, or knife switch contacts are loose on the switch panel, securely tighten their mounting screws or nuts from the rear of the switch panel using the R-1542 or R-2512 adjustable wrench. When using the wrench, wrap electrical tape around the entire handle to prevent shorting between the live contacts.

(b) If the moving arcing contact assembly or any of the stationary arcing contacts are loose, securely tighten the associated mounting screws using the AT-7825, 4-inch E screwdriver.

5.05 ***Condition of Contacts, Clips, and Blades:*** (Reqt 4.05)

(a) ***Cleaning and Smoothing Arcing Contact Surfaces:***

(1) To clean the arcing contact surfaces, moisten a clean KS-14666 cloth with KS-7860 petroleum spirits and wipe away all accumulated dirt. Wipe dry with a clean, dry KS-14666 cloth.

(2) If the contacts are pitted or have buildups, smooth them using KS-13148, L1, abrasive paper. After using the abrasive paper, remove all loose particles with a clean, dry KS-14666 cloth. Check requirements 4.07, 4.08, and 4.09. If the contacts are badly pitted or worn, replace them as covered in Section 030-785-801.

(b) ***Cleaning and Smoothing Contact Surfaces and Edges of Clips and Blades:***

(1) To clean the contact surfaces and edges of clips and blades, proceed as covered in subsubparagraphs 5.02(a)(4) through (6).

(2) If the copper contact surfaces or edges are rough or pitted, smooth them with KS-13148, L1, abrasive paper. For access to contact surfaces between clips or blades, wrap the abrasive paper around a fiberboard paddle and tie it to the paddle with a cord at each end. Take care to remove a minimum amount of copper to avoid shortening the life of the switch. Silver-plated contact surfaces should not be smoothed with abrasives. After smoothing, remove all loose particles with a clean KS-14666 cloth and a paddle prepared as covered in sub-subparagraph 5.02(a)(3). After cleaning or smoothing, lubricate the contact surfaces as covered in sub-subparagraphs 5.02(a)(7) and (8).

(c) ***Adjusting Contact Clips:***

(1) If the convergence of one or both contact clips in a pair is too great or too little, as indicated by binding or poor contact with the associated movable contact, bend the clip or clips slightly as follows. Referring to Fig. 10, place the end of the 3/4- by 4- by 6-inch hardwood block against the front edge of the clip so it engages all the fingers. Position the block to decrease the convergence of the clip if the clip binds or to increase the convergence if the clip makes poor contact. Then, using the ball peen hammer, tap the block to bend the clip. Take care to avoid excessive bending of the clip. Recheck the requirement, and check requirements 4.06 and 4.10.

(2) To line up one of the fingers of a contact clip with the other fingers, place one end of the 3/4- by 4- by 6-inch hardwood block against the front edge of the finger. Using the ball peen hammer, tap the block to bend the finger as required. Take care to avoid excessive bending of the finger. Recheck the requirements, and check requirements 4.06 and 4.10.

5.06 ***Engagement of Movable and Stationary Main and Knife Switch Contacts:*** (Reqt 4.06)

(a) If part (a) of the requirements is not met, check requirements 4.04 and 4.05.

(b) If part (b) of the requirement is not met, proceed as follows: Using the R-2512 adjustable wrench, remove the locknut, mounting nut, and spring washer from the knife switch hinge bolt and remove the bolt and knife blades. Check that the hinge contact clips and knife blades meet requirement 4.05(b) through (d). Remount the knife blades, tightening the mounting nut against the spring washer so the blades make good contact with the hinge contact clips. Make sure the blades do not bind in the hinge clip when the switch is operated. Securely tighten the locknut.

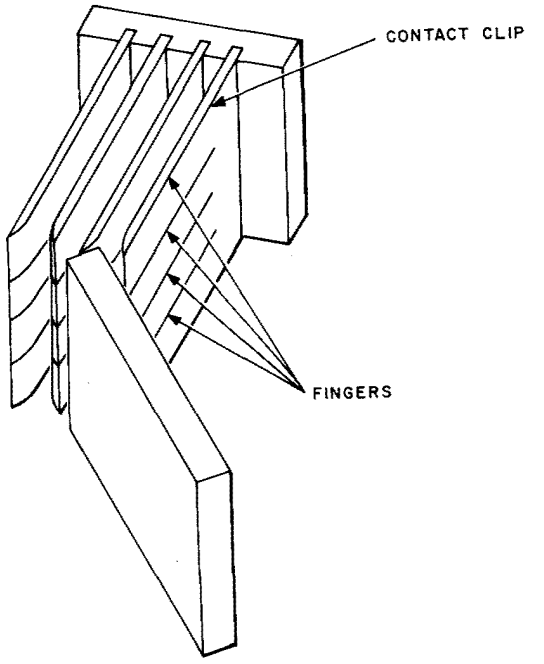

Fig. 10—Hardwood Block Positioned to Bend Contact Clip

5.07 ***Arcing Contact Follow:*** (Reqt 4.07)

5.08 ***Arcing Contact Clearance:*** (Reqt 4.08)

5.09 ***Arcing Contact Alignment:*** (Reqt 4.09)

If any requirement is not met, proceed as follows: Remove motor and control fuses and ground connection to center control rail. Remove contact block after first removing control brush assembly. Using the AT-7860 pliers, bend stop for each contact outward away from mounting plate (Fig. 3). Fasten block to angle bracket and tap each contact stop using hammer and hardwood block so all stops are aligned and touching mounting plate. Replace contact block, and

observe alignment and adjustment of contacts. Replace the control brush assembly and the ground connection to center control rail and securely tighten screws. Then recheck the requirements. If all requirements cannot be met, replace the arcing contact assembly as covered in Section 030-785-801.

5.10 ***Voltage Drop Across Main Contacts:*** (Reqt 4.10)—If the requirement is not met, check requirements 4.04 through 4.06 and 4.25. After making required adjustments, recheck the requirement.

5.11 ***Noise and Vibration:*** (Reqt 4.11)—If the requirement is not met, securely tighten all screws and nuts. Examine the motor brushes for evidence of chattering. If the noise and vibration continues, check requirement 4.03.

5.12 ***Voltage and Current of Motor:*** (Reqt 4.12)

5.13 ***Motor Torque:*** (Reqt 4.13)

If either requirement is not met, check requirements 4.03 and 4.14 through 4.16. If the requirements involved cannot be met, replace the motor as covered in Section 030-785-801.

5.14 ***Condition of Motor Commutator Surface:*** (Reqt 4.14)

(1) To clean the commutator surface, first remove the motor, as covered in (2). Then disassemble the motor, clean the commutator surface, and remount the parts, as covered in (3) through (9).

(2) Tag and disconnect the motor leads from the relay and terminal block using the 4-inch E screwdriver and the R-1542 adjustable wrench. Using the R-3094, Detail 18 socket wrench with R-3094, Detail 8 universal joint, R-3094, Detail 5 extension, and R-3094, Detail 2 handle, remove the motor mounting screws and washers. Lower the motor to disengage the pinion, and remove the motor.

(3) Using the AT-7825, 3-inch C screwdriver, remove the brush plate mounting screws. Remove both brush plates and brush assemblies. Mark the brush assemblies for remounting in their original positions.

(4) Mark the motor housing and end shields to obtain the same relation between them when remounting the end shields. Using the AT-7825, 4-inch E screwdriver and R-3094, Detail 16 socket wrench with the R-3094, Detail 2 handle, remove the motor assembly screws and nuts. Pull or pry off the end shield containing the brush holders. If necessary, the rotor may be removed by prying off the other end shield and removing the rotor with the end shield.

(5) Clean the commutator surface as covered in the Sections 171-110-701 and 171-110-801.

(6) If the rotor and associated end shield were removed, insert the rotor in the motor housing and position the end shield on the housing. Mount the end shield containing the brush holders, and securely tighten the nuts on the assembly screws.

(7) Remount both brush assemblies in their original positions. Carefully compress each brush spring, and remount the brush plates, securely tightening the screws.

(8) Raise the motor into position on the switch panel so the pinion on the motor shaft meshes properly with its associated gears on the switch panel. Mount the motor, and securely tighten the screws.

(9) Connect the motor leads to the proper terminals on the relay and terminal block, securely tightening the screws.

5.15 ***Commutation:*** (Reqt 4.15)—If the motor is suspected of poor commutation, check requirement 4.15. If the requirement is not met, check requirements 4.12 through 4.14. If the requirements involved cannot be met, replace the motor as covered in Section 030-785-801.

5.16 ***Brushes:*** (Reqt 4.16)—If a brush binds, remove the brush assembly from its holder, marking the brush for remounting in its original position. Clean the brush and brush holder with a clean, dry KS-14666 cloth. Remove any rough projections with 4/0 abrasive paper. If a brush is excessively worn or chipped, replace the brush as covered in Section 030-785-801.

5.17 ***Position of Control Rails:*** (Reqt 4.17)

(a) If any part of the requirement is not met, determine which control rail should be reposi-

tioned from the observations made when checking the requirements. Raising or lowering the rail controlling the upward travel will raise or lower the upper limit of travel of the bridging slider. Raising or lowering the rail controlling the downward travel will raise or lower the lower limit of downward travel of the bridging slider. When repositioning a control rail to limit the travel of the bridging slider, make sure that the relative positions of the rails controlling the upward and downward travel specified in the requirement are maintained. To reposition a control rail, proceed as covered in (b).

(b) Remove the motor fuse and control circuit fuse for the switch from the associated plant control panel and ground connection to center control rail. Using the R-3094, Detail 14 socket wrench with the R-3094, Detail 2 handle, loosen the positioning screws associated with the rail to be repositioned. Raise or lower the rail as required, securely tighten the screws, and reconnect ground connection to center control rail. Recheck the requirement, and check requirements 4.21 and 4.22.

5.18 ***Condition and Alignment of Control Rails and Control Rail Sliding Contacts:*** Reqt 4.18—To clean the contact surfaces of the control rails and control rail sliding contacts, remove the motor fuse and control circuit fuse for the switch on the associated plant control panel. Using a KS-14666 cloth moistened with KS-19578, L1, trichloroethane, wipe the surfaces clean applying pressure to remove any accumulated dirt and contamination. Wipe dry with a clean, dry KS-14666 cloth. If the surfaces are pitted, clean them by rubbing lightly with 4/0 abrasive paper. After cleaning, remove all loose particles and wipe with clean, dry KS-14666 cloths moistened with trichloroethane.

5.19 ***Contact Pressure and Freedom of Movement of Control Rail Sliding Contacts:*** (Reqt 4.19)

(1) If the requirement is not met, remove and clean the sliding contact assembly, as covered in (2) through (6).

(2) Remove the motor fuse and control circuit fuse for the switch from the associated plant control panel and ground connection to center control rail. Referring to Fig. 7, remove the sliding contact assembly mounting screws using the R-1324 screwdriver. Loosen the top screw slightly, and rotate the contact assembly forward, away from the panel at the bottom until the brushes are free of the control rails. Remove the top screw, and withdraw the sliding contact assembly.

(3) Check pressure requirement (2) by placing a 1/4- by 1/2- by 4-inch block of wood on platform scale. Position one of the control brushes over the block, and press on the top of the control brush assembly until the brush begins to move. Scale reading in pounds should meet requirement. Repeat for all three brushes.

(4) Check the clearance requirement with the brushes in all movable positions, unactuated and depressed.

(5) To check condition of parts, use the B long-nose pliers to remove the cotter pin through the shaft and remove the shaft. Move the sliding contacts out of the holder taking care not to damage their leads, and remove spacers between the contacts. Remove the contact actuators from the holder. Using the R-1324 screwdriver, remove the rear cap on the holder and drop out the compression springs and push rods.

(6) Using a KS-14666 cloth moistened with KS-19578, L1, trichloroethane, clean all parts, including holder. Carefully examine all parts, including holder, for evidence of corrosion and/or abrasion. If any parts are corroded, replace control assembly. If any parts are abraded, smooth with abrasive paper.

(7) If pressure requirement is not met, check springs for deformation; ie, uniform cord diameter and distance between turns. Also check for abrasion and corrosion of parts and clearance requirement. If all appear satisfactory and pressure requirement is not met, replace control assembly as covered in 030-785-801.

(8) If clearance requirement is not met, lightly sand the sides of the housing with the 4/0 abrasive paper until the requirement is met.

(9) Reclean all parts, as covered in (6), and wipe dry with a clean, dry KS-14666 cloth.

(10) Remount the parts in the holder in reverse order of removal. Recheck the pressure re-

quirement. If the requirement is met, remount the contact assembly in reverse order of removal (b) above. If the requirement cannot be met, replace the sliding contact assembly as covered in Section 030-785-801.

5.20 ***Mounting of Limit Switches and OFF-NORMAL Switch:*** (Reqt 4.20)—If the switch is loose on the mounting bracket, securely tighten the switch mounting screws using the R-3193 wrench with the AT-7825, 4-inch E screwdriver or 207 tool. If the switch mounting bracket is loose on the switch panel, securely tighten the bracket mounting screws with the R-1542 adjustable wrench or the AT-7825, 4-inch E screwdriver.

5.21 ***Operation of Limit Switches:*** (Reqt 4.21)

(a) If the requirement is not met, adjust vertically mounted limit switches, as covered in (b), and horizontally mounted limit switches, as covered in (c). First, remove the motor fuse and control circuit fuse for the switch panel on the associated plant control panel to remove voltage from the limit switches.

(b) To adjust vertically mounted limit switches, hold the switch plunger with the B long-nose pliers and loosen the locknut on the plunger using the R-1542 adjustable wrench. Then apply the wrench to the hexagonal section of the plunger, and turn the plunger so it projects farther from the switch to obtain earlier operation or less to obtain later operation. Securely tighten the locknut. Recheck the requirement. If the requirement cannot be met, replace the limit switch as covered in Section 030-785-801.

(c) To adjust horizontally mounted limit switches, loosen the limit switch bracket mounting screws using the R-1542 adjustable wrench. When adjusting the upper limit switch, lower the bracket to obtain earlier operation of the switch or raise the bracket to obtain later operation. When adjusting the lower limit switch, raise the bracket to obtain earlier operation of the limit switch or lower the bracket to obtain later operation. Securely tighten the mounting screws. Recheck the requirement. If the requirement cannot be met, replace the limit switch as covered in Section 030-785-801.

5.22 ***Operation of OFF-NORMAL Switch:*** (Reqt 4.22)—If the requirement is not met, adjust the OFF-NORMAL switch, as covered in subparagraph 5.21(b) or (c), for the limit switches. If the requirement cannot be met, replace the OFF-NORMAL switch as covered in Section 030-785-801.

5.23 ***Struthers-Dunn 166BXB100 Relay:*** (Reqt 4.23)—If the requirement cannot be met, replace the relay as covered in Section 030-785-801.

5.24 ***Resistors:*** (Reqt 4.24)—If the requirement cannot be met, replace the resistor as covered in Section 030-785-801.

5.25 ***Temperature:*** (Reqt 4.25)

(a) If the temperature of the motor frame exceeds the specified limits, check requirements 4.03 and 4.12 through 4.16. Recheck the requirement. If the requirements involved cannot be met, replace the motor as covered in Section 030-785-801.

(b) If the temperature of the switch parts exceeds the specified limits, clean and lubricate the contacts, as covered in subparagraph 5.02(1), and check requirements 4.04 through 4.06 and 4.10. Recheck the requirement.