AnsaldoSTS
Union Switch & Signal
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# M-3 Electric Switch Machine
# Standard Low Profile Model

| US&S Part No. |
| --- |
| Left Hand: N4511601401 |
| Right Hand: N4511601501 |

- ♦ Installation
- ♦ Description and Operation
- ♦ Maintenance

# Proprietary Notice



# Important Notice

US&S constantly strives to improve our products and keep our customers apprised of changes in technology. Following the recommendations contained in the attached service manual will provide our customers with optimum operational reliability. The data contained herein purports solely to describe the product, and does not create any warranties.

Within the scope of the attached manual, it is impossible to take into account every eventuality that may arise with technical equipment in service. Please consult your local US&S Account Executive in the event of any irregularities with our product.

We expressly disclaim liability resulting from any improper handling or use of our equipment, even if these instructions contain no specific indication in this respect. We strongly recommend that only approved US&S spare parts be used as replacements.

# Revision History

| Rev. | Date | Nature of Revision |
|---|---|---|
| Original | October 1990 | Initial Issue |
| 1.0 | May 2008 | Revised per ECO 139712-32: Updated various parts lists and illustratrions.<br><br>Revised per ECO CRS01220: Changed 1/8" clearance to 1/16" in step 8 of Section 5.7.2 and changed contact insulation (Item J) to angle bracket (Item H); also added a Note after step 8 on using a padlock. Added "Normal Release Lever (When Used)" to Item G in Figure 5-4.<br><br>Modified most illustrations in Sectiosn 1 through 6 to increase clarity. Updated Section 7, Parts Lists (figures and tables).<br><br>Revised to incorporate additional engineering review comments from Ed Edwards and Kevin McQuisten. |

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# 1. General Information

## 1.1 Introduction

This service manual covers the Standard Low Clearance M-3 Electric Switch Machine (M-3). The machine is similar to the Standard M-3 Electric Switch Machine (refer to SM 6263), but is 5/8" lower vertically. This switch machine is designed for applications where the maximum clearance is lower between the vehicle and the machine. For example, on third-rail transit properties, the Standard Low Clearance M-3 provides optimum clearance with the vehicle's pick-up shoe.

The Standard Low Clearance M-3 Electric Switch Machine is also similar to the special machine built exclusively for NYCT (refer to SM 6260). Both machines have the same overall height. However, the NYCT machine is equipped with special contactors for motor operation.

**NOTE**

In this manual, the term M-3 is used for the Standard Low Clearance M-3 Electric Switch Machine.

## 1.2 Description

### 1.2.1 General

The M-3 consists of a motor, a gear train, a cam arrangement for operating and locking the switch, and a circuit controller that includes a point detector (with latch-out device). For installations with little horizontal space around the machine (i.e., subway tunnels), the internal point detector bar can be removed vertically.

Components are contained in a cast-iron housing. The machine has no permanent attachments for hand operation, but may be manually operated by inserting a removable crank. Machine N451160-1401 is used for left-hand layouts, while machine N451160-1501 is used for right hand layouts.

The M-3 is provided with a single type of motor (110 Vdc) and a single gear ratio of 189:1. The machines are fully wired at the factory with internal wiring connected to a main terminal board in the motor compartment. A typical wiring diagram is enclosed with each shipped machine. The diagram shows how external connections should be made to the main terminal board for a particular application. To allow standardized wiring, the circuit controller is designed so that certain contacts always indicate Normal regardless of which end of the operating stroke is established as Normal. The internal wiring includes wires for an electric heater that can be added in the circuit controller. An electric heater for the motor compartment is also available.

### 1.2.2 Operating Mechanism

As Figure 1-1 shows, the M-3 consists of the following compartments.

1. **Motor** – The motor compartment houses the motor, the main terminal board, and has a wire outlet for external wiring. The friction clutch of the gear train projects into this compartment.

2. **Gearbox** - The gearbox compartment houses the gears. Actually, there are two compartments in the gearbox, one for the spur gear portion of the reduction gearing, and the other for the main crank and worm gear drive. The connection between the spur gears and the worm shaft is through the friction clutch, which projects into the motor compartment. The friction clutch protects the mechanism from shock at the end of the stroke, or when travel is suddenly stopped by an obstruction in the switch point or by lock rod fouling. The gearbox also houses the mechanism for hand crank operation.

3. **Circuit Controller** - The circuit controller compartment contains the circuit controller, locking features, point detector device, and a separate set of motor cutout contacts. These contacts open the motor circuit, and may also control a line circuit when the hand crank is inserted.

In addition to the above elements, a slide bar runs longitudinally in the base of the machine. This bar is driven by the main crank and operates the lock box in the circuit controller compartment. A switch operating bar runs at right angles to the mechanism and beneath the slide bar. The switch operating bar is also driven by the main crank and is connected to the switch operating rod (See Figure 3-1). The point detector rod and lock rods, operated by connections to the switch points, are supported crosswise in the circuit controller compartment.

Switch operation, switch locking, and circuit controller operation are all performed by the vertical main crank in the gearbox. The main crank is driven either by the motor or by the hand crank. Refer to Section 3 for a detailed operating description of the M-3 Switch Machine.

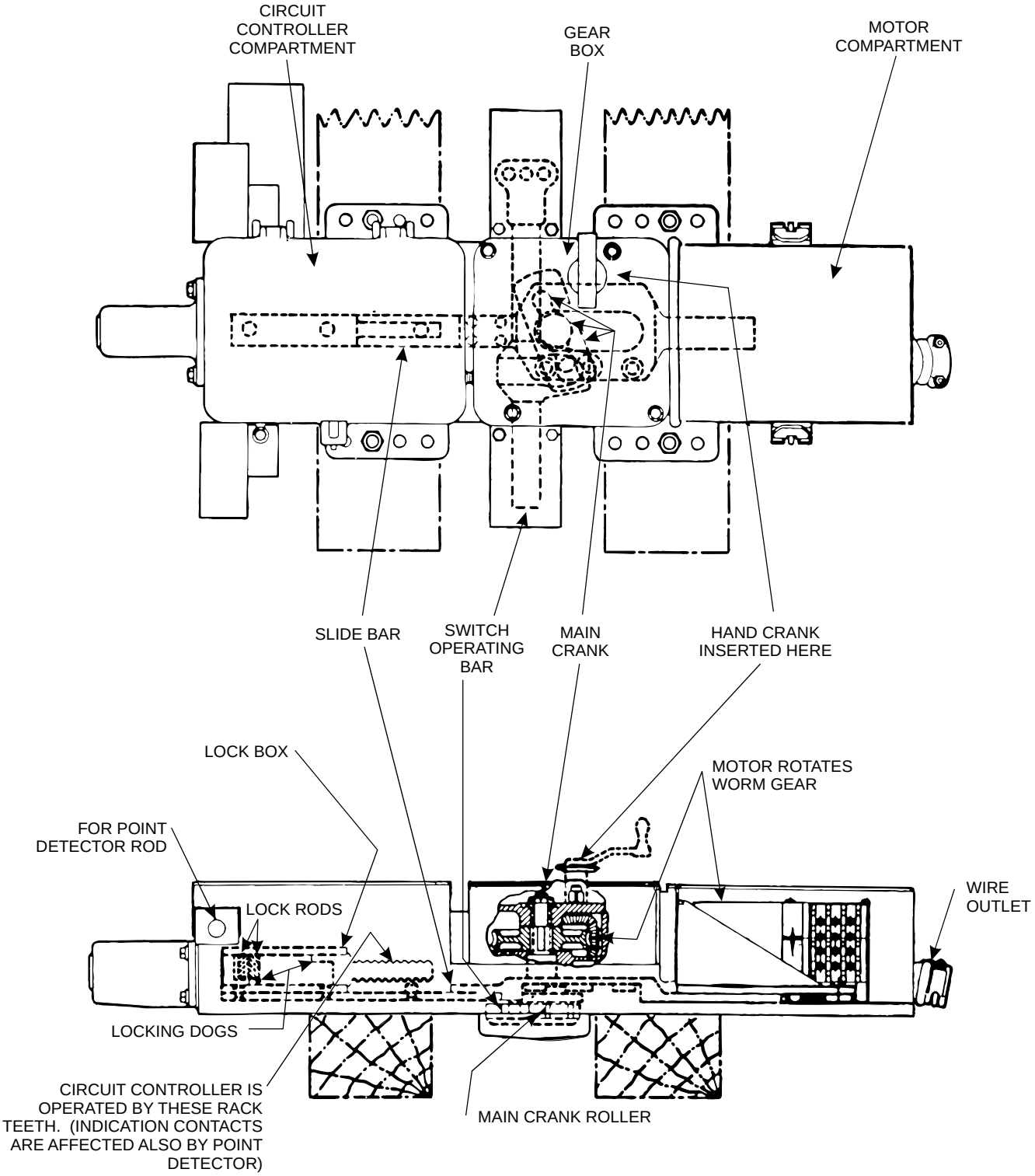



**Figure 1-1. - General Arrangement of the M-3 Clearance Switch Machine**

## 1.3 Specifications

### 1.3.1 Mechanical

| | |
|---|---|
| Length: | 5’ 3-1/2” |
| Width: | 19” (less bars and covers) |
| Height | Without mounting plate = 9-5/8” |
| | With mounting plate = 9-7/8” |
| Weight: | 810 lbs. |

### 1.3.2 Operational

| | |
|---|---|
| Operating Time: | 5 seconds |
| Gear Ratio: | 189:1 |
| Clutch Setting: | 14 A |
| Operating Bar Stroke: | 6” |

### 1.3.3 Electrical (Motor)

| | |
|---|---|
| Type: | Permanent Magnet |
| Horsepower: | 0.68 |
| Voltage: | 110 Vdc |
| RPM: | 1,430 (full load) |

# 2. Installation and Adjustment

## 2.1 Machine Preparation

M-3 switch machines are assembled and shipped from the factory for left- or right-hand switch layouts, per customer order. However, either type of machine can be converted in the field to the alternate layout. Refer to Section 2.4.2 for the conversion procedure.

After the machine is assembled for the layout, check the following:

a. Two 3/8" pipe plugs are enclosed in a bag tied in the motor compartment. If the switch machine is used in an area with excessive blowing sand or dust, install the pipe plugs in the two drain holes in the cover under the crank case compartment (Figure 5-3). The plugs will help keep this debris out of the machine. The plugs should be periodically removed to allow drainage of the crankcase, especially prior to freezing weather. If excessive sand or dust is not a problem, leave these plugs out to allow continual drainage.

b. Two other drain plugs (Figure 7-1, Items 45 and 415 and Figure 5-3) are provided in the circuit controller compartment. These consist of slotted head bolts with lock washers and are shipped in place, but not fully tightened. The plugs should be periodically removed to allow drainage of the crankcase, especially prior to freezing weather. In non-dust prone areas, leave these plugs out to allow continual drainage.

c. For machine installations on elevated structures, drain plugs may remain installed to prevent oil seepage (that is, staining) onto objects below.

## 2.2 Mounting

Figure 2-1 shows the installation dimensions for the M-3 switch machine, while Figure 2-2 and Figure 2-3 show typical layouts. These figures are provided for general reference only. Refer to the detailed layout plans supplied with the machine when installing the machine.

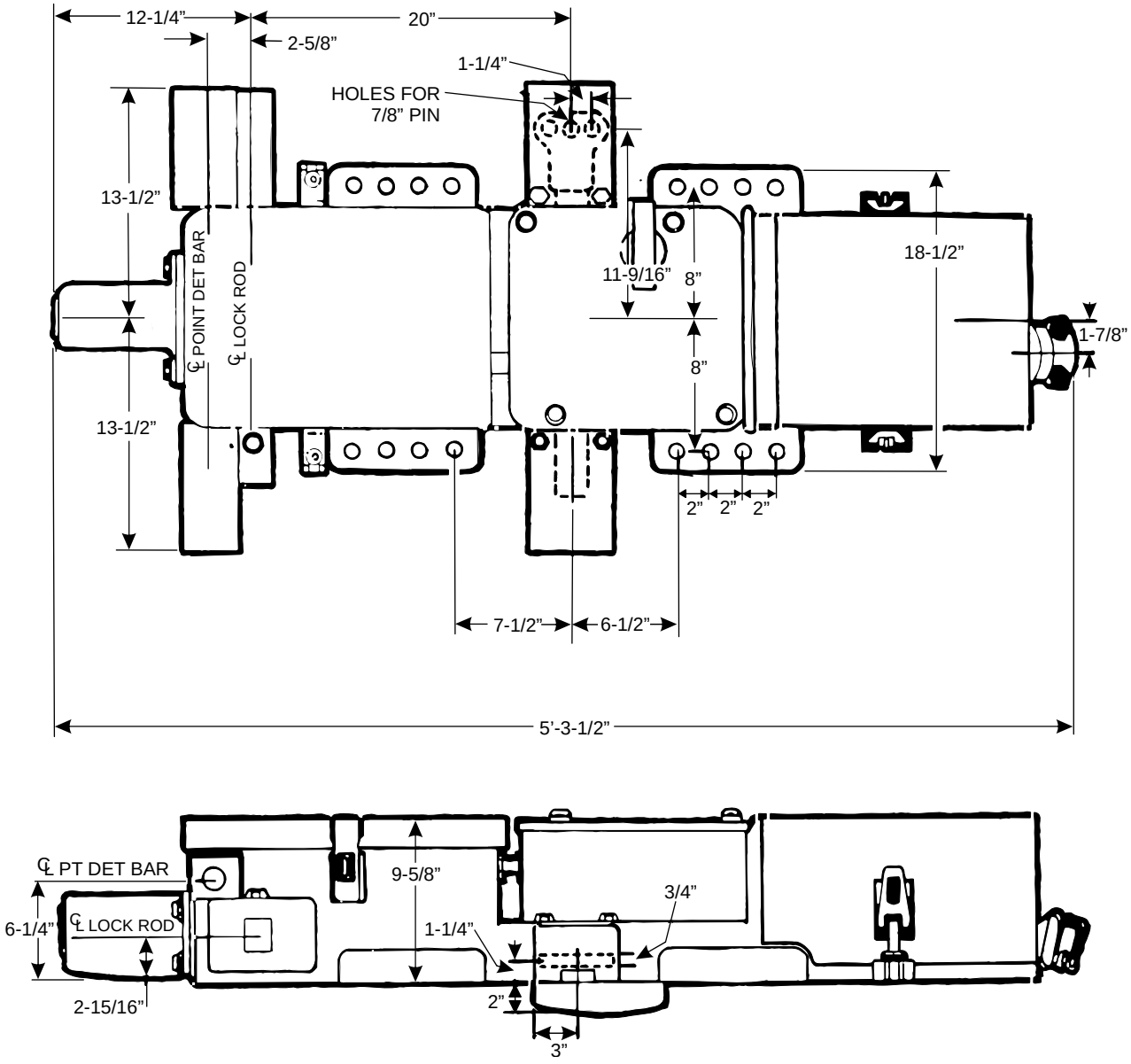
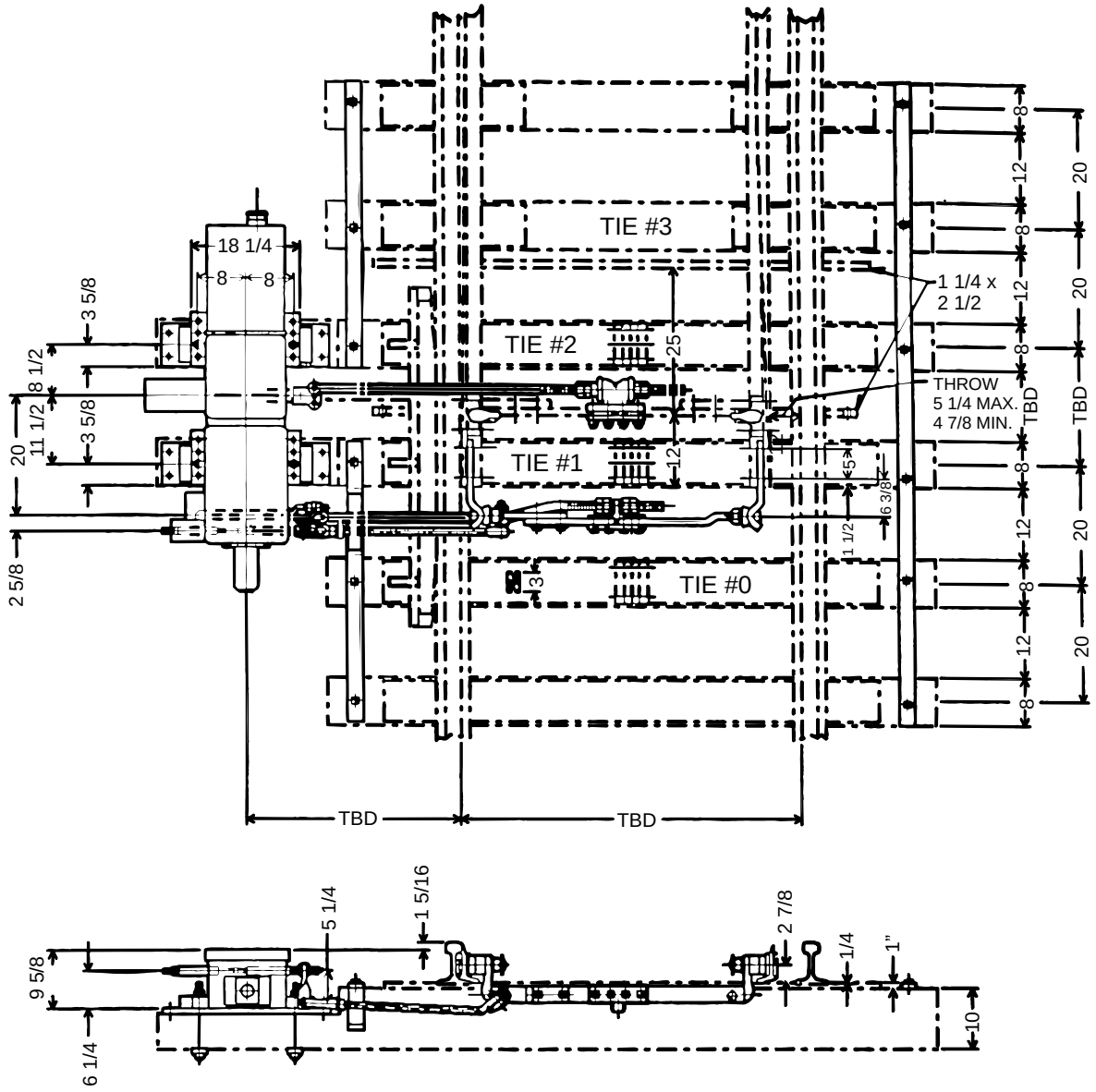



**Figure 2-1. - Installation Dimensions**

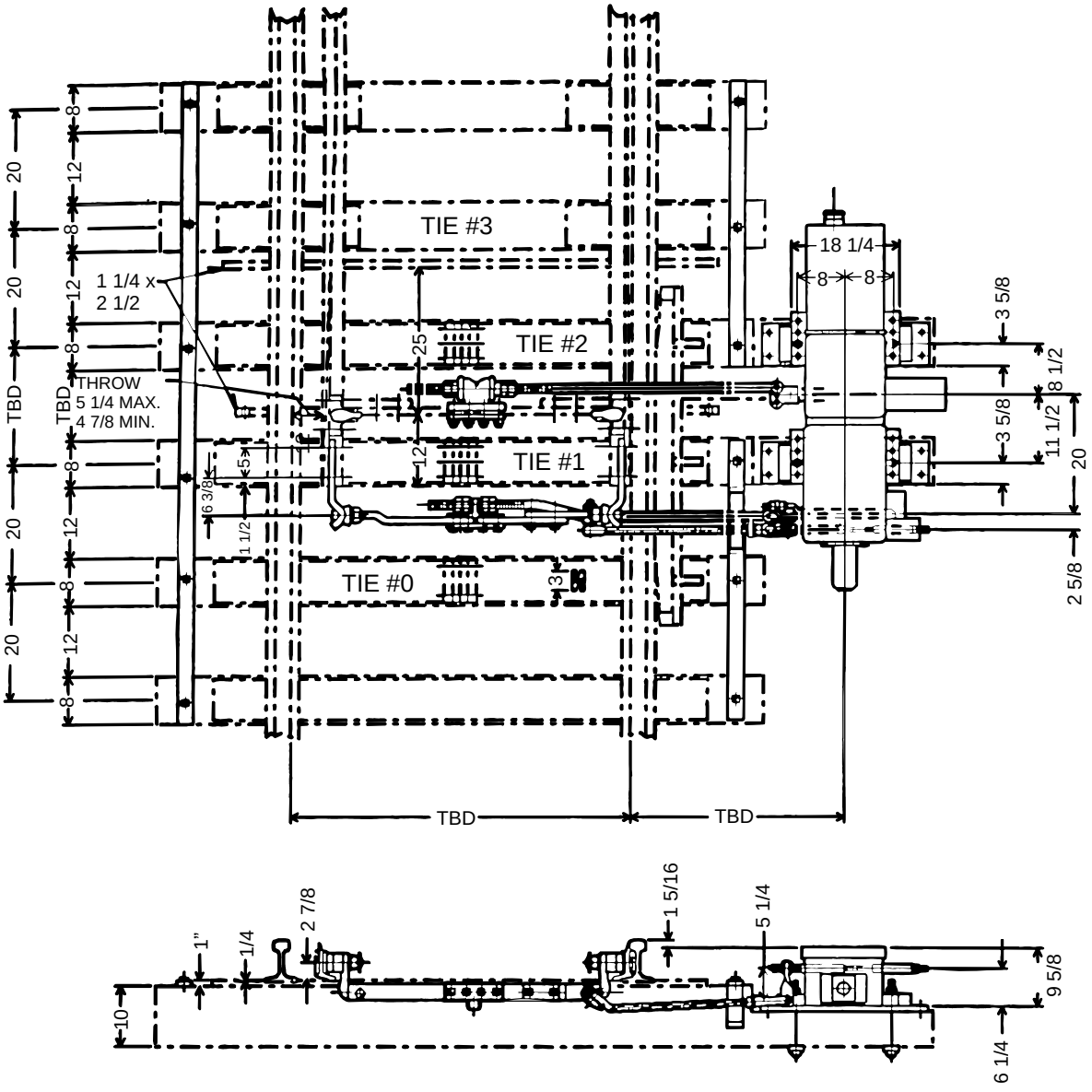



TBD = TO BE DETERMINED BY R.R.

ALL DIMENSIONS ARE SUBJECT TO CHANGE PER R.R. REQUIREMENT.

ALL DIMENSIONS ARE IN INCHES.

**Figure 2-2. - Typical Left-Hand Layout, Point Closed**




TBD = TO BE DETERMINED BY R.R.

ALL DIMENSIONS ARE SUBJECT TO CHANGE PER R.R. REQUIREMENT.

ALL DIMENSIONS ARE IN INCHES.

**Figure 2-3. - Typical Right-Hand Layout, Point Closed**

## 2.3 Switch Rod Installation and Adjustment

Connect the switch operating rod and adjust the rod nuts at the switch basket to obtain the proper pressure at the switch points. It is not necessary to apply more than normal pressure at the points.

## 2.4 Lock Rod Installation and Adjustment

With the covers removed and machine at mid-stroke, apply the lock rods. Be sure that the flat plate snow cover is assembled on the track side (where applicable) when applying the lock rods. Also, be sure the rods are so assembled that the locking dogs in the lock box will enter the narrow notches first. Refer to Figure 3-2 and Figure 3-3.

Preliminary adjustments should be made by setting the nuts so that the narrow notches are approximately centered on the locking dogs at each end of the stroke. The upper narrow notch can be seen directly. Index marks are provided on the top surface opposite the notched ends for the lower notch. Make final adjustments in accordance with applicable railroad standards.

### 2.4.1 Inverting Lock Box

Normally, the lock box dogs must enter the narrow notches of the lock rod before reaching the wide notch (refer also to Section 3.1). Sometimes it may be necessary to invert the lock box to obtain this configuration. The procedure is as follows (see Figure 3-5):

1. Remove the lock rods.
2. Place the machine in the end-stroke position, which brings lock box (G) nearest the motor.
3. Note which of the indication cams (N or P) has its notch up, and that this notch is centered about roller (D).
4. Unscrew the four bolts (T) that hold the circuit controller to the case.
5. Lift the controller upward, pivoting it around the edge of the case adjacent to the wire conduit.
6. Turn lock box (G) upside-down, taking care that it is replaced properly on the driving studs of the slide bar.
7. Replace the circuit controller, checking that pinion gear (F in Figure 3-6) meshes with the rack teeth on the lock box so as to place the indication cam with its notch up and centered about roller (D). This returns the equipment to the configuration before the circuit controller was removed.
8. Fasten the circuit controller in place with the four bolts (T) removed in Step 4.

### 2.4.2 Changing Operation: from LH to RH, RH to LH

1. Invert the lock box as described in Section 2.4.1. See Figure 2-4 for correct positioning.

2. Change the snow scraper and bearing bracket to the opposite side and reassemble per Figure 2-5.

3. Remove the left-hand lock rod and insert the right-hand lock rod. The rods are marked LH and RH. See also Figure 2-6.

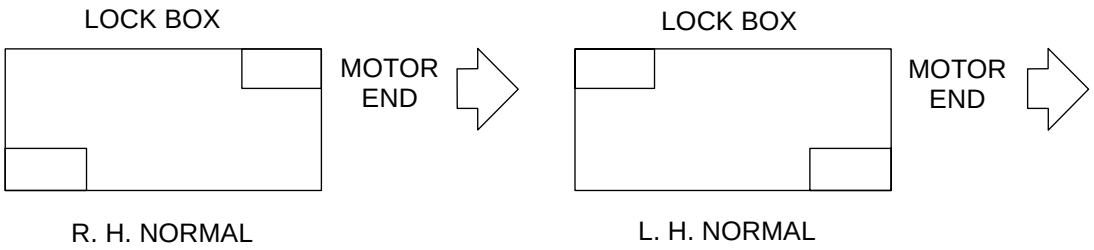



**Figure 2-4. - Basic Positions of Lock Box**

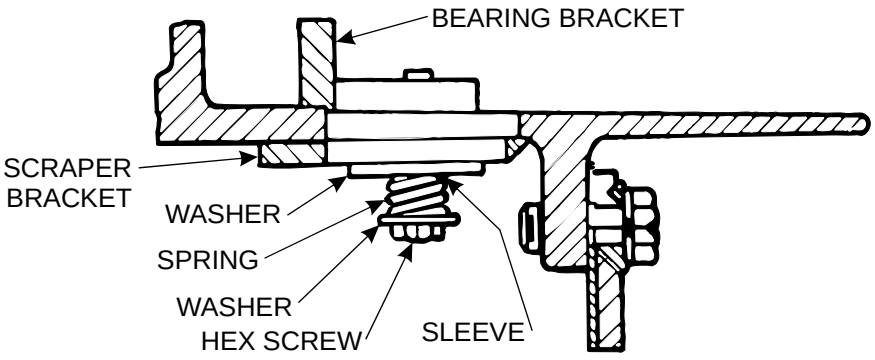



**Figure 2-5. - Snow Scraper and Bearing Bracket Installation**

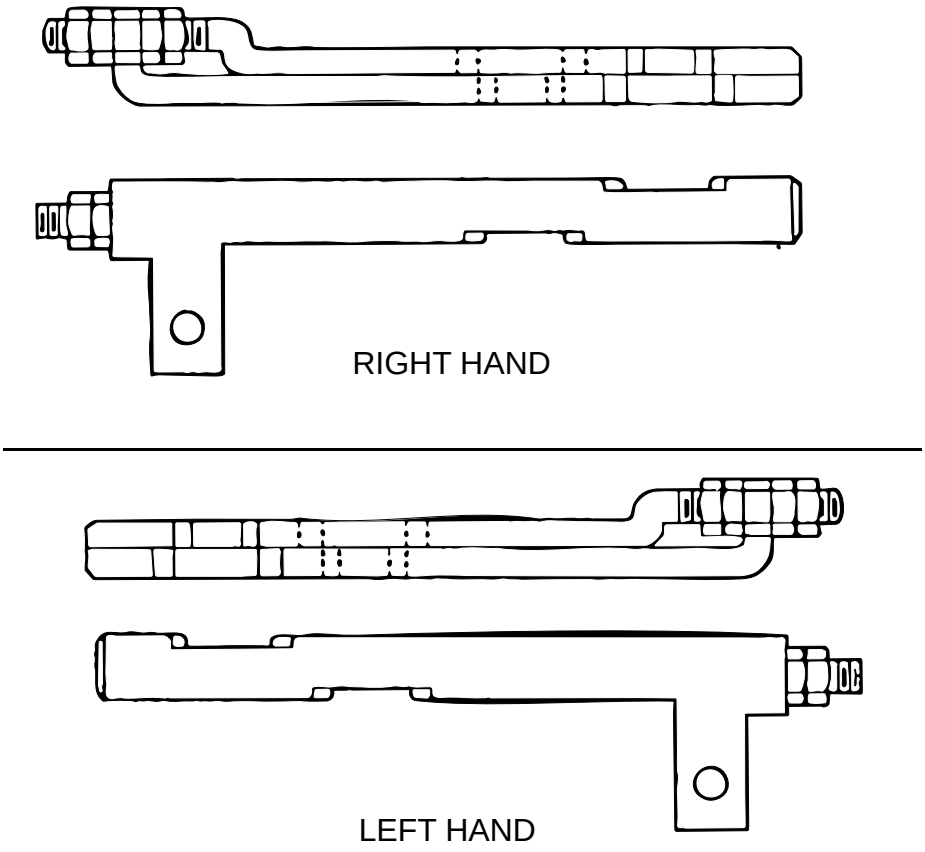



**Figure 2-6. - Left and Right Hand Adjustable Lock Rods**

## 2.5 Point Detector Bar Installation and Adjustment

Apply the point detector bar (remove shipping closures in the housing) and their connecting rods. Adjust to check far and near switch point opening in accordance with AREMA Signal Section or railroad instructions. When making adjustments, be sure to work first with adjustments for the far switch point, using the nuts on the track end of the far point detector bar; then adjust for the near switch point, working at the field end of the near point detector bar.

**NOTE**

The switch-operating rod, point detector rod, and lock rods should be kept in adjustment to meet AREMA Signal Section or railroad specifications. Refer to Section 5.8.1 for using a gauge to check the point detector between periodic obstruction tests.

Check that the indication cam (N in Figure 3-5), on the left side of machine center line, as viewed from controller end, has its notch up when machine is in the Normal position. Also, check that indication cam (P in Figure 3-5) on the right side has its notch up when machine is in the reverse position. If it is found that these cams are not in agreement with the foregoing, shift them in accordance with instructions in Section 2.6.

## 2.6 Shifting Indication Cams

**WARNING**

Disconnect the motor and indication power before attempting to shift the indication cams. Failure to observe this warning could result in personal injury and/or equipment damage.

### 2.6.1 Introduction

Indication cams (N and P in Figure 3-5) are arranged so that either cam can have its notch up when the slide bar is at either end of its stroke. This is done to:

a. Permit standardized wiring.

b. Always have the indication contacts on the left side of the circuit controller indicate Normal, regardless of which end of the slide bar and lock box stroke is designated Normal.

Each cam is driven by a stud in the side of the gear. Each cam also has two slots so that each can be engaged with its corresponding stud in either of two positions. The cams are held with their respective studs by spring force and an 8-32 Allen Head setscrew (adjacent to slots). This screw is tightened against the gear hub after adjustments have been made.

### 2.6.2 Procedure

The two cams must be shifted individually. Each cam can be shifted from one position to the other as follows:

1. Loosen the 8-32 Allen head setscrew (adjacent to the slots).

2. To avoid distortion of the contact springs, carefully insert two screw drivers between the cam and the gear.

3. Force the cam away from the gear against the force of its coil spring.

4. Rotate the cam to the alternate position until it snaps in place (see Figure 3-8, view A).

5. Tighten the setscrews.

6. Repeat this procedure for the other cam.

## 2.7 Electric Connections and Control Wiring

### 2.7.1 General Description of Internal and Control Circuits

Figure 2-7 shows the internal wiring and typical control wiring schemes for operating the M-3 switch machine. (The internal wiring diagram is also shipped with the machine.) The Control Wiring section (Figure 2-7) is provided for reference only. Make certain to read the specific circuit application sheets for the switch machine location when installing the control wiring.

Figure 2-7shows the switch machine's internal wiring diagram. In this figure, the circuit controller indication cams are shown for a switch having the right-hand point normally closed and in the Normal position. However, this is applicable to right or left hand installations.

Figure 2-7 shows typical application circuits for the control of the switch machine using standard US&S PN-150SO, the PN-l50BM, and PP-151 plug-in relays. Part B shows a polar circuit with the PP-151 and PN-150BM in combination. Part C shows a neutral circuit with two PN-150BM relays. These circuits show wiring (of the relays) that corresponds to internal wiring diagrams applied to single switches.

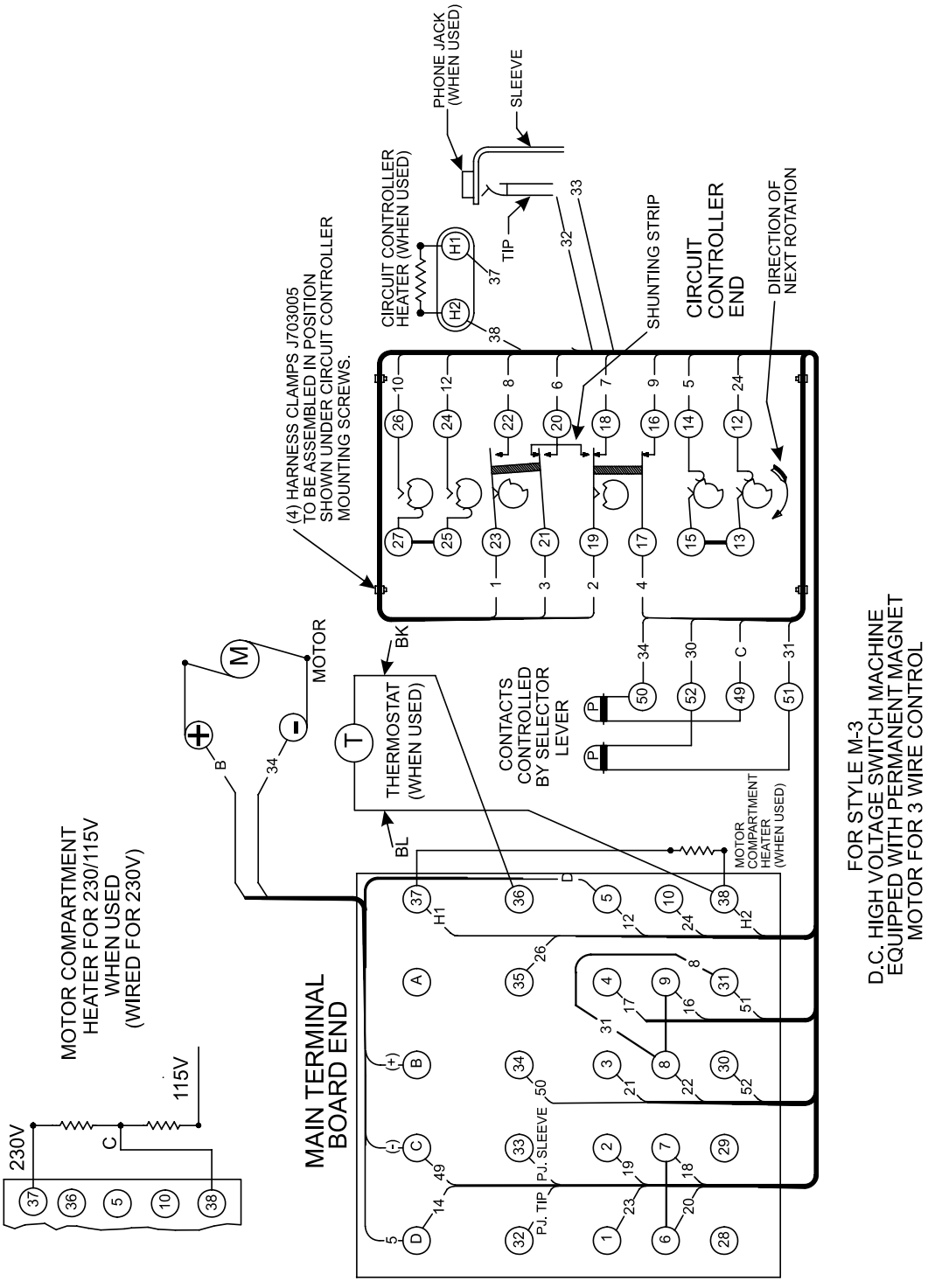



**Figure 2-7. - Internal Wiring and Typical Control Circuits, Sheet 1**

US&S's PP-151 and PN-150BM relays are the standard switch control relays used in the M-3 control circuits. The PP-151 is a magnetic stick relay used for reversing the polarity of the switch motor and keeping the operating winding and stick winding of the overload relay in agreement. The PN-150BM is a biased relay with magnetic heavy-duty contacts. This relay is used for closing the switch motor circuit and opening the circuit under abnormal operating conditions. The PN-l50BM can break stalled switch motor current in excess of 50 amps at 110 volts DC. The PP-151/PN-150BM combination is self-checking because of the bias feature on the PN-l50BM relay.

Earlier model US&S relays can be used for the M-3 switch control circuit. Relays equivalent to the PP-151 include the shelf type DP-25 or the earlier style plug-in type PNP-69. The DP-25 is available with two neutral magnetic blowout contacts for a double-break switch motor circuit. Refer to US&S Service Manual SM 2378N for conversion of a DP-25 relay with one magnetic blowout contact (without low-voltage neutral contacts) to a relay with two magnetic blowout contacts. The DP-25 and PNP-69 can also break stalled switch motor current in excess of 50 amps at 110 volts DC.

Pole changing contacts and other circuits not shown for control of the WR relay should be arranged in accordance with the circuits designed for the specific installation.

**NOTE**

If the latch (refer to Section 3.3) is arranged to be "self-restoring," examine the control and indication circuits before installing the switch machine to ensure the circuits will not prevent the machine from restoring the latch automatically after a latch-out occurs.

### 2.7.2 Connection of Wiring and Modifications

Connect external wiring to the M-3 terminal board according to the wiring diagram for the particular location. If the layout calls for a left-hand point normally closed, interchange the leads as indicated in the note at the bottom of Figure 2-8. Refer to Section 2.6 when reversing the circuit controller cams for the indication contacts.

All M-3 machines have two leads from the main terminal board to the circuit controller compartment to operate a circuit controller heater. Refer to Section 3.8 for additional information on use of the heater.

## 2.8 Initial Lubrication

Apply a light coat of this lubricant to the teeth of the machine's spur gear only. Pour the remainder of the lubricant into the worm gear compartment. It is not necessary to lubricate any other parts of the machine. These parts are thoroughly lubricated at the factory. However, if the machine is being reassembled following maintenance, more extensive lubrication is required. Refer to Section 5.7 for these lubrication procedures.

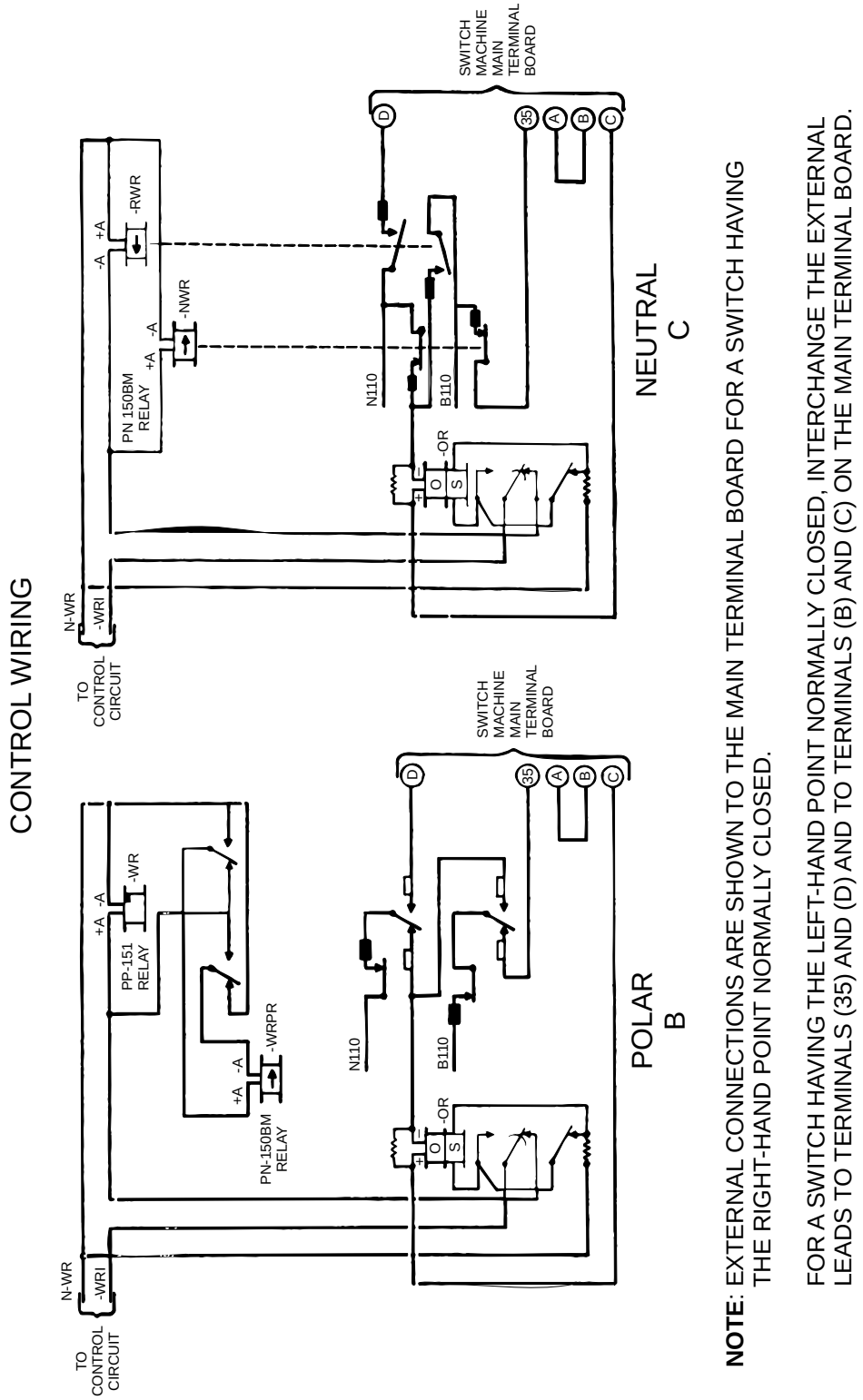



**Figure 2-8. - Internal Wiring and Typical Control Circuits, Sheet 2**

**NOTE**

The machine contains a small quantity oil slushing compound to protect components from corrosion during extended storage. Do not remove this compound during initial lubrication.

Also lubricate the pins that hold the lock rod control rod, point detector, control rod, and operating rod. These pins are equipped with grease fittings. Use Alemite brand grease for lubricant.

## 2.9 Final Pre-Operation Checks

Before putting the M-3 switch machine into service, make the following checks:

1. Check the compartment lids for proper fit and adjust if necessary.
2. Check the motor cutout to be certain it is operating properly. Make sure the crank cannot be inserted without the cutout contacts being latched out. Adjust if necessary per Section 5.8.2.
3. Check all wiring for proper connections.
4. Check the clutch adjustment.
5. Check the machine's response to an obstruction between the switch points:
   a. Place an obstruction between the switch point and the stock rail.
   b. Connect an ammeter to the motor power terminals.
   c. Electrically operate the machine.
   d. When the switch point jams against the obstruction, the worm gear and worm shaft will be stopped, but the motor should continue to run during the overload time delay period, slipping the friction clutch.
   e. The motor current drawn during this period should be 14 amps, +/-10%
   f. If necessary, readjust the friction clutch spring to obtain the specified clutch slip current. Refer to Section 5.6.4.4 for the adjustment procedure.

**NOTE**

If the friction clutch slips too easily, the motor current may not operate the overload relay. As a result, the battery may be exhausted. If the friction clutch adjustment is too tight, mechanical parts may wear out prematurely due to the lack absence of shock protection. During routine operation without obstruction of the switch points, some clutch slippage at both ends of the power stroke is normal.

# 3. Description and Operation

## 3.1 Switch Operating and Locking Mechanism

The main crank drives both the switch-operating bar and the slide bar. The latter carries the lock box with its locking dogs which enter notches in the lock rods when the switch points are in proper position, and also carries rack teeth which operate the circuit controller. Assuming the machine to be at one end of its stroke, operation to the opposite end of the stroke involves rotation of the main crank by the motor or by the hand crank. As the main crank turns, it first shifts the slide bar so as to withdraw the locking dog from the lock rod notch before the switch points start to move. The main crank then holds the slide bar in the mid-position (both locking dogs clear of the lock rods) while driving the switch-operating bar full stroke to its opposite position. Finally, the main crank holds the switch-operating bar while driving the slide bar to its full-stroke position, engaging the top locking dog in the corresponding lock rod notch.

The manner in which the crank imparts these motions can be understood by referring to Figure 3-1 and Figure 3-2.

Assuming that Figure 3-3A shows the Normal position, a reverse movement is started by a clockwise rotation of the main crank.

Lug 1 on the main crank, acting against roller 1 on the slide bar effects the unlocking of the lock rod by causing the slide bar to move to the left one-half of its stroke. Meanwhile, roller 4 on the underside of the main crank is moved through an arc of 40 degrees in the radial portion of groove in the switch-operating bar, thus freeing the bar for the reverse stroke. During the next 140 degrees of rotation of the main crank, roller 4 engages the straight (reverse) operating face of the groove in the switch-operating bar and moves the bar to the reverse position.

Figure 3-3B shows the relative mid-stroke positions of the switch-operating bar and the slide bar; with the main crank still rotating clockwise but not transmitting motion to the slide bar as lug 1 has become disengaged from roller 1. The surfaces of the slide bar are radial to the center of the shaft and prevent the slide bar from moving.

The full reverse position is shown by Figure 3-3C. Roller 4 on the main crank, acting in the groove has moved the switch-operating bar to the reverse position and secured it against back thrust; lug 2 has come into contact with roller 2 during the last 40 degrees of rotation of the main crank, thus driving the slide bar to its full reverse position.

The lock box rests on and is operated from an extension of the slide bar as shown in Figure 3-2. During the first 40 degrees of rotation of the main crank, the corresponding motion of the slide bar withdraws the lower locking dog of the lock box from the lower notch of the lock rod, thus unlocking the switch points.

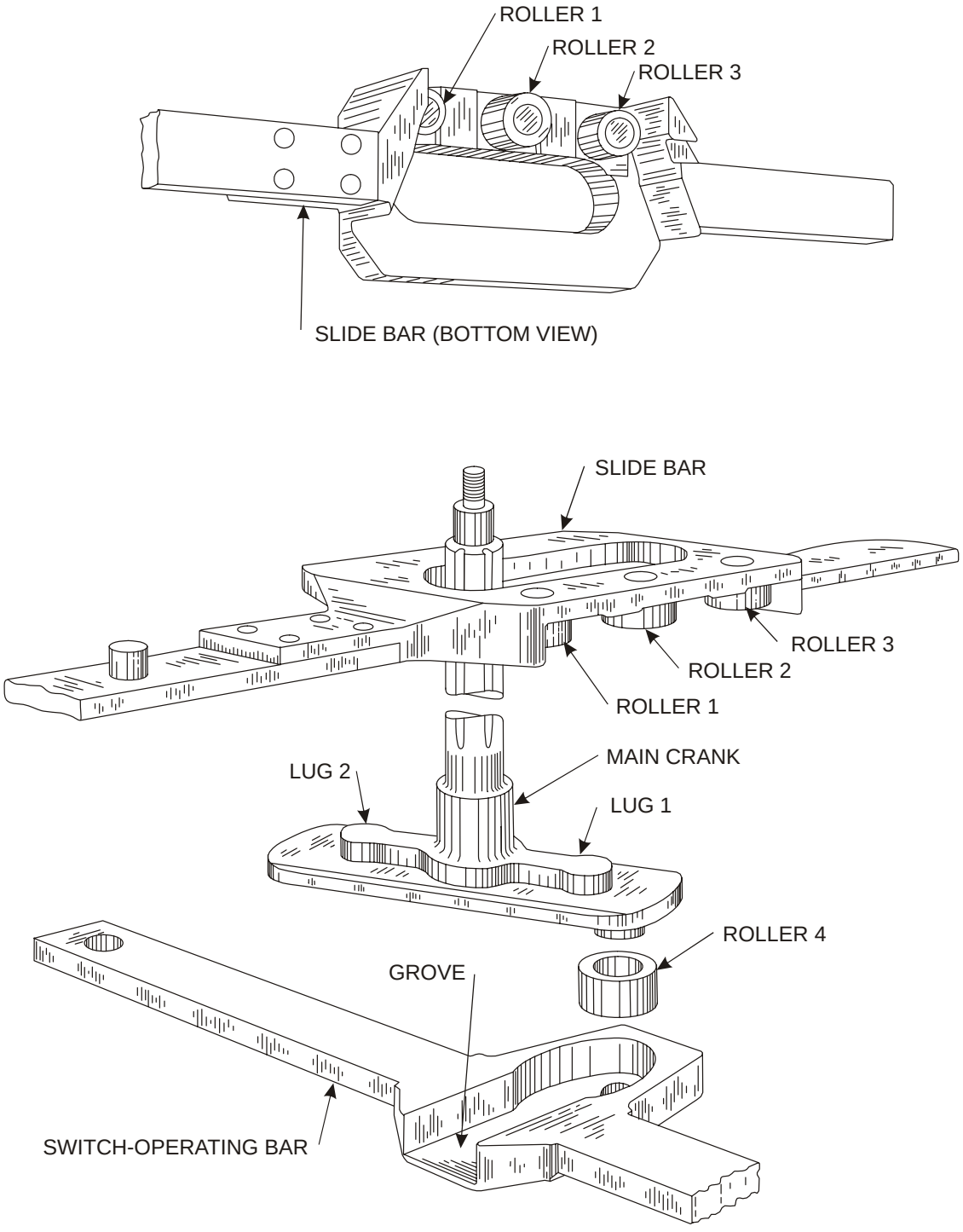
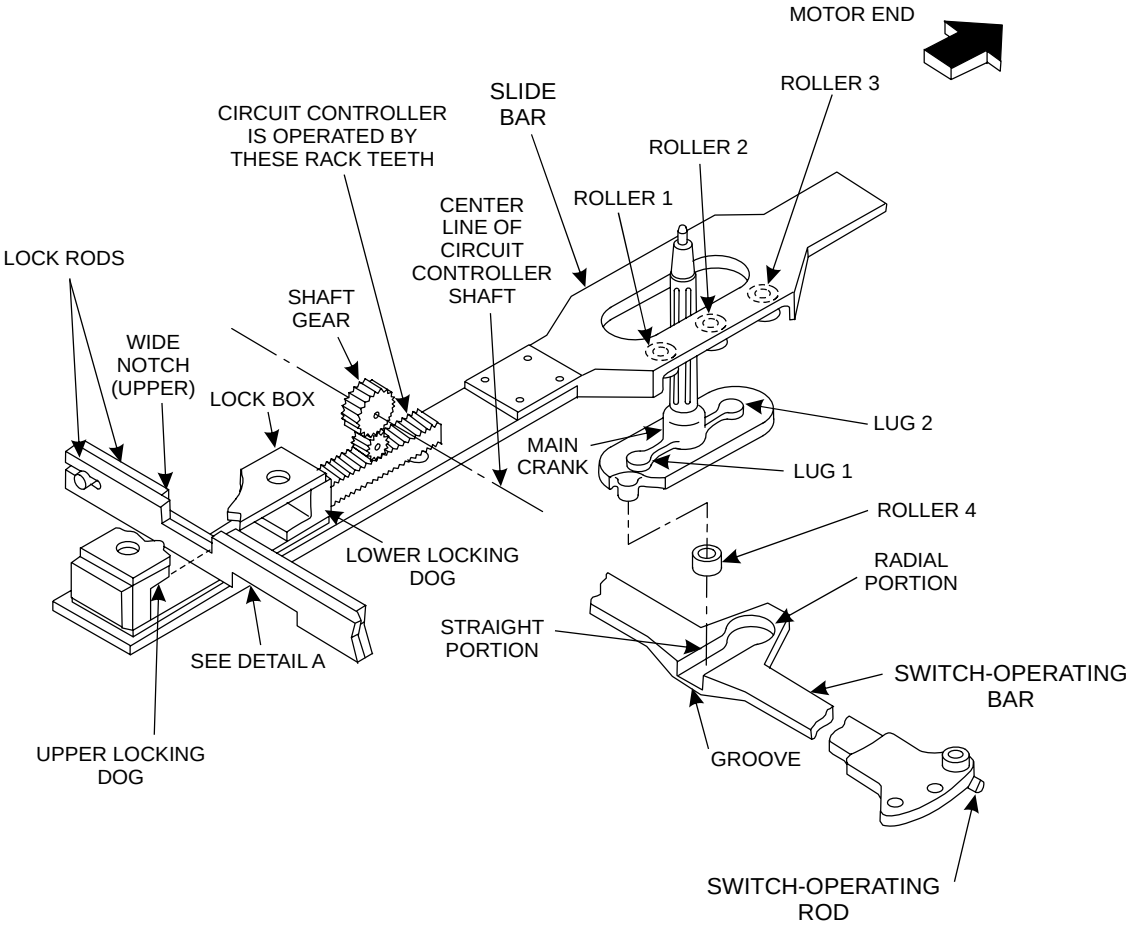
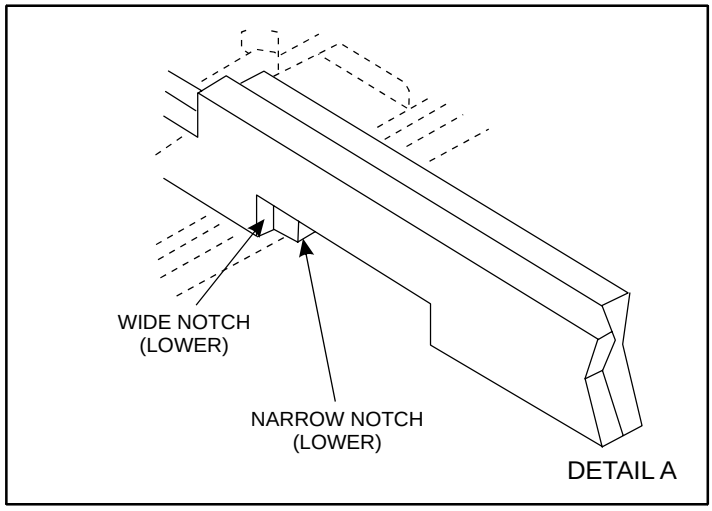



**Figure 3-1. - Switch Operating Mechanism**




NOTE:
DIRECTION OF MOVEMENTS SHOWN ARE FOR A LEFT-HAND SWITCH MACHINE. THE DIRECTION OF MOVEMENTS ARE REVERSED FOR A RIGHT-HAND MACHINE. THE SLIDE BAR AND OPERATING BAR STROKE TIMING RELATIONSHIPS REMAIN THE SAME.

**Figure 3-2. - Driving Parts**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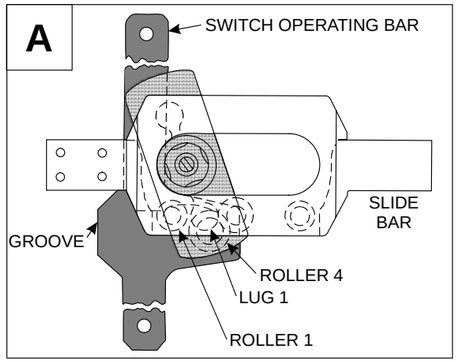
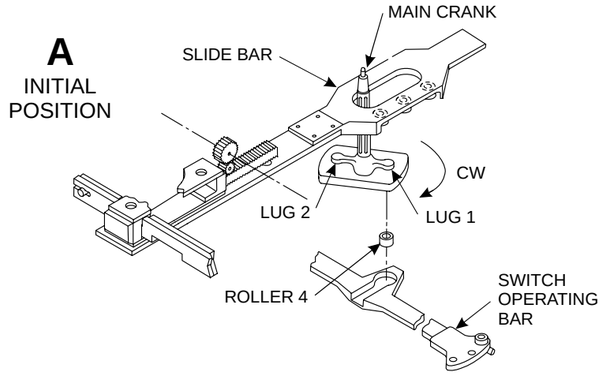
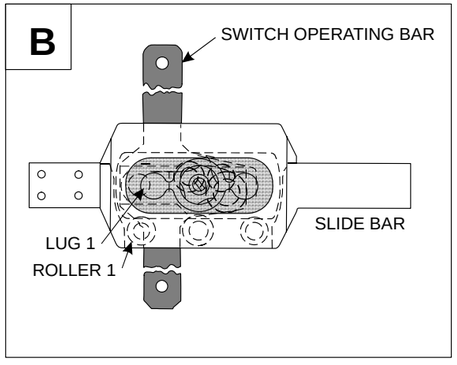
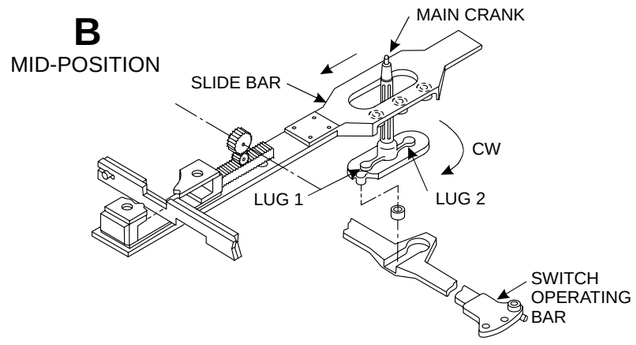
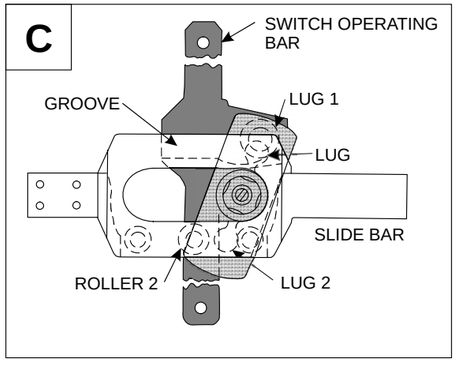


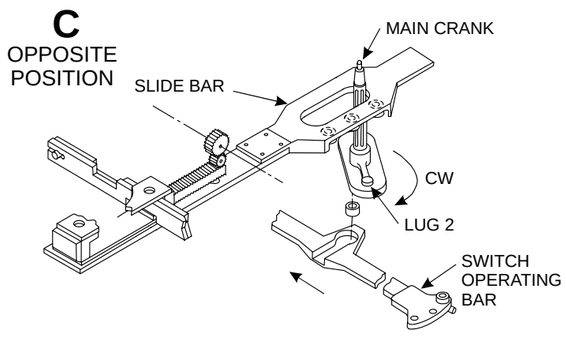




**Figure 3-3. - Driving Parts (Continued)**

The following 140 degrees of rotation of the crank operates the switch, and the lock rod stops with its upper notch aligned to receive the upper locking dog of the lock box. The final 40 degrees of rotation of the crank completes the stroke of the slide bar, driving the upper locking dog into the lock rod notch to lock the switch points in the reverse position.

## 3.2 Switch Point Locking

The lock rods shown in Figure 3-4 are comprised of two rectangular rods side-by-side. Each has a narrow notch only slightly wider than the locking dogs, this narrow notch in one rod being on top and in the other rod on the bottom. To allow for variations in switch throw, the two rods are adjustable longitudinally with respect to each other, and each has a wide notch located alongside the narrow notch of the other. The notch is on top of the lock rods for one position of the switch, and on the bottom for the other position. The lock box likewise has one dog on top and the other on the bottom. It thus follows that the slide bar with its lock box can complete its stroke only if the lock rods are shifted by the switch points to the position corresponding to proper point closure. When the stroke is completed, the switch is secured by the locking.

The stroke of the slide bar and its lock box is such that the locking dogs provide adequate interlock with only the lock rod that the locking dog enters first. Therefore, the lock box and the lock rods must be assembled so that the dogs will enter the narrow notches first.

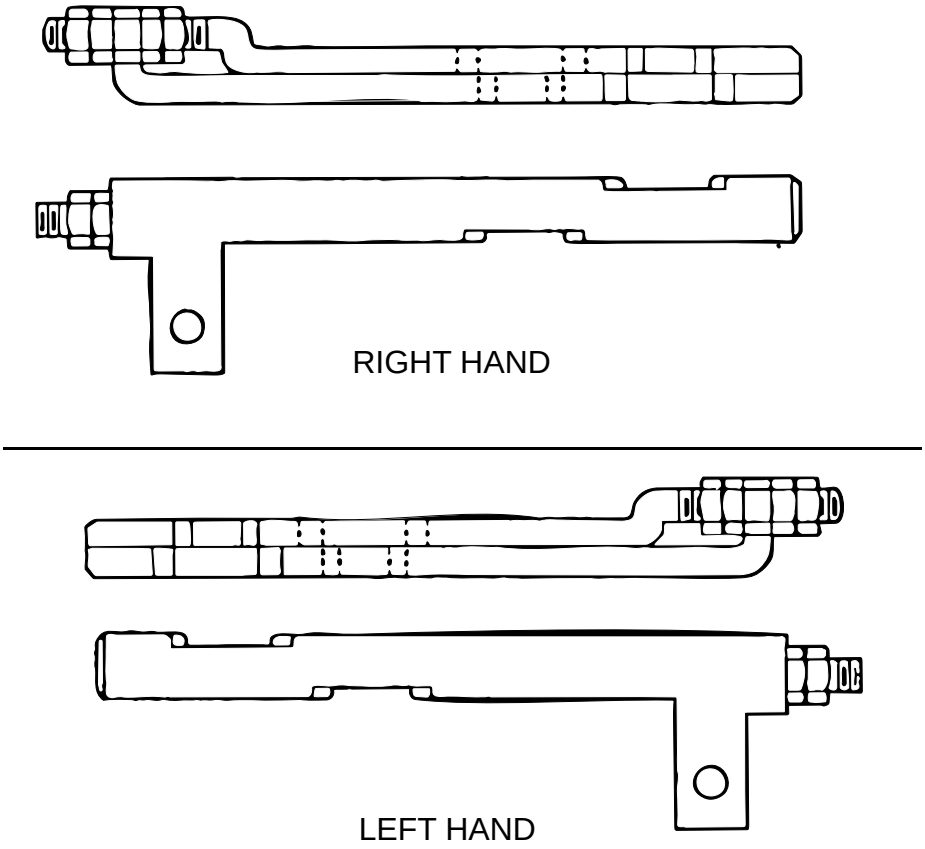
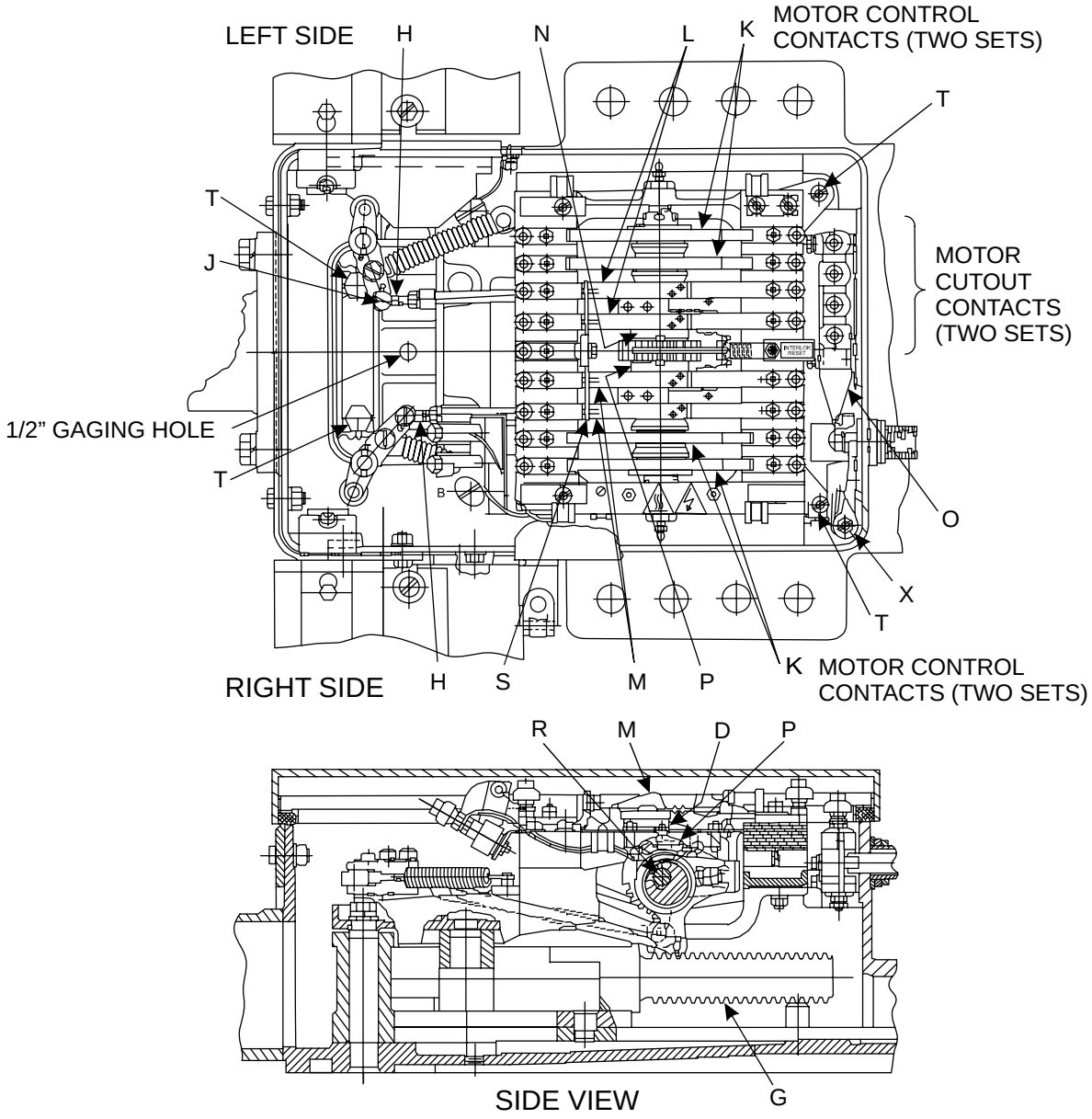



**Figure 3-4. - Adjustable Lock Rods**




LEGEND

| | |
|---|---|
| D - ROLLER | N - INDICATION CAM |
| G - LOCK BOX | O - MOTOR CUTOUT CONTACTS |
| H - EYE ROD | P - INDICATION CAM |
| J - SCREW | R - SHAFT |
| K - MOTOR CONTROL CONTACTS | S - SHUNTING STRIP |
| L - INDICATION CONTACTS LEFT | T - BOLTS |
| M - INDICATION CONTACTS RIGHT | X - LATCH |

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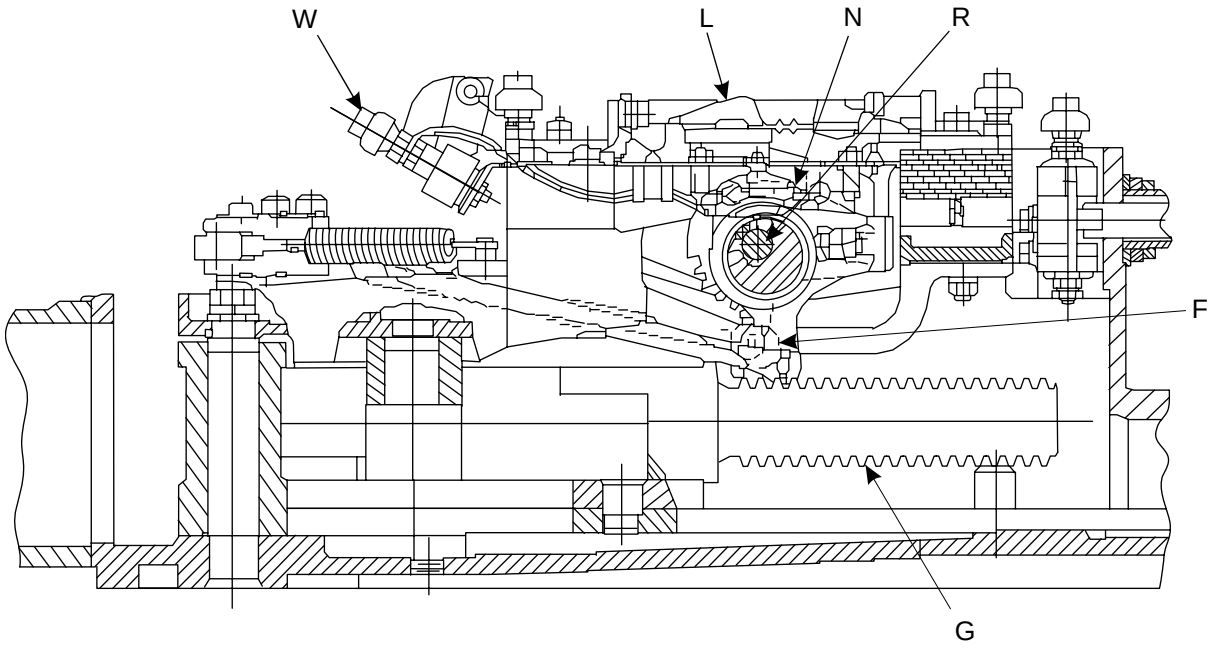
**Figure 3-5. - Indication Circuit Controller**




LEGEND

F - IDLER PINION GEAR
G - LOCK BOX
L - INDICATION CONTACTS LEFT
N - INDICATION CAM
R - SHAFT
W* - HEATER ASSEMBLY (OPTIONAL)

* INSTALLED AT TOP-LEVEL ASSEMBLY

**Figure 3-6. - Sectional View of Circuit Controller**

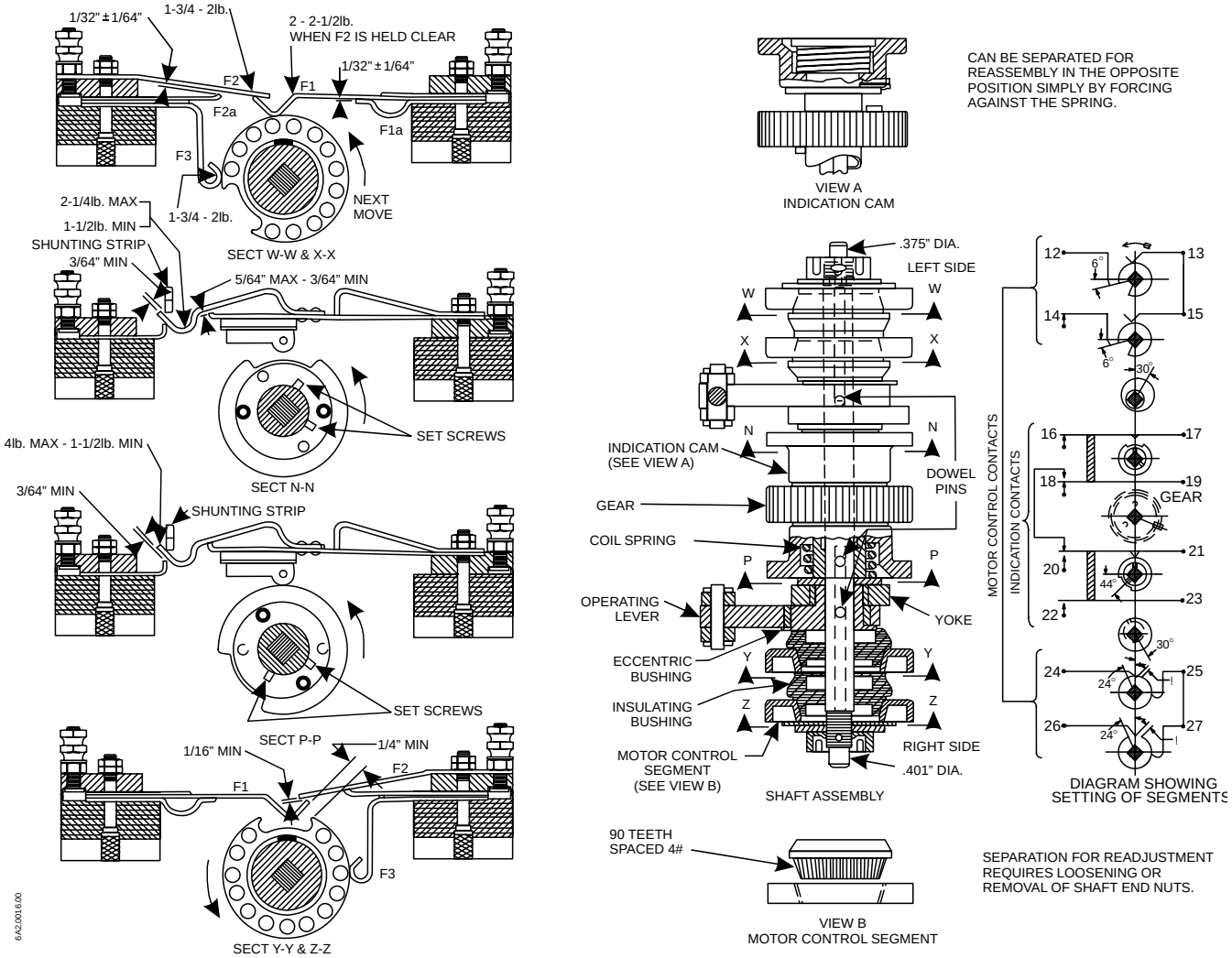



**Figure 3-7. - Sectional View of Indication Circuit Controller**

## 3.3 Circuit Controller

The circuit controller has indication contacts that are operated jointly by the lock box and the point detector mechanism. The contacts are operated in such a manner that the machine, as checked by the lock box, must have completed its throwing and locking stroke in the proper direction, and the corresponding switch point must be closed properly, as checked by the point detector, before the corresponding indication contacts can close. It also has segmental type motor control contacts for opening the motor circuit when the machine is in its full normal or full reverse position.

As illustrated in Figure 3-5, the circuit controller has a total of eight sets of contacts operated by cams and segments on shaft (R), which is rotated by the slide bar motion transmitted through the lock box rack teeth, the idler pinion, and the shaft gear. The two sets of contacts at the left side (viewed from lock rod end of the machine, Figure 3-7), and the two at the right side, comprise the motor control contacts, while the four intervening sets comprise the indication contacts. The motor control contacts are operated solely by the shaft-carried segments, but the indication contacts are also subject to point detector operation.

The shaft assembly, shown in Figure 3-7, consists of a square shaft on which the two end insulating washers, the four motor control segment insulating bushings, the two eccentric bushings, and the gear each have square holes to force them to rotate with the shaft. To ensure proper relative assembly of the gear and eccentric bushings, the shaft is made with unlike ends so that it can go into the controller only one way. The shaft has one corner flattened for a distance of 2 inches at one end and 3 inches at the other end, and the gear and the eccentric bushings have dowel pins that can be assembled only in these flats.

With the exception of the indication cams and their coil springs, the two arms of the yoke, and the operating levers, all the parts are pulled up solidly end-to-end by the nuts on the ends of the shaft. The indication cams and their respective springs ride on the gear hub and are held against the gear face by action of the springs and locked in place with set screws. The cams may have either of two operating positions as determined by slots in the cam hub engaging the stud in the gear face. The yoke is free to rotate around the concentric hub portions of the eccentric bushings, and the operating levers are free to rotate around the eccentric portions, or be held stationary while the shaft and eccentric bushings rotate.

### 3.3.1 Indication Contacts

The four sets of indication contacts operate as two pairs, one pair indicating the normal position and the other indicating the reverse position. Each pair is operated by a single cam and both are subject to point detector operation. Wiring and wire nomenclature are standardized so that the left pair of contacts (L, Figure 3-5; Sect. N-N, Figure 3-7) are used to indicate “normal” on all installations. This means that in some applications the left pair of contacts must indicate that end of the stroke that has the slide bar toward the lock rod end of machine, and in other applications must indicate that end of the stroke that has the slide bar toward the motor end of the machine. The right pair of contacts (M, Figure 3-5) similarly must indicate sometimes one end and sometimes the other end of the slide bar stroke, so as to indicate “reverse.”

Referring to Figure 3-6, when cam N has its notch up, the associated “normal” pair of contacts L closes as shown (except when prevented by point detection, as explained later). For a right-hand layout with right-hand point normally closed cam N has its notch up when the slide bar is at that end of its stroke where it is nearest the motor end of the machine. At the same time, cam P is holding its associated pair of contacts up (Sect. P-P and Sect. N-N of Figure 3-7). When the machine is operated towards the opposite end of its stroke, the notch in cam N rotates counterclockwise out from under the follower, forcing the contacts up.

While the switch is in transit, both the normal and the reverse indication contacts are up, engaging the shunting strip (S, Figure 3-5and Figure 3-7) to provide a shunt for the indication relay. When the machines leave the factory, this strip is assembled to shunt both normal and reverse contacts, but may be reassembled to shunt two inside contacts when indication circuits require such arrangement. When the machine reaches the end of its stroke, the notch in cam P goes on top, and thus permits the "reverse" pair of contacts to close (except when prevented by point detection). Cams that control these contacts are factory set and sealed.

### 3.3.2 Motor Control Contacts

Of the four sets of motor control contacts (Figure 3-5), the two on the right side (viewed from lock rod end of machine) are open and the two on the left side are closed when the machine is in the position shown. When the machine reaches full opposite position, the closed contacts have been opened to break the motor circuit and the open contacts are closed to provide a circuit for operating the machine back to its original position.

Each set of motor control contacts provides two parallel circuit paths, one through direct contact of opposing spring fingers F1 and F2 (Figure 3-7) and the other through finger F1, the conducting segment, and finger F3. The circuit through the segment opens last, as the notch passes under the "V" end of the finger F1, finger F2 being stopped first before the "V" end clears the segment altogether. This arrangement protects the direct finger contact from having to open the motor circuit under normal conditions, yet ensures a circuit in case the segment should become coated with frost.

Referring to Figure 3-7, note that each motor control segment is nested on the tapered hub of its insulating bushings. The cone engagement has teeth in both elements that prevent the segment from rotating relative to the shaft when the shaft end nuts are pulled up, but that permit the segment to be shifted angularly around the shaft in 4-degree steps when the shaft end nuts are backed off. These segments are set in the factory to provide approximately 1/4-in. opening between the segment ring and the "V' end of the contact finger Fl (Section Y-Y and Z-Z) and approximately 1/8-in. margin against opening under finger F3 (Sect. W-W and X-X) when the machine is in its full stroke position. That is, operated as far as it will go by rotating the friction clutch by hand with the hand crank cover in the Open position.

The motor control contacts are set at the factory. Ordinarily, readjustment will not be required as long as the assembly remains undisturbed. If an adjustment is required, it would be best to adjust the machine in the maintenance shop. Refer to Section 5.6.5.1 for these procedures.

## 3.4 Point Detector

### 3.4.1 General Description

The indication contacts are positively opened by the lock box action and close when the cam notches are aligned, unless closure is prevented by a point detector action. The point detector check switch point closure separately from the lock rod connection, and is used to:

a. Check the switch point when it is first closed.

b. Detect damage to a switch point caused by dragging equipment or by traffic running through the switch improperly while the machine is in the locked-up position.

The point detector apparatus in this circuit controller is 'selective' (like the locking). The point detector bar must shift to correspond with the switch operating stroke when the machine is reversed. It also has a latch-out feature that will hold the indication contacts open (until reset) when the point detector bar is displaced while the machine is in the locked-up position.

The latch is arranged to take advantage of the considerable displacement of the point detector bar. This displacement occurs (when the switch points are being deflected by improperly trailing traffic or by dragging equipment) so that the contacts are prevented from making an indication, even though the points may subsequently spring back and leave the point detector bar near its original position. Thus, protection is provided in case the switch points are damaged and unsafe for facing point traffic, yet distorted so as to leave very little net shift of the point detector bar.

The latch is equipped with a "self-restoring" feature. This feature is provided in case the latch becomes unnecessarily latched up due to unusual traffic shocks that do not affect the fit of the switch point against the rail. The latch resets automatically with the next operation of the machine to withdraw the locking dog from the lock rod notch. The latch self-restoring feature may be removed.

If the latch is latched-up as the result of damage to the switch point, the machine cannot complete its stroke in either direction due to lock rod fouling. The latch can also be reset manually.

### 3.4.2 Operation

The following figures are provided to illustrate the operation of the point detector mechanism.

Figure 3-9: Relative positions of the eccentric bushings, operating rods, and point detector rollers for the Normal position of the switch machine. In the Normal position, parts are illustrated for a machine in which cams are assembled so that the Normal end of the stroke places switch points to the right.

Figure 3-10: Mid-stroke positions of the various parts.

Figure 3-11: Reverse positions of the various parts.

Figure 3-12: Various parts latched-up in the reverse position.

The right and left-hand operating crank springs hold the yoke, which is pivoted on the controller shaft, up against the yoke stop on the latch bracket. This occurs for all controller positions, except when the point detector bar is displaced due to improperly positioned switch points. As shown in Figure 3-9 through Figure 3-12, the yoke assembly remains in a fixed position for normal operation of the machine with the switch points in proper adjustment.

With the switch machine in the normal position as shown in Figure 3-9:

1. Point detector rollers A and B stand clear of the point detector bar, thus preventing wear of point detector parts under traffic conditions. However, roller A is in position to deflect the yoke downward should the point detector bar be displaced.

2. When the machine is moved out of its normal position, the controller shaft rotates in a counterclockwise direction (viewed from right-hand side). The operating levers are shifted by the eccentric bushings to move point detector roller A away from the point detector bar. This permits movement of the point detector bar from the normal position to the reverse position without contacting either roller.

Reverse position:

a. Both rollers are again clear of the bar.

b. Roller B is in position to deflect the yoke downward should the point detector bar become displaced.

Latched-out position:

1. The point detector bar is shifted from its reverse position due to deflection of the switch points caused by improper trailing.

2. The large diameter section of the point detector bar is brought into contact with point detector roller B. As a result, the connecting rod shifts the operating levers, thereby rotating the yoke downward about the controller shaft until the latch (as biased by the latch spring) snaps over the top of the yoke midsection. (If the latch does not clear the top of the yoke and operate, add shims under the yoke stop until the latch operates (see Figure 3-12).

3. As the yoke is rotated downward, the upright cam portion of the yoke engages the roller on the underside of both indication contact assemblies.

4. This lifts the reverse contact assembly to open the reverse indication contacts and close the indication contacts against the short-circuiting strip.

The latch can be restored manually or by operating the machine to the opposite position so that the cam on the controller shaft gear in mid-stroke lifts the latch. This permits the yoke to be restored to its horizontal position resting against the yoke stop.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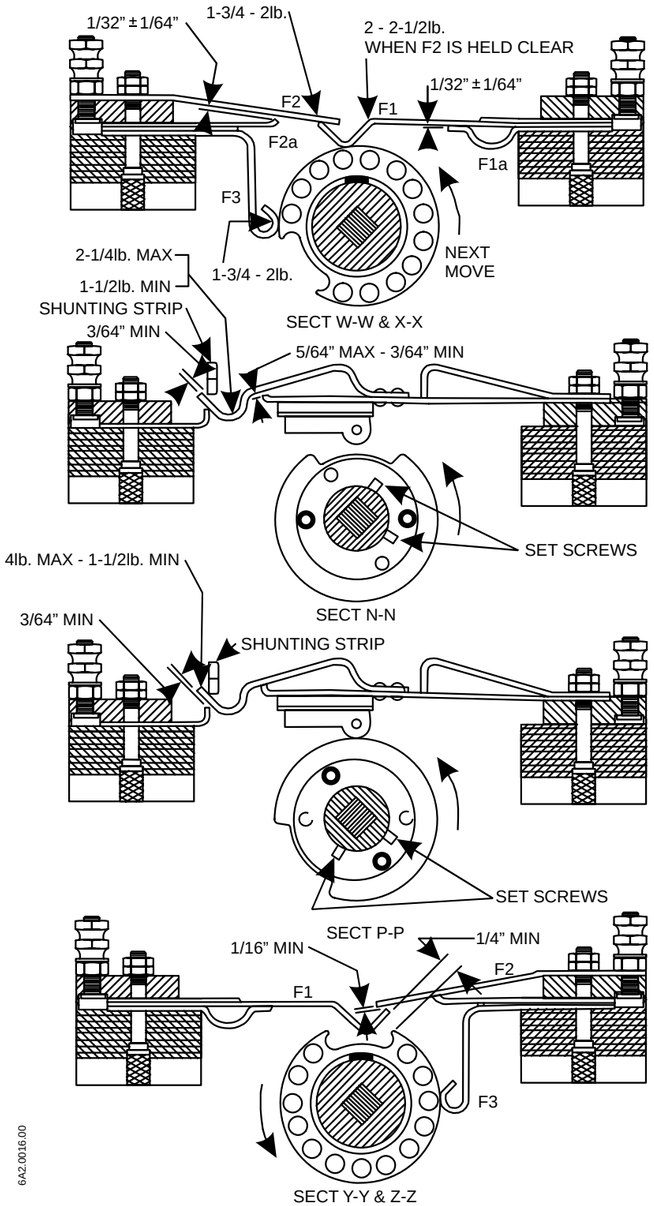


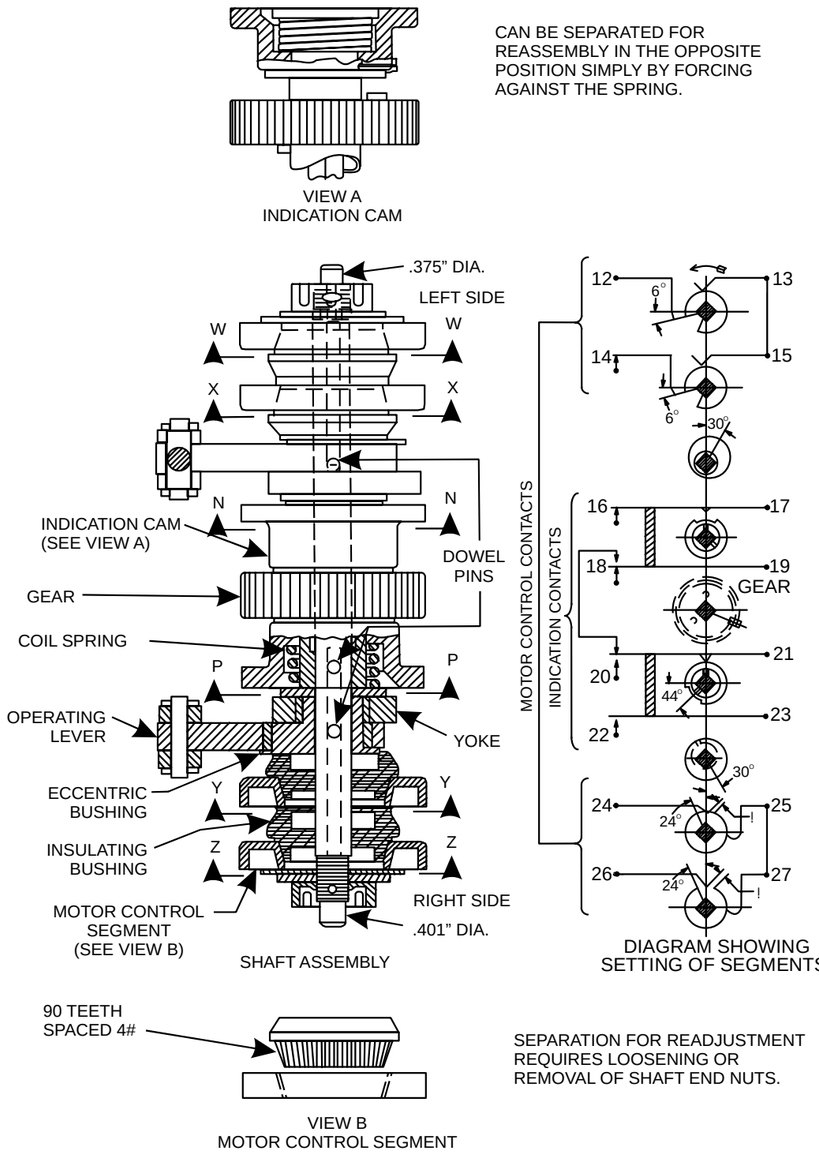




**Figure 3-8. - Circuit Controller Adjustment and Shaft Assembly**

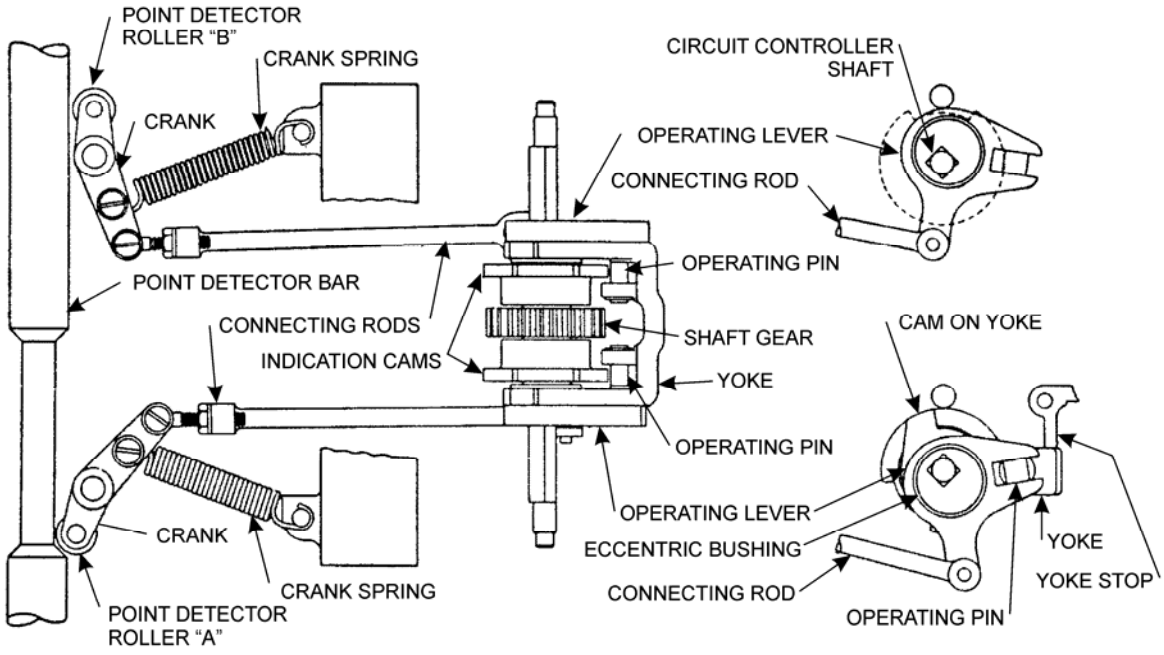



**Figure 3-9. - Point Detector - Parts in Normal Position**

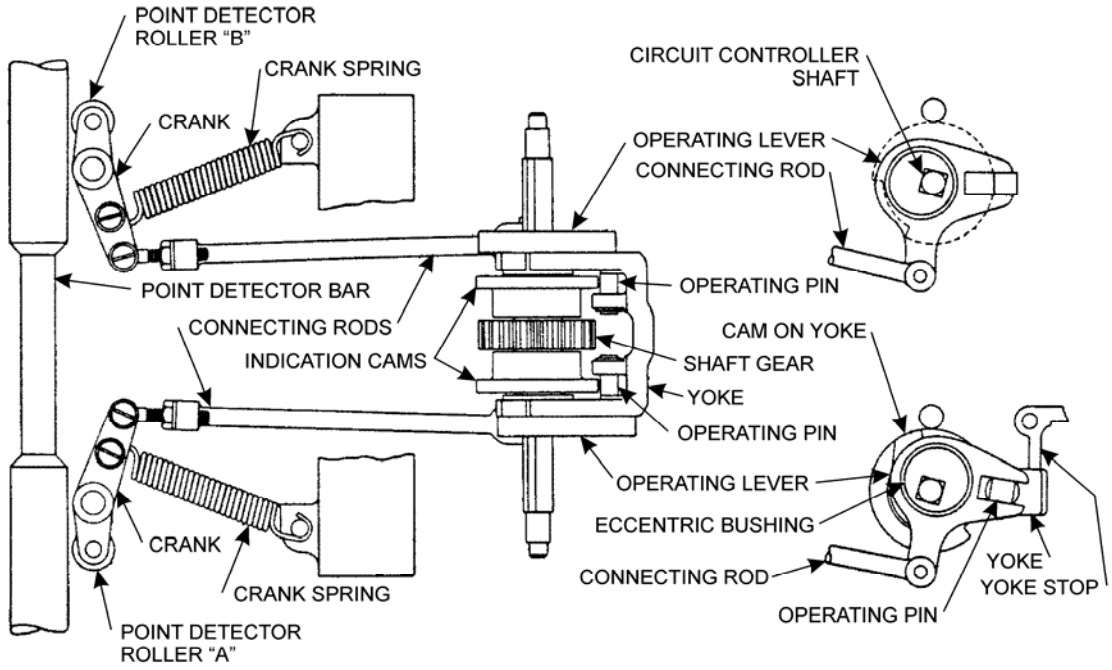



**Figure 3-10. - Point Detector - Parts in Mid-Stroke Position**

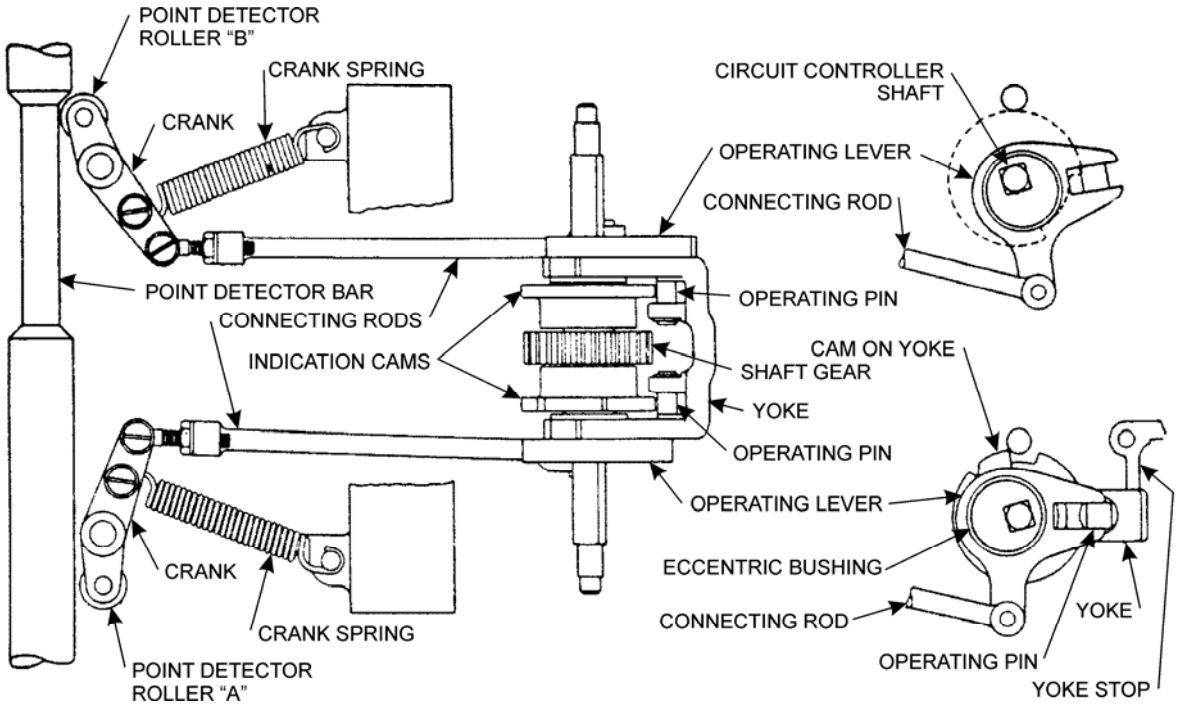



**Figure 3-11. - Point Detector - Parts in Reverse Position**

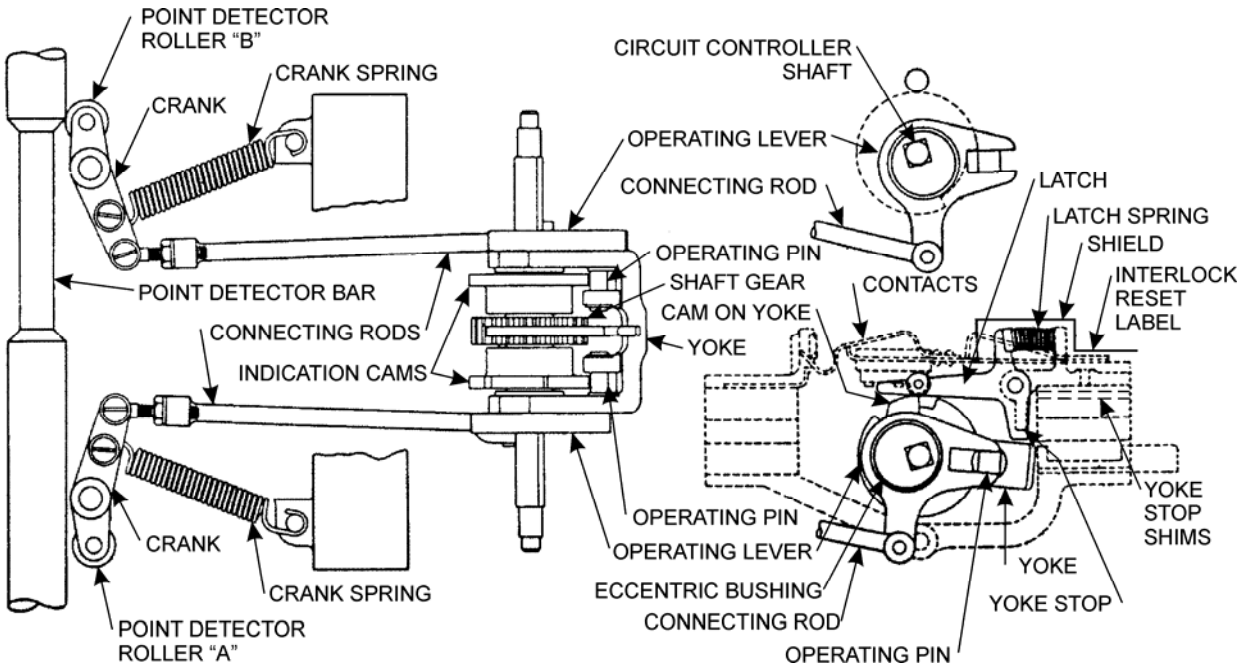



**Figure 3-12. - Point Detector - Parts in Reverse Position and Latched-Up**

## 3.5 Gear Train

The reduction gear train between the motor and the worm gear consists of:

a. A pinion on the end of the motor shaft

b. One or two reduction gears

c. A clutch gear

d. A friction clutch

e. A worm shaft and worm gear

Note that each reduction gear actually comprises two gears, a large gear and a small gear, made as a unit. The reduction gear specifications are as follows:

- Nominal Speed: 4.5 seconds
- Gear Ratio: 189:1
- Number of Teeth on Clutch Gear: 43
- Reduction Gear: 43
- Pinion: 22
- Motor Pinion: 12

The pinion end of the motor is supported in an opening in the gearbox. This opening positions the pinion relative to the other gear centers.

The reduction gears are assembled on shafts supported in Oilite bearings. The ends of these shafts are supported by an end plate slotted to fit over a neck in each shaft.

The clutch gear, which is the final spur gear, is supported on the worm gear shaft with an Oilite bushing. This gear is connected to the worm shaft through the friction clutch.

The worm shaft meshes with the worm gear on the main crankshaft and is supported at the end adjacent to the controller by a double-row ball bearing. This bearing takes both radial load and end thrust. The shaft is also supported by a single-row ball bearing in the wall between the worm gear compartment and the spur gear compartment. Both ball bearings are lubricated by the worm gear lubricant. A cap on the outside seals the outer side of the double-row ball bearing. An oil seal, pressed into the opening, is provided on the spur gear side of the single-row ball bearing.

The friction clutch housing has a tubular neck supported in an Oilite bushing. This bushing is pressed into the gearbox bore. The inside diameter provides slight clearance for the worm shaft. The housing has felt packing to prevent oil seepage into the friction clutch. The worm shaft is grooved and the housing has ribs to drive alternate friction discs. These discs are compressed by the action of the

heavy coil spring. The spring force is contained between the adjusting nut and Oilite thrust plate supported on the tapered shoulder on the worm shaft.

Note that the clutch gear hub has a three-finger engagement with the clutch housing tubular neck. This allows the clutch housing to driven by the motor. The friction discs provide the drive action between the clutch housing and the worm shaft.

## 3.6 Hand Crank Operation

The M-3 switch machine can be hand operated by inserting a removable hand crank through the hand hole in the gearbox cover. The motor cutout contacts (Figure 3-5, Item O) are operated through a linkage to open the motor circuit (and in some cases to open a control circuit). This occurs when the hasp for the hand hole cover is released and the crank inserted. Latch X holds the motor cutout contacts latched out until they are reset manually. This latch can be removed if not needed.

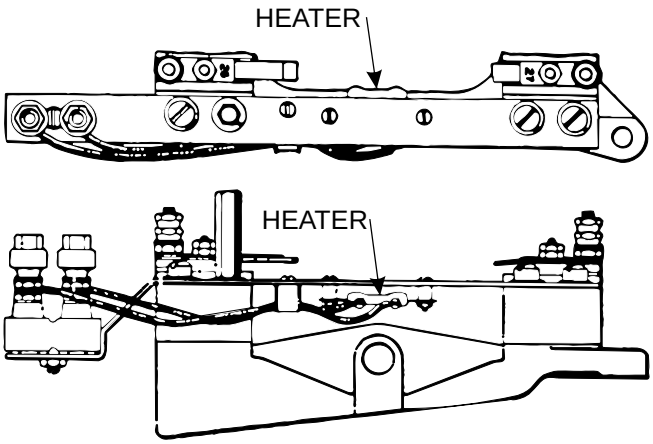
## 3.7 Motor Overload Protection

The standard plug-in relay for overload protection of the M-3 switch machines is the PN-l50SO relay. This relay is used in conjunction with the PN-150BM or the SML-110 switch control relays and the Style PP-151 magnetic stick relay for overload and short circuit protection (refer also to Section 2.7.1). Earlier model US&S relays used for these functions include the OR-11 relay for overload protection and the DP-25 relay for switch control.

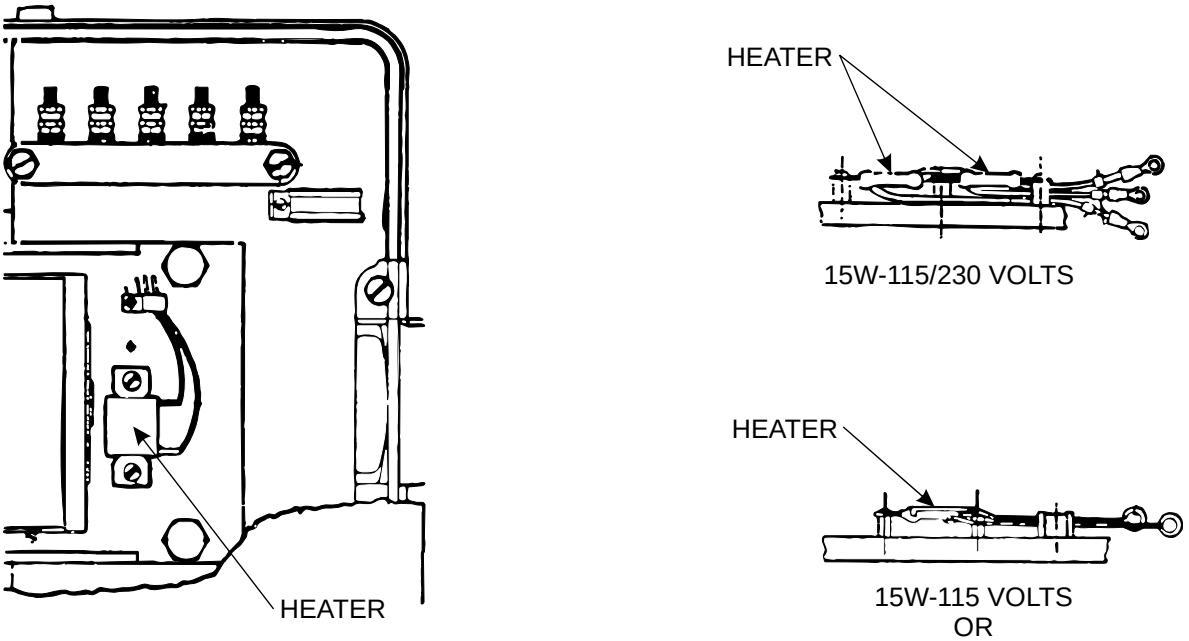
## 3.8 Heaters

Heaters are available for the circuit controller compartment and the motor compartment. Fifteen watt heaters are used in both compartments and are energized by the 110 Vdc power feed to the machine. A dual-element heater is also available.

The controller compartment heater mounts at the end of the controller opposite the wire inlet as shown in Figure 3-13. This heater is held in place by the same four screws that fasten the controller terminal board at that end. The motor compartment heater is mounted on the motor assembly cradle as shown in Figure 3-13.




(A) HEATER FOR CIRCUIT CONTROLLER




(B) HEATER FOR MOTOR COMPARTMENT

**Figure 3-13. - Circuit Controller and Motor Compartment Heaters**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# 4. Field Maintenance

**WARNING**

Disconnect motor power before any work is performed on the M-3 switch machine or switch layout. Failure to observe this warning could result in personal injury and/or equipment damage

## 4.1 Preventive Maintenance

Preventive maintenance of the M-3 switch machine is performed to minimize the chance of an in-service failure of the machine. Preventive maintenance consists of periodic inspection, cleaning, lubrication, and performance testing. A recommended schedule is shown in Table 4-1. This schedule is only intended as a general guide. Factors such as the machine's operating environment, frequency of usage, and the customer's own maintenance regulations should define the actual schedule.

**Table 4-1. - Preventive Maintenance Schedule**

| Frequency* | Equipment | Routine Inspection | Action | | |
|---|---|---|---|---|---|
| | | | Clean | Lubrication | Performance |
| Monthly | Switch Layout | X | | | |
| Semiannually | Switch Machine | X | | | |
| Semiannually | Machine Circuit Controller Compartment | | X | | |
| Semiannually | Switch Machine | | | X | |
| Monthly | Switch Machine | | | | X |

*Maximum allowable interval

## 4.2 Inspection

### 4.2.1 General

Both the M-3 switch machine and the switch layout area should be visually inspected on a scheduled basis. The inspection should cover the condition switch points, switch rods, connecting rods, electrical connections, and the interior of the switch machine. The switch layout should also be inspected for potential switch obstructions. Any and all substandard components should be immediately replaced.

### 4.2.2 Switch Layout

Perform switch layout inspection as follows:

1. Check that ties are well tamped to withstand vibration and strain caused by passing trains.
2. Check that tie plates, tie straps, rail braces, and switch fittings are secure.
3. Check that there are no signs of water accumulation around switch machine. If water is found, drainage is inadequate.
4. Remove any material within layout that could obstruct switch movement.

### 4.2.3 Switch Machine

Perform switch machine inspection as follows:

1. Remove covers from switch machine circuit controller, gearbox, and motor compartments.
2. Using hand crank, operate switch back and forth as needed to check for:
    a. Proper and smooth operation of switch points: No excessive drag or spring, points riding on all slide plates. Also check for switch point obstructions at this time.
    b. Loose or damaged electrical connections.
    c. Burned, frayed, or broken insulation.
    d. Proper movement of switch machine main crank, slide bar/lock box, switch-operating bar, circuit controller shaft, and circuit-controller point-detector connecting rods.
    e. Excessive wear, lost motion, or accumulation of foreign or conductive material.
    f. Excessive or unusual vibration and noise.
3. Electrically operate the switch machine and check for:
    a. Smooth movement of the switch machine motor and gears. No binding or related faults should be observed.
    b. Conditions listed in Step 2, above.

4. Make sure no water has accumulated in the switch machine compartments. For switch machines with installed drain plugs:

   a. If there is water in the crankcase compartment, remove the two 3/8-inch pipe plugs from the base of the compartment and allow water to drain.

   b. If there is water in the circuit controller compartment, remove the slotted head bolts (with lock washers) at the base of the compartment and allow water to drain.

**CAUTION**

Make sure to perform the above checks for water prior to sub-freezing weather. Frozen water within the switch machine could result in improper operation or equipment damage.

   c. Reinstall plugs in drain holes where required by the application.

**NOTE**

The drain plugs are only installed when the switch machine is used in a highly dusty or sandy area, or when the machine is installed on an elevated structure where drainage could contaminate objects below the structure. Otherwise, the drain holes should be left open to permit continual drainage.

5. Check that motor control contacts, indication contacts, motor cutout contacts, and associated cams and linkages are clean and do not show excessive wear (refer also to Section 4.3).

6. Check that all switch machine parts requiring lubrication are lubricated in accordance with Section 5.7.

7. Check that the conduit between switch machine motor compartment and junction box is not crimped, nicked, cut, or otherwise damaged.

8. Remove the two screws that secure the access plate over the motor commutator:

   a. Check that commutator is smooth and clear.

   b. Check that commutator brushes are free in their holders and are not excessively worn.

## 4.3 Cleaning

The M-3 switch machine does not require external cleaning. However, it is important that the circuit controller compartment be cleaned during inspection to ensure proper electrical operation. Refer to Sections 4.3.1 and 4.3.2 for cleaning procedures:

### 4.3.1 Required Equipment/Materials

The following items are required to clean the circuit controller compartment:

a. Household degreaser

b. Lint-free cloths

### 4.3.2 Procedure

Clean the circuit controller compartment as follows:

1. Dampen the lint-free cloth with the household degreaser, and wipe motor control and indication and motor cutout contact springs free of any accumulated dirt. Then dry with a clean, lint-free cloth.

2. Repeat Step 1 with the motor control segments, indication cams, yoke, operating levers, and point detector connecting rods, crank, and crank springs. Dry these with another clean lint-free cloth (do not reuse the first cloth).

**NOTE**

If the contact springs, motor control segments, or indication cams show any signs of pitting, corrosion or general deterioration, they must be replaced. Refer to 5 for procedures.

3. Lubricate all cleaned areas per Section 5.7.

## 4.4 Lubrication

After the switch machine has been inspected and cleaned, it must be lubricated to ensure optimum operation. Refer to Section 5.7 for lubrication procedures.

## 4.5 Performance Test

Conduct a performance test on the switch layout(s). This test should be done in accordance with customer's operating rules. The test should include mechanical operation of the switch machine and electrical tests of power distribution and switch control and indication circuits.

## 4.6 Corrective Maintenance - Adjustments

### 4.6.1 Friction Clutch

The friction clutch (see also Figure 5-1) must slip at just the right amount of torque. This torque must be:

a. Sufficient to carry the machine's operational loading during driving of the switch points.

b. Not so tight that the mechanism is unprotected from shock.

To check the friction clutch adjustment, refer to Section 5.6.4.4.

**CAUTION**

Make sure to keep the friction disks free of oil contamination. Oil on the disks could cause excessive clutch slippage. In turn, this could cause motor damage. Replace the disks if oil contamination occurs.

**NOTE**

Oil contamination of the disks could be caused by oil running along the shaft. If this is observed, replace felt packing in the clutch housing as described in Section 5.6.4.2.

### 4.6.2 Additional Adjustments

Table 4-2 lists section references for additional field adjustments to the M-3 switch machine.

**Table 4-2. - Switch Machine Field Adjustments**

| Adjustment | Section Reference |
|---|---|
| Machine-to-Switch | 2.3, 2.4, 2.5 |
| Motor Control Contacts | 5.6.5.2 |
| Indication Contacts | 5.6.5.3 |
| Motor Cut-Out Contacts | 5.8.2 |

## 4.7 Repair Procedures

Field repair of the M-3 switch machine is limited to removal and replacement of the motor brushes and major switch machine assemblies. Table 4-3 lists section references for the field repair procedures. Component-level disassembly of the machine should only be performed in the shop, not in the field.

**NOTE**

Before removing the M-3 Switch Machine from service, the proper authority must be informed, and railroad rules for this procedure must be followed. Otherwise, a major service disruption could be created.

**Table 4-3. - Field Repair Procedures**

| Component | Section Reference |
|---|---|
| Motor Brushes | 5.5.1, 5.6.2 |
| Motor | 5.5.2, 5.6.3 |
| Friction Clutch Assembly | 5.5.3 |
| Circuit Controller | 5.5.4, 5.6.5 |

# 5. Shop Maintenance

## 5.1 Maintenance Checklist

The switch machine should be removed from service and subjected to shop maintenance at a frequency of no less than every three years but not more than five years depending on usage. The various items to be checked are listed in Table 5-1.

**Table 5-1. - Shop Maintenance Checklist**

| Item | Process | Section Reference |
|---|---|---|
| Motor | Remove from the machine | 5.5.2 |
| | Remove brushes from the motor | 5.5.1 |
| Friction Clutch Assembly | Remove from the machine | 5.5.3 |
| Circuit Controller | Remove from the machine | 5.5.4 |
| Gearbox | Remove from the machine | 5.5.5 |
| | Remove the main crank | 5.5.6 |
| | Remove the worm gear | 5.5.7 |

## 5.2 Special Tools

The tools listed in Table 5-2, Table 5-3, and Table 5-4 are required to perform shop maintenance on the M-3 switch machine. The ordering reference for a complete set of tools is X49125301, X49125302, and X49125303.

**Table 5-2. - Required Maintenance Tools - Basic Set(X49125301)**

| Tool | Part Number |
|---|---|
| Ratchet, 1/2” Drive, 10” long | J0390000129 |
| Handle, Hinge, 15-3/4” long | J0390000131 |
| Extension, 1/2” Drive, 10” long | J0390000130 |
| Hex Bit, 3/8” | J0390000141 |
| Socket Set, 1/2“ Drive | J0390000140 |
| Screwdriver, WAGO No. 210-119 | J0390000134 |
| Screwdriver, 1/4” Slotted, 6” long | J0390000144 |
| Screwdriver, 1/2” Slotted, 10” long | J0390000143 |
| Screwdriver, Phillips No. 2, 10” long | J0390000142 |
| Wrench, Adjustable, 6” long | J0390000132 |

| Tool | Part Number |
|---|---|
| Wrench, Adjustable, 10” long | J0390000133 |
| Wrench, Combination, 5/16” | J0390000128 |
| Wrench, 1-1/8”, Thin Head | J039723 |
| Hex Key Set, L-shaped, 13 piece | J0390000145 |
| Retriever, Flexible, 13-1/2” | J0390000146 |
| Gauge Set, Feeler, 25 Blades | J0390000147 |
| Hammer, Ball Peen, 12 oz. Head | J0390000148 |
| Grease Gun, Mini, 3-1/2 oz. | J0390000135 |
| Pliers- Slip Joint, 6-1/2” long | J0390000138 |
| Seater, Brush, 1/2” W x 1/4” T | J0390000136 |
| Handle, Brush Seater | J0390000137 |
| Wrench, Terminal | J0390000127 |
| Gauge – Switch Obstruction | J0390000139 |
| Point Detector Gage Comp | J039000 |
| Bag, Tool, Canvas | J0390000155 |
| Strap Shoulder, Adjustable | J039000154 |
| Bag, Leather Accessory | J0390000153 |

**NOTE**

Tool Set X49125302 includes all of Tool Set X49125301 plus these additional tools.

**Table 5-3. - Maintenance Tools – Basic Set with Track Tools (X49125302)**

| Tool | Part Number |
|---|---|
| Wrench, Switch, Adjustable, 2-1/16” | J0390000125 |
| Wrench, Switch, Adjustable, 1-5/16” and 1-11/16. | J0390000126 |

## 5.3 Component Cleaning

All major mechanical parts should be thoroughly cleaned to remove accumulation of dirt, grease and grime. Use only appropriate cleaning agents for the material being cleaned and follow manufacturer's recommendations for use.

**CAUTION**

The use of cleaning fluids on electrical components, such as the motor, heaters, wiring harness, or circuit controller should be minimized, otherwise damage to these parts will occur.

**NOTE**

Tool Set X49125303 includes all of Tool Set X49125302 plus these additional tools parts, and is required to adjust the current controller contacts.

**Table 5-4. - Maintenance Tools – Basic Set with Track and Circuit Controller Tools (X49125303)**

| Tool | Part Number |
|---|---|
| Scale, Spring, 12 pounds | J0390000151 |
| Scale, Spring, 0-6 pounds | J0390000150 |
| Bender Spring, 3" | M439054 |
| Bender Spring, 6" | M439053 |
| Bender Spring, Angle | M439055 |
| Bender Spring, T-Handle | R439056 |
| Gauge, Spring Tension, 0-5 pound | J0390000152 |

## 5.4 Component Inspection

During disassembly of the M-3 switch machine, carefully examine each part for signs of damage. All damaged components, regardless of the degree of damage, should be replaced with new components.

After cleaning, carefully check case, cover, and other structural components for hair-line cracks, breaks, weak points, or any other signs of physical damage.

## 5.5 Disassembly

### 5.5.1 Motor Brushes Removal

To remove the motor brushes, perform the following steps. See Figure 7-1.

1. Remove the motor compartment cover (Item 180).
2. Remove the motor brush/commutator covers by removing two screws on each side of the cover.
3. Lift and push to release the spring holder.
4. Remove the motor brush from case.
5. Repeat above procedure for other the brush.

### 5.5.2 Motor Removal

To remove the motor, proceed as follows. See Figure 7-1.

1. Remove the motor compartment cover (Item 180).
2. Tag and remove the wires attached to the connections at the motor's end (closest to the conduit outlet).
3. Position the wiring harness out of the way.
4. Remove two 1/2"-13 x 2" hex head cap screws (Item 380) at the rear of the motor's mounting bracket (commutator end).
5. Remove the two associated 1/2" plain lock washers (Item 415).
6. Lift the motor assembly (Item 10) up and pull towards the conduit outlet until the pinion gear on the motor shaft is clear of the motor opening. If required, remove the pinion from the shaft and motor from the bracket using Allen wrenches.

### 5.5.3 Friction Clutch Assembly Removal

To remove the friction clutch assembly, perform the following steps. See Figure 5-1.

1. Remove the cotter key (Item 11) from the clutch adjusting nut (Item 10).
2. Remove the clutch adjusting nut (Item 10) from the worm shaft (Item 12).
3. Remove the clutch spring (Item 9).
4. Remove the two cap screws (Item 13) securing the plate (Item 2).

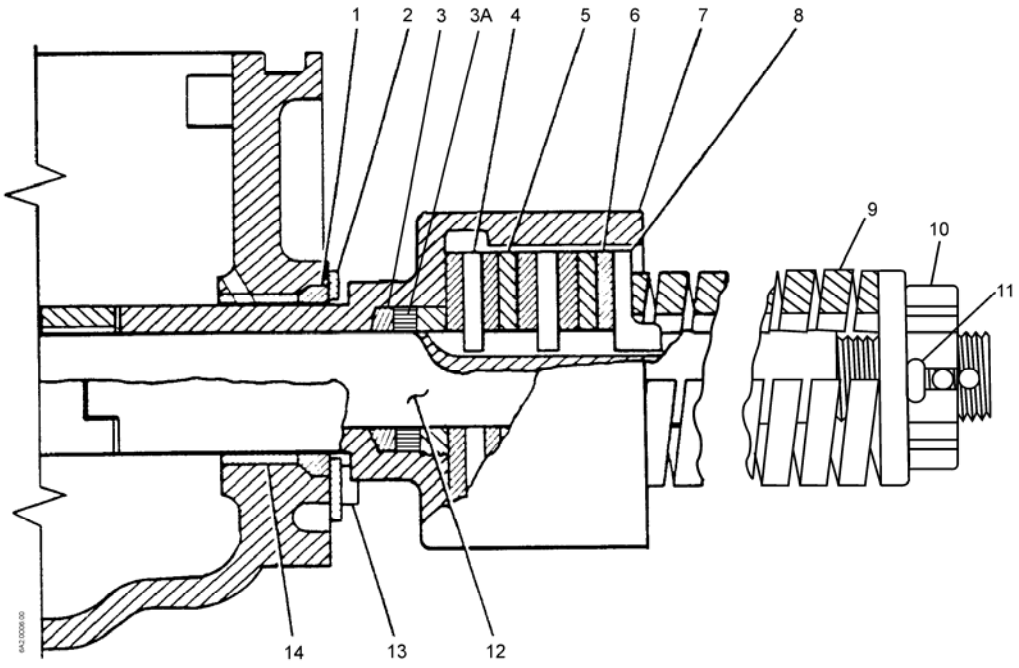
5. Remove the plate and the gasket (Item 1).

6. Pull the clutch housing/tubular neck (Item 7) out of engagement with the gear hub. Continue to pull the housing until the tubular neck is clear of the opening in the gearbox, exposing the worm shaft.

### 5.5.4 Circuit Controller Removal

To remove the circuit controller, follow these steps. See Figure 7-1.

1. Remove the circuit controller cover (Item 160).
2. Tag and remove the wires attached to the circuit controller terminals and heater.
3. Position the wiring harness out of way by removing the four wire clamps, screws, and lock washers.
4. Remove the two screws (Item 20) and washers (Items 410, 730) attached to the feet of the circuit controller nearest the motor compartment.
5. Remove the two screws (Item 390), lock washers (Item 415) and plate (Item 30) between the point detector cranks.
6. Lift and remove the circuit controller from the compartment.
7. If further disassembly is required, see Figure 7-4.



| Item No. | Description | US&S Part No. |
|---|---|---|
| 1 | Gasket | M245192 |
| 2 | Plate | M147400 |
| 3 | Felt Washer | J047335 |
| 4 | Clutch Plate | M146574 |
| 5 | Clutch Plate | M146573 |
| 6 | Clutch Disk | M146650 |
| 7 | Clutch Housing | N172752 |
| 8 | Clutch End Plate | M146575 |
| 9 | Clutch Spring | M239322 |
| 10 | Clutch Adjusting Nut M-3 | M286615 |
| 11 | Cotter, 3/16” x 2” (Tin. Pl.) | - - |
| 12 | Worm Shaft | M286612 |
| 13 | Cap Screw, 1/4”-20 x ¾” Hex. Head (Tin. Pl.) | - - |
| 14 | Bushing | J790004 |

**Figure 5-1. - Friction Clutch Assembly**

### 5.5.5 Gearbox Removal

Remove the gearbox by performing the following steps. See Figure 7-1.

1. Disconnect the pull knob from the yoke.
2. Remove the two screws on either side of the cotter key (Item 435) that links the push rods and the motor cutout contact controls.
3. Remove the push rod (Item 120) by holding it at the end nearest the motor compartment and pulling until the opposite end clears the pipe(Item 140).
4. Remove the push rod by lifting and pulling until the pin at the other end clears the hold in the side of the housing.
5. Remove the four screws (Items 380, 400, and 405) that secure the gearbox to the base.
6. Remove the cotter pin (Item 440), 1”-8 nut (Item 255), and steel collar (Item 250) from the threaded top of the main crank.
7. Lift the gearbox from the base of the switch machine.
8. If further disassembly of the gearbox is required, see Figure 7-3.

**NOTE**

Before proceeding with further disassembly of the machine, review Sections 1, 2, and 3 of this manual. The information in these sections will aid in the final disassembly of the machine.

### 5.5.6 Main Crank Removal

**NOTE**

The main crank can only be taken out of the bottom of the machine. Removal of the main crank will release the worm gear and the slide bar.

1. Remove the bottom cover and the wear plates supporting the operating bar. This allows the operating bar and crank roller to drop down.

2. Rotate the crank (turn the friction clutch by hand) until the bottom end is perpendicular to the machine.

3. Unscrew the nut at the top of the main crankshaft. This will permit the crank to drop out through the bottom.

### 5.5.7 Worm Shaft Removal

1. Take the gearbox off the base casting.

**NOTE**

This step is necessary to prevent the end of the worm shaft from striking the wall of the circuit controller compartment.

2. Remove the lock box and motor.

3. Remove the slide bar through the motor compartment.

### 5.5.8 Final Disassembly

After removing all major subassemblies per Sections 5.5.1 through 5.5.7, disassemble the remaining components as required by referring to Figure 7-1 and the associated parts list. Disassemble only to the degree necessary to repair the switch machine.

## 5.6 Assembly

### 5.6.1 Installation of Gearbox

To install the gearbox, use the following procedure. See Figure 7-1.

1. Place the gearbox onto the switch machine base.
2. Align the mounting holes in the gearbox with the holes in the base.
3. Install four screws (Items 380, 400, and 405).
4. Install the push rod (Item 120) by inserting the pin into the housing and lowering the push rod.
5. Install push rod Item by sliding the cutout contact end through the pipe (Item 140).
6. Align the holes at the end of the push rod with their respective swivels and install the two screws.
7. Mount and adjust the knob to the yoke.

### 5.6.2 Installation of Motor Brushes

Install the motor brushes by proceeding as follows. See Figure 7-1.

1. Before installing the motor brushes, check that the motor commutator is smooth and free from grease and oil.
2. To dress the commutator, use a fine grain commutator stone or a piece of No. 00 sandpaper. Never use emery cloth for cleaning the commutator or brushes. These commutators must not be undercut.
3. Fit the brushes to the commutator, using No. 00 sandpaper.
4. Install the motor commutator brush in holder.
5. Install the spring hold-down by pushing it into the slot beside the brush and hooking it over the end of the brush holder.
6. Repeat Steps 1 through 5 for the other brush.
7. Check that the motor commutator brushes are free in their holders.
8. Install the motor brush/commutator covers with two screws on each cover.
9. Install the motor cover (Item 180).
10. Operate the switch machine motor to determine if the brushes are properly installed.

### 5.6.3 Installation of Motor

To install the motor, perform the steps below. See Figure 7-1.

1. Lower the motor bracket onto the base of the switch machine so that the pinion end of the motor is inserted through the motor shaft opening.

2. Position the motor so that the pinion is mated properly with the reduction gear.

3. Align the mounting holes in the motor bracket at commutator end with the holes in the base of the switch machine.

4. Insert two 1/2" x 2" hex head cap screws (Item 380) and two associated 1/2" plain lock washers in the motor's mounting bracket (commutator end).

5. Reattach the wires to the motor connections.

6. Install the motor cover (Item 180).

### 5.6.4 Installation of Friction Clutch Assembly

#### 5.6.4.1 General

Proceed as follows, while making reference to Figure 5-1.

1. Before assembly, check that the friction disks (Item 6) are free of oil. If the disks are oily, check for oil that might be entering along the shaft.

2. If oil is entering along the shaft, replace the felt packing in the clutch housing. Refer to Section 5.6.4.2 for the replacement procedure. If oil is not entering along the shaft, continue with Sections 5.6.4.2 and 5.6.4.3.

#### 5.6.4.2 Application of New Felt Packing in Clutch Housing

To apply new felt packing in the clutch housing, perform the following steps. See Figure 5-2.

1. Measure the length of the clutch spring before disassembling, and record this dimension for use during reassembly.

2. Swing the terminal board out of the way; remove the adjusting nut and clutch spring, and slide the clutch housing off the shaft.

3. Remove the disks and plates.

4. Remove the old packing and clean the shaft and the inside of the clutch housing with a non-flammable grease solvent.

5. Apply two new felt washers, US&S part no. J047335, to the housing recess and assemble the press-in oil seal.

6. Coat the rubbing surfaces of packing rings with gearbox lubricant.

7. Attach the housing to the shaft.

8. Clean the excess lubricant from the shaft surface inside the clutch space. Old fabric discs should be discarded and replaced. Old clutch plates should be thoroughly cleaned in a non-flammable grease solvent to remove any accumulation of lubricant, and then reassembled as shown in Figure 5-2. Note that a fabric disk goes in the bottom of the housing. The first metallic disc has the teeth engaging the shaft.

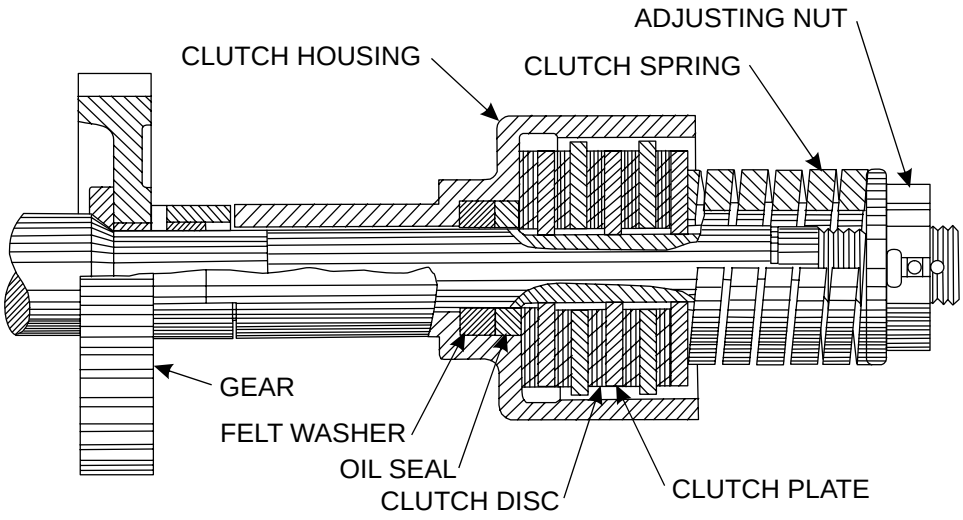



**Figure 5-2. - Friction Clutch Assembly**

### 5.6.4.3 Assembly of Friction Clutch

To assemble the friction clutch, perform the following procedure. See Figure 5-1.

1. Install the gasket (Item 1) in the gearbox opening.

2. Install the plate (Item 2) with two 1/4-20 x 3/4" hex head cap screws (Item 13).

3. Align the tubular neck of the clutch assembly and the worm shaft (Item 12).

4. Insert the tubular neck of the clutch assembly partially over the worm shaft and through the gearbox bushing.

5. Align the three-finger end of the tubular neck with the matching slots in the clutch gear hub.

6. Push the tubular neck into the gear hub slots until the neck/hub is in the clutch gear hub.
7. Push the tubular neck into the gear hub slots until the neck/hub is solidly engaged.
8. Install the following items on the worm shaft as follows:
    a. Insert the clutch disc until it sets against the inner wall of the clutch housing.
    b. Insert the clutch plate in the groove on the worm shaft until it mates with the clutch disc.
    c. Insert another clutch disc.
    d. Insert another clutch plate.
    e. Repeat Steps c and d for three remaining clutch discs and two remaining clutch plates.
    f. Insert the clutch end plate on the worm shaft.
9. Slide the clutch spring over the worm shaft until it rests against the clutch end plate.
10. Install the clutch adjusting nut on the worm shaft.
11. Tighten the clutch adjusting nut in accordance with the friction clutch adjustment procedures.
12. Recheck this adjustment after a brief wearing-in period.

#### 5.6.4.4 Friction Clutch Adjustment

**NOTE**

The friction clutch adjustment should be checked to ensure that the clutch slips at a torque that is adequate to carry normal operating loads, and also protects the mechanism from shock. For proper operation of the overload relay, the clutch must be set to slip at a current value above the minimum current rating of the relay; otherwise no protection will be obtained.

1. Attach a temporary jumper across the binding posts of the pick-up coil on the overload relay.

**NOTE**

If a bridge rectifier is used, all 6-1/4 amp Fusetrons on the 110Vdc side of a bridge rectifier should also be temporarily jumpered out

2. Insert an ammeter in the motor circuit as follows:

a. Connect the negative ammeter lead to binding post A on the switch machine terminal board.

b. Connect the positive ammeter lead to binding post 5 or 10, depending upon the switch point position.

c. Read the motor current with the clutch slipping. The meter should show 14 amps, +/-10%. A variance of approximately 1 to 3 amps may exist due to mechanical alignments and motor characteristics. The current should be checked in both directions.

d. If the current reading is out of specification, remove cotter and screw the friction clutch spring adjusting nut (see Figure 5-2) in or out to obtain desired current.

e. Remove temporary jumper(s).

### 5.6.5 Installation of Circuit Controller

Perform the procedure in Section 5.6.5.1, while making reference to Figure 7-1.

#### 5.6.5.1 General

1. Lower the circuit controller into the circuit controller compartment.

2. Align the mounting holes.

3. Reinstall the two screws (Item 410) and 3/8" lock washers in the holes nearest the motor compartment.

4. Reinstall the plate (Item 30), two 1/2"-13 x 1" hex head cadmium-plated steel cap screws (Item 20), and washers (Items 410, 730) between the point detector cranks.

5. With the wire harness in clamps, reinstall the four wire clamps with four 5/16" x 1-5/8" fillister head machine screws (cadmium plated) and four 5/16" plain steel lock washers (extra heavy, tin plated).

6. Refer to the tags and reattach the harness wires to correct the circuit controller terminals and the heater connections.

7. Tighten all screws securely and make sure the gearing on the circuit controller meshes properly with the crank teeth on the movement lock box.

8. Using the hand crank, operate the movement to the end of its stroke. This places the slide bar and lock box toward the motor.

9. Make sure the circuit controller shaft assembly is in the angular position as shown in section Y-Y of Figure 7-4, checking specifically the relation shown in the schematic diagram for setting of

segments for contacts 24 - 25 and 26 - 27. This should place the cam block (Item 57) of the main shaft gear (Item 56) in the position shown in Figure 7-4. The next move should rotate the cam block away from, rather than into, the pinion gear (Item 59).

10. Install three of the circuit controller frame hold-down bolts, but do not tighten.

11. Using the hand crank, operate the movement slowly, checking that the cam block moves in the proper direction.

12. Before tightening the circuit controller frame hold-down bolts, check that full stroke controller shaft rotation gives symmetrical contact relationship at both ends of the stroke. Shift the gear tooth engagement, if necessary, to obtain this condition.

13. Install and tighten all hold-down bolts.

**CAUTION**

When removing the old circuit controller, the movement must be hand cranked. Also, the lock box must be toward the motor end before installing the circuit controller into the switch movement, otherwise the controller may be damaged.

### 5.6.5.2 Motor Control Contact Adjustment

The motor control contacts are set at the factory to ensure that the switch machine is locked in accordance with AAR specifications. Ordinarily, readjustment should not be required as long as the assembly remains undisturbed. If an adjustment is required, proceed as follows. See Figure 3-8.

1. Clean and degrease the contacts with a suitable cleaner.

2. With the machine in an unlocked position, insert a 1/2” +0”, -.01” x 2” x 24” steel bar into the lock rod slot.

3. Turn the clutch housing by hand until the lock dog bears against the 1/2” wide bar. In this position, the machine is fully locked.

4. Connect an ohmmeter or test light across one of the appropriate control contacts.

5. Loosen the nuts that hold the V end of finger Fl (Figure 3-8) and slide the finger in or out until a point where any additional cam rotation will open the contact.

6. Retighten the nuts. When a 15/32” +0”, 2” x 24” steel bar is used for this test, the contacts should be open.

7. Repeat the procedure for the other three motor control contacts. Check to see that adjacent control contacts open simultaneously.

Contact finger Fl should be adjusted to bear against the segment with 2 to 2-1/2 lbs. pressure while finger F2 is held clear.

1. Adjust finger stop F1a to have 1/32" ±1/64" clearance from finger F1 when the latter is riding the segment.

2. Adjust finger F2 to bear on finger Fl with 1-3/4 to 2 lbs. pressure when finger Fl is on the segment.

3. Adjust stop F2a to clear finger F2 by 1/32" ±1/64" when the contacts are closed as shown in sections W-W and X-X. This also permits finger Fl to clear finger F2 by 1/16" minimum when contacts are open as shown in sections Y-Y and Z-Z.

4. Adjust finger F3 to bear on the segment with 1-3/4 to 2 lbs. pressure.

### 5.6.5.3 Contact Pressures and Clearances

Contact pressure and clearances must be in accordance with Sections P-P and N-N of Figure 3-8. These clearances are obtained by performing the following procedure:

1. With the switch machine at the end of stroke to enable the roller to drop into the cam notch, adjust the reinforcing spring (Item N) by relieving tension with a spring bender to break away from the contact spring at a load of 8 to 11 pounds.

2. Check that clearance between the cam and the roller with the roller in the cam notch is 3/64" to 5/64". If not, readjust the reinforcing spring to obtain the correct clearance and recheck the reinforcing spring breakaway load to make sure it is not greater than 11 pounds or less than 8 pounds.

3. Check that the slotted ends of the contact springs (Figure 3-8, Item M) are in alignment, bear evenly on fixed contact (Item W) and on the short circuiting strip, and both contact springs of each pair make and break at the same time. It may be necessary to slightly bend the contact fingers to meet this requirement.

4. Check for a 1/8" minimum space between the end of the indication contact spring (Item M) and the short circuiting strip. Check for 3/64" minimum clearances between the spring (Item M) and the fixed contact, and between the spring (M) and the short circuiting strip. No adjustment should be necessary to obtain these dimensions if the spring (Item M) is adjusted properly.

5. With contacts at indicating position, check the gap clearances at section Y for 3/64" to 5/64", and check the contact pressure between the indication contact spring (Item M) and the fixed contact with spring scale at section X to see if the pressure is 1-1/2 pounds to 2-1/4 pounds. Adjust the reinforcing spring breakaway load if necessary to meet these requirements and recheck to make sure it is not greater than 11 pounds or less than 8 pounds.

6. With contacts made against the short circuiting strip, check at the front end of the contact fingers with a push scale for a load of 1-1/2 pounds to 4 pounds.

## 5.7 Lubrication

Before leaving the factory all working parts of the machine except the worm gear compartment are well lubricated. Unpainted and unplated parts are coated with a special lubricant designed to protect these parts against corrosion until installation. This lubricant need not be removed since it will mix readily when new lubricants are added.

For best results, only lubricants complying with strict specifications are recommended. The recommended lubricants can be purchased in convenient quantities from US&S. Additionally, for optimum performance of the gear box, remove the lubricant the from the gear box, clean the gear box, and refill it to the recommended level at least every five years.

**CAUTION**

Lubrication at proper intervals is essential to ensure proper equipment operation. **Do Not Permit Grease Or Oil To Enter Spring End Of Friction Clutch, Otherwise Friction Clutch May Malfunction**.

Figure 5-3 identifies the areas of the switch machine that need lubrication. These points and the proper lubrication are further described in Table 5-5. The following steps present the general lubrication requirements for the switch machines.

a. Apply pressure gun grease.
    1. Point detector bar bearings (use gun on grease fittings).
    2. Operating bar wearing plates (use gun on grease fittings).
    3. Selector and hand-throw lever shaft bearings (use gun on grease fittings).
    4. Surfaces of slide bar and lock box and rack G, using brush or paddle for application (a heavy oil, viscosity 120-200, (SAE-140) may be used as an alternate on these surfaces).
    5. Circuit controller trunnions (use gun on grease fittings).

b. Apply medium body motor oil viscosity 54.4°C 185-220 (SAE-30), to the following parts:
    1. Yoke bearings and point detector linkage.
    2. Spur gear journals (machines are equipped with Oilite bushings).
        a. Holes in box casting.
        b. Holes in reduction gears and in clutch gear.

**Note**

Oil should be applied sparingly to clutch gear bearing to prevent seepage through clutch shaft packing to the friction discs.

3. Main crank shaft – remove oil plug in top cover. Oil will collect in a recess and be led to shaft surfaces needing lubrication.
4. Linkage connections for motor cutout.
5. Fill recess on top crank bearing.

c. Apply a light oil (See Table 5-5).

1. To contact segments of indication circuit controller (segments and contact springs should be thoroughly cleaned before application).
2. Sparingly to motor commutator if brushes chatter.

d. From the container shipped with the machine, apply the gear lubricant (See Table 5-5). This is a low-temperature all-weather lubricant that has little change in consistency with temperature variations. It will retain its lubricating properties at the highest temperatures encountered and not become so stiff at low operating temperatures as to require thinning. (If sustained abnormally low temperatures are anticipated, a special lubricant may be ordered. Contact your salesman or the Engineering Department for an ordering reference number.)

1. Apply a light coat of gear lubricant to spur gear teeth. The gear lubricant must be packed well around the worm gear and the selector clutch in the worm gear compartment. It must be replaced as necessary to keep the worm gear covered.

Scheduled lubrication is recommended; however, the period between times of lubricating depends upon the frequency of operation and upon climatic and local conditions, and therefore can be established from experience with the switch machine and its specific operation.

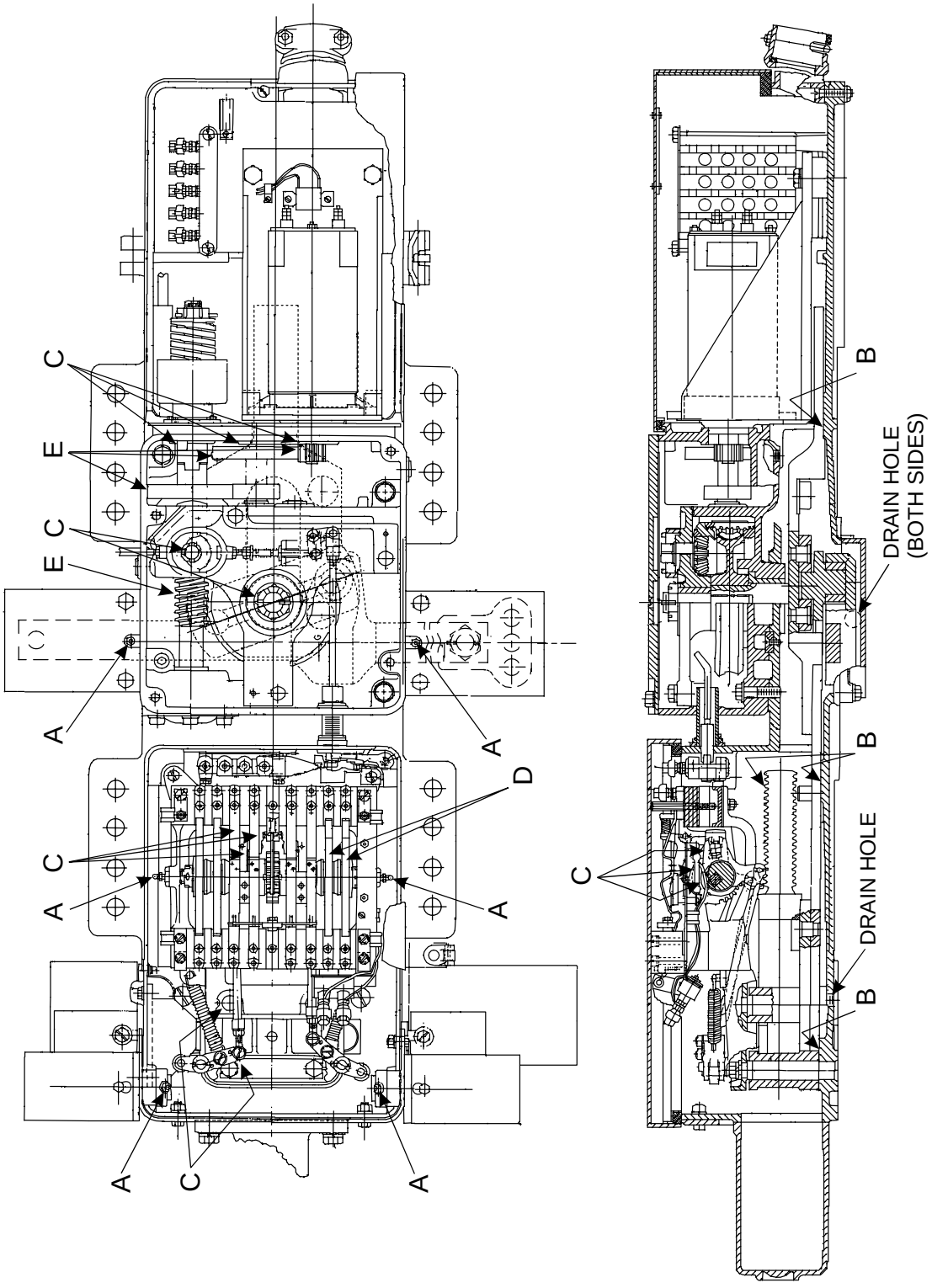



**Figure 5-3. - M-3 Switch Machine Lubricants and Lubrication Points**
(Refer to Table 5-5.)

**Table 5-5. - Preventive Maintenance Schedule**

| Point of Application | Type of Lubricant | Suggested Commercial Products | Method | Apply To | Remarks |
|---|---|---|---|---|---|
| A | Pressure Gun Grease | Alemite Solidified Oil #32 (Alemite Temprite) Solidified Oil E.P. (Prime Mfg. Co.) | Grease Gun | Grease Fittings | Apply until surplus is visible at edges of bearing |
| B | Either Pressure Gun Grease OR Heavy Oil (Viscosity120 to 200 at 99°C) | Same as above | Grease Gun | Surface | |
| | | Auto. Transmission and rear end lubricant S.A.E. 140 (Texaco Novatex) | Pour | Surface | |
| C | Medium Body Oil (Viscosity 185 to 220 at 54°C) | Automobile Engine Oil S.A.E. 30 | Oil Can | Bearings & Oil Holes | A few drops periodically as required |
| | | | Pour | Recess on top crank bearing | Fill recess periodically as required |
| D | Low Temperature Oil | Low Temperature Lubricating Oil (Texaco Spindura Oil 22, Code 788) | Oil Can | Surface | Apply very light film to all contact segments at frequent intervals after thorough cleaning |
| E | Low Temperature Lubricating Oil | Lubriplate 5555 (Fiske Brothers Refining Co.) | Pour | Spur Gear Teeth | Apply light coat to teeth as required |
| | | | | Worm Gear Compartment | Pour in. Fill only to top of worm gear |

Regular and systematic lubrication is recommended. However, the period between times of lubricating depends upon the frequency of operation and upon climatic and local conditions, and therefore can be established from experience by the Supervisory Department.

## 5.8 Adjustments

### 5.8.1 Point Detector

Point detector rollers should be maintained to clear the small diameter of the point detector bar by not more than 0.03 in. If necessary, adjust the screwing eyebolts (19) (Figure 7-4) in or out [screws (67)] must first be removed.

1. Use point detector gauge N295326 (Figure 5-4) to check latch operation in normal and reverse switch positions.
2. Ensure that the point detector latching mechanism is unlatched, i.e., the latch must be clear to allow the yoke to rest against the yoke stop (see Figure 5-5).
3. Check that the space between the point detector roller and the bevel of the point detector bar is sufficient to permit the insertion of the feeler gage (Figure 5-5). If not, adjust the point detector bar per Section 2.4.
4. Pry the point detector roller out of the way and insert the sleeve gage over the narrow diameter of the point detector bar (Figure 5-7). The sleeve gauge must be tight against the bevel of the point detector bar. The insertion of the sleeve lifts the connecting rod and rotates the yoke so that the latch snaps over the top of the yoke midsection.
5. Swing the latch so that the yoke clears the latch and rests against the yoke stop.
6. Release the latch. The latch must clear the yoke and snap over the top of the yoke midsection. If not, adjust the point detector bar per Section 2.4.
7. Remove the sleeve gage from the point detector bar. With the mechanism latched, all indication contacts should be in the open position (Figure 5-7).
8. Add a sufficient amount of shims as required to enable latch to clear the top of the yoke in both switch positions and latch properly. Check indication contacts in latched positions to ensure that they are open a minimum of 0.05 in..

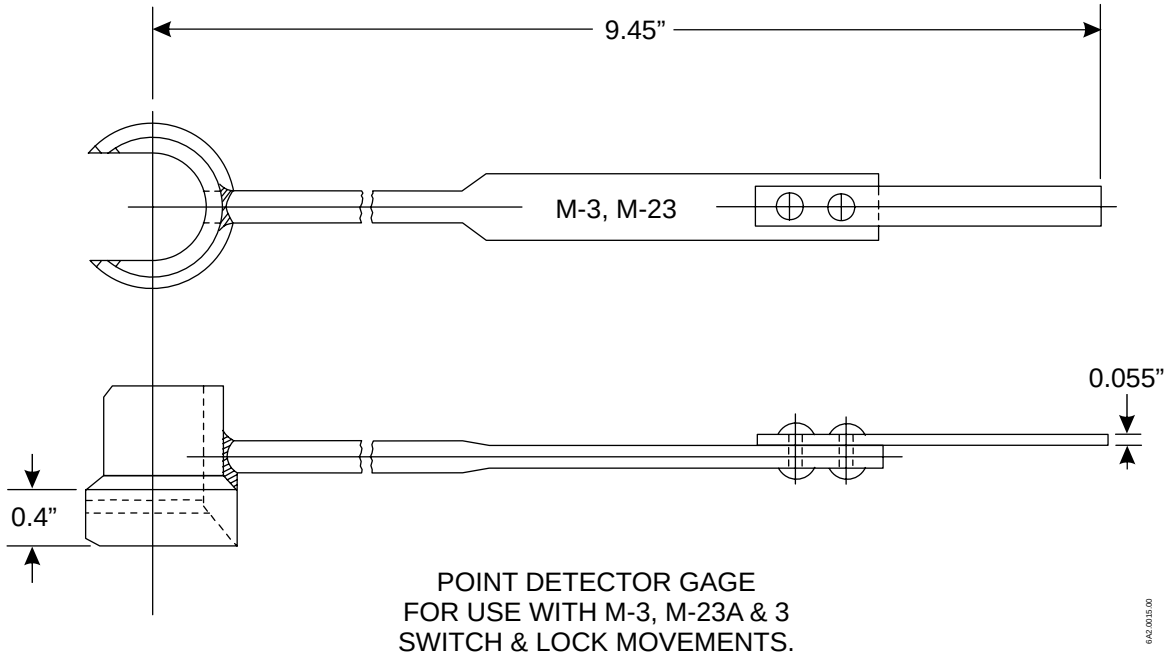



**Figure 5-4. - Point Detector Gage N295326**

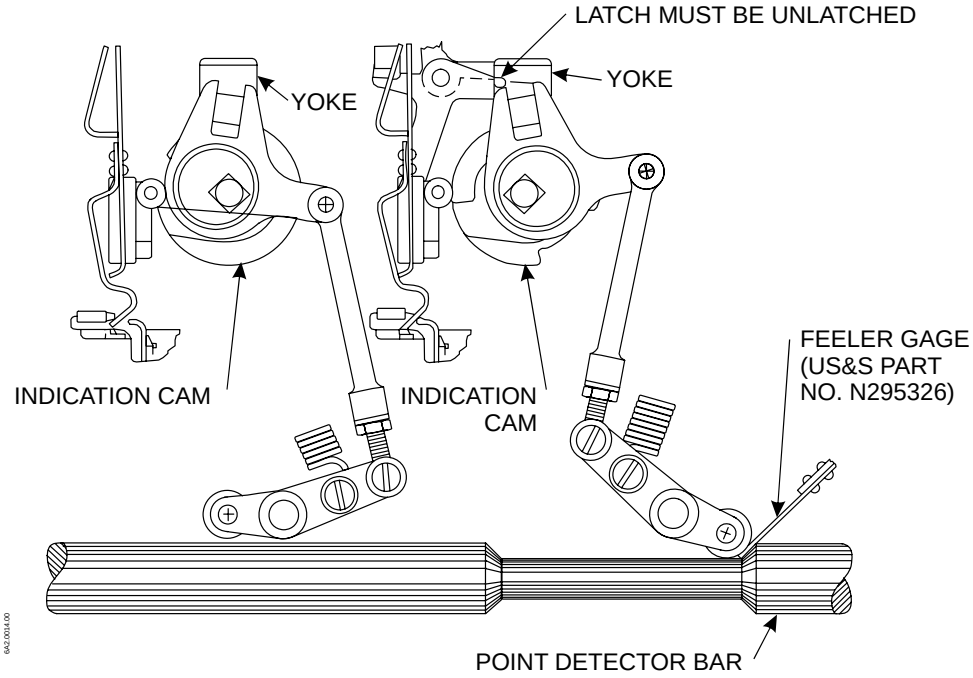



**Figure 5-5. - Latch in Unlatched Position**

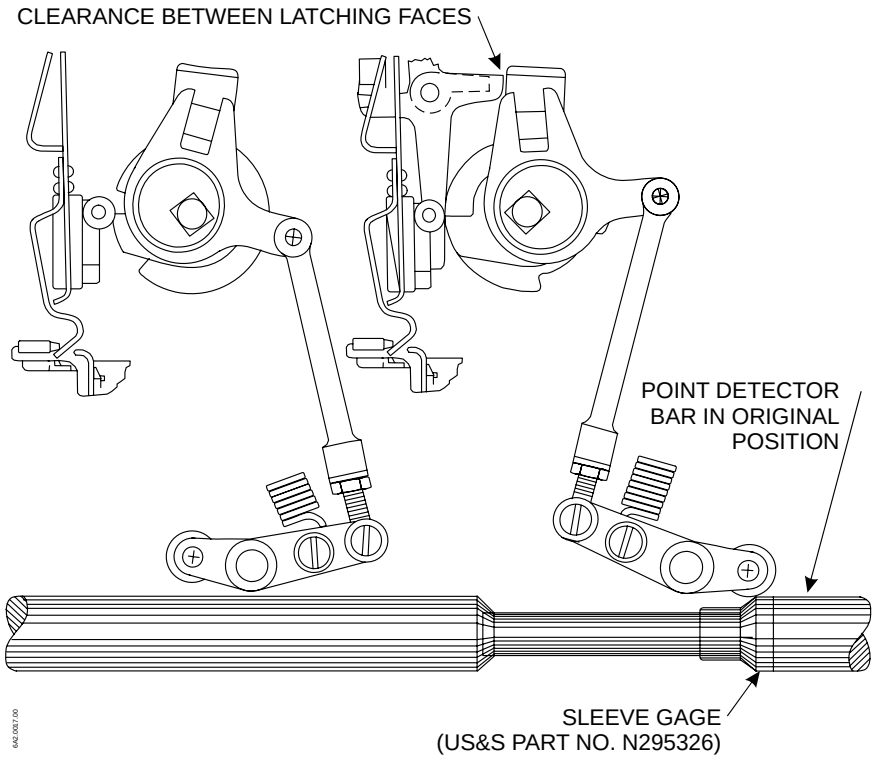



**Figure 5-6. - Inserting the Sleeve Gage**

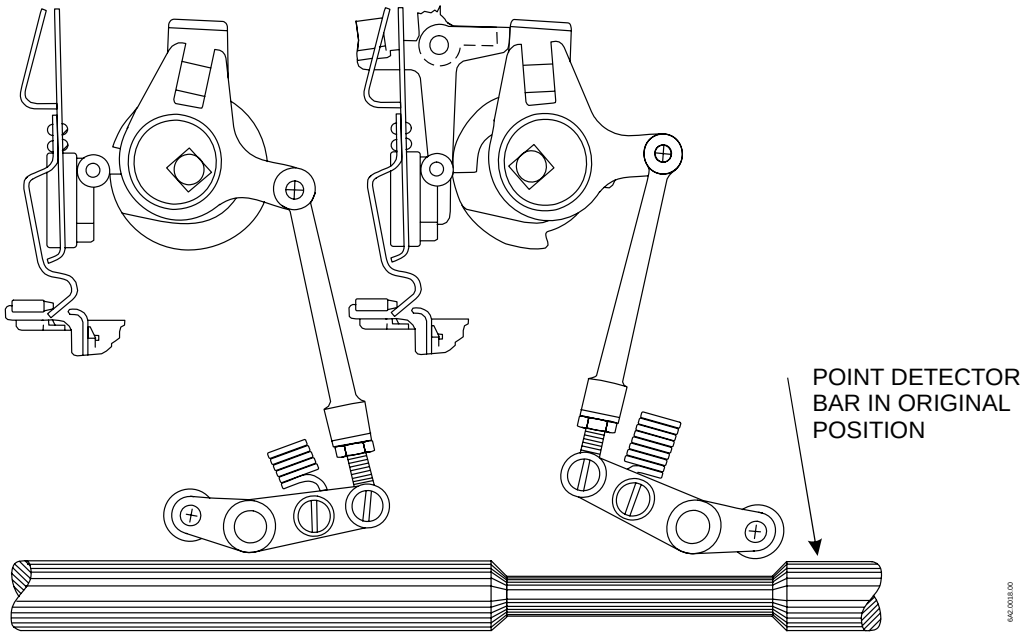



**Figure 5-7. - Contacts Latched Out and in the Open Position**

### 5.8.2 Motor Cutout Contacts

Adjust the length of push rod (A) so that when the hand crank cover hasp is in the notch in the pad lock staple, the yoke (B) is against the machined stop surface on the top bearing (C). It is necessary to take off the gearbox cover to check that the yoke is against the stop.

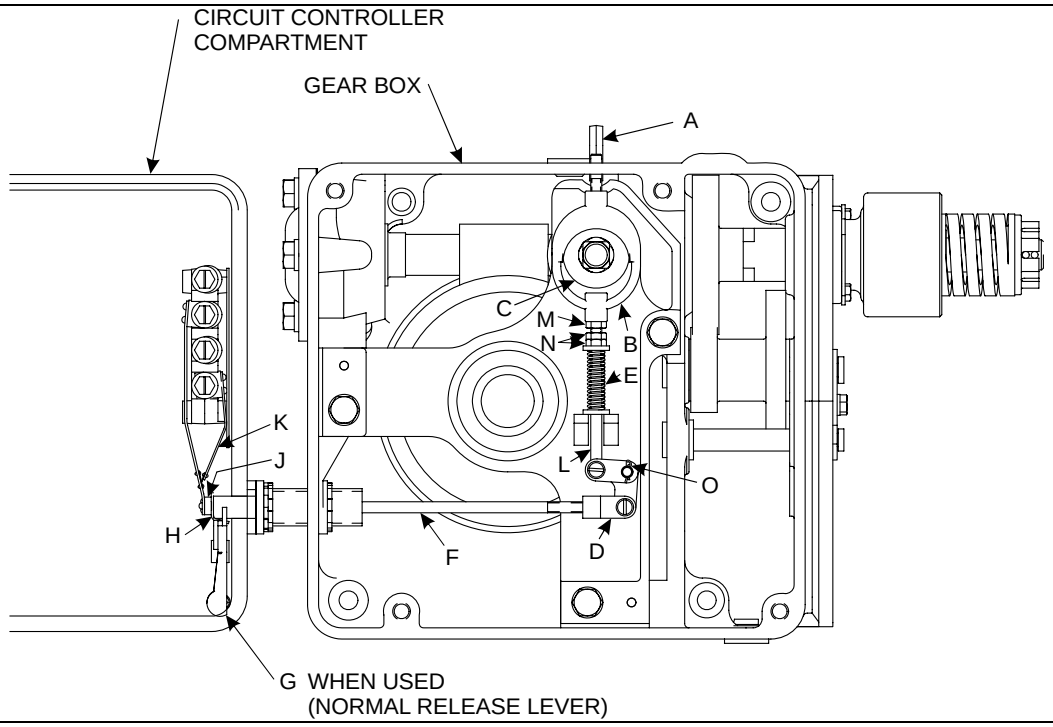
Assemble eyebolt (L) to yoke (B) so that threaded end of eyebolt is just flush or one thread below surface of boss on yoke (B). Tighten nut (M). Adjust nuts (N) so that there is a space of 3/8-in. to 7/16-in. between nuts (M) and (N). Lock nuts (N) in place.

Remove the screw from the screw jaw (D) with the spring (E) driving the yoke (B) against the other side of the top bearing (C). Adjust the length of the push rod (F) by turning the screw jaw (D) so that the latch (G) clears the "L" shaped bracket (H), attached to the motor cutout contact insulation (J), by 1/16-in. or slightly over.

With the hand crank cover closed and hasp in the staple notch, adjust the contact springs (K) so that there is 1/16-in. clearance between the angle bracket (H) and the push rod (F). With this clearance the contacts will be closed with a pressure of approximately three pounds. In order to adjust the contacts, a "T" shaped spring bender (Figure 5-9) is required to get at the bottom contact. (See Table 5-4).

**CAUTION**

Use of a padlock on the gearbox hasp with a shackle diameter of less than 3/8-in. may result in the motor cutout contacts opening if the hasp is disengaged from the notch in the staple.




| Item Number | Description |
|---|---|
| A | Push Rod |
| B | Yoke |
| C | Bearing |
| D | Screw Jaw |
| E | Spring |
| F | Push Rod |
| G | Latch |

| Item Number | Description |
|---|---|
| H | Bracket |
| J | Contact Insulation |
| K | Contact Spring |
| L | Eyebolt |
| M | Nut |
| N | Nuts |
| O | Cotter Pin |

**Figure 5-8. - Adjustment of Motor Cutout Contacts**

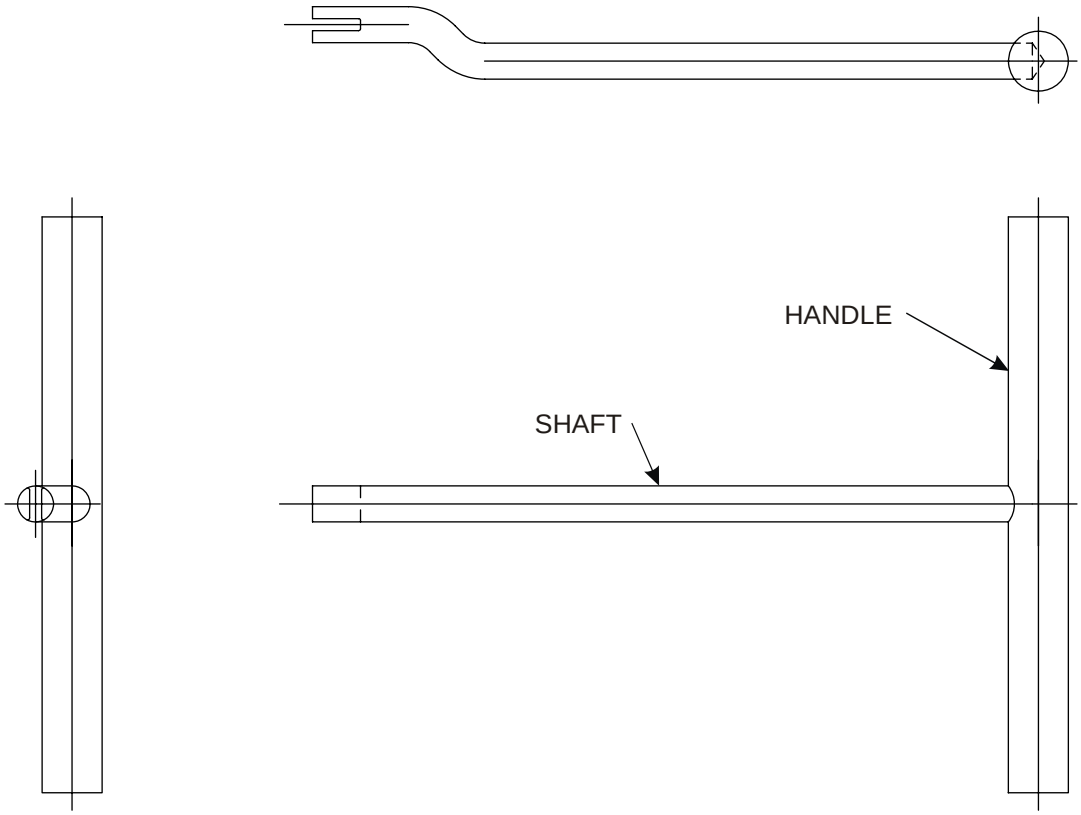



**Figure 5-9. - T-Shaped Spring Bender (R439056)**

# 6. Troubleshooting

Table 6-1 presents troubleshooting information for the M-3 switch machine. Because it is impossible to foresee or predict all possible problems with the machine, these troubleshooting steps address the most common problems that occur with an M-3 switch machine.

**Table 6-1. - Troubleshooting the M-3 Switch Machine**

| Problem | Cause | Solution |
|---|---|---|
| Motor power is present from the wayside yet motor does not run. | A. Hand crank cover is in the open or un-locked position. | 1. Close the hand crank cover such that the hasp is in the staple recess.<br>2. Depress the motor cutout contact restoring the latch in the circuit controller compartment. |
| | B. Motor cutout contacts are open. | 1. Confirm that the hand crank cover, located on the gear box cover, is closed and that the hasp is in the staple notch.<br>2. Depress the motor cutout contact restoring latch in the circuit controller compartment.<br>3. Check adjustment of motor cutout contacts. Readjust per Section 5.8.2 and Figure 5-8. |
| | C. Motor cutout contacts are broken | 1. Visually inspect the motor cutout contacts and if they are broken or cracked, replace them.<br>(This is **not** recommended as a field service procedure and should be done in the Service Shop only)<br>2. Remove the wire leads from the motor cutout and the circuit controller.<br>3. Remove the hardware and lift out the circuit controller. Refer to Section 5.5.4 and Figure 7-1.<br>4. Remove the hardware from the cutout contact assembly.<br>5. Install a new motor cutout contact assembly.<br>6. Adjust per Section 5.8.2.<br>7. Reinstall circuit controller. Refer to Section 5.6.5. |
| | D. Wire harness is severed or wire terminals are loose or broken. | 1. Perform a “point to point” continuity test on each wire lead. Tighten any loose connections and replace damaged wire(s) or terminal(s). |
| | E. Motor control contacts are out of adjustment, damaged, or broken. | 1. Confirm the contact pressure. Refer to Section 5.8.2.<br>2. Replace any damaged contact spring(s). |

| Problem | Cause | Solution |
|---|---|---|
| | F. Motor stopped running. | 1 Check for sufficient brush length and that motor commutator is smooth and free of grease. Refer to Section 5.6.2.<br>2. Replace the motor brushes. Refer to Section 5.6.2.<br>3. If Steps 1 and 2 do not restore motor operation then replace the motor. Refer to Section 5.5.2 for motor removal. |
| | G. General failure of the circuit controller. | 1. Remove the switch machine from service and take it to a service shop for an overhaul or replacement of the circuit controller. Refer to Section 5.5.4. |
| Motor runs but not in the proper direction causing the friction clutch to slip. | A. Incorrect motor polarity. | 1. Reverse the motor wires. Refer to the Control Wiring Diagrams, Figure 2-7 and Figure 2-8. |
| | B. Control circuit is incorrect. | 1. Check all wiring connections against the circuit diagram. |
| Switch machine operates and locks, however no indication is given. | A. Indication contact springs are out of adjustment. | 1. Confirm contact spring pressures and gaps. Refer to Section 5.6.5.3. |
| | B. Indication contact springs broken. | 1. Replace with new indication contact spring assemblies. Refer to Section 5.6.5.3. |
| | C. Obstruction between switch points and stock rail. | 1. Remove the obstruction. Check for damage to the switch points, layout connecting rods, and switch machine.<br>2. Cycle the switch machine several times to confirm normal operation of the switch machine. Confirm that the switch points are against the stock rail. |
| | D. Point detector bar is broken. | Replace the point detector bar as follows. (Refer to layout drawing)<br>1. Remove the connection to the point detector connecting rod.<br>2. Remove the broken point detector bar.<br>3. Check the switch machine for any visible signs of damage.<br>4. Replace with a new point detector bar. The bar must slide freely in its bushings.<br>5. Reconnect the point detector bar to the point detector connecting rod.<br>6. Readjust the point detector bar to both near and far closed switch points. |
| | E. Point detector bar is out of adjustment. | 1. Readjust the point detector bar. Refer to Section 5.8.1 |

| Problem | Cause | Solution |
|---|---|---|
| | F. Point detector connecting rod is broken. | Replace the point detector connecting rod as follows:<br>1. Remove the connection at the switch machine.<br>2. Remove the connection at the layout point detector lug.<br>3. Replace and reconnect the connecting rod to the point detector lug and the switch machine point detector bar.<br>4. Readjust per Section 5.8.1. |
| | G. The latch out device was not reset from a prior incident. | 1. Reset the latchout device in the circuit controller compartment. |
| | H. The rail braces are loose allowing for movement of the stock rail. | 1. Tighten the rail braces. |
| Switch machine operates, however the machine does not lock – clutch slips. | A. Lock rod connecting rod is out of adjustment. | Adjust the lock rod as follows:<br>1. Close the far switch point.<br>2. Loosen the hardware to allow for independent movement of the lock rods.<br>3. Adjust the lock rod so that the notch in the lock rod assembly is roughly centered about the lock box dog. Refer to Figure 3-2 and Figure 3-3.<br>4. Tighten the connecting rod hardware for the far point connection.<br>5. Repeat the above process for the near point side.<br>6. Tighten the lock rod assembly hardware to lock the adjustment. |
| | B. Lock rod connecting rod is broken | Replace the lock rod connecting rod as follows:<br>1. Remove the field side jam nuts at the threaded end of the lock rod connecting rod assembly.<br>2. Remove the jam nuts at the threaded end of the switch machine internal lock rod assembly.<br>3. Hand crank the switch machine to its mid-stroke position.<br>4. Remove and replace the lock rod connecting rod assembly.<br>5. Replace all hardware removed above.<br>6. Readjust per the lock rod adjustment solution above. |

| Problem | Cause | Solution |
|---|---|---|
| | C. Switch machine internal lock rod assembly is out of adjustment. | Adjust the lock rod assembly as follows:<br>1. Close the far switch point.<br>2. Loosen the hardware to allow for independent movement of the lock rods.<br>3. Adjust the lock rods so that the notch in the lock rod assembly is roughly centered about the lock box dog. Refer to Figure 3-2 and Figure 3-3.<br>4. Tighten the connecting rod hardware for the far point connection.<br>5. Repeat the above process for the near point side.<br>6. Tighten the lock rod assembly hardware to lock the adjustment. |
| | D. Switch machine internal lock rod assembly is broken. | Replace the internal lock rod assembly as follows:<br>1. Loosen the jam nuts that lock the position of the threaded end of the lock rod connecting rod to the front rod assembly lug.<br>2. Hand crank the switch machine to its mid-stroke position.<br>3. Separate the lock rod connecting rod from the switch machine lock rod assembly.<br>4. Remove the lock rod assembly from the field side of the switch machine.<br>5. Replace the lock rod assembly with a new lock rod assembly. Refer to Table 7-1 and Figure 7-1.<br>6. Reconnect the lock rod assembly to the lock rod connecting rod. Refer to Table 7-1 and Figure 7-1.<br>7. Readjust per the lock rod adjustment solution above. |
| | E. Obstruction between the switch points and the stock rail. | 1. Clear out any obstructions.<br>2. Cycle the switch machine several times to ensure normal operation.<br>3. Inspect the layout and switch machine for signs of damage. |
| | F. Switch machine mounting hardware is loose. | 1. Tighten all mounting hardware. |
| | G. Friction clutch discs have become contaminated. (oil, grease, etc.) | 1. Replace all clutch plates and discs. See service manual for instructions. Section 5.5.3 and Section 5.6.4. |

# 7. Parts Lists

## 7.1 Switch Machines N4511601401 and N4511601501

Table 6-1 is the parts list for the left-hand model (N4511601401) and the right-hand model (N4511601501) of the M-3 switch machine. The figure associated with this table is Figure 7-1.

**NOTE**

The right-hand model (N4511601501) of the switch machine is identical to the left-hand model, except that Item 75 (Operating Bar) and its attached components are mounted on the direct opposite side of the machine. Item 580 (Lock Rod Cover) is also mounted on the opposite side of the right-hand machine..

**Table 7-1. - Switch Machines N4511601401 and N4511601501 Parts List**

| Item Number | Description | Part Number |
|---|---|---|
| 5 | Machine Base Assembly | N4511601601 |
| 10 | Motor Assembly (Subsection 7.4 - Parts List) | N4511611701 |
| 15 | Circuit Controller (Section 7.3 - Parts List) | N4518170501 |
| 20 | Screw, 3/8-16 x 1-1/4", Hex Hd | J507372 |
| 25 | Name Plate, Aluminum | J063117 |
| 30 | Plate, 1/8" x 1" CF Steel | M146595 |
| 35 | Plate, Wrap-around | M4511612201 |
| 40 | Lug | M4516144502 |
| 45 | Screw, 1/2-13 x 1/2" Rd Hd | J507366 |
| 50 | Roller, CF Steel Rd | M108315 |
| 55 | Roller, 1-3/4" Steel | M074737 |
| 60 | Bar, Locking | N178100 |
| 65 | Slide Bar Cam | R146444 |
| 70 | Roller, 2-1/8" Steel Alloy | M061066 |
| 75 | Operating Bar | M146441 |
| 80 | Lug, Switch Point | M146443 |

**Table 7-1. - Switch Machines N4511601401 and N4511601501 Parts List**

| Item Number | Description | Part Number |
|---|---|---|
| 85 | Wearing Bracket | M189024 |
| 90 | Key, 3/8” x 1” Steel | M146782 |
| 95 | Tubing - Fiber, 1-1/4” I.D., 30” Long | J034625 |
| 100 | Conduit, Outlet Component | N238223 |
| 105 | (Not Referenced) | - - |
| 110 | Bolt, 3/8-16 x 8”, Hex Hd | J507369 |
| 115 | Support, Terminal Board CI | M172662 |
| 120 | Push Rod, Component | N180861 |
| 125 | Strap, 1/8” x 7/8” Steel | M162242 |
| 130 | Contact, Motor | N226029 |
| 135 | Bolt, 7/8”, 9 x 3, Hex Hd | J460113 |
| 140 | Pipe, SMLS Steel Tubing | M146723 |
| 145 | Gasket, 1/4” Felt | M147398 |
| 150 | Washer | M147409 |
| 155 | Cover, Slide Bar, Cast-Iron | M074911 |
| 156 | Component, Formagasket #2 | J041505 |
| 160 | Cover, Circuit Controller | N4511612701 |
| 165 | Hood, 0.0677 x 48 x 120 Steel | M148141001 |
| 170 | Cover, End Closed | R159272 |
| 175 | Cover, Crankcase Bottom | R4511613501 |
| 180 | Cover, Motor | N4511613801 |
| 185 | Clip, Cable Burndy #CH18 | J700934 |
| 190 | Washer, #10, Flat Steel Commercial | J475077 |
| 195 | Washer | M002423 |
| 200 | Washer | M286594 |
| 205 | Spring, Steel for Lk Movement | M181001 |
| 210 | End Cover, Component | N439013 |
| 215 | Screw, Locking | N242122 |
| 220 | Protector, Snow | M4511613402 |
| 225 | (Not Referenced) | - - |

**Table 7-1. - Switch Machines N4511601401 and N4511601501 Parts List**

| Item Number | Description | Part Number |
|---|---|---|
| 230 | Spring, Compression | J680204 |
| 235 | Cover, Point Detector | PN4511613204 |
| 240 | (Not Referenced) | - - |
| 245 | Nut, Lock, 2-1/8” Steel Rd | M223351 |
| 250 | Collar, 2” Rd CF Steel | M074741 |
| 255 | Nut, 1/8” Jam | M074742 |
| 260 | Operating Crank | M071158 |
| 265 | (Not Referenced) | - - |
| 270 | Washer | M067454 |
| 275 | Cover, Crankcase | N4511612402 |
| 280 | Cut-out, Trigger Component | N146670 |
| 285 | Stud, 5/16” Steel Rd | M146675 |
| 290 | Nut, 5/16-18 UNC-2B Jam | J048007 |
| 295 | Latch, C Brass Cut-out | M186209 |
| 300 | Stud, 1/4” Steel Hex | M181032 |
| 305 | Harness | N4518170401 |
| 310 | Lead | N281552 |
| 315 | (Not Referenced) | - - |
| 320 | Terminal Connector | M120343 |
| 325 | Terminal Connector | M022725 |
| 330 | Clamp, Harness | J703005 |
| 335 | Bushing, Point Detector | M4511611801 |
| 340 | Bar, Lock Bearing | M4511613607 |
| 345 | Washer, W-08, SK Lock | J047821 |
| 350 | Fitting, 1610 Alem Hyd | J039137 |
| 355 | Lug, Bung Cap W-14X | J320015 |
| 360 | Rivet, 1/8” x 1/4” Rd Hd, Aluminum | J049910 |
| 365 | Screw, 1/4-20 x 3/4” Fil Hd | J052025 |
| 370 | Screw, 10-32 x 9/16” Fil Hd | J522151 |
| 375 | Screw. 3/8-16 x 1-1/4” Hex Socket | J0523620003 |
| 380 | Screw, 1/2-13 x 2”, Hex Head | J050098 |

**Table 7-1. - Switch Machines N4511601401 and N4511601501 Parts List**

| Item Number | Description | Part Number |
|---|---|---|
| 385 | Screw, 1/2-13 x 3/4", Hex Head | J050086 |
| 390 | Screw Cap, 1/2-13 x 1", Hex Head | J050088 |
| 400 | Screw, 1/2-13 x 1-1/2", Hex Head | J050092 |
| 405 | Screw, 1/2" x 1-1/2", SCH | J050236 |
| 410 | Washer, 3/8" Steel Lock Ex | J047768 |
| 415 | Washer, 1/2" Plated Steel, Lock | J047769 |
| 420 | Washer, 7/8" Steel Lock Ex | J047773 |
| 425 | (Not Referenced) | - - |
| 430 | Nut, 7/8-9 UNC-2B, Heavy | J048136 |
| 435 | Cotter, 1/8" x 3/4", Spring Steel | J048618 |
| 440 | Cotter, 3/16" x 2", Spring Steel | J048636 |
| 445 | (Not Referenced) | J032911 |
| 450 | Nut, Lock, 3/4" Conduit | J048415 |
| 455 | (Not Referenced) | - - |
| 460 | Screw, 5/16" x 2-1/4", Hex Hd | J050194 |
| 465 | Washer, 5/16" Steel Lock Ex | J047767 |
| 470 | Nut, 5/16-18 UNC-2B | J048006 |
| 475 | Washer, 5/16" Steel Plate | J047642 |
| 480 | Stat-O-Seal 7100 1/2 | J792450 |
| 485 | Slushing Compound M-7646 | A041390 |
| 490 | Lubricant, Can | N320264 |
| 495 | Tape, 0.010 M-7136-50 | A773010 |
| 500 | (Not Referenced) | - - |
| 505 | Tag | M4516408001 |
| 510 | Resistor, 800 ohms, 30 watt | N294241 |
| 515 | Tag | S000333 |
| 520 | Clip, Cable Burndy HP 8N | J700590 |
| 525 | Screw, 8-32 x 1-1/4", Rd Hd Steel | J525111 |
| 530 | Screw, 8-32 x 1/2" Fil Hd | J052256 |
| 535 | (Not Referenced) | - - |

**Table 7-1. - Switch Machines N4511601401 and N4511601501 Parts List**

| Item Number | Description | Part Number |
|---|---|---|
| 540 | Heater, Component | N253225 |
| 545 | Plug, 1/8", Square Hd Steel | J032900 |
| 550 | Plastic Bag #60F-0404 | J078399 |
| 555 | Tag Form | S000169 |
| 560 | (Not Referenced) | - - |
| 565 | Cable Clamp, 3 POS ring, 1-1/2" Dia. Max. | J700589 |
| 570 | Washer, SS Lock No. 10 | J4751210109 |
| 575 | Tag Form | S001857 |
| 580 | Cover, Lock Rod | N4511611902 (LH) or N4511611904 (RH) |
| 585 - 595 | (Not Referenced) | - - |
| 600 | Hasp, M.I. Cast | N072832 |
| 605 | Tag, Instruction | S000264 |
| 610 | Pipe, 1/4" Galv. | M4511614005 |
| 615 | Screw, 3/8" x 1-1/2" Hex Hd | J050057 |
| 620 | Pin, 420 Spring Slotted, 1/8" x 7/8" | J487025 |
| 625 | Screw, 1/4-20 x 3/4" Hex Hd, SS | J5000970112 |
| 630 | (Not Referenced) | - - |
| 635 | Screw, 5/16-18 x 1" Hex Hd | J050038 |
| 640 | (Not Referenced) | - - |
| 645 | Screw, 3/8-16 x 1" Hex Hd | J050053 |
| 650 | Nut, WABCO 502369 | J048356 |
| 655 – 695 | (Not Referenced) | -- |
| 700 | M-3 Gearbox Assembly (Section A.2 Parts List) | N287485003 |
| 705 | Bracket, Angle | M4511619701 |
| 710 | Screw, 5/16-18 x 1-1/4", Hex Hd | J050040 |
| 715 | Spacer, 3/8 Rd Hd Brass | J725920 |
| 720 | Plate, Cover | M4511612401 |
| 725 | Washer, 3/8" Lock SS | J4751210113 |
| 730 | Washer, Flt SS Commercial 3/8" | J475126 |

**Table 7-1. - Switch Machines N4511601401 and N4511601501 Parts List**

| Item Number | Description | Part Number |
|---|---|---|
| 735 | Plate, Rat | M4511614401 |
| 740 | Stud, Hasp | M387732 |
| 745 | Washer, 1/2” Steel Plate | J047503 |
| 750 | Nut, Molded | J048300 |
| 755 | Washer, 1/4” Steel, Lock Med | J047775 |
| 760 | Washer | M4513740301 |
| 765 | Wire, Tag 12” Bundle | S705.11 |
| 770 | Terminal Board | N184425 |
| 775 | Screw, 12-13 x 2-1/2”, Hex Hd | J050101 |

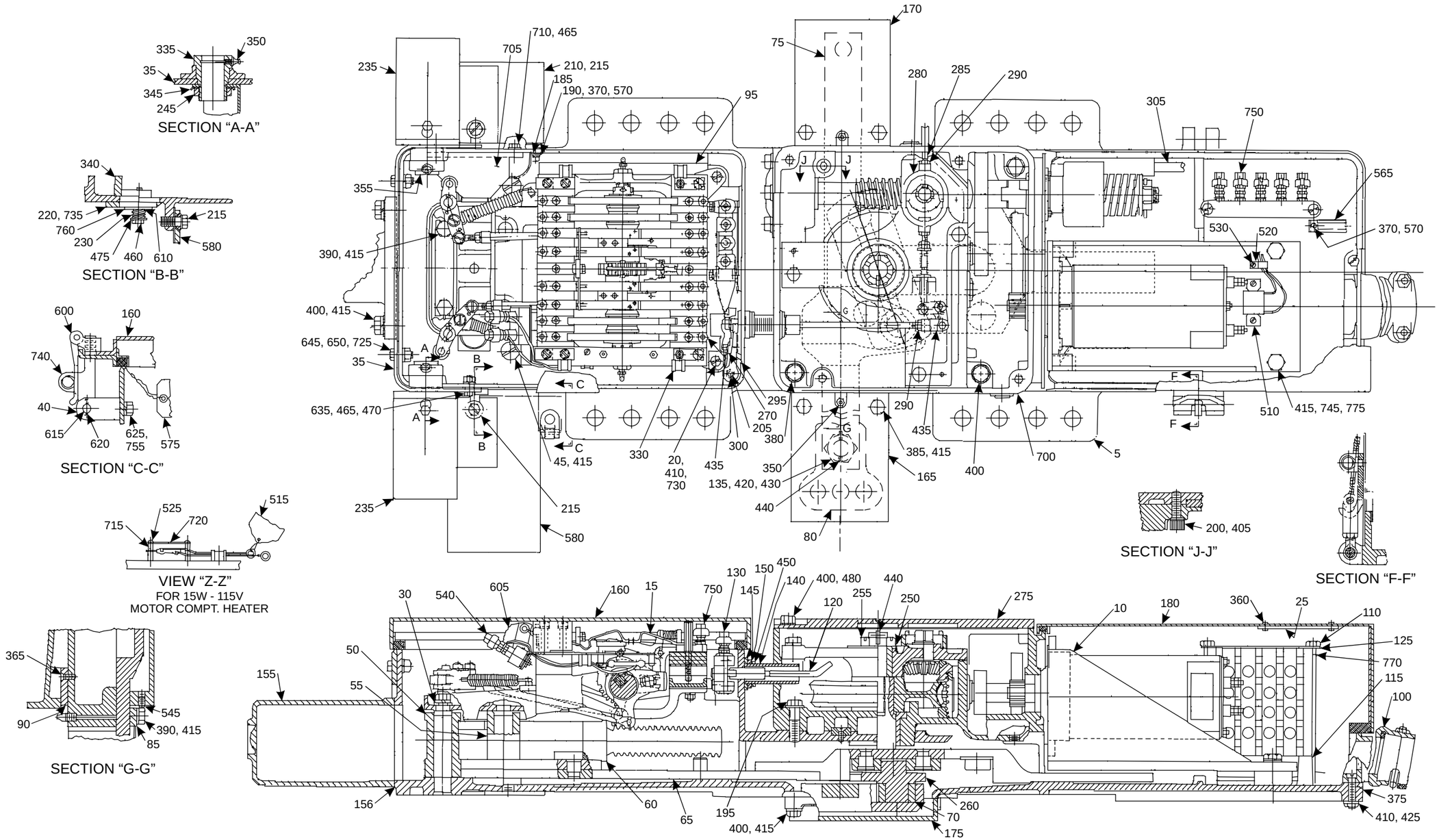
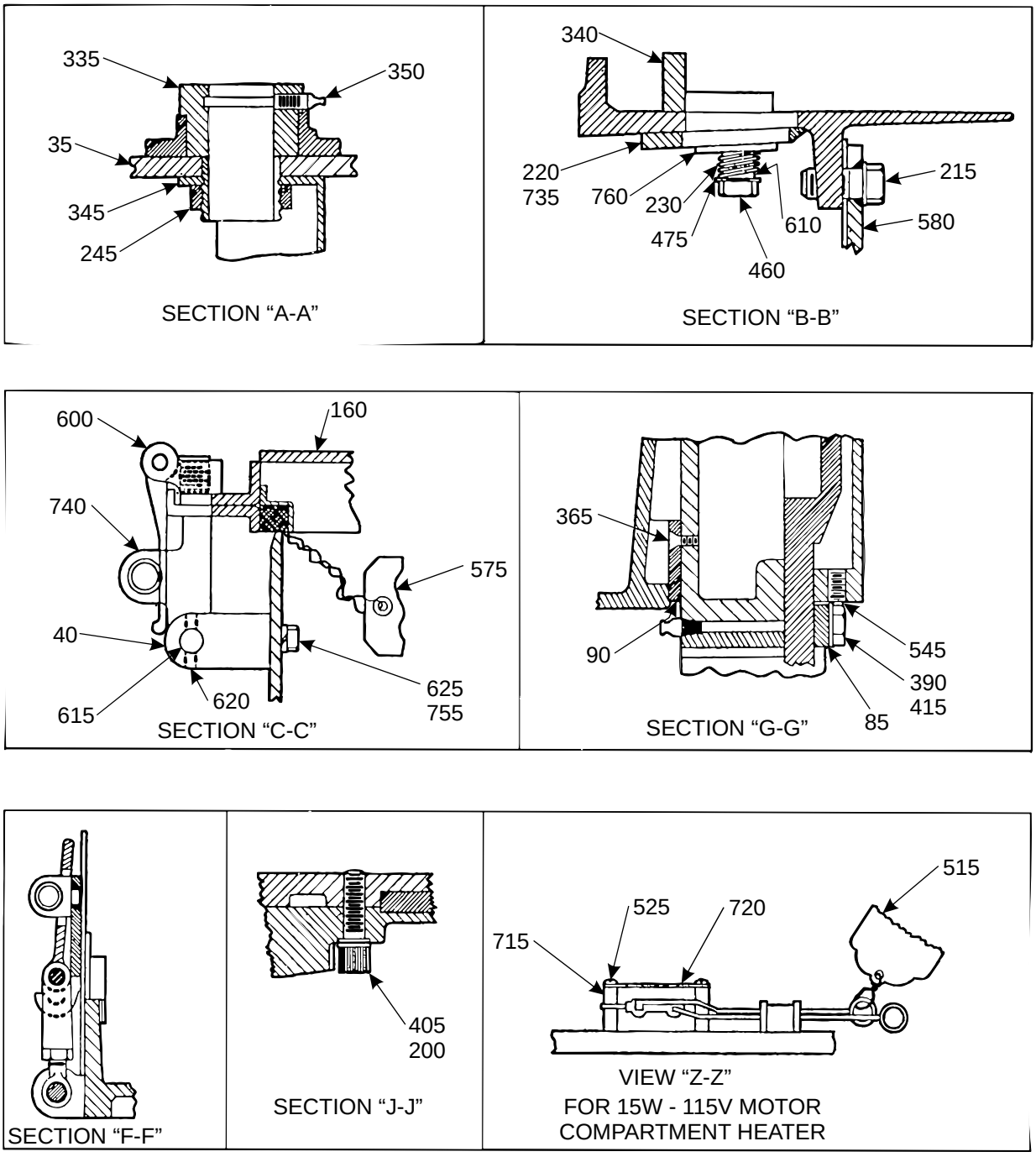



**Figure 7-1. - M-3 Switch Machine Assembly**




See Figure 7-1 for the location of the above section views on the main switch assembly.

**Figure 7-2. - M-3 Switch Machine Section Views**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## 7.2 Gearbox Assembly N287485003

Table 7-2 is the parts list for gearbox assembly N287485003. The figure associated with this gearbox assembly is Figure 7-3.

**Table 7-2. - Gearbox Assembly N287485003**

| Item Number | Description | Part Number |
|---|---|---|
| 5 | Gear Box, Complete | N287085 |
| 10 | Bearing, Top Component | PN146606 |
| 15 | Shaft, Worm | M286612 |
| 20 | Housing, Clutch | N172752 |
| 25 | Plate, End | M146575 |
| 30 | Plate, Clutch | M146574 |
| 35 | Disc, Lining 3/16” Thk | M146650 |
| 45 | Spring, Steel Friction Clutch | M239322 |
| 50 | Nut, Adj. | M286615 |
| 55 | Gasket, Felt | J047335 |
| 60 | Washer | M245192 |
| 65 | Plate, .0966 x 48 x 120 Steel | M147400 |
| 70 | Gasket, 1/32” x 36 Vellm | M147410 |
| 75 | Cap, Bearing Cast-Iron | M274596 |
| 80 | Gear, Clutch | N286583 |
| 85 | Gear, Bevel | M286995 |
| 90 | Pinion Hand Crank | M146377001 |
| 95 | Shaft, 3/4” Dia. Steel | M149700 |
| 100 | Reduction, Gear | M286576 |
| 120 | Shaft, End Plate | M286587 |
| 125 | Pin, 1/4” x 1-1/4” Dowel | J048925 |
| 130 | Bushing, Oilite 2” Dia. X 1/4” | J079694 |
| 135 | Cover, Spur Gear | N4511612102 |
| 140 | Gear, Shaft | M292426 |
| 145 | Hasp, Lug | M165738 |
| 150 | Screw, 1/4-20 x 3/4” Hex Hd SS | J5000970112 |

**Table 7-2. - Gearbox Assembly N287485003**

| Item Number | Description | Part Number |
|---|---|---|
| 155 | Screw, 5/16” x 3/4” Hex Hd | J050036 |
| 160 | Screw, 1/2-13 x 1-1/4” Hex Hd | J050090 |
| 165 | Screw, 1/2-13 x 1-1/2” Hex Hd | J050092 |
| 170 | Washer, 5/16”, Lock, Plated Steel | J047526 |
| 175 | Washer, 1/2”, Lock, Plated Steel | J047783 |
| 180 | Plug, 1/2” Pipe Steel | J032904 |
| 185 | Bearing, Ball, Angular Contact, Double Row, 35mm | J066032 |
| 190 | Bearing, Ball Single Row | J066246 |
| 195 | Washer, Lock, WH-07 SKF | J047810 |
| 200 | Nut, Lock, N-07 SKF | J048575 |
| 205 | Key, 9WDF, 3/4” x 3/16” | J048755 |
| 210 | Cotter, 3/16” x 2” Spring Steel | J048636 |
| 215 | Ring, External Retaining | J790076 |
| 220 | Seal, Garlock 556 OL | J790261 |
| 221* | Clutch, Plate | M146573 |
| 225* | Worm Gear | M074805 |

* Not shown in Figure 7-3. See Figure 7-1 for the location of these items.

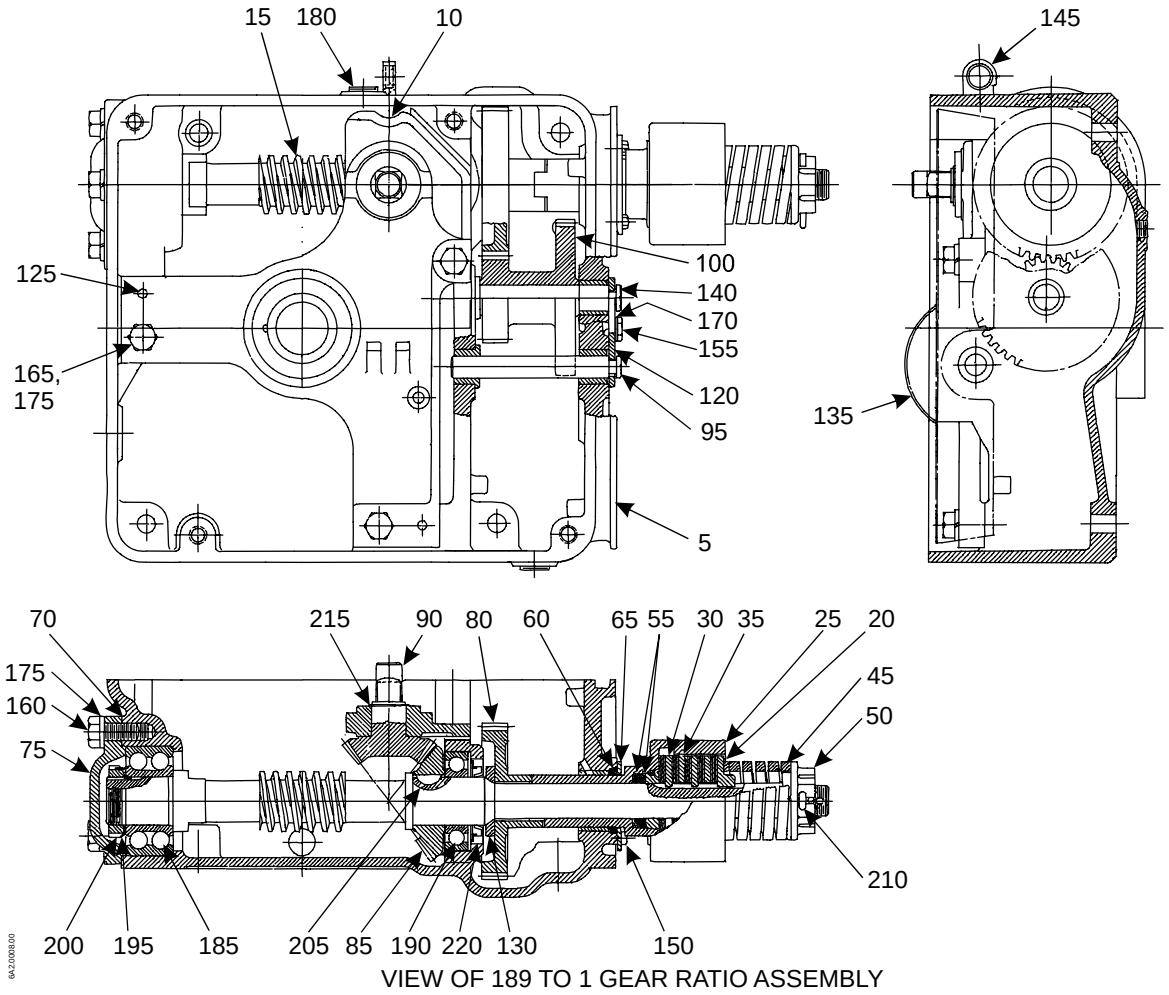


**Figure 7-3. - Gearbox Assembly N287485003**

## 7.3 Circuit Controller N4518170501

Table 7-3 is the parts list for circuit controller N4518170501. The figure associated with this controller assembly is Figure 7-4.

**Table 7-3. - Circuit Controller N4518170501**

| Item | Description | US&S Part No. |
|---|---|---|
| 5 | Frame, Component | N284499 |
| 10 | Bearing, Idler | PN338004 |
| 15 | Bracket, M.I. | M284493 |
| 20 | Yoke, Comp. | PN284681 |
| 25 | LH, Crank | PN284650 |
| 30 | RH, Crank | PN284649 |
| 35 | Rod, Connecting | PN338005 |
| 40 | Latch, Blank | M284495 |
| 45 | Bushing Component | N284653 |
| 50 | Coil, Spring | M142167 |
| 55 | Support, Cast Brass | M074427001 |
| 60 | Eyebolt, Drop Forged | M164921 |
| 65 | Spring, Lever SS | J068952 |
| 70 | Board, Terminal | J077705 |
| 75 | Terminal | M146475 |
| 80 | Terminal Connector | M146476 |
| 85 | Terminal, Connector | PN146478 |
| 90 | Insulation,1/4” Lam. Plastic | M142173 |
| 100 | Terminal, Post | M138723 |
| 105 | Nut, .437 Brass Hex | M026545 |
| 110 | Terminal, Post | M048854001 |
| 115 | Washer, 17/64” x 9/16” Copper | J047818 |
| 120 | Nut, 14-24 Hex Brass NP | J480300 |
| 125 | Spring Indication | PN284721 |
| 130 | Spring #16 x .376 Bronze | M074783 |
| 135 | Spring #16 x .376 Bronze | M138718 |
| 140 | Spring #16 x .376 Bronze | M074777 |

**Table 7-3. - Circuit Controller N4518170501**

| Item | Description | US&S Part No. |
|---|---|---|
| 145 | Spring #14 x 1/2” Bronze | M138696 |
| 150 | Spring. 0575 x 18 x 96 Sheet Steel | M045269 |
| 155 | Spring #14 x 1/2” Bronze | M172380 |
| 160 | Strip,1/8 x 1/2” Phos. Bronze | M175725 |
| 170 | Plate, .0428 x 48 x 120 Steel | M146775 |
| 175 | Screw, 7/16” Hex Hd Steel | M056236 |
| 180 | Trunnion | M055305 |
| 185 | Trunnion | M285410 |
| 190 | Nut, #11 x 1/2” Brass | M050258 |
| 195 | Washer | M042627 |
| 200 | Washer | M042585 |
| 205 | Washer | M048692 |
| 210 | Segment, 11 Gauge x 3.25” Copper SJ | M045942 |
| 215 | Insulation | J078019 |
| 220 | Cam, Indication | M284494 |
| 225 | Washer, Plated Flat Steel | J475180 |
| 230 | Spring, Steel Coil | J068281 |
| 235 | Gear Component | PN284679 |
| 245 | Shaft, 1/2” Steel Rd | M282431 |
| 250 | Screw, 8-32 x 5/16” Safset | J050731 |
| 255 | Pin, Operating | M285389 |
| 260 | Washer, Plated Flat Steel | J475186 |
| 265 | Nut, 5/16-24 Hex | J048005 |
| 270 | Latch, Pin | M284718 |
| 275 | Screw, 3/8-24 x 1-1/4” Socket | M285432 |
| 280 | Screw, 9/16” steel Rd | M236061 |
| 285 | Shim, #29 Steel Sheet | M134595 |
| 290 | Contact, Spring | M251938 |
| 295 | Stop, Spring #16 x .376 Bronze | M251939 |
| 300 | Stop, Spring #16 x .376 Bronze | M251940 |
| 305 | Spring, Seat | M285393 |
| 310 | Washer | M339088 |

**Table 7-3. - Circuit Controller N4518170501**

| Item | Description | US&S Part No. |
|---|---|---|
| 315 | Screw, 5/16-18 x 1-5/8” Fl Hd | J052362 |
| 320 | Screw, 5/16-18 Hex Hd | M4513583324 |
| 325 | Washer, Lock, 5/16” Plated Steel | J047526 |
| 330 | Washer, 1/4” Plated Steel Lock | J047766 |
| 335 | Washer, 3/8” Lock, SS | J4751210113 |
| 340 | Cotter, 1/16” x 1/2” SS Kelknotters | J048686 |
| 345 | Pin, Cotter, 3/34" x 1" SS | J048613 |
| 350 | Cotter, 1/8” x 1-1/2” SS | J486001 |
| 355 | Ring, External Retaining | J790074 |
| 360 | Washer | M056203 |
| 365 | Cover Stop Stud | M4511616204 |
| 370 | Nut, Molded | J048300 |
| 375 | Fitting, Hydraulic 90 deg ELL | J039150 |
| 385 | W-18 Soft Black Iron | A043025 |
| 390 | Washer, Lock 5/16” SS | J4751210131 |
| 400 | Shim | M4511614903 |
| 405 | Shim | M4511614902 |
| 410 | Spacer, 5/8” x 1.25” Steel | M4511616203 |
| 415 | Screw, 5/16-18 x 3” Fil Hd | J0523620001 |
| 420 | Nut, 1/2-20 Thick, Slotted | J048057 |
| 425 | Washer, Lock, 5/16” Steel, Extra Heavy | J047767 |

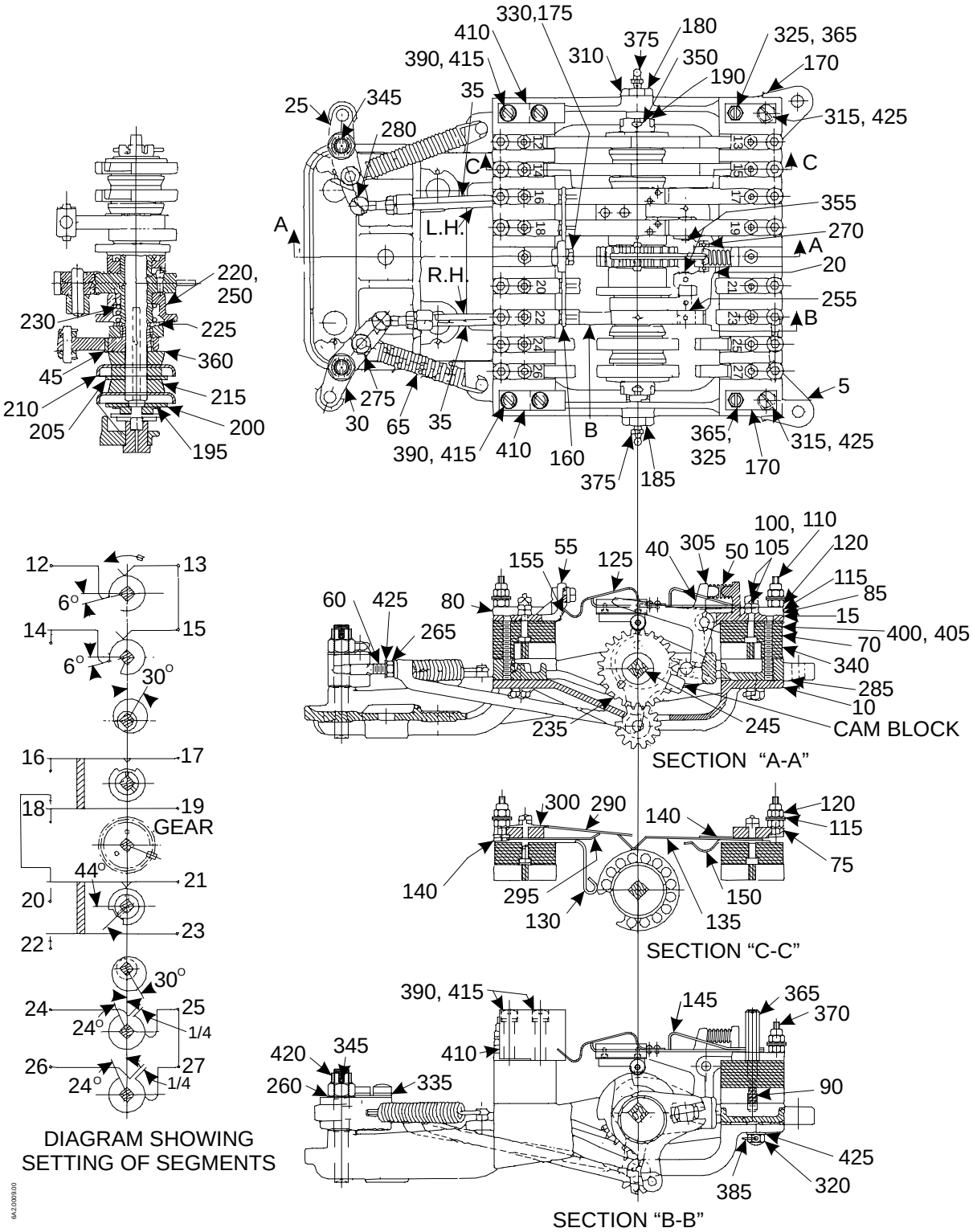


**Figure 7-4. - Circuit Controller N4518170501**

## 7.4 Motor Assembly N4511611701

Table 7-4 is the parts list for motor assembly N4511611701. The figure associated with this assembly is Figure 7-5.

**Table 7-4. - Motor Assembly N4511611701**

| Item Number | Description | Part Number |
|---|---|---|
| 5 | Motor Frame Adapter | M41000602 |
| 10 | Motor, Electric 110 Vac | J7172160301 |
| 25 | Screw, 3/8" x 1" Fil Hd SS | J5001240002 |
| 30 | Gear, 1-1/2" Steel Rd | M4511611601 |
| 35 | Key, 3/16" Square Steel | M4511611305 |
| 40 | Screw, 10-32 x 1/4" Allen Hd | J507363 |
| 45 | Ring, External Retaining Snap | J792852 |
| 55 | Washer, 3/8" Lock, External Tooth Countersunk | J4751430002 |

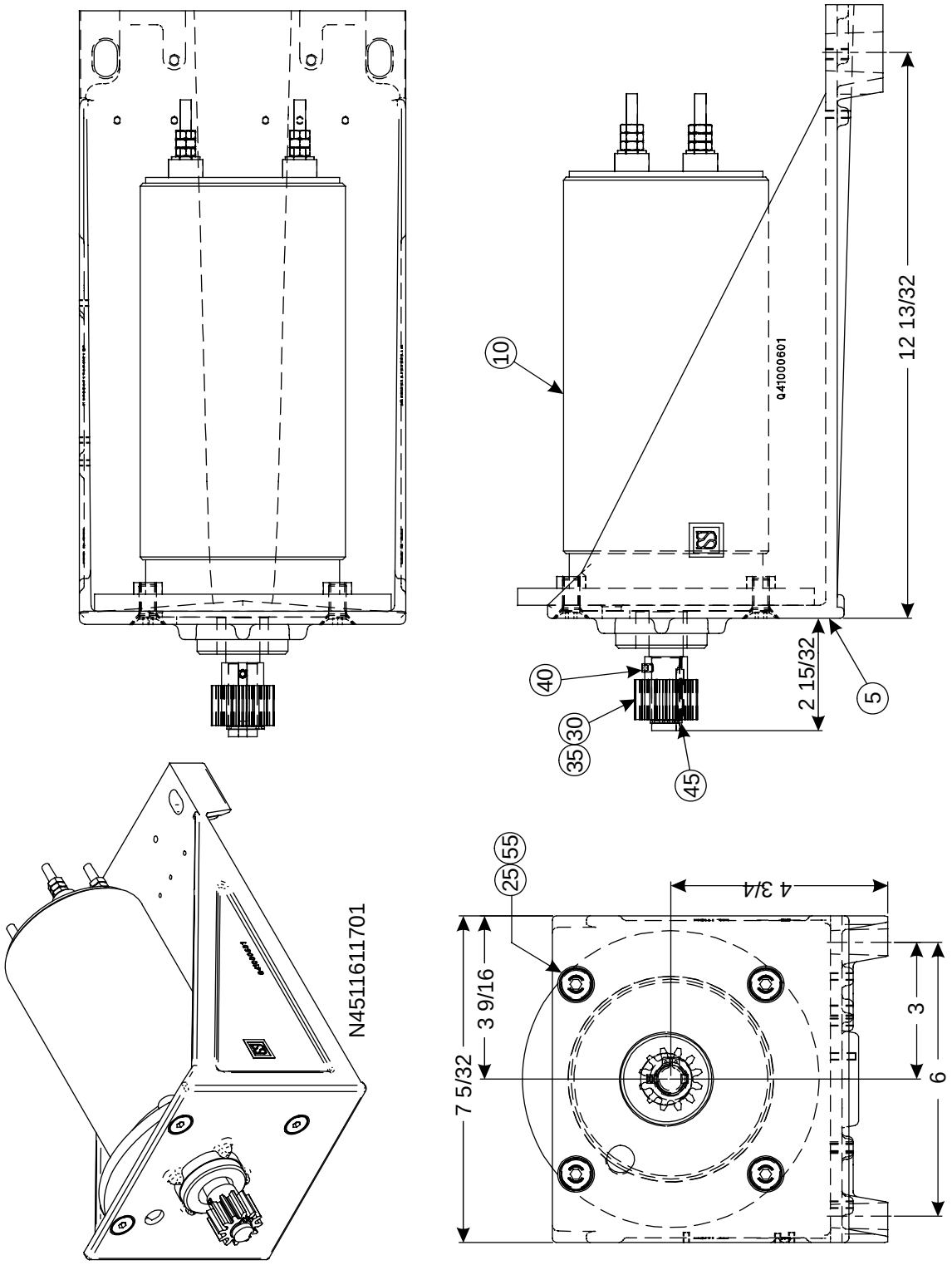


**Figure 7-5. - Motor Assembly**


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# 8. Rail Team and Technical Support

The *Rapid Action Information Link (RAIL) Team* is comprised of experienced product and application engineers ready to assist and resolve technical issues concerning any US&S product.

Any questions regarding the contents of this service manual can be answered by contacting the RAIL Team via e-mail at *railteam@switch.com* or a toll-free call to 800-652-7276.


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