

## MOTOR-DRIVEN SWITCHES

### KS-15847 TYPE

### REQUIREMENTS AND ADJUSTING PROCEDURES

#### 1. GENERAL

1.01 This section covers the KS-15847 L1 through L6 and L11 through L13 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 delete caution 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 The KS-15847 L1, L4, and L11 switches operate on 24 Vdc, the L2, L5, and L12 on 48 Vdc, and the L3, L6, and L13 on 130 Vdc. The KS-15847 L1 through L3 are 3-position (NOR, A, and B) switches. The KS-15847 L4 through L6 and L11 through L13 are 4-position (NOR, A1, A2, and B) switches. The designation of each position is marked on the cam dial of the switch.

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

1.06 *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.

1.07 *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.

1.08 *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.

**Caution:** *When working on the switch panel, take care to maintain office voltage. Before doing any work on the switch panel, 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.*

#### 2. REQUIREMENTS

##### 2.001 Operation

(a) Prior to switch operation, the accessible cam contacts (A) and the stationary contacts (B) should be checked for contamination or lubrication. Control relays, control cams, and auxiliary switches should be checked visually for possible defects; and corrective action should be taken before operating switch as covered in (b).

(b) The switches should be operated to the A position for 3-position switches and A2 position for 4-position switches at quarterly intervals maximum, and it is recommended that the

switches be operated to the B position at least once annually.

- (c) Manual (cranking) operation of the switch should be checked annually.

## 2.01 Lubrication

**Caution:** When working on the switch panel, take care to maintain office voltage. Before doing any work on the switch panel, 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) **Cam Contacts (A) and Stationary Contacts (B):** Fig. 1 and 2—The surfaces of the cam and stationary contacts accessible in the NOR and A positions of the switch shall be cleaned with the KS-7860 solvent to remove accumulated dirt and dried lubricant and relubricated with a light film of center point oil every 3 months unless operating experience or examination as covered in 2.001 indicates interval should be extended.
- (b) **Speed Reducer:** The speed reducer shall be cleaned and repacked with fresh 260-300P grease every 3 years.
- (c) **Exposed Gears:** The exposed gears shall be lubricated annually with a small amount of 260-300P grease.
- (d) **Upper and Lower Camshaft Bearings:** The camshaft bearings shall be lubricated semiannually with three drops of KS-16326 L1 oil.
- (e) **Motor Bearings:** The bearings in the motor are a double-shielded-type ball bearing and do not require lubrication.

**2.02 Motor and Camshaft Bearings:** The bearings shall be free from excessive wear. If the motor and camshaft operate satisfactorily under all conditions of normal operation (1.08) and

requirement 2.06 is met, the bearings shall be considered to be in satisfactory condition.

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

**2.03 Condition of Cam Contacts (A) and Stationary Contacts (B):** The silver-faced contact surfaces of the cam and stationary contacts shall be clean and free from scores and pits.

Gauge by eye.

**2.04 Contact Follow:** Contact follow of each stationary contact shall be

Min 0.025 inch  
Max 0.040 inch

Gauge by eye.

To check, operate the switch to the A position for 3-position switches or the A2 position for 4-position switches and restore it to the NOR position as covered in 3.004. Observe the movements of the stationary contact as it makes or breaks with its associated cam contact.

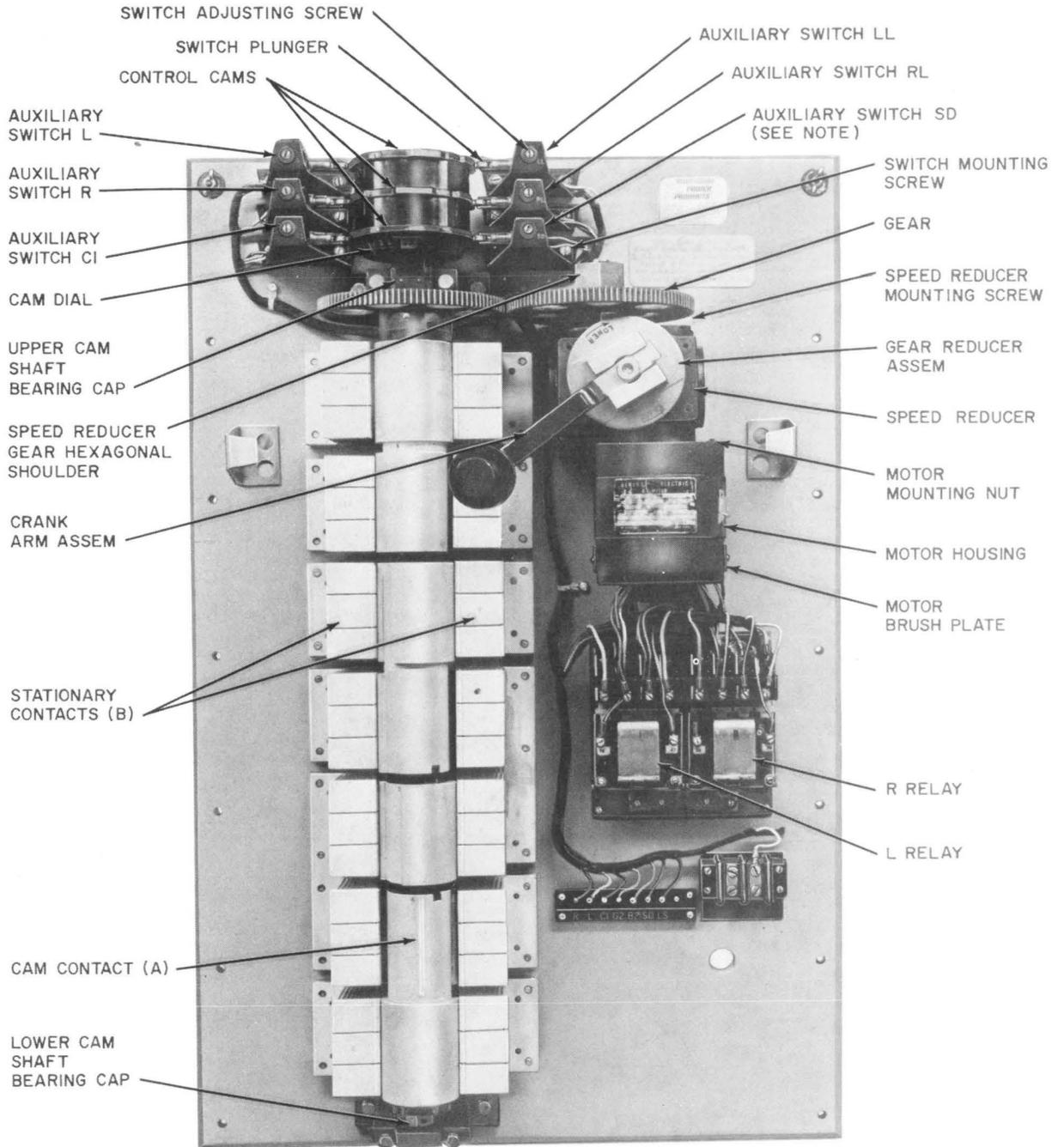
**Caution:** The switch should not be operated and returned to the NOR position more often than twice every 5 minutes with at least a 35-second interval between each operation.

**2.05 Voltage Drop:** The voltage drop between each stationary contact and its associated cam contact shall not exceed 5 millivolts for full loads and prorated fractions thereof for smaller loads. The voltage drop shall be checked quarterly unless periodic inspections have indicated that conditions are such that the interval may be extended.

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

**Caution 1:** Do not apply the meter across open contacts as this could cause damage to the meter.

To check this requirement, connect the meter across each stationary contact and its associated cam contact which are closed in the NOR position by applying one test pick of the meter to the stationary



NOTE:  
 AUXILIARY SWITCH SD IS NOT PROVIDED ON KS-15847, L1, L2,  
 AND L3 MOTOR-DRIVEN SWITCHES.

**Fig. 1—KS-15847-Type Switch With Crank for Manual Emergency Operation (Front View)**

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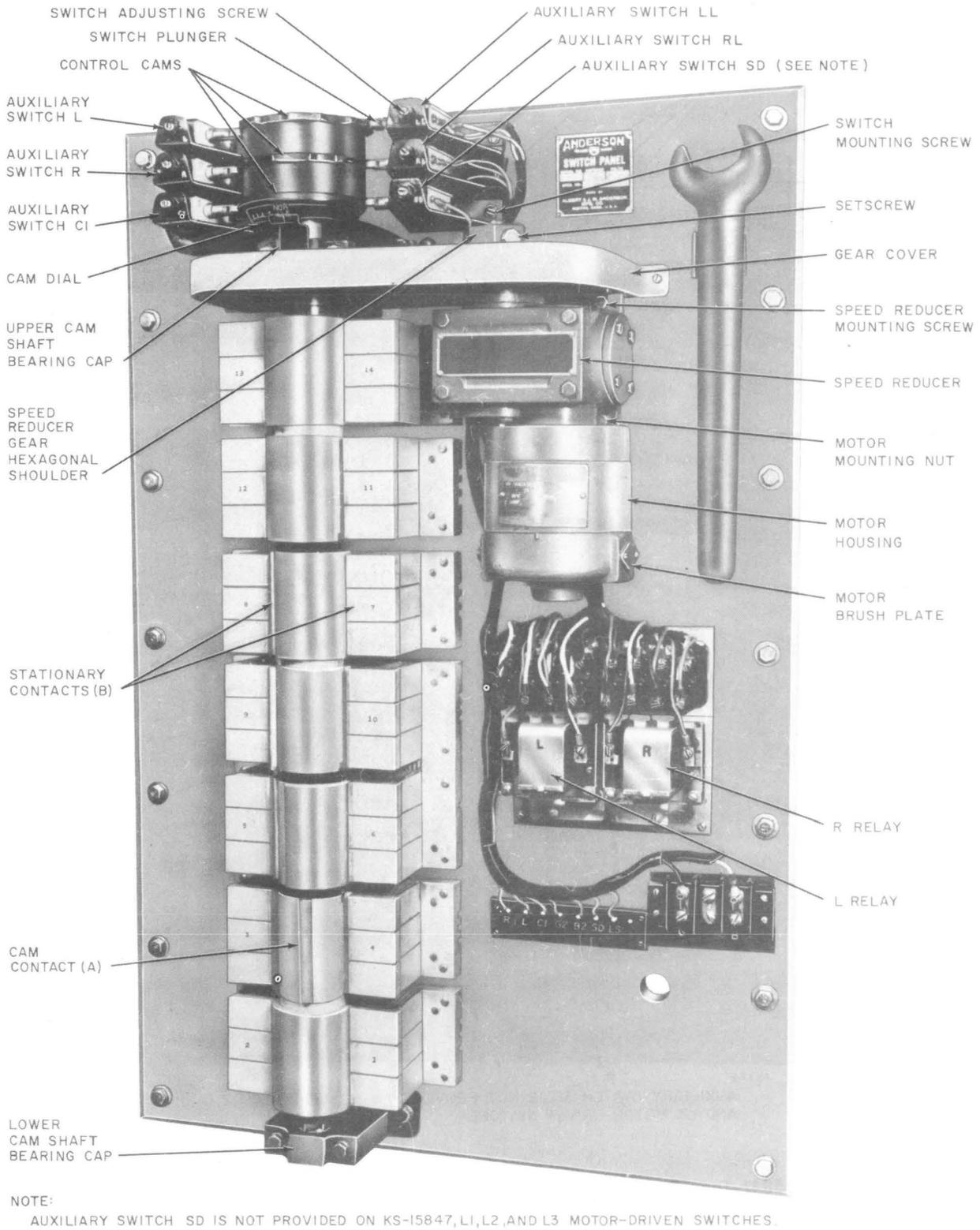


Fig. 2—KS-15847-Type Switch (Manufacture Discontinued) With Wrench for Manual Emergency Operation (Front View)

contact and the other test pick to the associated cam contact. Locate the test picks adjacent to the contact silver facings. Then operate the switch to the A position for 3-position switches or the A2 position for 4-position switches as covered in 3.004(1) and repeat the check across the closed contacts in this position. Restore the switch to the NOR position as covered in 3.004(2) when the work is completed.

**Caution 2:** *The switch should not be operated and returned to the NOR position more often than twice every 5 minutes with at least a 35-second interval between each operation.*

**2.06 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 ear and feel.

**2.07 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.

It is not necessary to measure the voltage and current of the motor unless the temperature of the motor housing exceeds a 50°C temperature rise (temperature rise = measured temperature minus ambient temperature). Use the R-1032, detail 1 thermometer to measure temperature rise.

Use the KS-8039 dc voltmilliammeter and a dc ammeter capable of reading 500 percent of the nameplate rated full load motor current to measure the voltage and current of the motor.

**2.08 Motor Torque:** The motor shall develop sufficient torque to start and move the switch from one position to another within 5 seconds for 3-position switches and 4 seconds for 4-position switches.

Gauge by eye.

**2.09 Motor Commutator Surface:** The motor commutator surface shall be clean and free from scores, pits, or other deformations of the surface.

Gauge by eye and feel.

**2.10 Commutation:** The motor shall commute successfully under all conditions of normal operation. (See 1.07 and 1.08.)

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

Gauge by eye and feel.

**2.12 Ward-Leonard Relay:** The Ward-Leonard relay shall meet applicable requirements in the section covering contactors, emergency cell switches, relays, and starters.

### 2.13 Auxiliary Switches

(a) **Switch Mounting:** The auxiliary switches shall be securely fastened to the switch panel.

Gauge by feel.

(b) **Contact Closure Range:** The contacts of the auxiliary switches shall be closed during the cam dial ranges specified in Table A for the 3-position motor-driven switch and Table B for the 4-position motor-driven switch.

Use the 81A 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, remove the switch control (VR and ECM) fuses on the plant control panel to remove voltage from the auxiliary switches. Connect the test set across the terminals of the auxiliary switch to be checked. Manually operate the motor-driven switch as covered in 3.005(b) and (d) between NOR and maximum 10.3 on the cam dial for 3-position motor-driven switches or between NOR and maximum 12.4 for 4-position motor-driven switches. Record the cam dial readings at which the auxiliary switch contacts open and close.

**Caution 1:** *It is not practicable to operate the 3-position motor-driven switch beyond 10.3 on the cam dial or the 4-position motor-driven switch beyond 12.4 since this would cause an excessive increase in plant*

voltage. For this reason the requirement need not be checked beyond this point.

**Caution 2:** Do not stop turning the 3-position motor-driven switch between cam dial readings 1.4 and 6.7 or the 4-position motor-driven switch between 2.1 and 3.6 or 6.2 and 10.2. Stopping the switch between these points might cause damage to the current limiting resistors on the rear of the switch.

TABLE A

(Operation of Auxiliary Switches on 3-Position Motor-Driven Switch)

AUXILIARY SWITCH	CONTACT CLOSURE RANGE† CAM DIAL READING
L	0.9 – 7.0 8.5 – 15.1††
LL	6.8 – 8.7 14.9 – POS B STOP††
R	1.2 – 7.9 9.4 – 15.4††
RL	NOR STOP – 1.4 7.7 – 9.6
C1	1.4 – POS B STOP††

† Allowable tolerance on all values +0.1 except at NOR STOP and POS B STOP where tolerance does not apply.

†† See *Cautions* under requirement 2.13(b).

(c) **Contact Sequence:** The contacts of the L and R auxiliary switches shall close with a minimum tolerance of 0.2 divisions on the cam dial before the contacts of auxiliary switches LL and RL, respectively, open.

To check, refer to the record of contact open and closure made in (b).

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

**MAX:**

95°C (203°F) Motor frame

TABLE B

(Operation of Auxiliary Switches on 4-Position Motor-Driven Switch)

AUXILIARY SWITCH	CONTACT CLOSURE RANGE† CAM DIAL READING
L	0.9 – 3.6 5.1 – 9.1 11.1 – 15.2††
LL	3.4 – 5.3 8.9 – 11.3 15.0 – POS B STOP††
R	1.2 – 4.5 6.0 – 10.5 12.4 – 15.4††
RL	NOR STOP – 1.4 4.3 – 6.2 10.3 – 12.6††
C1	5.3 – POS B STOP††
SD	NOR STOP – 1.4

† Allowable tolerance on all values +0.1 except at NOR STOP and POS B STOP where tolerance does not apply.

†† See *Cautions* under requirement 2.13(b).

70°C (158°F) Main contacts and terminals studs

Use the R-1032, detail 1 thermometer.

To check, place the bulb of the thermometer on the part, covering the exposed portion of the bulb with a piece of felt, and observe the highest temperature reading.

**3. ADJUSTING PROCEDURES**

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

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
141	Cord tip (two required)
245	3/8- and 7/16-inch hex. open double-end wrench

CODE OR SPEC NO.	DESCRIPTION	CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>		<b>MATERIALS</b>	
486A	Oilcan	—	2-1/2 by 6-inch hardwood wedge with 1-1/2 inch base
—	1-pound ball peen hammer	—	2-1/2 by 1- by 6-inch hardwood block
KS-6278	Connecting clip (two required)		
KS-6320	Orange stick	<b>TEST APPARATUS</b>	
KS-14164	Brush	1W13B	Test cord (two required)
R-1324	Screwdriver	81A	Test set
R-1542	Adjustable wrench	KS-8039	Voltmilliammeter
R-2966	Brush	R-1032, Det 1	Thermometer
R-3094, Det 2	Handle	—	DC ammeter (See 2.07.)
R-3094, Det 5	Extension	—	Test cord, Weston Electrical Instrument Company, No. D-79650 (two required)
R-3094, Det 8	Universal joint		
R-3094, Det 17	7/16-inch socket wrench	<b>3.002</b>	When working on the switch, do not simultaneously touch current carrying parts and ground with the hands or tools.
—	1/4-inch Allen wrench (furnished with switch)	<b>3.003</b>	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.
—	3-inch C screwdriver	<b>3.004</b>	<b>Automatic Operation of Switch</b>
—	4-inch E screwdriver	(1)	Turn off all charging units in the associated plant as covered in the BSP section for the plant. After the switch has operated to the A position on 3-position switches or to A2 position on 4-position switches, operate the MAN-AUTO key on the plant control panel to MAN to prevent further automatic operation.
<b>MATERIALS</b>		(2)	To restore the switch to the NOR position, operate the MAN-AUTO key on the plant control panel to AUTO and restore the charging units to service. When the batteries are charged to their proper voltage, the switch will return to the NOR position.
KS-7860	Petroleum spirits		
KS-14666	Cloth		
KS-16326 L1	Oil		
—	Abrasive paper, Garnet, 4/0		
KS-7471	(260-300P) Grease		
—	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)◆		

**Caution:** *The switch should not be operated and returned to the NOR position more often than twice every 5 minutes with at least a 35-second interval between each operation.*

**3.005 Manual Operation of Switch**

**Caution:** *Before doing any work on the switch panel, 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) Operating 4-Position Switch to A1**

- (1) Operate the MAN-AUTO key on the associated plant control panel to MAN.
- (2) If wrench is provided for manual operation, remove the setscrew in the hexagonal shoulder on the speed reducer gear using the Allen wrench furnished with the switch for a socket head screw or the R-1542 adjustable wrench for a hexagonal head screw. Removal of the setscrew will uncouple the gear from the speed reducer. Apply the insulated wrench furnished with the switch to the hexagonal shoulder on the gear and turn the shoulder rapidly clockwise until the switch is in A1 position.
- (3) If crank is provided for manual operation, attach crank to gear reducer assembly and turn crank counterclockwise until the switch is in the A1 position.

**Caution:** *Do not stop turning the switch between 2.1 and 3.6 on the cam dial. Stopping the switch between these points might cause damage to the current limiting resistors on the rear of the switch.*

**(b) Operating 3-Position Switch to A and 4-Position Switch to A2**

- (1) Operate the MAN-AUTO key on the associated plant control panel to MAN. Turn off all charging units in the plant as

covered in the BSP section for the plant. When the RC relay in the emergency cell switch control circuit of the plant operates, manually operate the switch as covered in (2) and (3).

- (2) If wrench is used for manual operation, remove the setscrew in the hexagonal shoulder on the speed reducer gear using the Allen wrench furnished with the switch for a socket head screw or the R-1542 adjustable wrench for a hexagonal head screw. Removal of the setscrew will uncouple the gear from the speed reducer. Apply the insulated wrench furnished with the switch to the hexagonal shoulder on the gear. On 3-position switches, turn the shoulder rapidly clockwise until the switch is in the A position. On 4-position switches, turn the gear rapidly clockwise until the switch is in the A2 position.

- (3) If crank is provided for manual operation, attach crank to gear reducer assembly and turn crank counterclockwise until switch is in the A position (for 3-position switches) or A2 position (for 4-position switches).

**Caution:** *While checking requirements or making adjustments, the switch may be operated slightly beyond positions noted above. However, during clockwise rotation, do not rotate the 3-position switch beyond 10.3 on the cam dial or the 4-position switch beyond 12.4 since this would place the switch in the B position, resulting in an excessive increase in plant voltage. Do not stop turning the 3-position switch between 1.4 and 6.7 or the 4-position switch between 2.1 and 3.6 or 6.2 and 10.2. Stopping the switch between these points might cause damage to the current limiting resistors at the rear of the switch.*

**(c) Restoring 4-Position Switch From A1 to NOR**

- (1) If wrench is provided for manual operation, apply the wrench furnished with the switch to the hexagonal shoulder on the speed reducer gear and turn the shoulder rapidly counterclockwise until the switch is in the NOR position and the setscrew hole in the hexagonal shoulder is in line with the hole in the shaft of the speed reducer. When the work is completed, remount and securely tighten the setscrew.

(2) If crank is provided for manual operation, attach crank to gear reducer assembly and turn crank clockwise until the switch is in the NOR position.

(3) Operate MAN-AUTO key on the plant control panel to AUTO.

**Caution 1:** *Do not stop turning the switch between 2.1 and 3.6 on the cam dial. Stopping the switch between these points might cause damage to the current limiting resistors on the rear of the switch.*

**Caution 2:** *The switch should not be operated and returned to NOR more often than twice every 5 minutes with at least a 35-second interval between each operation.*

(d) **Restoring 3-Position Switch From A to NOR and 4-Position Switch From A2 to NOR:** Restore the charging units in the associated plant to service as covered in the BSP section for the plant. When the LC relay in the emergency cell switch control circuit of the plant operates, proceed as covered in (c)(1), (2), and (3).

**Caution 1:** *Do not stop turning the 3-position switch between 1.4 and 6.7 on the cam dial or the 4-position switch between 2.1 and 3.6 or 6.2 and 10.2. Stopping the switch between these points might cause damage to the current limiting resistors on the rear of the switch.*

**Caution 2:** *The switch should not be operated and returned to the NOR position more often than twice every 5 minutes with at least a 35-second interval between each operation.*

**3.006** 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 panel, take care to maintain office voltage. Before doing any work on the switch panel, 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) **Cam Contacts (A) and Stationary Contacts (B):** With the switch in the NOR position, wipe the accessible cam and stationary contact surfaces with a clean KS-14666 cloth moistened with KS-7860 petroleum spirits to remove any accumulated dirt and old lubricant. Then wipe the surfaces clean using a clean KS-14666 cloth. Operate the switch to the A position on 3-position switches or the A2 position on 4-position switches as covered in 3.004(1) and similarly clean the contact surfaces which were not accessible with the switch in the NOR position. Using a KS-14666 cloth moistened with center point oil, apply a thin film of the oil to the accessible cam contact surfaces. Using the KS-14164 brush, apply a thin film of the oil to the accessible stationary contact surfaces. Then return the switch to the NOR position as covered in 3.004(2) and similarly lubricate the contact surfaces which were not accessible in the A position.

**Caution:** *The switch should not be operated and returned to the NOR position more often than twice every 5 minutes with at least a 35-second interval between each operation.*

(b) **Speed Reducer:** Remove the gear box cover using the 245 wrench. Then using the KS-6320 orange stick and a clean KS-14666 cloth, remove as much of the old grease as possible. Add fresh 260-300P grease and remount the gear box cover.

(c) **Exposed Gears**

(1) If a gear cover is provided, remove the cover mounting screws using the 4-inch E screwdriver and remove the cover.

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(2) With the switch in the NOR position, wipe off as much of the old grease as possible from the teeth and accessible surfaces of the gears using a clean KS-14666 cloth moistened with KS-7860 petroleum spirits. If necessary remove hardened grease with a KS-6320 orange stick. Wipe dry with a clean KS-14666 cloth.

(3) Operate the switch to the A position on 3-position switches or the A2 position on 4-position switches as covered in 3.004(1) and clean the gear teeth and surfaces which were inaccessible with the switch in the NOR position. Apply fresh 260-300P grease sparingly with the R-2966 brush to the accessible gear teeth.

(4) Restore the switch to the NOR position as covered in 3.004(2) and similarly apply the fresh grease to the accessible gear teeth.

(5) If a gear cover is provided, remount it and securely tighten the screws.

**Caution:** *The switch should not be operated and returned to the NOR position more often than twice every 5 minutes with at least a 35-second interval between each operation.*

### (d) **Upper and Lower Camshaft Bearings:**

Remove the bearing cap using the 245 wrench. Using the 486A oilcan, apply three drops of KS-16326 L1 oil to the top of the bearing. Remount the bearing cap.

### 3.02 **Motor and Camshaft Bearings:** (Reqt 2.02)

(a) **Motor Bearings:** If the bearings are in unsatisfactory condition, replace them as covered in Section 030-786-801.

(b) **Camshaft Bearings:** If the bearings are in unsatisfactory condition, the matter should be referred to the supervisor to consider replacing the bearings.

### 3.03 **Condition of Cam Contacts (A) and Stationary Contacts (B):** (Reqt 2.03)

**Caution 1:** *When working on the switch panel, take care to maintain office voltage. Before doing any work on the switch*

*panel, 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) With the switch in the NOR position, wipe the accessible silver-faced contact surfaces with a clean KS-14666 cloth moistened with KS-7860 petroleum spirits, applying pressure in order to remove accumulated dirt and lubricant. If the contact surfaces are rough or pitted, smooth them with 4/0 abrasive paper. Take care to remove a minimum of silver facing. After smoothing, remove all loose particles with a clean, dry cloth and lubricate the contacts as covered in 3.01(a). Operate the switch to the A position on 3-position switches or the A2 position on 4-position switches as covered in 3.004(1) and similarly clean the cam and stationary contacts which were not accessible in the NOR position. Restore the switch to the NOR position as covered in 3.004(2) when the work is completed.

**Caution 2:** *The switch should not be operated and returned to the NOR position more often than twice every 5 minutes with at least a 35-second interval between each operation.*

### 3.04 **Contact Follow:** (Reqt 2.04)

(1) Adjust the contact follow of stationary contacts 3, 4, 9, 10, and 11 with the switch in the NOR position as covered in (2) through (4). To adjust contact follow of stationary contacts 2, 12, and 13, operate the switch to the A position on 3-position switches or the A2 position on 4-position switches as covered in 3.004(1) and proceed as covered in (2) through (4). To adjust the contact follow of stationary contacts 5 and 6 on the 4-position switches, manually operate the switch to 12.4 on the cam dial as covered in 3.005(b) and proceed as covered in (2) through (4).

**Caution 1:** *It is not practicable to operate the 3-position switch beyond 10.3 on the cam dial or the 4-position switch beyond 12.4, since this would cause an excessive increase in plant voltage.*

**Caution 2: The switch should not be operated and returned to the NOR position more often than twice every 5 minutes with at least a 35-second interval between each operation.**

(2) To increase follow of the stationary contact, position one end of the 2-1/2 by 1- by 6-inch hardwood block against the surface of the stationary contact directly in back of the silver-faced contact surface. Then using the AT-7329 hammer, carefully tap the other end of the block to bend the stationary contact toward the cam. Take care not to bend the contact excessively.

(3) To decrease follow of the stationary contact, insert the 6-inch hardwood wedge between the stationary contact and cam with the tapered side of the wedge against the cam. Using the AT-7329 hammer, carefully tap the base of the wedge to bend the stationary contact away from the cam. Take care not to bend the contact excessively.

(4) After adjustment of a stationary contact, recheck the requirement; check that the contacts are closed during the cam dial ranges specified in Table C for 3-position switches or Table D for 4-position switches, and check that requirement 2.05 is met.

**TABLE C**  
(Operation of Main Contacts on  
3-Position Switch)

STATIONARY CONTACT	CONTACT CLOSURE RANGE CAM DIAL READING (TOL $\pm 0.3$ ) $\checkmark$
1	NOR STOP — POS B STOP $\checkmark\checkmark$
2	NOR STOP — 3.3
3	4.6 — POS B STOP
4	1.8 — 5.6
5	NOR STOP — 10.1 $\checkmark\checkmark$
6	NOR STOP — 10.1 $\checkmark\checkmark$
7	NOR STOP — 12.2 $\checkmark\checkmark$
8	NOR STOP — POS B STOP $\checkmark\checkmark$
9	10.7 — 14.5 $\checkmark\checkmark$
10	13.7 — POS B STOP $\checkmark\checkmark$
11	4.2 — POS B STOP
12	NOR STOP — 6.3
13	NOR STOP — 3.6
14	NOR STOP — POS B STOP $\checkmark\checkmark$

$\checkmark$  Where indicated that contacts must remain closed to mechanical stops, tolerance does not apply.

$\checkmark\checkmark$  See *Caution 1* under 3.04(1).

**TABLE D**  
(Operation of Main Contacts on  
4-Position Switch)

STATIONARY CONTACT	CONTACT CLOSURE RANGE CAM DIAL READING (TOL $\pm 0.3$ ) $\checkmark$
1	NOR STOP — POS B STOP $\checkmark\checkmark$
2	NOR STOP — 7.3
3	8.3 — POS B STOP
4	6.6 — 9.8
5	NOR STOP — 12.0
6	NOR STOP — 12.0
7	NOR STOP — 13.5 $\checkmark\checkmark$
8	NOR STOP — POS B STOP $\checkmark\checkmark$
9	12.8 — 16.0 $\checkmark\checkmark$
10	14.2 — POS B STOP $\checkmark\checkmark$
11	2.5 — POS B STOP
12	NOR STOP — 3.2
13	NOR STOP — 1.8
14	NOR STOP — POS B STOP $\checkmark\checkmark$

$\checkmark$  Where indicated that contacts must remain closed to mechanical stops, tolerance does not apply.

$\checkmark\checkmark$  See *Caution 1* under 3.04(1).

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**3.05 Voltage Drop:** (Reqt 2.05)—If the requirement is not met, check requirements 2.03 and 2.14. Then recheck the requirement. If the requirement is still not met, check requirement 2.04.

**3.06 Noise and Vibration:** (Reqt 2.06)—Tighten all bolts, nuts, and screws securely. Examine the motor brushes for evidence of chattering. If the noise and vibration continues, check the bearings as covered in requirement 2.02.

**3.07 Voltage and Current of Motor:** (Reqt 2.07)

**3.08 Motor Torque:** (Reqt 2.08)—If either requirement is not met, check requirements 2.02 and 2.09 through 2.11. If the requirements involved cannot be met, replace the motor as covered in Section 030-786-801.

**3.09 Motor Commutator Surface:** (Reqt 2.09)

(1) In order to clean the commutator, first remove the motor and speed reducer as covered in (a) through (f). Then clean the commutator as covered in (g) and remount the motor and speed reducer as covered in (h) through (k).

(a) Remove the ECM and VR fuses from the associated plant control panel to remove voltage from the motor and motor control circuit.

(b) Tag and disconnect the motor leads from the relay and the terminal block using the 4-inch E screwdriver.

(c) If a gear cover is provided, remove the cover mounting screws using the 4-inch E screwdriver and remove the cover. Using a pencil or crayon, mark the gears to insure meshing of the same teeth when remounting the motor and speed reducer.

(d) Using the R-3094, detail 17 socket wrench with the R-3094, detail 8 universal joint, R-3094, detail 5 extension, and R-3094, detail 2 handle, remove the 4-speed reducer mounting screws and lockwashers, supporting the speed reducer before removing the last screw. Remove the speed reducer and motor from the switch panel and place them on a workbench.

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

(f) Using the 245 open-end wrench, remove the two motor housing mounting nuts on the motor end plate which is part of the speed reducer. Hold the speed reducer with one hand, and with the other hand, grasp the motor housing and pull it straight out from the speed reducer. If the rotor pulls out from the speed reducer with the housing, take care not to lose the Woodruff key in the rotor shaft, the finger spring washer, and flat washer associated with the motor bearing. The washers may come out with the shaft or remain in the bearing housing in the end plate on the speed reducer. Carefully remove the rotor from the open end of the motor housing. If the rotor remains in the speed reducer, it will probably not be necessary to remove it to clean the commutator. In this case, place a suitable block of wood under the bearing to support the free end of the rotor while working on the commutator.

(g) Clean the commutator surface as covered in Section 171-110-701.

(h) If the rotor was removed from the speed reducer, remount it as follows. Place the flat washer against the shoulder at the inner end of the bearing housing in the motor end plate on the speed reducer. With the fingers of the finger spring washer toward the open end of the housing, position the spring washer against the flat washer. Look through the hole in the motor end plate on the speed reducer and note the position of the slot in the gear just inside the speed reducer. Position the key end of the rotor shaft so the key lines up with the gear slot. Carefully insert the shaft into the gear with the key engaging the slot, taking care not to dislodge the washers in the bearing housing.

(i) Hold the rotor firmly in the speed reducer and position the speed reducer on the switch panel with the gears in mesh. Refer to the markings previously made on the gears

and, if necessary, rotate the rotor to obtain the original condition of gear mesh. Then taking care not to rotate the rotor, place the speed reducer and rotor on the workbench. Again taking care not to rotate the rotor, position the motor housing so that the mounting studs line up with their associated holes in the motor end plate on the speed reducer and so that the motor nameplate will be at the front when the speed reducer and motor are mounted on the switch panel. Carefully mount the housing on the end plate and securely tighten the nuts.

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

(k) Mount the speed reducer with the motor on the switch panel and make sure the gears mesh freely and the marks on both gears are in line. Then securely tighten the mounting screws. If a gear cover is provided, remount the cover and securely tighten the screws. Connect the motor leads to their respective terminals on the relay and terminal blocks.

**3.10 Commutation:** (Reqt 2.10)—If the motor is suspected of poor commutation, check requirement 2.11. Then if the requirement is not met, check requirements 2.07 through 2.09. If the requirements involved cannot be met, replace the motor as covered in Section 030-786-801.

**3.11 Brushes:** (Reqt 2.11)—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. Any rough projections should be removed with 4/0 abrasive paper. If a brush is excessively worn or chipped, replace the brush as covered in Section 030-786-801.

**3.12 Ward-Leonard Relay:** (Reqt 2.12)—If the requirement cannot be met, replace the relay as covered in Section 030-786-801.

**3.13 Auxiliary Switches:** (Reqt 2.13)

(a) **Mounting:** Using the R-1324 screwdriver, securely tighten the auxiliary switch mounting screws.

(b) **Contact Closure Range:** To adjust an auxiliary switch for contact open and closure, proceed as follows.

- (1) Remove the ECM and VR fuses from the associated plant control panel to remove voltage from the auxiliary switches.
- (2) Manually operate the switch as covered in 3.005 to the point on the cam dial at which the auxiliary switch to be adjusted should just begin its contact closure range.

**Caution 1:** *During manual operation of the 3-position motor-driven switch, do not stop turning the switch between cam dial readings 1.4 and 6.7. Do not turn the switch beyond 10.3, since this would cause an excessive increase in plant voltage. However, between cam dial readings NOR to 1.4 (range of NOR position) and 6.7 to 10.3 (range of A position), the switch may be turned in either direction and stopped without any restrictions.*

**Caution 2:** *During manual operation of the 4-position motor-driven switch, do not stop turning the switch between cam dial readings 2.1 and 3.6 or 6.2 and 10.2. Do not turn the switch beyond 12.4 since this would cause an excessive increase in plant voltage. However, between cam dial readings NOR to 2.1 (range of NOR position), 3.6 to 6.2 (range of A1 position), and 10.2 to 12.4 (range of A2 position), the switch may be turned in either direction without any restrictions.*

**Caution 3:** *The switch should not be operated and returned to the NOR position more often than twice every 5 minutes with at least a 35-second interval between each operation.*

(3) Using the two 1W13B cords, each equipped with the 141 cord tip on one end and the KS-6278 connecting clip on the other end, connect the 81A test set across the terminals of the auxiliary switch to be adjusted.

(4) Operate the test set switch to C. If the test set indicates that the switch contacts are closed, turn the auxiliary switch adjusting screw counterclockwise with the 4-inch E

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screwdriver until the contacts are open. Then turn the screw so the contacts just close. Recheck the requirement. If the requirement cannot be met, replace the auxiliary switch as covered in Section 030-786-801.

**3.14 Temperature:** (Reqt 2.14)

(a) If the temperature of the motor frame exceeds the specified limits, check requirements 2.02 and 2.07 through 2.11. Then recheck the

requirement. If the requirements involved cannot be met, replace the motor as covered in Section 030-786-801.

(b) If the temperature of the switch parts exceeds the specified limits, clean and lubricate the switch as covered in 3.01(a) and check requirements 2.03 and 2.05. Then recheck the requirement. If the requirement is still not met, check requirement 2.04.