

## MOTOR-DRIVEN SWITCHES

### KS-5502 AND KS-15836 TYPE

### REQUIREMENTS AND ADJUSTING PROCEDURES

#### 1. GENERAL

1.01 This section covers the KS-5502- and KS-15836-type motor-driven switches.

1.02 This section is reissued for the following reasons:

- To add caution as required
- To add supplier for center point oil
- To add note to 3.003(1)(d) and (3)(d)
- To make minor changes as required.

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 **Phi ( $\phi$ ):** 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 its performance indicates that such a check is advisable.

1.06 **Successful Commutation:** 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.

1.07 **Normal Operation:** 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 conducting cams engaging the associated stationary main contacts smoothly and positively, and the switch-actuating motor and mechanism operating satisfactorily.

1.08 On some switches, only the driving mechanism is protected by a cover. To inspect or work on the mechanism, remove the cover mounting screws using the 4-inch E screwdriver or R-1542 adjustable wrench and remove the cover. On switches which are entirely protected by a cover, remove the cover by slightly lifting the cover and then pulling it outward.

**Caution:** When working on the switch, take care to maintain office voltage. Before doing any work on the switch, remove the motor fuse and control circuit fuse for the switch from the associated plant control panel to prevent unexpected starting while working on the switch. Remount the fuses when the work is completed. Requirements should be checked preferably during a period when they will cause the least unfavorable service reaction.

1.09 Unless otherwise stated, all requirements shall be checked and procedures performed with the knife switch blades in the top position.

1.10 Cam switches shown on Fig. 4 are the new improved type, and any new KS-5502 and KS-15836 switches ordered will include the improved cam switches. It is recommended that the new improved cam switches be applied to existing KS-5502 and KS-15836 switches where the old-type cam switches do not meet the requirements. Refer to Section 030-787-801 for replacement information.

2. REQUIREMENTS

**2.001 Operation:** Prior to switch operation, the accessible main and auxiliary contacts and drive mechanism should be checked for contamination and lubrication. Also the control cams, switches, and relays should be checked for alignment and condition. The switches should be checked and operated on quarterly intervals.

**2.01 Lubrication**

**Caution:** When working on the switch, take care to maintain office voltage. Before doing any work on the switch, remove the motor fuse and control circuit fuse for the switch from the associated plant control panel to prevent unexpected starting while working on the switch. Remount the fuses when the work is completed. Requirements should be checked preferably during a period when they will cause the least unfavorable service reaction.

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

Fig. 1 and 2—The contact surfaces of the main contacts, auxiliary contacts, and knife switch blades shall be cleaned and then lubricated with a thin film of petrolatum every 6 months unless conditions are such that the interval may be extended.

(b) **Motor Bearing:** The bearing at the brush end of each motor shall be cleaned and then repacked with fresh 260-300P grease every 3 years in service, when the motor is put in service after two or more years of storage, or when the motor is dismantled for other reasons.

**Note:** In some cases the bearing at the gear case end of the motor is lubricated with oil from the gear case and does not require repacking. Where double-shielded-type ball bearings are provided, no lubrication is required.

(c) **Crankshaft Bearings, Gear Case Pinion Bearing, and Linkage Bearings:** The crankshaft bearings, gear case pinion bearing, and linkage bearings shall be lubricated by adding four to six drops of KS-16326 L1 oil annually to the oil cup associated with each bearing.

(d) **Gear Case, Gear Case Pinion, and Crankshaft Gear:** Fig. 3

(1) **Gear Case on Master Motors:** The gear case shall be drained and refilled with fresh 130-170 S 210 oil every 3 years. Unless a gear case shows signs of leakage, no other periodic filling should be necessary.

**Note:** When installing the switch, remove the seals, where provided, from the filling hole vent plugs on the gear cases. Check whether the gear cases are full of oil and refill them if necessary.

(2) **Gear Case on Bodine Dyna Motors and Brown-Brockmeyer Motors:** The gear case shall be lubricated with fresh 260-300P grease every 3 years.

(3) **Gear Case Pinion and Crankshaft Gear:** The gear case pinion and crankshaft gear shall be lubricated with a small amount of 260-300P grease at the time of lubrication of the gear case.

**\*2.02 Conditions of Motor Bearings:** The bearings in each motor shall be free from excessive wear. If the switch operates satisfactorily under all conditions of normal operation (1.07) and requirement 2.08 is met, the bearings shall be considered to be in satisfactory condition.

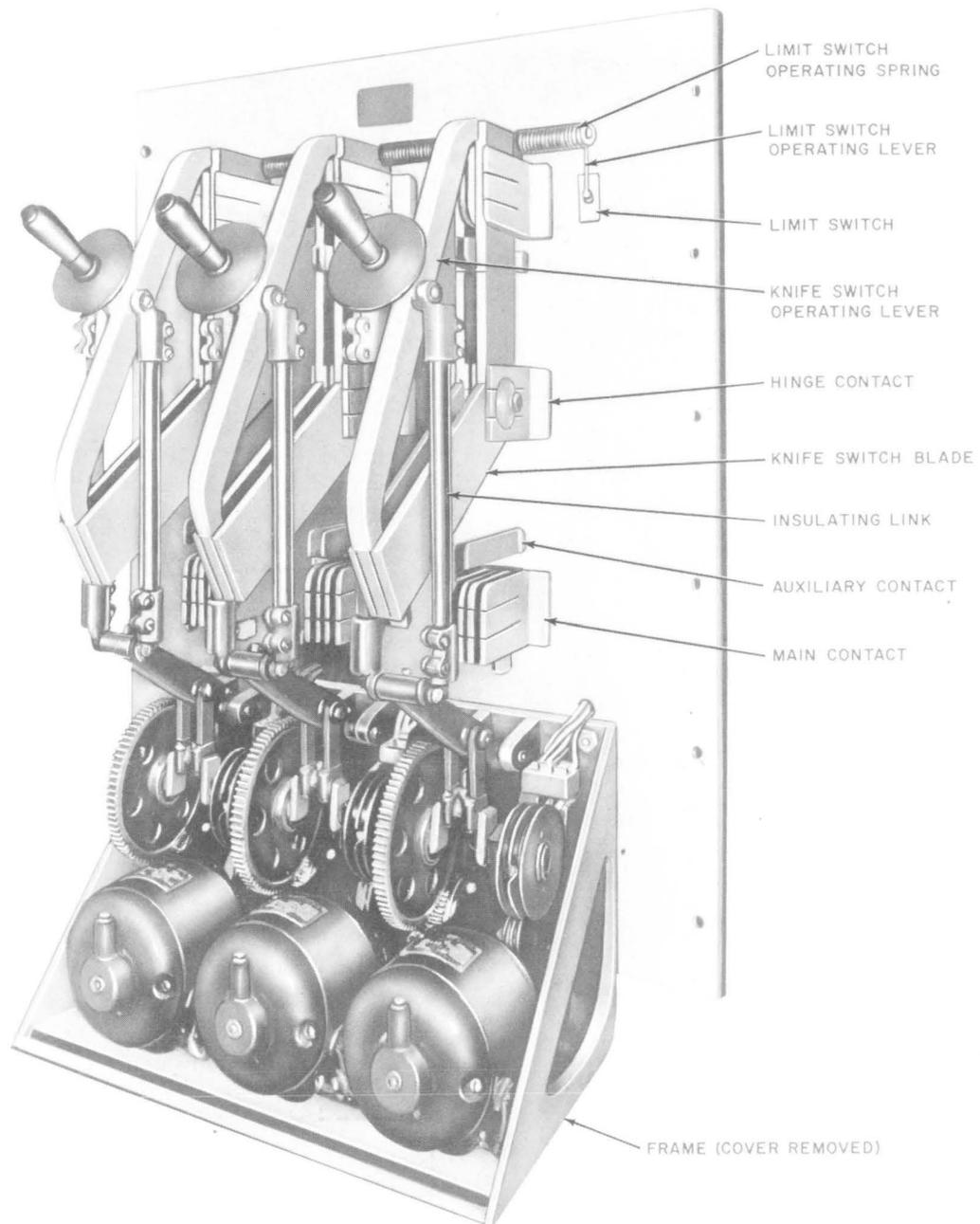
**Note:** Abnormal noise from a bearing is an indication of excessive wear.

**2.03 Mounting of Knife Switch Contacts:** Fig. 1 and 2—All knife switch contacts, including the knife switch hinge contacts, shall be securely fastened to the switch panel.

Gauge by eye and feel.

To check the requirement, operate the knife switches in accordance with 3.005. There should be no movement at the mounting base of the contacts when the knife switch blades just make or break with the main or auxiliary contacts.

**2.04 Condition of Knife Switch Blades and Contact Clips:** Fig. 1 and 2



**Fig. 1—KS-5502-Type Motor-Driven Switch**

(a) The contact surfaces and edges of the knife switch blades and contact clips shall be clean and smooth.

Gauge by eye.

(b) The contact clips of each pair shall converge slightly toward the front.

Gauge by eye.

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

Gauge by eye.

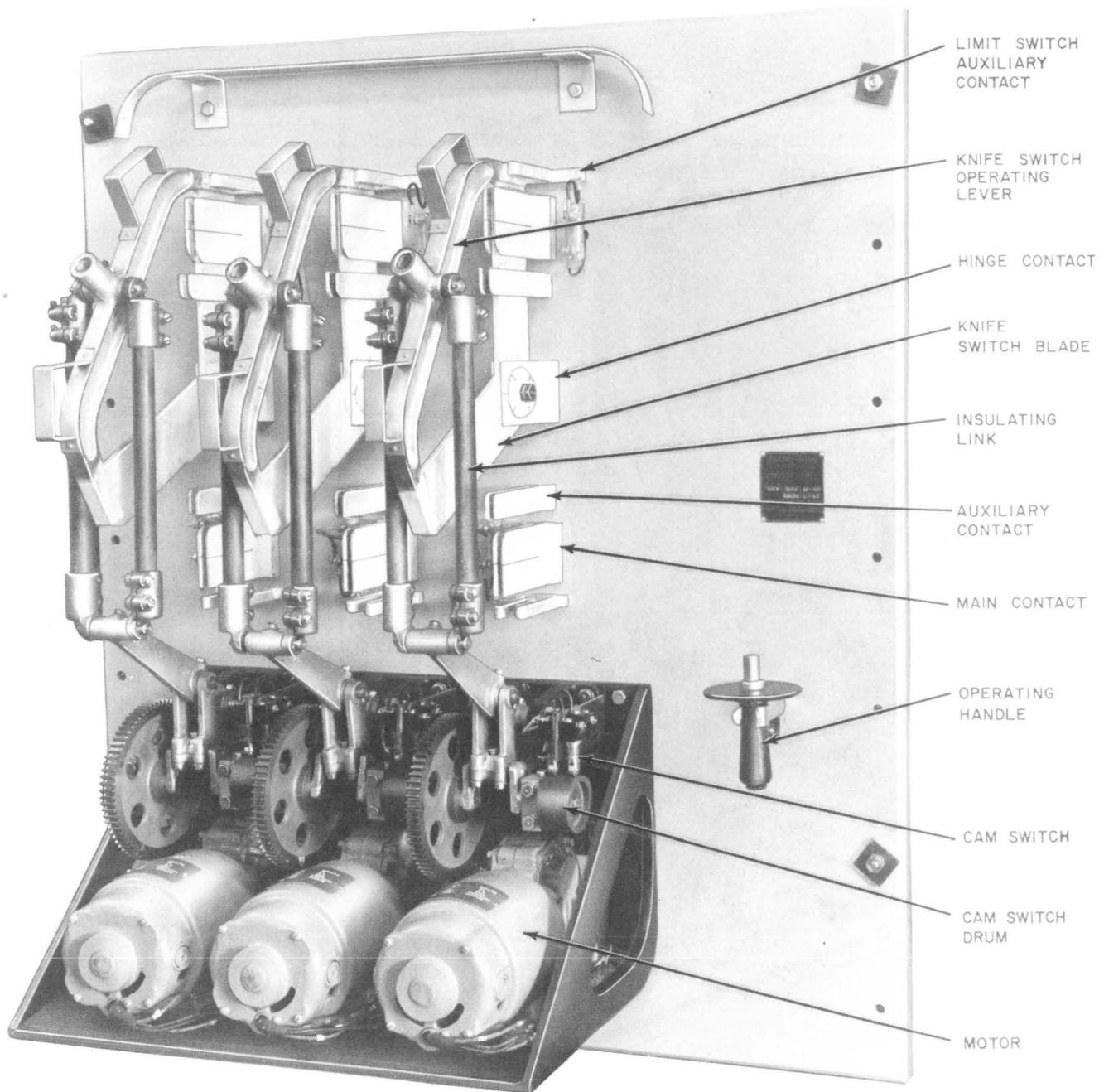


Fig. 2—KS-15836-Type Motor-Driven Switch

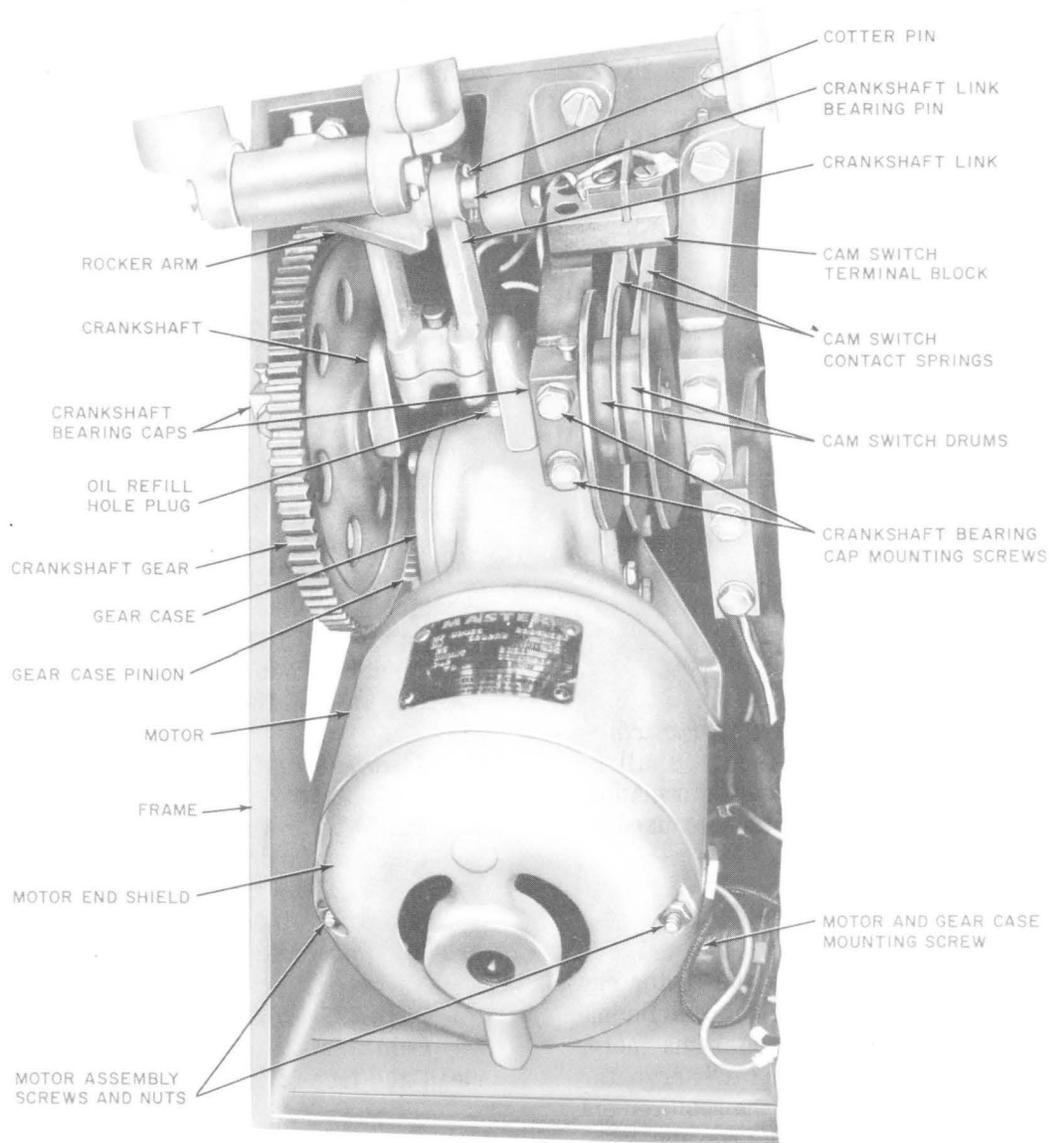
**2.05 Engagement of Knife Switch Blades and Contact Clips:** Fig. 1 and 2

(a) With the knife switch blades in the fully made position, a 0.0015-inch thickness gauge shall not enter between a blade and contact clip 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 eye and feel.



**Fig. 3—Portion of KS-5502-Type Motor-Driven Switch Showing Motor and Crankshaft Assembly**

To check the requirement, manually operate each knife switch in accordance with 3.005 and observe whether there is good contact without bind between the hinge contact clips and blades.

**2.06 Voltage Drop:** The voltage drop between the base of a knife switch hinge contact and the base of a main contact when the main contact is fully engaged by the blades shall not exceed 25 millivolts for full loads and prorated fractions thereof for smaller loads. The voltage

drop shall be checked quarterly unless periodic inspections have indicated that the interval may be extended.

Use the KS-8039 voltmilliammeter equipped with the Weston (D-79650) test cords.

**2.07 Noise and Vibration:** The noise and vibration of a motor and associated mechanism under all conditions of normal operation (1.07) shall not be excessive.

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Gauge by ear and feel.

**\*2.08 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 when the voltage is within the allowable nameplate limits.

Use the KS-8039 dc voltmilliammeter equipped with Weston (D-79650) test cords and a dc ammeter capable of reading 500 percent of the nameplate rated full-load motor current.

**2.09 Motor Torque:** The motor shall develop sufficient torque to start and move the knife switch blades from one position to another within 2 seconds.

Gauge by eye.

Use the KS-3008 stopwatch.

**\*2.10 Condition of Motor Commutator Surface:**

The motor commutator surface shall be clean and free from scores, pits, or other deformations of the surface or structure except those caused by normal wear.

Gauge by eye and feel.

To check the requirements, remove the motor end shield in accordance with 3.10(2)(a) for the Bodine motor, Brown-Brockmeyer motor, and Dyna motor or 3.10(3)(a) for the Master motor. Observe the condition of the commutator. When the requirement is met, remount the parts in accordance with 3.10(2)(c) for the Bodine, Brown-Brockmeyer, and Dyna motor or 3.10(3)(d) for the Master motor.

**\*2.11 Commutation:** The motor shall commute successfully under all conditions of normal operation. (See 1.06 and 1.07.)

**\*2.12 Brushes:** The brushes shall be free in their holders and shall fit so as to ensure successful commutation.

Gauge by eye and feel.

To check the requirement, proceed as follows.

- (1) **Bodine Motor, Brown-Brockmeyer Motor, and Dyna Motor:** Using the 4-inch E

screwdriver, remove the brush caps and move each brush in and out of the holder several times, observing whether the brush binds. Remove the brush, marking it for remounting in its original position, and observe the condition of the contact surface. When the requirement is met, remount the brush and brush cap. Take care not to tighten the cap excessively to avoid splitting it.

- (2) **Master Motor:** Remove the end shield as covered in 3.10(b)(1). Grasp the brush pigtail lead and gently move each brush into the holder. Release the lead and observe whether the brush binds and whether it makes good contact with the commutator. When the requirement is met, make sure that the slot in the brush holder bracket engages the pin in the motor housing and that the brushes rest properly against the commutator. Place the endplay washers in their proper order in the bearing housing in the motor end shield. Then remount the end shield and securely tighten the nuts.

### 2.13 Condition of Cam Switches

- (a) **KS-5502 Motor-Driven Switch:** Fig. 3—The cam switch drums and cam switch contact springs shall be clean. Alignment of contact springs shall be parallel to but shall not touch or rub on insulating barriers.

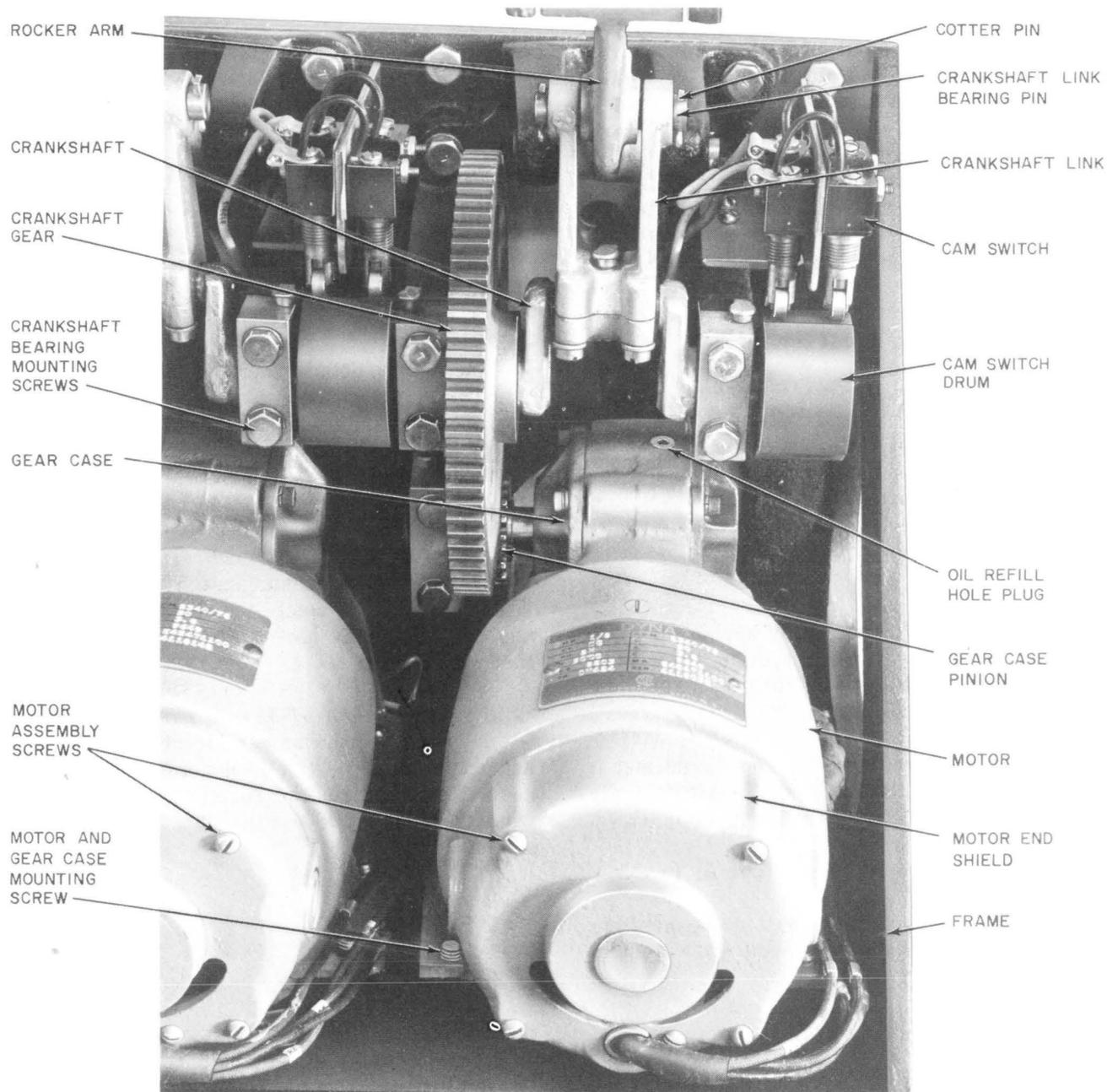
- (b) **KS-5836 Motor-Driven Switch:** Fig. 4—Cam surface and roller followers shall be clean and free of lubricant.

### 2.14 Operation of Cam Switches

- (a) **KS-5502 Motor-Driven Switch:** Fig. 3

- (1) The pressure of each cam switch contact spring against the insulated depression on the cam switch drum shall be 1 1/2 to 2 pounds at tip.

- (2) To check the requirements, remove the motor fuse and control circuit fuse for the switch from the battery control board of the associated plant to remove voltage from the cam switch. Then loop string under each contact finger adjacent to contact face and lift perpendicularly with spring balance until contact opens on switch drum. Lifting force



**Fig. 4—Portion of KS-15836-Type Motor-Driven Switch Showing Motor and Crankshaft Assembly**

shall be 1 1/2 to 2 pounds. Remount fuses when work is completed.

(b) **KS-15836 Motor-Driven Switch:** Fig. 4

(1) The roller followers of the cam switches shall operate essentially simultaneously.

(2) The rollers shall drop into the cam dwell to open the circuit and stop the drive mechanism with the crankshaft approximately top or bottom dead center.

#### **2.15 Condition of Limit Switches**

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(a) **KS-5502 Motor-Driven Switch:** Fig. 3—The limit switches shall meet the requirements for the 378A key (bottom limit switches) and 392A key (top limit switches) covered in Section 032-711-701.

(b) **KS-15836 Motor-Driven Switch:** Fig. 2—The limit switch contact surfaces shall be clean and smooth. The contact surfaces shall be parallel to each other and shall converge slightly toward the rear.

**\*2.16 Operation of Limit Switches**

(a) **KS-5502 Motor-Driven Switch**

(1) Each limit switch shall be operated by the associated operating lever when the knife blade enters the main contact and actuates the spring.

Gauge by eye.

(2) Each limit switch shall remain operated by the associated operating lever until the cam switch contact springs make with the contacts of the cam switch drums.

The requirements shall be considered met if the motor-driven switch operates satisfactorily under all conditions of normal operation (1.07).

(b) **KS-15836 Motor-Driven Switch:** Fig. 2

(1) Each limit switch shall make positive contact with the knife blade after it enters the main contact.

Gauge by eye.

(2) With the knife switch in the fully mated position, a 0.0015-inch thickness gauge shall not enter between the blade and the limit switch contact clips at minimum 50 percent of accessible outer junction line.

Use the KS-6909 gauge.

**2.17 Temperature:** Under normal conditions, the temperature rise of the following parts above any ambient temperature between the limits of 10°C (50°F) and 40°C (104°F) shall not exceed:

Motor Frame	Motors having class A insulation on field windings 25° C (77° F)
	Motors having class B insulation on field windings 30° C (86° F)
Switch Blades, Contacts, and Terminal Studs	30° C (86° F)

Use the R-1032, detail 1 thermometer.

To check the requirement, apply the bulb of the thermometer to various spots on the surface to be checked in order to find the hottest spot. Cover the portion of the bulb not in contact with the surface with a small amount of the clay and cover the clay with a small felt pad. Take care not to touch any of the hot surfaces with the fingers. When the work is completed, be sure to remove any clay that may have adhered to the surface that was checked.

**\*2.18 Resistance of Motor Field Windings:** (Brown-Brockmeyer Motor, Dyna Motor, and Master Motor)—With the motor at approximately room temperature, the resistance of the field windings shall not be less than:

	RESISTANCE (Minimum)
25-volt motor	11 ohms
50-volt motor	45 ohms

This requirement need not be checked unless the temperature of the motor frame is excessive.

Use the KS-8340 L2 ohmmeter with the KS-8340 L3 test leads.

To check the resistance of the field winding, first remove the motor fuse and control circuit fuse for the switch from the battery control board of the associated plant and allow the motor to cool to room temperature. Tag and disconnect the F2, A2, and G motor leads at the lead connectors. If lead connectors are not provided, disconnect the leads from the terminal block at the rear of the switch panel using the 4-inch E screwdriver or

R-1542 adjustable wrench. Then apply the ohmmeter across the F2 and G motor leads and observe the reading on the meter. When the requirement is met, connect the leads to their proper terminals and remount the fuses.

**3. ADJUSTING PROCEDURES**

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

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
KS-6320	Orange stick
KS-14220 L1	Sliding tee handle
KS-14220 L5	9-inch long extension bar
KS-14220 L11	11/32-inch socket wrench
KS-14220 L12	3/8-inch socket wrench
KS-14220 L16	1/2-inch socket wrench
KS-14220 L20	5/8-inch socket wrench
KS-14796	Oiler
R-1542	Adjustable wrench
R-2652	Adjustable wrench
R-2969	Brush
—	3-inch C screwdriver
—	4-inch E screwdriver
—	P long-nose pliers
—	1-pound ball peen hammer
—	1/8-inch drive pin punch, L.S. Starrett Company, No. 565 or equivalent
—	Oiler, Gem Division, Plews Oiler Company, No. 1706

—	Grease gun, Lincoln Engineering Company, No. 5958
<b>GAUGES</b>	
KS-3008	Stopwatch
KS-6909	Thickness gauge nest
—	2-pound spring scale
<b>MATERIALS</b>	
KS-2423	Cloth
KS-6824	Sealing compound
KS-7471	260-300P grease
KS-7860	Petroleum spirits
KS-16326 L1	Oil
—	◆Center point oil (available from Anderson Power Products, 115 Newton Street, Boston, Mass., 02135 or Chicago Manufacturing and Distributing Division, Evans Products Company, 1928 West 46th Street, Chicago, Ill., 60609, in 4-ounce tubes)◆
KS-16736 L1	Compound
—	Petrolatum
—	String
—	130-170 S 210 oil
—	3-inch cotton bandage
—	Felt pad or equivalent
—	1/16- by 1-3/4 by 10-inch fiberboard
—	3/4- by 4- by 6-inch hardwood block
—	10-32 round head machine screw, 1/2 inch long
—	Abrasive paper, Garnet 4/0

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CODE OR SPEC NO. MATERIALS	DESCRIPTION
—	Electrical tape, Scotch No. 33 or equivalent
—	Modeling clay, sculpture house or equivalent
<b>TEST APPARATUS</b>	
KS-8039	Voltmilliammeter
KS-8340 L2	Ohmmeter
KS-8340 L3	Test lead (two required)
—	Test cord, Weston Electrical Instrument Company, No. D-79650 (two required)
—	DC ammeter (See 2.08.)

**Caution 1:** *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.*

### 3.002 Automatic Operation of Knife Switches

- (1) For automatic operation of the knife switch from its normal to its emergency position, turn off all the charging units in the associated plant as covered in the BSP section for the plant. After a short interval, the knife switch will operate to its emergency position. Operate the MAN-AUTO key on the battery control board of the plant to MAN to prevent further automatic operation.

**Note:** Automatic operation of the knife switch to the group 2 position should only be performed as required.

- (2) To restore the knife switch to the normal position, operate the MAN-AUTO key on the battery control board of the plant to AUTO and restore the charging units to service. When the batteries are charged to their proper voltage, the knife switch will operate to its normal position.

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

**Caution 2:** *Switches shall be moved in a continuous motion from the normal to emergency position or when returning to the normal position.*

### 3.003 Manual Operation of Knife Switches

**Caution:** *When working on the switch, take care to maintain office voltage. Before doing any work on the switch, remove the motor fuse and control circuit fuse for the switch from the associated plant control panel to prevent unexpected starting while working on the switch. Remount the fuses when the work is completed. Requirements should be checked preferably during a period when they will cause the least unfavorable service reaction.*

#### (1) Operation of Knife Switch From Normal to Emergency Position

- (a) Operate the MAN-AUTO key on the battery control board of the associated plant to MAN. The knife switch that is operated during this procedure is the right-end knife switch on the switches covered per SD-81022-02 and SD-81023-02 and the center knife switch for switches covered per SD-81022-01, SD-81023-01, and SD-80577-01.
- (b) Disconnect the upper ends of the insulating links from the operating lever of the knife switch as follows. Using the P long-nose pliers, remove one of the cotter pins from the bearing pin through the links and remove the bearing pin. Allow the links to hang temporarily from the rocker arm.
- (c) Insert the shaft of the handle furnished with the switch into the hole on the operating lever of the knife switch.
- (d) Turn off all the charging units in the associated plant as covered in the BSP section for the plant. When the R relay in the emergency cell switch control circuit of the plant operates, operate the knife switch to its emergency position.

**Note:** ♦The switch off-normal alarm may be operated.♦

(2) **Restoring Knife Switch From Emergency Position to Normal Position**

(a) Restore the charging units in the associated plant to service. When the L relay in the emergency cell switch control circuit of the plant operates, operate the knife switch to its normal position.

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

(b) Position the upper ends of the insulating links on the operating lever. Remount the bearing pin and secure the cotter pin in the end of the bearing pin using the P long-nose pliers.

(c) Operate the MAN-AUTO key on the battery control board of the plant to AUTO when the work is completed.

(3) **Operation of the Knife Switch From Group 1 to Group 1 and 2 Position As Covered by SD-80577-01, SD-81022-01, and SD-81023-01:** The knife switch to be operated is the switch on the right side.

(4) **Operation of the Knife Switches From Position 65A, 65B to Position 69A, 69B As Covered by SD-81022-02 and SD-81023-02:** The knife switches to be operated are the center knife switch and the knife switch on the left side.

**Caution 1:** *Operation of the knife switch from float position to charge position (knife switch on the left side on switches covered by SD-80577-01, SD-81022-01, and SD-81023-01) will affect the plant voltage if CEMF cells are furnished.*

**Caution 2:** *Switches shall be moved in a continuous motion from the top to the bottom position and when returning to the top position.*

**Caution 3:** ♦When working on the switch, take care to maintain office voltage. Before

*doing any work on the switch, remove the motor fuse and control circuit fuse for the switch from the associated plant control panel to prevent unexpected starting while working on the switch. Remount the fuses when the work is completed. Requirements should be checked preferably during a period when they will cause the least unfavorable service reaction.*

(5) **Restoring Knife Switch From Normal to Emergency Position**

(a) Restore the right-end knife switch on the switches covered per SD-81022-02 and SD-81023-02 and the center knife switch for switches covered per SD-81022-01, SD-81023-01, and SD-80577-01 to the normal position.♦

(b) Operate the MAN-AUTO key on the battery control board of associated plant to MAN.

(c) Turn off the emergency cell trickle charger in the associated plant.

(d) ♦Disconnect the upper ends of the insulating links from the operating lever of the knife switch as follows. Using the P long-nose pliers, remove one of the cotter pins from the bearing pin through the links and remove the bearing pin. Allow the links to hang temporarily from the rocker arm.♦

(e) Insert the shaft of the handle furnished with the switch into the hole on the operating lever of the knife switch to be operated. These switches may be operated from either position to the other without disturbing the plant voltage.

**Note:** ♦The switch off-normal alarm may be operated.♦

(f) When the work is completed, restore the knife switches to their top positions. Connect the insulating links as covered in 3.003(2)(b).

(g) Turn on the emergency cell trickle charger in the associated plant. Then operate the MAN-AUTO key on the battery control board of the associated plant to AUTO.

**3.004 Automatic Operation of the Knife Switch From Float to Charge Position:** (The Switch on the Left Side As Covered by SD-80577-01, SD-81022-01, and SD-81023-01 When CEMF Cells Are Furnished With the Power Plant)

**Caution:** *On power plants without CEMF cells, do not operate the switch if it is wired in the circuit.*

- (1) The center knife switch should be in the normal position. Operate all charging units in the associated plant to charge voltage as covered in the BSP section for the plant. After a short period of time, the switch will operate to the charge position.
- (2) To restore the knife switch to the float position, restore all charging units to float voltage. When the batteries have returned to their proper voltage, the knife switch will operate to the float position.
- (3) Check the water level in the CEMF cells as covered in the BSP section for the plant.

**3.005** 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.

**3.01 Lubrication:** (Reqt 2.01)

**Caution:** *When working on the switch, take care to maintain office voltage. Before doing any work on the switch, remove the motor fuse and control circuit fuse for the switch from the associated plant control panel to prevent unexpected starting while working on the switch. Remount the fuses when the work is completed. Requirements should be checked preferably during a period when they will cause the least unfavorable service reaction.*

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

(1) **General:** For cleaning and lubricating the contact surfaces, prepare several paddles as follows. Wrap several layers of 3-inch cotton bandage around the 1/16- by 1-3/4 by 10-inch fiberboard. Tie the bandage to the fiberboard with cord at each end and at the middle of the bandage.

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(2) Moisten the bandage on one of the paddles prepared, as covered in (1), 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. Then wipe dry using a paddle with a clean, dry bandage.

(3) Using a paddle with a clean, dry bandage, wipe a thin film of petrolatum on the accessible contact surfaces and edges of the contacts and knife blades. Avoid an excess of petrolatum as it will collect dust and dirt.

(4) Operate the knife switches to their bottom positions as covered in 3.003(5)(a) through (e). Clean and lubricate the contacts and knife blades which were inaccessible with these switches in their top positions as covered in (2) and (3). After lubrication, restore the switches to their top positions as covered in 3.003(5)(f) and (g).

(5) Make sure the knife switches covered in 3.003(5)(a) through (e) are restored to their top positions. Then operate the knife switch from the normal position to its emergency position as covered in 3.002(1). Clean and lubricate the contacts and knife blades which were inaccessible with this switch in its top position as covered in (2) and (3).

(6) After lubrication restore the knife switch to its top position as covered in 3.002(2). Then check requirement 2.06.

(7) The knife switch covered in 3.002(2) should be returned to the normal position. Then operate the knife switch from float to charge as covered in 3.004(1). Clean and lubricate the contacts and knife blades which were inaccessible with the switch in its top position as covered in (2) and (3).

(8) After lubrication restore the knife switch to its top position as covered in 3.004(2). Then check requirement 2.06.

**Caution:** *The knife switch should not be operated and restored to its normal position more often than once every 5 minutes.*

#### **Cleaning and Lubricating Copper Contact Surfaces**

(9) Clean all the accessible surfaces and edges of contacts and knife blades as covered in (2). Using a paddle prepared as covered in (1), apply KS-16736 L1 compound liberally to the contact surfaces with a circular scrubbing motion.

(10) Operate the knife switches to their bottom positions as covered in 3.003(5)(a) through (e). Similarly clean and apply the compound to the contact surfaces which were inaccessible with these switches in their top position. Then restore the knife switch to their top positions as covered in 3.003(5)(f) and (g).

(11) Make sure the knife switches as covered in 3.003(5)(a) through (e) are restored to their top positions. Then operate the knife switch from its normal position to its emergency position as covered in 3.002(1). Similarly clean and apply the compound to the contact surfaces which were inaccessible with this switch in its top position. Then restore the knife switch to its top position as covered in 3.002(2).

(12) Make sure the switches covered in 3.002(2) are restored to their normal position. Then operate the switch from the float position to the charge position as covered in 3.004(1). Similarly clean and apply the compound to the contact surfaces which were inaccessible with the switch in its top position. Then restore the knife switch to its float position as covered in 3.004(2).

**Caution:** *The knife switch should not be operated and restored to its normal position more than once every 5 minutes.*

(13) After a one-half hour interval, remove as much of the compound as possible from the accessible contact surfaces using a

paddle with a clean, dry bandage. Then clean and lubricate the accessible contact surfaces as covered in (2) and (3).

(14) Make sure the knife is in its normal position. Operate the knife switches to their bottom positions as covered in 3.003(5)(a) through (e). Remove as much of the compound as possible from the contact surfaces which were inaccessible with these switches in their top positions using a paddle with a clean, dry bandage. Clean and lubricate the contact surfaces as covered in (2) and (3). Then restore the knife switches to their top positions as covered in 3.003(5)(f) and (g).

(15) Make sure that the knife switches covered in 3.003(5)(a) through (e) are in their top positions. Operate the knife switch from its normal position to its emergency position as covered in 3.002(1). Remove as much of the compound as possible from the contact surfaces which were inaccessible with this switch in its top position using a paddle with a clean, dry bandage. Clean and lubricate the contact surfaces as covered in (2) and (3).

(16) After lubrication restore the knife switch to its top position as covered in 3.002(2). Then check requirement 2.06.

(17) Make sure that the knife switches covered in 3.002(2) are returned to their normal position. Operate the knife switch from the float position to its charge position as covered in 3.004(1). Remove as much of the compound as possible from the contact surfaces which were inaccessible with this switch in its float position using a paddle with a clean, dry bandage. Clean and lubricate the contact surfaces as covered in (2) and (3).

(18) After lubrication restore the knife switch to its float position as covered in 3.004(2). Then check requirement 2.06.

**Caution:** *The knife switch should not be operated and restored to its normal position more often than once every 5 minutes.*

(b) **Motor Bearing:** To clean and lubricate the bearing at the brush end of the motor, remove the end shield as covered in 3.10(a)(1) for the Bodine motor, Brown-Brockmeyer motor,

and Dyna motor or 3.10(b)(1) for the Master motor. Then proceed as follows.

- (1) Remove as much grease as possible from the unsealed side of the bearing using the KS-6320 orange stick and a KS-2423 cloth moistened with KS-7860 petroleum spirits. Then wipe the bearing with a clean, dry KS-2423 cloth. Apply the specified grease around the balls, filling the space between the inner and outer race approximately two-thirds full of grease.
  - (2) Clean the bearing housing in the motor end shield with a clean KS-2423 cloth moistened with KS-7860 petroleum spirits. Wipe dry with a clean, dry cloth.
  - (3) For the Master motor, make sure that the slot in the brush holder bracket engages the pin on the motor housing and the brushes rest properly against the commutator. Then remount the end shield and securely tighten the nuts.
  - (4) For the Bodine, Brown-Brockmeyer, or Dyna motor, remount the end shield and securely tighten the screws or nuts. Remount the brushes and brush caps. Take care not to tighten the caps excessively to avoid splitting them.
- (c) **Crankshaft Bearings, Gear Case Pinion Bearing, and Linkage Bearings:** Using the Gem oiler, add the specified quantity of oil to each bearing oil cup. Wipe away oil drippings with a clean, dry KS-2423 cloth.
- (d) **Gear Case, Gear Case Pinion, and Crankshaft Gear:** This lubrication requires removal of the gear case and motor and the associated crankshaft assembly. To lubricate the gear case, gear case pinion, and crankshaft gear, proceed as follows.
- (1) Remove one of the cotter pins through the crankshaft link bearing pin using the P long-nose pliers and remove the bearing pin. Support the crankshaft assembly and remove the crankshaft bearing cap mounting screws and lockwashers using the KS-14220 L1 handle, KS-14220 L5 extension, and KS-14220 L16 socket wrench. Remove the bearing caps and shims, if provided, and lay them out for

remounting in their original positions. Remove the crankshaft assembly, taking care not to damage the cam switch contact springs when disengaging them from the cam switch drums.

- (2) Using the handle, extension, and socket wrench, remove the gear case pinion bearing cap mounting screws and lockwashers and remove the bearing cap and shims, if provided, and lay them out for remounting in their original positions.
  - (3) The motor and gear case mounting screws are accessible from underneath the frame. Using the KS-14220 L1 handle and KS-14220 L20 socket wrench, remove the motor and gear case mounting screws and lockwashers. Do not disturb the adjustment of the motor leveling screws which are adjacent to the rear mounting screws. Using the 1/8-inch pin punch and the hammer from underneath the frame, knock out the taper pins holding the motor in alignment on the frame. Tag and disconnect the motor leads. Then remove the motor and gear case.
- (e) **Gear Case on Bodine Motors Associated With 200- or 400-Ampere Switches:** Remove the gear case cover screws using the 4-inch E screwdriver. Remove excess old grease with the KS-6320 orange stick and transfer to sheet of paper. Wipe off grease and dirt from the gear teeth and worm spindles using a clean KS-2423 cloth moistened with KS-7860 petroleum spirits. Refill gear cavity approximately three-fourths full using fresh 260-300P grease. Replace gear case cover. Wipe excess grease drippings from exterior using clean KS-2423 cloth.
- (f) **Gear Case on Master Motors Associated With 600-, 1200-, and 2000-Ampere Switches:** Remove the filling hole vent plug at the top of the gear case using the R-1542 adjustable wrench. Then remove the drain hole plug at the bottom and drain out the old oil. Clean the threads on the plugs and in the associated holes using a KS-2423 cloth moistened with KS-7860 petroleum spirits. Wipe dry with a clean, dry cloth. Coat the threads on the drain hole plug with KS-6824 sealing compound and remount and securely tighten the plug. Using the KS-14796 oiler, fill the gear case to the level of the refill hole with fresh 130-170 S 210 oil. Wipe away excess oil

with a clean KS-2423 cloth. Coat the threads of the filling hole vent plug with the sealing compound and remount and securely tighten the plug.

(g) ***Gear Case on Dyna Motors and Brown-Brockmeyer Motors:*** Using the R-1542 adjustable wrench, remove the filling hole vent plug at the top of the gear case and the drain hole plug at the bottom. Place several sheets of paper under the gear case to catch the old grease when refilling the gear case. Using the grease gun, pump fresh 260-300P grease into the gear case through the refill hole, thus pumping the old grease out through the drain hole. Continue pumping until some of the fresh grease is pumped out through the drain hole. Using a clean, dry KS-2423 cloth, wipe away grease drippings on the gear case. Then remount and securely tighten the plugs.

(h) ***Gear Case Pinion and Crankshaft Gear***

- (1) Wipe off grease and dirt from the teeth and surfaces of the gears using a clean KS-2423 cloth moistened with KS-7860 petroleum spirits. If necessary remove hardened grease with the KS-6320 orange stick. Wipe dry with a clean, dry cloth. Apply fresh 260-300P grease sparingly to the gear teeth.
- (2) Position the motor and gear case unit on the frame so the dowel pin holes in the unit line up with the associated holes in the frame. Place the dowel pins into the holes and tap them into place using the pin punch and hammer. Then, with the lockwashers on the screws, mount the unit and securely tighten the screws. Connect the motor leads to the proper lead connectors or terminals on the switch.
- (3) Position the crankshaft assembly on the frame so the cam switch contact springs rest against the depression in the cam switch drums and the crankshaft gear meshes with the pinion on the gear case. Place the lockwashers, crankshaft bearing cap, and shims, if provided, on the screws in that order and mount the caps, securely tightening the screws.
- (4) Check whether the crankshaft gear and pinion mesh properly as follows. Using the 3-inch C screwdriver, pry off the cap,

where provided, on the end of the motor shaft. Using the 4-inch E screwdriver, mount the 10-32 screw in the hole in the end of the motor shaft. Hold the free end of the crankshaft link away from adjacent parts to avoid jamming and turn the screw clockwise, thus turning the pinion and crankshaft gear. Continue turning for at least one revolution of the crankshaft gear. Check for gear bind or excessive play between the gears. If the gear mesh is not satisfactory, adjust the leveling screws as covered in (5).

(5) The leveling screws adjacent to the motor and gear case mounting screws at the rear are provided to raise and lower the motor and gear case when required to bring the pinion into proper mesh with the crankshaft gear. If the gears bind, loosen the locknuts on the leveling screws and turn each leveling screw counterclockwise, as required, using the R-1542 adjustable wrench to lower the pinion. Then securely tighten the mounting screws and locknuts. If there is excessive play between the gears, loosen the mounting screws and locknuts on the leveling screws and turn each leveling screw clockwise, as required, to raise the pinion. After obtaining satisfactory gear mesh, securely tighten the mounting screws and locknuts. Remove the screw from the end of the motor shaft and remount the cap.

(6) Place the lockwashers, gear case pinion bearing cap, and shims, if provided, on the screws in that order and mount the cap, securely tightening the screws. Line up the holes in the crankshaft link with the hole in the rocker arm, turning the crankshaft, if necessary, as covered in (4). Remount the crankshaft link bearing pin and secure the cotter pin in the end of the bearing pin using the P long-nose pliers.

**3.02 Condition of Motor Bearings:** (Reqt 2.02)—If the bearing at the brush end of the motor is considered to be in an unsatisfactory condition, replace the bearing as covered in Section 030-787-801. If the bearing at the gear case end of the motor is considered to be in an unsatisfactory condition, replace the motor and gear case unit as covered in Section 030-787-801.

**3.03 Mounting of Knife Switch Contacts:**  
(Reqt 2.03)

**Caution:** *When working on the switch, take care to maintain office voltage. Before doing any work on the switch, remove the motor fuse and control circuit fuse for the switch from the associated plant control panel to prevent unexpected starting while working on the switch. Remount the fuses when the work is completed. Requirements should be checked preferably during a period when they will cause the least unfavorable service reaction.*

- (1) If any of the main contacts, auxiliary contacts, or knife switch hinge 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-2652 adjustable wrench.

**3.04 Condition of Knife Switch Blades and Contact Clips:** (Reqt 2.04)

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

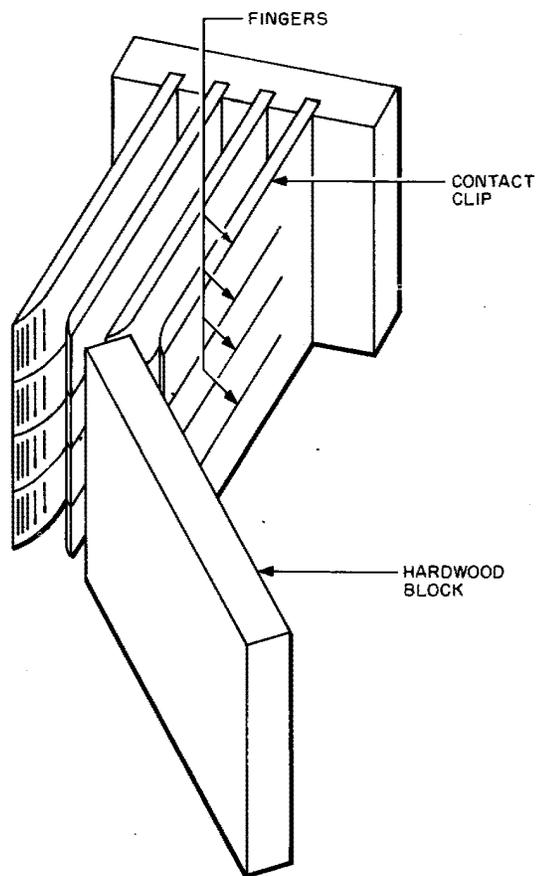
(1) Clean and then lubricate the contact surfaces and edges of clips and blades in accordance with 3.01(a)(2) through (6) for silver-plated contact surfaces or as covered in 3.01(a)(9) through (16) for copper contact surfaces. If the copper contact surfaces are rough or pitted, smooth them before lubrication as covered in (2).

(2) Smooth rough or pitted copper contact surfaces or edges with 4/0 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. After smoothing, remove all loose particles with a clean KS-2423 cloth and a paddle prepared as covered in 3.01(a)(i).

**Caution:** *Silver-plated contact surfaces should not be smoothed with abrasives.*

(b) **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 knife blade, bend the clip or clips slightly as follows. Referring to Fig. 5, 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 hammer, tap the block to bend the clip. Take care to avoid excessive bending of the clip. Recheck the requirement and check requirements 2.05 and 2.06.



**Fig. 5—Hardwood Block Positioned to Bend Contact**

- (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 hammer, tap the block to bend the finger as required. Take care to avoid excessive bending of the finger. Recheck the requirement and check requirements 2.05 and 2.06.

**3.05 Engagement of Knife Switch Blades and Contact Clips:** (Reqt 2.05)

- (a) If (1) of the requirement is not met, check requirements 2.03 and 2.04.
- (b) If a hinge contact clip binds or makes poor contact with the knife blade, proceed as covered in (1) through (5) for copper contact surfaces or (2) through (5) for silver-plated contact surfaces.
  - (1) For copper contact surfaces, apply KS-16736 L1 compound liberally at the junction line of the clip and blade. Manually operate the knife switch several times in accordance with 3.003 to work in the compound. After a one-half hour interval, wipe away as much of the compound as possible with a clean, dry KS-2423 cloth.
  - (2) Using the R-2969 brush, apply a small amount of petroleum spirits at the junction line of the clip and blade. Wipe away excess petroleum spirits with a clean, dry KS-2423 cloth to avoid dripping. Manually operate the knife switch several times in accordance with 3.003 to work in the petroleum spirits. Repeat this procedure several times. Wipe away grease or dirt at the junction line with a clean, dry KS-2423 cloth after each operation of the switch.
  - (3) Using the R-2969 brush, apply petrolatum at the junction line of the clip and blade. Manually operate the knife switch several times in accordance with 3.003 to work in the petrolatum. Wipe away excess petrolatum with a clean, dry KS-2423 cloth.
  - (4) If the hinge clips make poor contact with the blades, tighten the mounting nut and locknut on the hinge bolt using the R-1542 adjustable wrench. Take care to avoid excessively tightening the nuts as this may cause the blades to bind.
  - (5) Recheck the requirement and check requirements 2.06 and 2.17.

**3.06 Voltage Drop:** (Reqt 2.06)—If the requirement is not met, check requirements 2.03 through 2.05 and 2.17. After making the required adjustments, recheck the requirement.

**3.07 Noise and Vibration:** (Reqt 2.07)—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 continue, check requirement 2.02.

**3.08 Voltage and Current of Motor:** (Reqt 2.08)

**3.09 Motor Torque:** (Reqt 2.09)—If either requirement is not met, check requirements 2.02 and 2.10 through 2.12. If the requirements involved cannot be met, replace the motor as covered in Section 030-787-801.

**3.10 Condition of Motor Commutator Surface:** (Reqt 2.10)—To clean the commutator surfaces, proceed as follows.

(a) **Bodine Motor, Brown-Brockmeyer Motor, and Dyna Motor**

(1) Using the 4-inch E screwdriver, remove the brush caps and remove the brushes, marking them for remounting in their original positions. Remove the motor assembly screws or nuts at the front of the motor using the screwdriver or KS-14220 L11 socket wrench with the KS-14220 L1 handle as required. If necessary hold the head or nut on the other end of the screw using the P long-nose pliers when removing each nut. Pry the end shield off the motor using the 3-inch C screwdriver. Where provided, remove the endplay washers and lay them out for remounting in their proper order. Allow the end shield to hang temporarily on the leads.

(2) Clean the commutator in accordance with Section 171-110-701.

(3) Place the endplay washers in their proper order in the bearing housing in the motor end shield. Remount the end shield and securely tighten the screws or nuts. Remount the brushes and brush caps. Take care not to tighten the caps excessively to avoid splitting them.

(b) **Master Motor**

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(1) Using the KS-14220 L12 socket wrench with the KS-14220 L1 handle, remove the motor assembly nuts. If necessary hold the head on the other end of the assembly screw with the P long-nose pliers when removing each nut. Pry the end shield off the motor using the 3-inch C screwdriver. Remove the endplay washers and lay them out for remounting in their proper order.

(2) Remove the brush holder bracket from the rotor as follows. Grasp the brush leads and gently pull the brushes away from the commutator. While holding the brushes in this position, remove the bracket and allow it to hang temporarily from the leads.

(3) Clean the commutator in accordance with Section 171-110-701.

(4) Remount the brush holder bracket, making sure that the slot in the bracket engages the pin in the motor housing and that the brushes rest properly against the commutator. Place the endplay washers in their proper order in the bearing housing in the motor end shield. Then remount the end shield and securely tighten the nuts.

**3.11 Commutation:** (Reqt 2.11)—If the motor is suspected of poor commutation, check requirements 2.10 and 2.12. Then, if the requirement is not met, check requirements 2.08 and 2.09. If the requirements involved cannot be met, replace the motor as covered in Section 030-787-801.

**3.12 Brushes:** (Reqt 2.12)—If a brush binds, remove the brush from its holder, marking the brush for remounting in its original position. Clean the brush and brush holder with a clean KS-2423 cloth. Remove any rough projections with 4/0 abrasive paper. If the brush is excessively worn or chipped, replace the brush as covered in Section 030-787-801.

**3.13 Condition of Cam Switches:** (Reqt 2.13)

(a) **Open-Type Cam Switches**

(1) To clean the cam switch drums and cam switch contact springs, proceed as follows. Using a KS-2423 cloth moistened with KS-7860 petroleum spirits, wipe away dirt or grease

from the accessible surfaces of the cam switch drums. Wipe dry with a clean, dry cloth.

(2) Remove one of the cotter pins through the crankshaft link bearing pin using the P long-nose pliers and remove the bearing pin. Using the 3-inch C screwdriver, pry off the cap, where provided, on the end of the motor shaft. Using the 4-inch E screwdriver, mount the 10-32 screw in the hole in the end of the motor shaft. Hold the free end of the crankshaft link away from adjacent parts to avoid jamming and turn the screw clockwise, thus turning the cam switch drums. Turn the drums as required and clean the surfaces which were previously inaccessible as covered in (1).

(3) Taking care to avoid excessively bending the contact springs, lift the springs away from the cam switch drums and clean the contact surfaces using a KS-2423 cloth moistened with petroleum spirits. If necessary fold a corner of the moistened cloth around the end of the KS-6320 orange stick. Wipe dry with a clean, dry cloth.

(4) After cleaning turn the motor shaft, if necessary, in accordance with (2) and line up the holes in the crankshaft link with the hole in the rocker arm. Remount the crankshaft link bearing pin and secure the cotter pin in the end of the bearing pin using the P long-nose pliers. Remove the screw from the end of the motor shaft and remount the cap.

(b) **Closed-Type Cam Switches:** Switches and activating shaft shall be clean and free of lubricants. The actuating rollers and shaft spring shall operate freely and switches shall be rigidly mounted.

**3.14 Pressure of Cam Switch Contact Springs:** (Reqt 2.14)

(a) **Open-Type Cam Switches:** If the pressure of a cam switch contact spring is insufficient, remove the cam switch terminal block mounting screws using the 4-inch E screwdriver and lift the block to move the contact springs away from the drums. Using the P long-nose pliers, shape the spring so as to increase its pressure against the drum. Then, making sure that the contact springs rest properly against the drum, remount

the block and securely tighten the screws. Check contact pressure and repeat adjustment if necessary.

(b) ***Closed-Type Cam Switches***

(1) To advance or retard the stopping point or to adjust the height of the roller actuators relative to the cam, first remove the motor fuse and control circuit fuses from the battery control board of the associated plant.

(2) The rollers of the switch actuators should rest lightly in the dwell of the cam and exert no force on the switch operating plunger. Check by lifting roller from cam. Check for an endplay of approximately 0.015 inch. Use the KS-6909 gauge. Adjust by loosening two fastening nuts to permit vertical adjustment of switch relative to mounting bracket. Secure nuts after adjusting.

(3) To adjust the stopping point of the drive mechanism, loosen bracket mounting screws and move the assembly slightly away from the panel to advance or toward the panel to retard and secure mounting screws. Remount fuses when work is complete.

**3.15 *Condition of Limit Switches:*** (Reqt 2.15)—If the requirements in Section 032-711-701 cannot be met, replace the limit switch as covered in Section 030-787-801.

**3.16 *Operation of Limit Switches:*** (Reqt 2.16)—If either part of the requirement is not met, check requirement 2.15. If requirement 2.15 is met and the requirement is still not met, replace the limit switch operating spring as covered in Section 030-787-801.

**3.17 *Temperature:*** (Reqt 2.17)

(a) If the temperature of the motor frame exceeds the specified limits, check requirement 2.18. If requirement 2.18 is not met, replace the field windings as covered in Section 030-787-801.

(b) If the temperature of the knife switch parts exceeds the specified limit, clean and lubricate the contacts in accordance with 3.01(a) and check requirements 2.03 through 2.06. Then recheck the requirement.

**3.18 *Resistance of Motor Field Windings (Brown-Brockmeyer Motor, Dyna Motor, and Master Motor):*** (Reqt 2.18)—If the requirement is not met, replace the field windings as covered in Section 030-787-801.