M-3, M-23A, M23B
ELECTRIC SWITCH MACHINE
WITH FIELD-WOUND MOTOR
(IN BLACK CAST-IRON HOUSING)

SERVICE MANUAL

- **Installation**
- **Operation**
- **Troubleshooting**

SM 5481, Rev. 1
July 2009

Proprietary Notice

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Revision History

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1. INTRODUCTION AND EQUIPMENT OVERVIEW

1.1. Introduction

This service manual is for M-3, M-23A, and M-23B switch machines with field-wound motors. Mechanically and functionally, there are no major differences between these switch machines and the M-3, M-23A, and M-23B switch machines with permanent magnet motors. The only difference is in the motor and the associated wiring.

1.2. Equipment Overview

The M-3, M-23A, and M-23B electric switch machines consist essentially of a motor, a gear train, a cam arrangement for operating the switch and the locking, and a circuit controller, which includes a point detector with latch-out device. All three types of switch machine use the same base casting and have the same mounting layout. However, the M-23A and M-23B machines, as compared with the M-3 machine, have a larger vertical dimension (see dimensions shown in Figure 3-3 and Figure 3-4). Typical applications are shown in Figure 3-1 and Figure 3-2.

The M-23A and M-23B machines have dual-control operation: by electrical power or by a hand-throw lever. The M-3 switch machine is not designed for hand operation, except that in an emergency it may be operated by inserting a removable hand crank. The M-23A and M-23B may also be hand-operated by applying a ratchet wrench to the friction clutch adjusting nut.

The M-23A machine differs from the M-23B in that it uses a different hand-throw pinion, which affects the hand-throw locking. Operation by power is the same in both machines. In the M-23A, operation by the hand-throw lever gives the same mechanism stroke, including full lock rod protection, as operation by power. In the M-23B machine, however, operation by the hand-throw lever does not provide lock rod protection.

Different gear ratios are provided for operating the machines. Two gear ratios are available for low-voltage machines: one to provide relatively fast operation for general use, and the other to provide slower operation for use at locations where current draw must be minimized. A third gear ratio is used with the high-voltage motors. Motors and gear ratios can be changed without making changes to the gear box.

Machines are available for operation at three input voltages: 110 V dc, 20 V dc, and 110 V ac. The machines are completely wired at the factory. Internal wiring connects to the main terminal board in the motor compartment. The main terminal board is the interface for external wiring.

A typical wiring diagram or working drawing is enclosed with each machine to show how external connections are made to the main terminal board for a particular application. The internal wiring includes wires for electric heaters that can be added in the circuit controller and motor compartments.

2. FUNCTIONAL DESCRIPTION

2.1. General Description of Operating Mechanism

The switch machine is divided into three compartments. The components of each compartment are listed below. (See Figure 2-1 for the M-3 machine and Figure 2-2 for the M-23A and M-23B machines.)

Motor Compartment. This compartment houses the motor and contains the main terminal board. There is a wire outlet for the external wiring. The friction clutch of the gear train projects into this compartment.

Gear Box. The gear box is divided further into two compartments: one for the spur gear portion of the reduction gearing, and the other for the main crank and worm gear drive. 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. The clutch also protects the mechanism from shock if travel is stopped suddenly by an obstruction in the switch point or from shock due to lock rod fouling. The gear box also houses the mechanism for operation by a hand crank (M-3) or by the dual-control mechanism (M-23A and M-23B).

Circuit controller compartment. This compartment contains the circuit controller, locking features, point detector device, and a separate set of motor cutout contacts. The motor cutout contacts open the motor circuit and controls a line circuit when the hand crank is inserted in the machine (M-3), or the selector lever is moved out of the “motor” position (M-23A and M-23B).

In addition to the elements listed above, the slide bar runs lengthwise in the base of the machine. It is driven by the main crank and operates the lock box in the circuit controller compartment. Under the slide bar is the switch operating bar, which extends crosswise through the gear box. The switch operating bar is driven by the main crank. The external switch operating rod attaches to the switch operating bar.

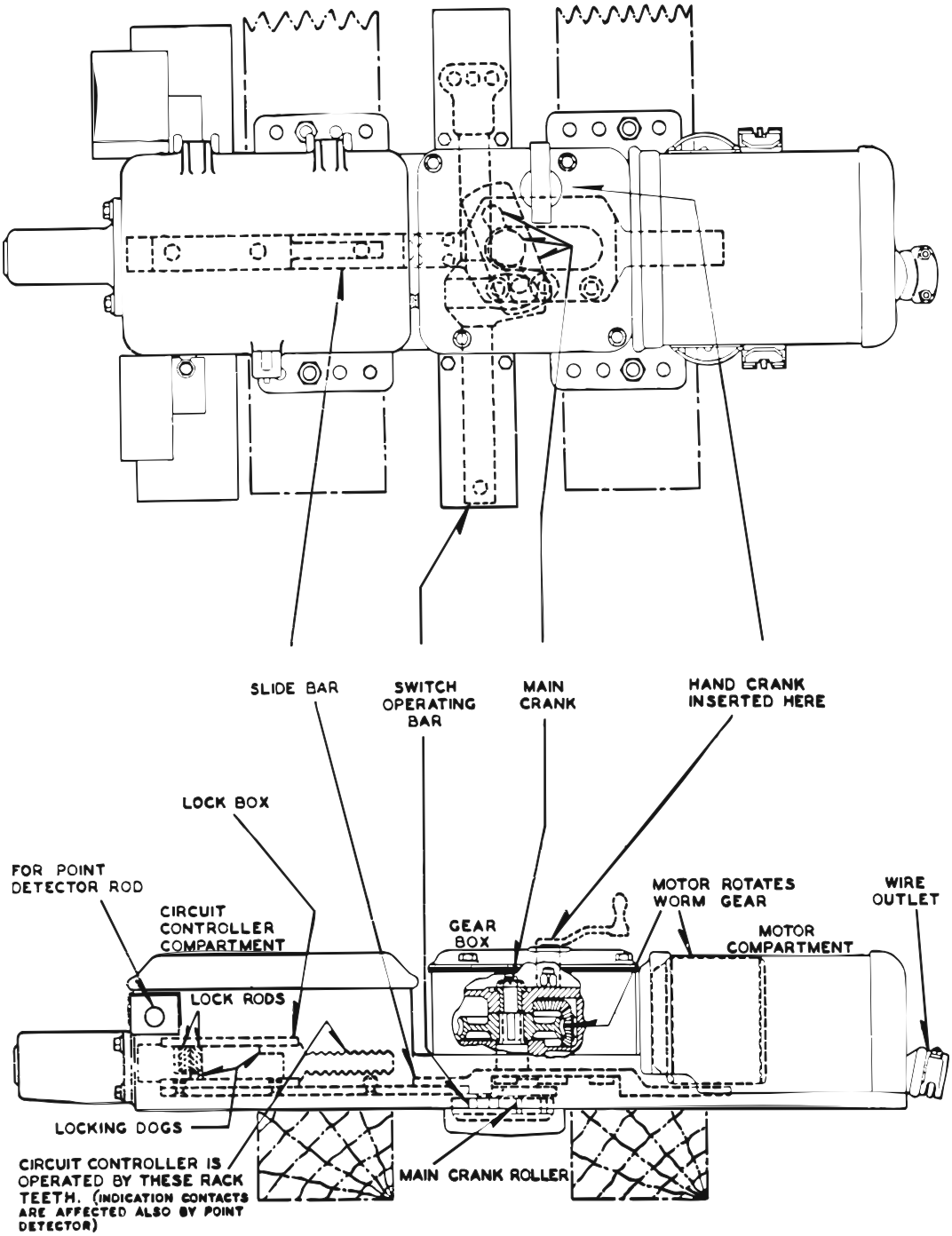


Figure 2-1. M-3 Switch Machine

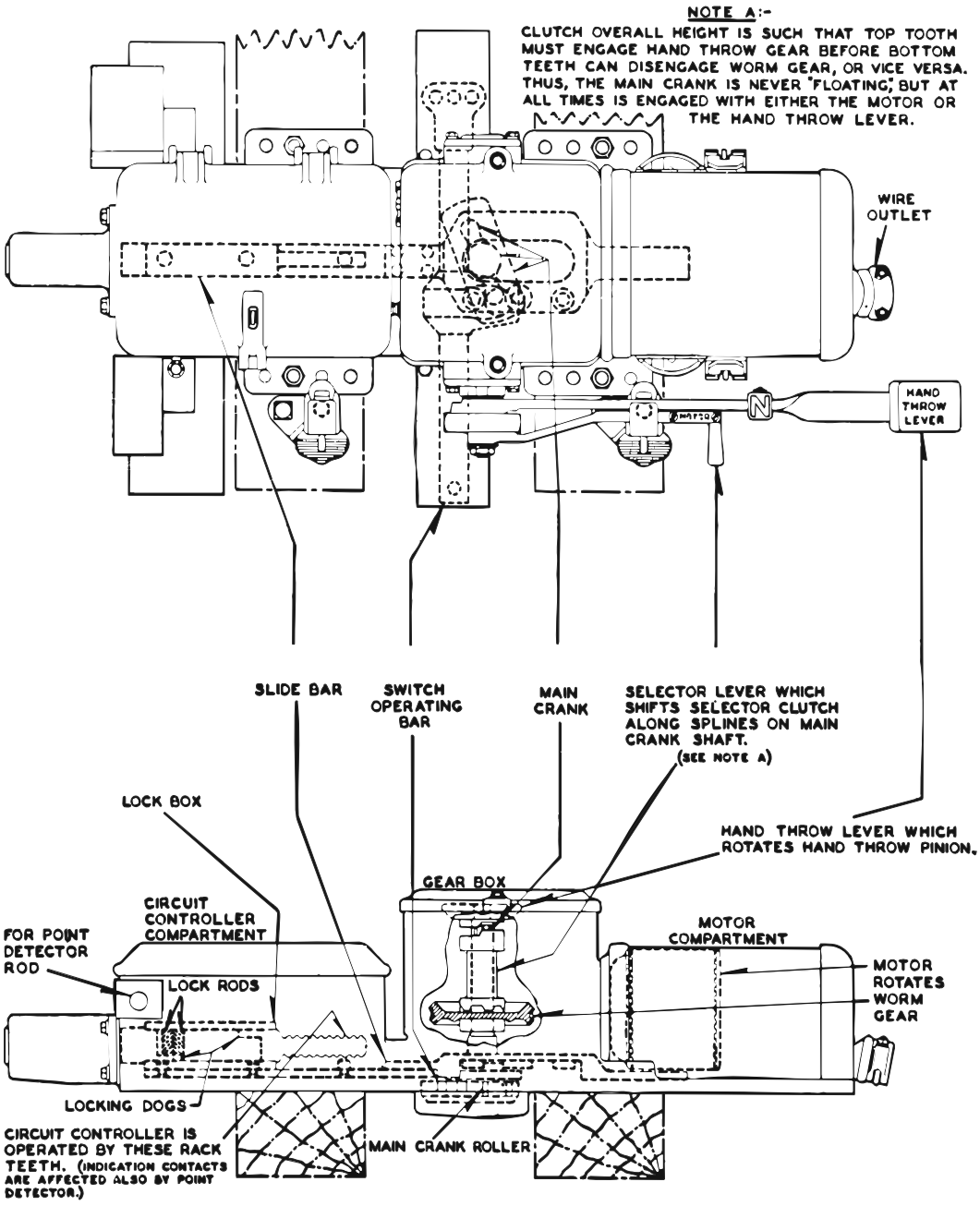


Figure 2-2. M-23A Switch Machine

2.2. Switch-Operating and Locking Mechanism

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 hand.

The main crank drives both the switch-operating bar and the slide bar. The slide bar carries the lock box with its locking dogs. The locking dogs enter notches in the lock rods when the switch

points are in proper position. The slide bar also carries rack teeth, which operate the circuit controller.

Figure 2-1 and Figure 2-2 show 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-throw lever. As the main crank turns, it first shifts the slide bar to withdraw the locking dog from the lock rod notch before the switch points start to move. The main crank holds the slide bar in mid-position, which keeps both locking dogs clear of the lock rods. The main crank then drives the switch-operating bar full stroke to its opposite position. Lastly, the main crank holds the switch-operating bar while driving the slide bar to its full-stroke position. This movement engages 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 Figures 2-1 to 2-4. In these figures, the main crank is designated "X," the switch-operating bar "Y," and the slide bar "Z."

Assuming that Figure 2-3 shows the normal position, a reverse movement is started by a clockwise rotation of main crank X. Lug X1 on top of main crank X acting against roller Z1 on slide bar Z causes the unlocking of the lock rod by causing slide bar Z to move to the left one-half of its stroke. Meanwhile, roller "x" on the underside of main crank X is moved through an arc of 40° in the radial portion of groove "y" in switch-operating bar Y, thus freeing the bar for the reverse stroke. During the next 140° rotation of main crank X, roller x engages the straight, or reverse, operating face of groove y and moves the switch-operating bar Y to the reverse position.

Figure 2-5 shows the relative mid-stroke positions of switch-operating bar Y and slide bar Z. Crank X is rotating clockwise but is not transmitting motion to slide bar Z as lug becomes disengaged from roller z1. Surfaces v and v1 of slide bar Z are radial to the center of the shaft and prevent the slide bar from moving.

The full reverse position is shown by Figure 2-6. Roller x on crank X acting in groove y has moved switch-operating bar Y to the reverse position and secured it against back thrust; lug x has come into contact with roller z during the last 40° of rotation of crank X, thus driving slide bar Z to its full reverse position.

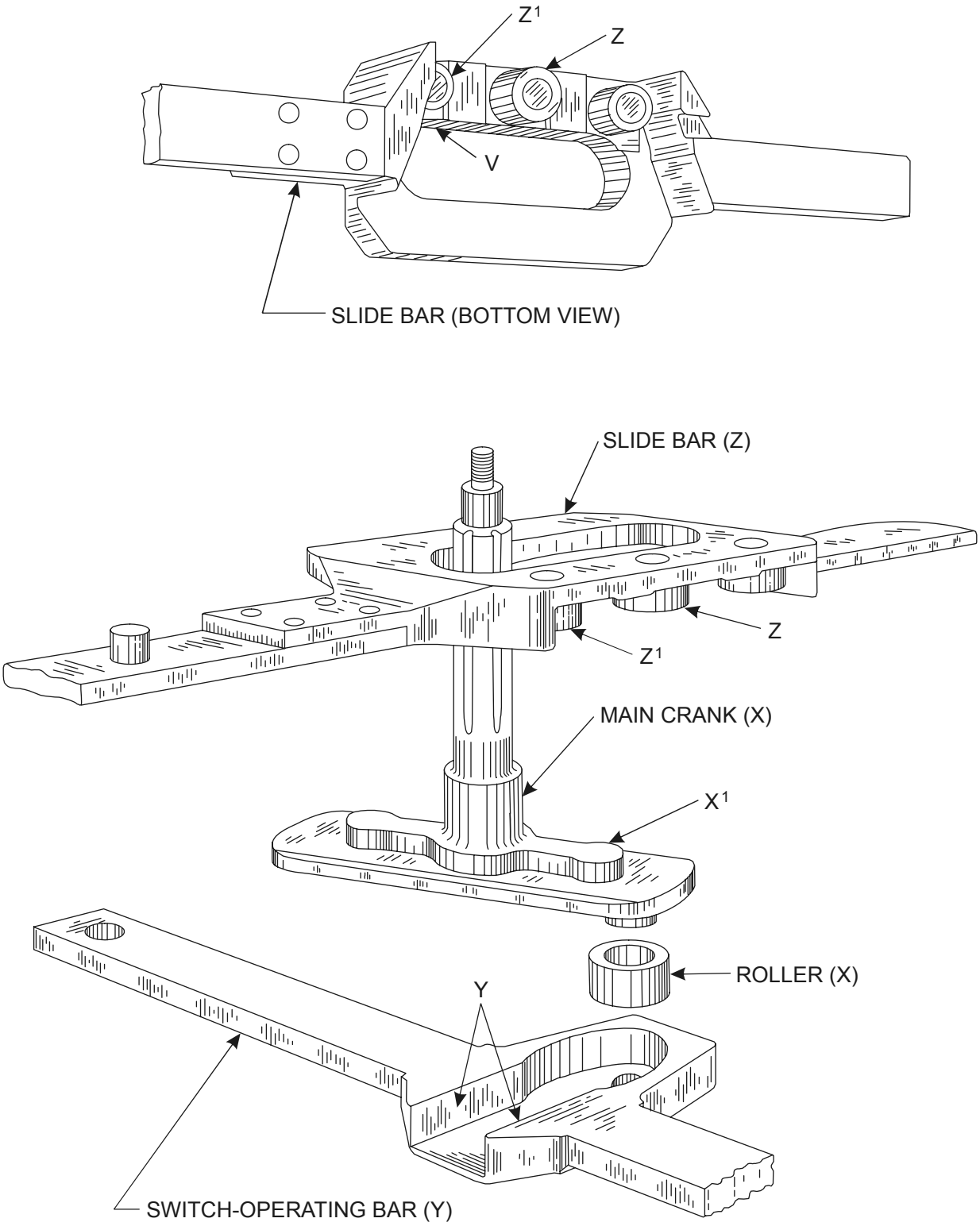


Figure 2-3. Switch-Operating Mechanism

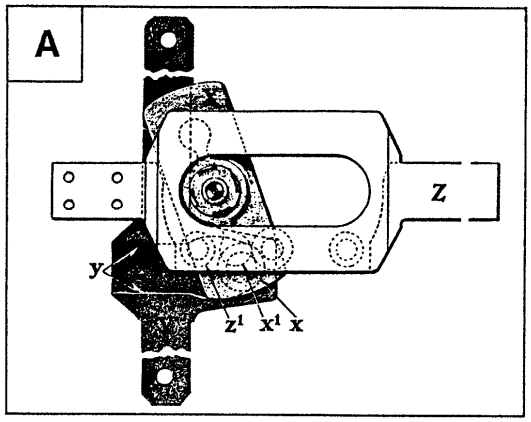


Figure 2-4. Driving Parts in Extreme Position

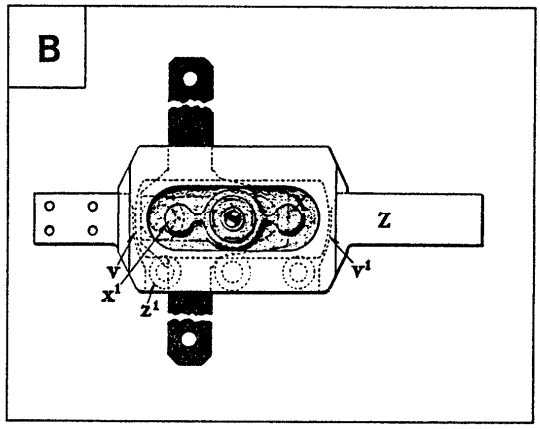


Figure 2-5. Driving Parts in Mid-Position

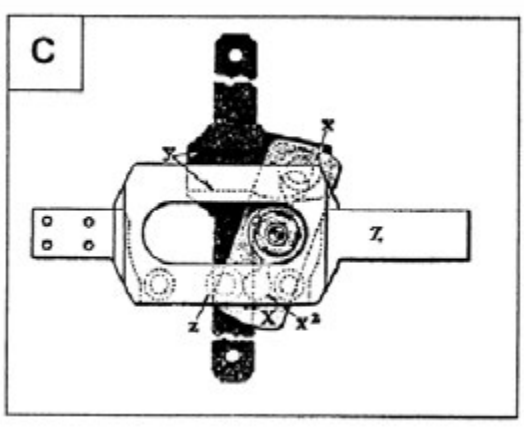


Figure 2-6. Driving Parts in Extreme Position (Opposite to Position Shown in Figure 2-4)

2.3. Switch Point Locking

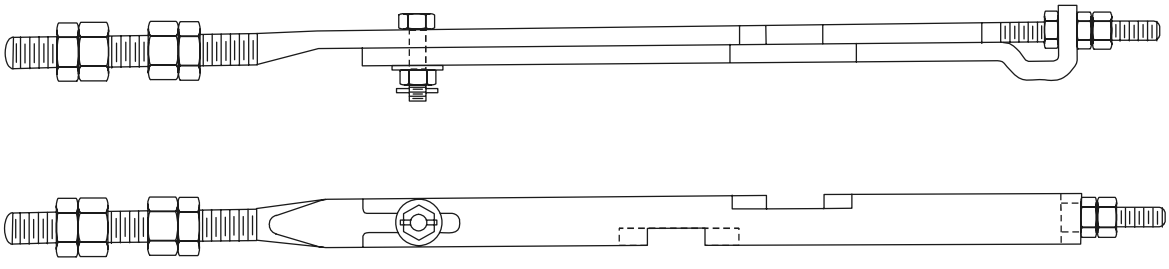
Connection to the switch points may be made at either end of switch-operating bar Y to suit the particular switch layout. The position of the switch points is checked and secured by the action of the lock box. The lock box rests on and is operated from an extension of the slide bar (see Figure 2-1).

During the first 40° 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. The following 140° 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° 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.

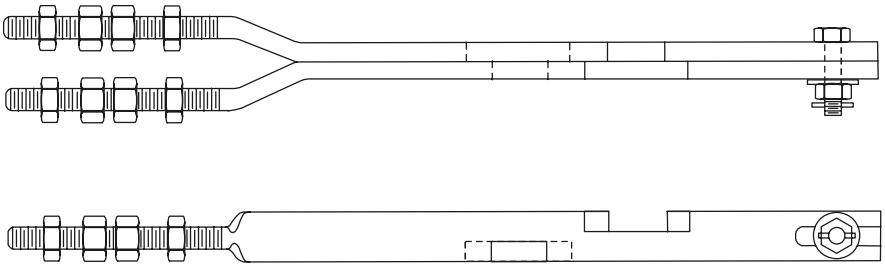
The lock rods consist of two rectangular rods side-by-side (see Figure 2-7). Each has a narrow notch only slightly wider than the locking dogs. This narrow notch in one rod is on top and in the other rod on the bottom. To allow for variations in switch throw, the two rods are adjustable longitudinally with respect to each other, and each has a wide notch located alongside the narrow notch of the other.

As the notch is on top of the lock rods for one position of the switch and on the bottom for the other position, and as the lock box likewise has one dog on top and the other on the bottom, it 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, which the dog enters first. Therefore, the lock box and the lock rods must be assembled so the dogs will enter the narrow notches first. The procedure for inverting the lock box, when necessary, is provided in Section 6.1.



(A) TYPE GENERALLY USED WITH BALL AND SOCKET CONNECTION



(B) TYPE USED WITH RIGID CONNECTION

Figure 2-7. Adjustable Lock Rods

2.4. Circuit Controller

The circuit controller has indication contacts that are operated jointly by the lock box and the point detector mechanism 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 that 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 shown in Figure 2-8, Figure 2-9, Figure 5-1, and Figure 5-2, the circuit controller has a total of 8 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 2-8) 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.

Note that the shaft assembly (see Figure 5-1 and Figure 5-2) 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 assure proper relative assembly of the gear and eccentric bushings, the shaft is made with unlike ends so that it can go into the controller in only one way, and has one corner flattened for a distance of 2 in. at one end and 3 in. at the other end, while the gear and the eccentric bushings have dowel pins, which 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. As will be explained later (Section 6.2), 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, as the case may be. See Section 6.3 for specific instructions on how to install a new or rebuilt circuit controller into a switch movement.

2.4.1. Motor Control Contacts

Of the four sets of motor control contacts (see Figure 2-8), 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 machine back to its original position.

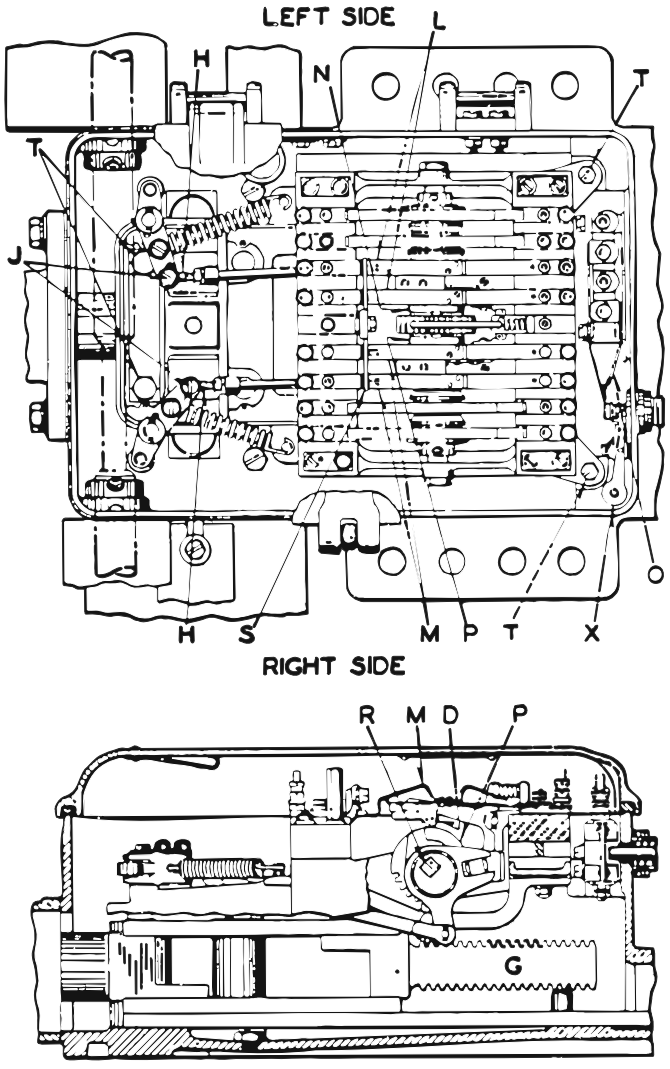


Figure 2-8. Circuit Controller

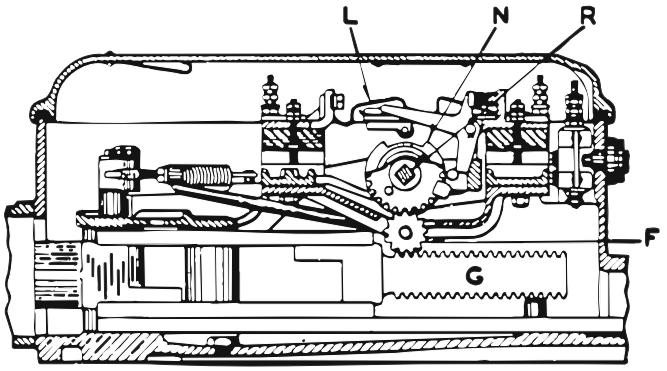


Figure 2-9. Circuit Controller (Additional Sectional View)

Each set of motor control contacts provides two parallel circuit paths, one through direct contact of opposing spring fingers Fl and F2 (see Figure 5-1 and Figure 5-2) and the other through finger

Fl (the conducting segment) and finger F3. The circuit through the conducting segment opens last, as the notch passes under the "V" end of finger Fl. Finger F2 is stopped first before the "V" end clears the segment entirely. This arrangement protects the direct finger contact from opening the motor circuit under normal conditions, yet assures a circuit in case the segment should become coated with frost.

Referring to Figure 5-1 and Figure 5-2, note that each motor control segment is nested on the tapered hub of its insulating bushings. The cone engagement has teeth in both elements, which prevents the segment from rotating relative to the shaft while the shaft end nuts are pulled up, but which permits the segment to be shifted around the shaft in 4-degree steps when the shaft end nuts are backed off. These segments are factory-set to provide approximately 1/4 in. opening between the segment ring and the "V" end of the contact finger Fl (Sect. 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 (operated as far as it will go by rotating the friction clutch while in "motor" position). See Section 5.1.2 for instructions for adjustment of this opening and closing of the contact springs.

2.4.2. Indication Contacts

The four sets of indication contacts operate as two pairs. One pair indicates the normal position and the other pair indicates 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 in Figure 2-8, and N-N of Figure 5-1) is used to indicate "normal" on all installations. This means that in some applications the left pair of contacts must indicate the end of the stroke that has the slide bar toward the lock end of the machine. In other applications, the left pair of contacts must indicate the end of the stroke that has the slide bar toward the motor end of the machine. Similarly, the right pair of contacts (M in Figure 2-8) must indicate sometimes one end and sometimes the other end of the slide bar stroke, so as to indicate "reverse".

When cam N has its notch up, the associated "normal" pair of contacts (L in Figure 2-9) closes, except when prevented by point detection (as explained in Section 2.4.3). For the 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, as illustrated. At the same time, cam P is holding its associated pair of contacts up (Sect. P-P & Sect. N-N of Figure 5-1). When the machine is operated toward 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 (S in Figure 2-8 and Figure 5-1) to provide a shunt for the indication relay. When the machine leaves the factory, this strip is assembled to connect one normal and one reverse contact, but may be reassembled to shunt all four contacts when indication circuits require such arrangement. When the machine reaches the end of its stroke, the notch in cam P comes on top and thus permits the "reverse" pair of contacts to close (except when prevented by point detection as explained in Section 2.4.3).

Instructions are provided in Section 6.2, for shifting the cams to reverse the ends of the stroke at which they have their notches up. Instructions are provided in 5.1.2 for adjustment of the contacts.

2.4.3. Point Detector

As described in the preceding section (2.4.2), the indication contacts are positively opened by the lock box action and merely permitted to close when the cam notches are aligned, unless closure is prevented by point detector action. Point detection checks switch point closure separately from the lock rod connection and is used not only to check the switch point when it is first closed but also to 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) in that 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, which 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 that occurs at the time the switch points are being deflected by improperly trailing traffic or by dragging equipment, so that the contacts are prevented from indicating 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 have been damaged in such a way as to be unsafe for facing point traffic yet so distorted as to leave very little net shift of the point detector bar. The latch is equipped with a "self-restoring" feature (that may be readily removed if not wanted) to take care of situations where the latch may become unnecessarily latched up due to unusual traffic shocks that do not affect the fit of the switch point against the rail, the latch being reset automatically when the machine is next operated so as to withdraw the locking dog from the lock rod notch. If the latch were latched-up as the result of damage to the switch point, it would be found impossible for the machine to complete its stroke in either direction due to lock rod fouling. The latch can also be reset manually.

Detailed construction of the point detector mechanism is shown in Figure 2-8; and the relative positions of the eccentric bushings, operating rods, and point detector rollers for the normal position of the switch machine are shown in Figure 2-10. Mid-stroke positions of the various parts are shown in Figure 2-11. Reverse positions of the various parts are shown in Figure 2-12. Figure 2-13 shows the 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 for all controller positions, except when the point detector bar has been displaced due to improperly positioned switch points. That is, for normal operation of the machine with the switch points in proper adjustment, the yoke assembly remains in a fixed position as can be seen in Figure 2-10, Figure 2-11, and Figure 2-12.

With the switch machine in the normal position, as shown in Figure 2-10, point detector rollers A and B stand clear of the point detector bar, thus preventing wear of point detector parts under traffic conditions. Roller A, however, is in position to detect the yoke downward should the

point detector bar be displaced. When the machine is operated out of the normal position, the controller shaft rotates in a counterclockwise direction (viewed from right-hand side) and the operating levers are shifted by the eccentric bushings so as to move point detector roller A away from the point detector bar and permit movement of the point detector bar from the normal to reverse position without contacting either roller. Mid-stroke positions are shown Figure 2-11.

Reverse positions of the parts are shown in Figure 2-12. Both rollers are again clear of the bar, but roller B is in position to deflect the yoke downward should the point detector bar become displaced.

The latched-out position of the circuit controller is shown in Figure 2-13. In this position, the point detector bar has been shifted from its reverse position due to deflection of the switch points caused by improper trailing. The large diameter of the point detector bar has been brought into contact with point detector roller B, resulting in the connecting rod shifting the operating levers and 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. As the yoke is rotated downward, the upright cam portion of the yoke engages the roller on the under side of both indication contact assemblies and thereby lifts the reverse contact assembly so as to open the reverse indication contacts and to 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 will lift the latch to permit the yoke to be restored to its horizontal position resting against the yoke stop.

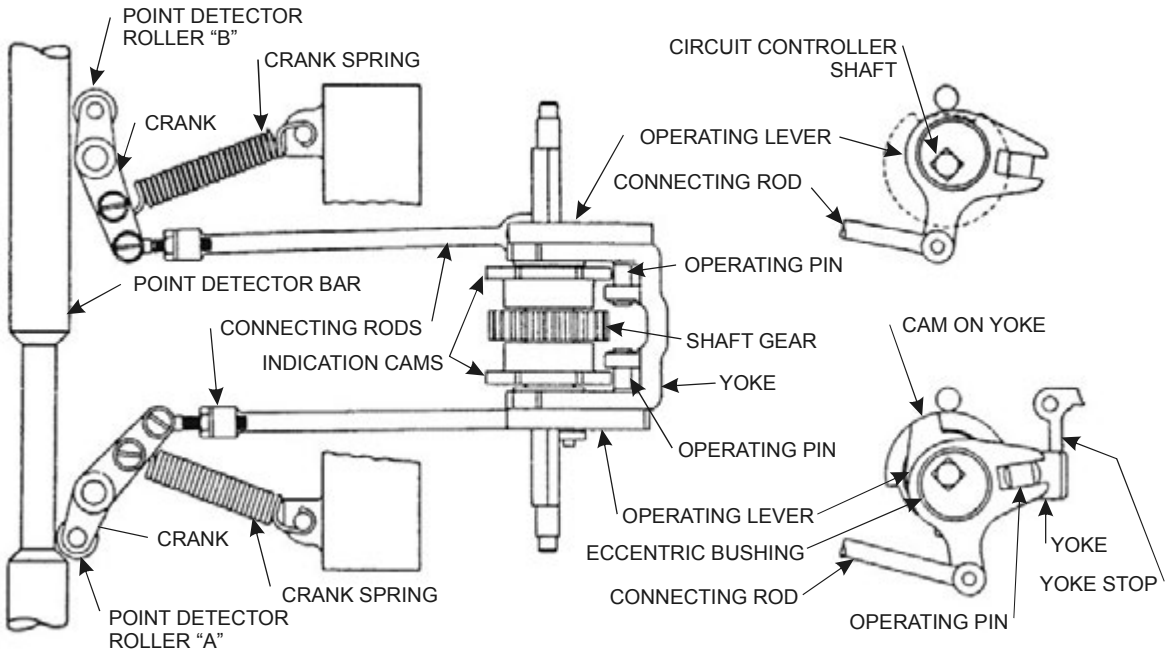


Figure 2-10. Point Detector Parts in Normal Position

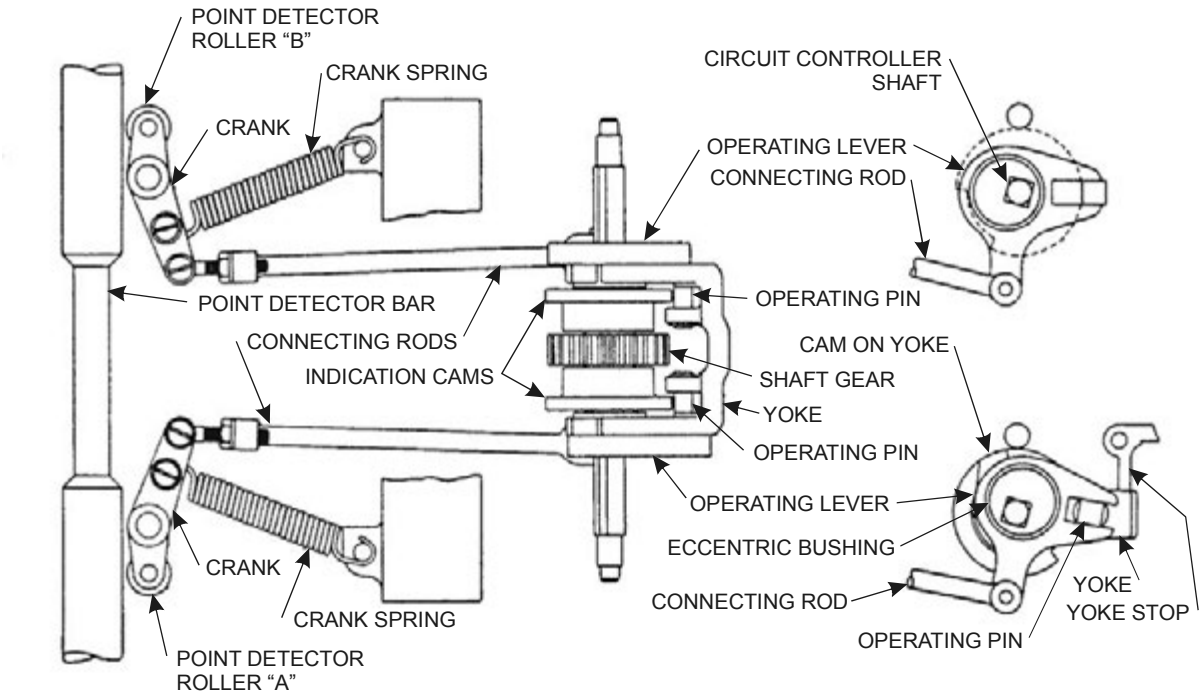


Figure 2-11. Point Detector Parts in Mid-Stroke Position

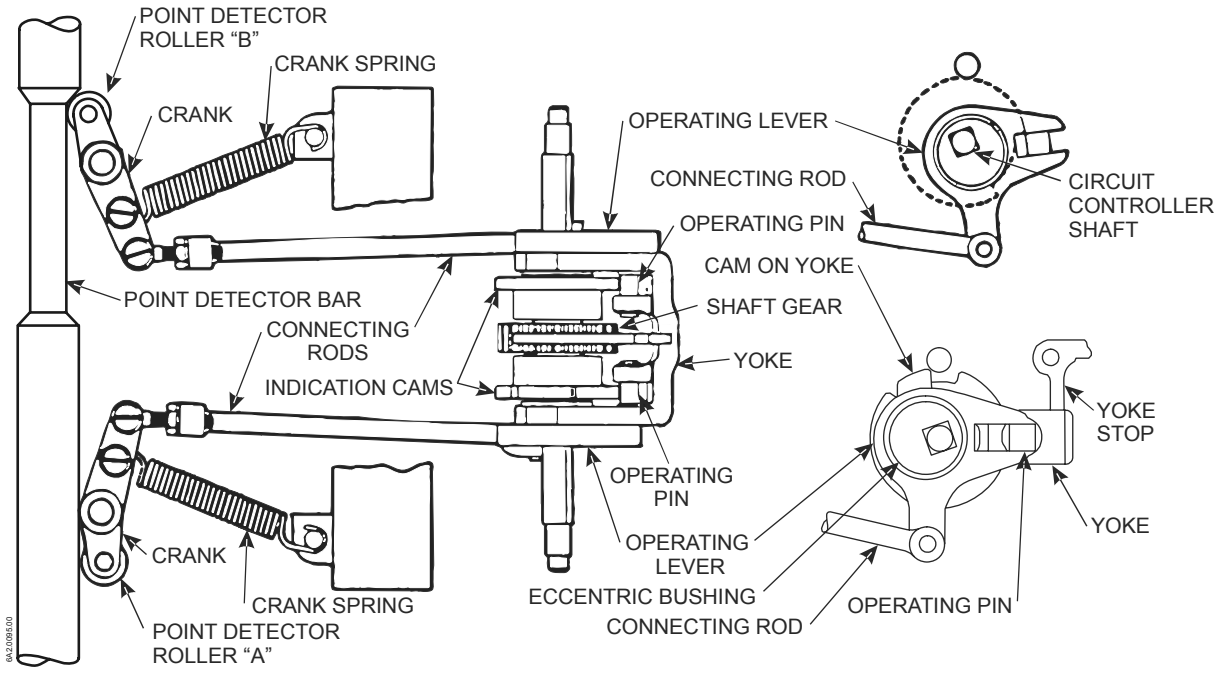


Figure 2-12. Point Detector Parts in Reverse Position

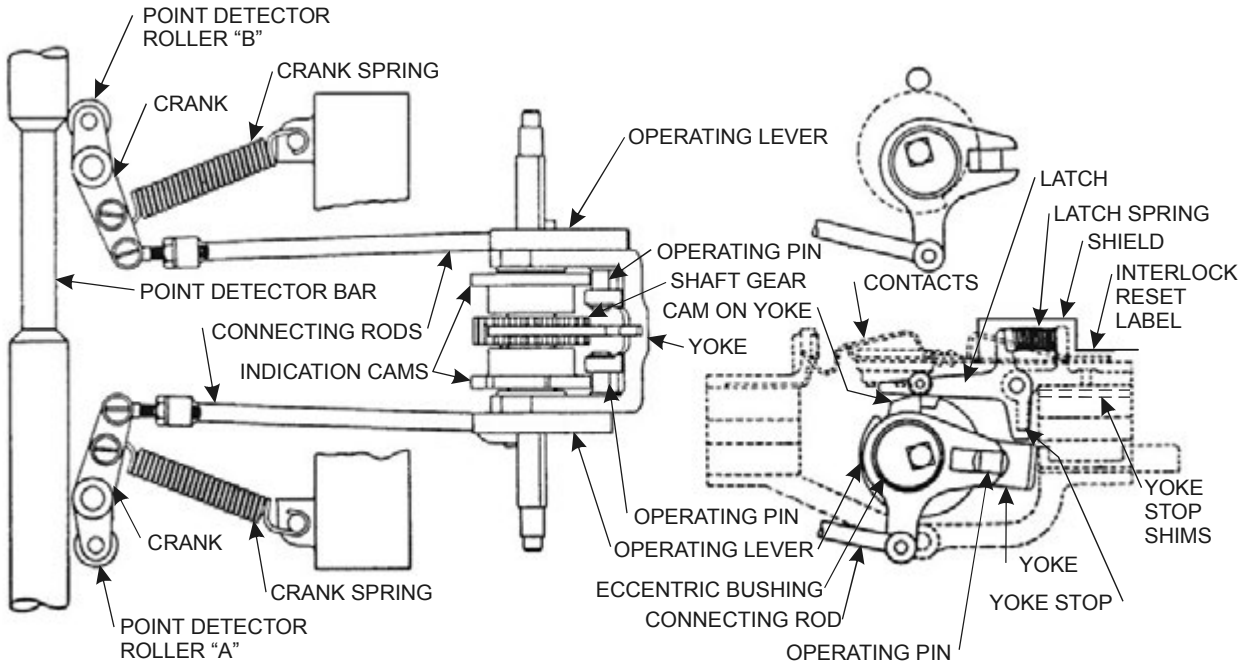


Figure 2-13. Point Detector Parts in Reverse Position and Latched

2.5. Gear Train

The reduction gear train between the motor and the worm gear consists of a pinion on the end of the motor shaft, one or two reduction gears, clutch gear, friction clutch, worm shaft and worm gear (see Figure 7-3). Note that each reduction gear actually is comprised of two gears: a large gear and a small gear assembled together. The gear ratio is changed by changing out the reduction gears, using the combinations as listed in Table 2-1.

Table 2-1. Gear Train Specifications

Machine Input Voltage	Nominal Speed (seconds)	Gear Ratio	Number of Teeth					
			Clutch Gear	1st Reduction Gear		2nd Reduction Gear		Motor Pinion
				Gear	Pinion	Gear	Pinion	
110 V ac	3	189 to 1	43	-	-	43	22	12
110 V dc	3.5	189 to 1	43	-	-	43	22	12
20 V dc	8	360 to 1	43	32	32	41	22	12
20 V dc	15	528 to 1	43	16	16	45	22	12

The pinion end of the motor is supported in an opening in the gear box that locates the pinion properly relative to the other gear centers. This opening is sealed by a felt ring with a metal backing on the motor hub. The motor can be removed by taking out the two bolts in the motor bracket at the commutator end. (For detailed information on the motor, see Section 2.8.)

The reduction gears are assembled on shafts supported in Oilite bearings. The shafts are held in place endwise by the shaft end plate, which is slotted to fit over a neck in each shaft. To remove

these shafts to change out the reduction gears, it is necessary to first shift the motor out of the way.

The clutch gear, which is the final spur gear, has an Oilite bushing to support it on the worm shaft. 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 the controller by a double-row ball bearing, which takes both radial load and end thrust. It also is 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 pressed into the gear box bore. The inside diameter provides slight clearance for the worm shaft. The housing has a felt packing to prevent seepage of oil into the friction clutch. The worm shaft is grooved and the housing has ribs to drive alternate friction disks, which are compressed by action of the heavy coil spring. This spring force is contained between the adjusting nut and Oilite thrust plate, which is supported on the tapered shoulder on the worm shaft.

The clutch gear hub has a three-finger engagement with the clutch housing tubular neck so that the clutch housing is driven by the motor. Drive between the clutch housing and the worm shaft is through the friction disks.

2.6. Operation By Hand Crank (M-3 Only)

Provision is made in the M-3 switch machine for hand operation by inserting a removable hand crank through the hole in the gear box cover (see Figure 2-1). Motor cutout contacts (O in Figure 2-8) are operated by means of a linkage to open the motor circuit (and in some cases to open a control circuit) when the hasp for the hand crank cover is released. Latch X, which can be removed if not desired, serves to hold the motor cutout contacts latched out until reset manually—a useful feature when others than the signal maintainer are authorized to use the hand crank.

WARNING

Remove the hand crank after use. Do not permit traffic through the switch when the hand crank is installed. An installed hand crank could contact a vehicle power shoe causing equipment damage and creating a hazardous condition.

2.7. Dual-Control Mechanism (M-23A and M-23B)

2.7.1. General Functional Description

Switch operation, switch locking, and circuit controller operation are all performed by the vertical main crank in the gear compartment (see Figure 2-2). The main crank is always in engagement with either (a) the motor, through the reduction gear train and its friction clutch, or (b) the hand-throw lever, through the hand throw pinion. The selector clutch slides along splines on the shaft of the main crank, and is shifted up or down by the selector lever. To permit the selector lever stroke to be completed even though the top tooth of the selector clutch may not be in alignment with the tooth space in the hand-throw pinion hub when shifting from motor position (shown in Figure 2-2) to hand-throw position connection between the selector lever and the selector clutch is made through a coil spring mounted on the selector clutch.

The selector clutch will snap into engagement with the hand throw pinion when the hand-throw lever is operated to a position corresponding with the switch position. This spring connection acts similarly when returning the selector lever to the motor position; however, in this case it is the motor that must be operated to align the worm gear hub teeth to receive the selector clutch teeth. Note that the main crank remains engaged with its original connected driving element until it is engaged with the other element (see note A in Figure 2-2).

In Figure 2-2, the top tooth is shown in alignment with the tooth space in the hub of the hand throw pinion because the switch and the hand-throw lever are both in normal position. There may be times when the switch is blocked in mid-stroke by an obstruction so that the main crank will not be in normal position; and, if the last motor operation left the switch in the reverse position, the teeth likewise are not aligned.

NOTE

When the hand-throw selector is moved to HAND position, the switch-operating mechanism may initially remain engaged with the motor rather than with the hand-throw lever. Operation using the hand-throw lever assures that the machine shifts to hand operation mode.

2.7.2. Operation by Selector Lever

The selector clutch assembly is shifted up or down by a 180° rotation of the selector lever. The inner crank finger of the selector lever swings the selector clutch yoke up or down. This yoke has rollers on each side, which engage the upper and lower spring cups of the selector clutch assembly.

The selector clutch assembly (see Figure 2-14) has a spool-shaped core made in two parts, which are screwed together and are held from becoming unscrewed in service by the splines in both portions. The upper part, or “clutch for hand operation,” has a single tooth on top for engaging

the hand-throw pinion, which requires strict agreement of the hand-throw lever position with the position of the switch when engaged. The lower part has five teeth for engagement with the worm gear. The upper and lower parts are separable only when the assembly is removed from the splined shaft, this arrangement being used to permit assembly of the spring and two spring cups. The spring cups are ordinarily held tightly against the upper and lower flanges of the core by the compression force of the spring.

When the selector lever is operated 180° from position shown, this action lifts one end of the selector clutch yoke so that its lower rollers push upward against the underside of the flange on the lower spring cup. If the switch is in the position corresponding to the position of the hand-throw lever so that the tooth of the hand-throw pinion is aligned to receive the tooth of the "clutch for hand operation', and assuming no restraining friction between the teeth at the bottom, the selector clutch assembly will shift upward without deflection of the spring. At times, however, there may be a torque load on the lower teeth when the selector lever is operated (for example, if the switch is stalled on an obstruction) and this may cause sufficient friction to hold the clutch down while the yoke is lifted. As a result, the spring will be compressed as the lower spring cup is lifted by the lower rollers on the yoke, until the top of the lower spring cup engages the bottom of the upper spring cup.

Further operation of the selector lever provides a positive drive to pull the lower teeth apart far enough that the chamfered corners of the teeth are in engagement instead of the nearly vertical working faces. At this point the single tooth at the top of the clutch assembly is raised sufficiently to start to engage the hand-throw pinion and will be moved into engagement with it by the spring force and any upward thrust due to the torque load on the lower teeth, provided the two upper teeth are aligned to permit such engagement. If these upper teeth are not aligned, the spring will hold the "clutch for hand operation" against the hand throw pinion tooth until the hand-throw lever is operated to obtain alignment.

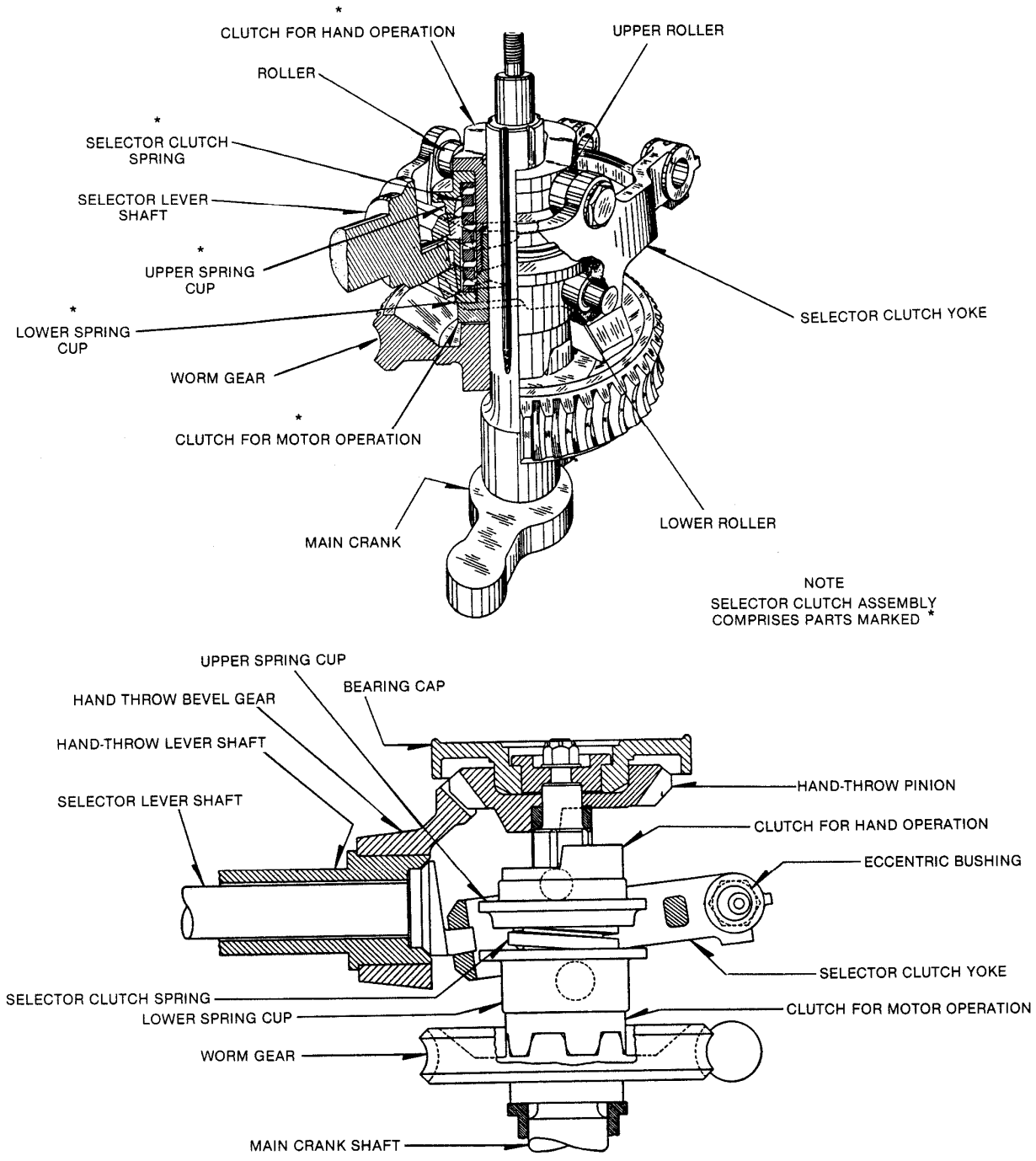


Figure 2-14. Dual Control Mechanism

The spring functions in a similar manner if the worm gear teeth are not aligned when the selector lever is returned to the MOTOR position. Operation of the selector lever out of the MOTOR position also actuates a pair of motor cutout contacts to open the motor circuit and in some cases to control a line circuit. The cutout contacts are mounted in the circuit controller compartment and are operated by a spring-return push rod projecting into the gear box. This push rod is shifted toward the circuit controller by the action of a cam ledge on the selector clutch yoke engaging an adjustable rocker arm (see Figure 2-15).

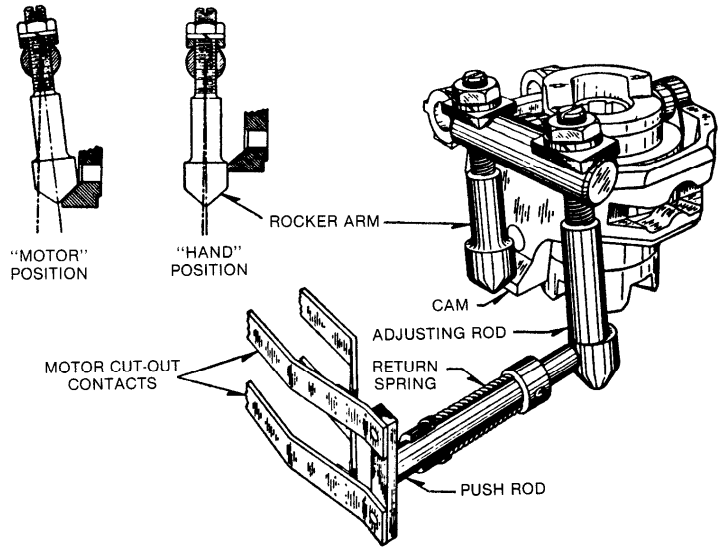
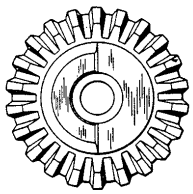


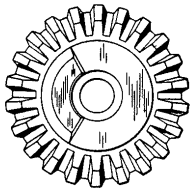
Figure 2-15. Motor Cutout Contact Assembly (M-23A and M-23B)

2.7.3. M-23B Mechanism

The mechanical difference between M-23A and M-23B mechanisms is in the hand throw pinion (see Figure 2-16). The single tooth on the hub of the hand throw pinion for the M-23B mechanism is of shorter arc than that for the M-23A, thus introducing sufficient lost motion between the pinion and the selector clutch to permit full stroke of the hand throw lever (and thus the switch points) without moving the slide bar far enough for the locking dogs to engage the lock rods and thereby lock the switch points. The travel of the main crank is ample, however, to lock the switch-operating bar against back thrust.



(a) BOTTOM VIEW OF HAND THROW BEVEL PINION FOR M-23A MOVEMENT



(b) BOTTOM VIEW OF HAND THROW BEVEL PINION FOR M-23B MOVEMENT

Figure 2-16. Bottom Views of Hand-Throw Bevel Pinions

2.7.4. Lever Interlock

The hand-throw and selector levers are interlocked by means of a steel ball and suitable recesses in the lever hubs to prevent operation of the hand throw lever unless the selector lever is in the HAND position. The lever interlock also prevents return of the selector lever from the HAND position unless the hand-throw lever is in one or the other of its full-stroke positions. (See Figure 6-3.)

The interlock can also be assembled to require that the hand-throw lever always be returned to NORMAL position before the selector lever can be returned from the HAND position. Also, it is possible to apply the selector lever to its shaft in either of two ways, 180° apart, so as to have the MOTOR position of the selector lever toward either the motor end or the circuit controller end of the machine for both right-hand and left-hand assemblies. See Section 6.5 for procedures for changing selector lever position and interlock.

2.8. Motors

Motors are available for input voltages of 20 V dc, 110 V dc, or 110 V ac at 25, 50, or 60 Hz. The same motor is used for all low-voltage machines by proper assembly of the terminal connectors on the motor terminal board for the motor field connections. Machines having a 528 to 1 gear ratio (nominal speed 15 seconds) should have the terminal connectors assembled as shown in diagram (A) of Figure 2-17, resulting in series-parallel connection of the field coils. Machines having a 360 to 1 gear ratio (nominal speed 8 seconds) should have the terminal connectors assembled as in diagram (B) of Figure 2-17, to provide a parallel-parallel connection of the field coils.

The same motor is used for all dc high-voltage machines by proper assembly of the terminal connectors on the motor terminal board for the motor field connections. Machines that use high-voltage motors, dc or ac, have a 189 to 1 gear ratio (nominal speed 3.5 seconds for DC, 3.0 seconds for AC). Series-parallel field connections shown in diagram (C) of Figure 2-17and split field connections in diagram (E) of Figure 2-17 for dc high-voltage machines are obtained by proper connections on the motor terminal board and the main terminal board. Connections for the motor of the ac high-voltage machines are shown in diagram (F) of Figure 2-17. All high-voltage motors are interchangeable by making proper connections at the motor terminal board and the main terminal board with the proper change in power source.

For low-voltage motors, the voltage at the motor terminals should be not less than 20 volts under the most adverse conditions of load, temperature, and battery voltage. Dc high-voltage motors should have not less than 85 volts, and ac motors should have not less than 100 V at the motor terminals. With the exception of the split field motor, the minimum voltage is the sum of the voltages across field terminals A and D on the motor terminal board and armature terminals X and Y, measured at the same time and with the clutch slipping. Information on the adjustment to slip the clutch is given in Section 4.2.1.2. For the split field motor, this minimum voltage is the sum of the voltages across the energized field terminals, A and V, or D and W, on the motor terminal board, and armature terminals X and Y, measured at the same time with the clutch slipping.

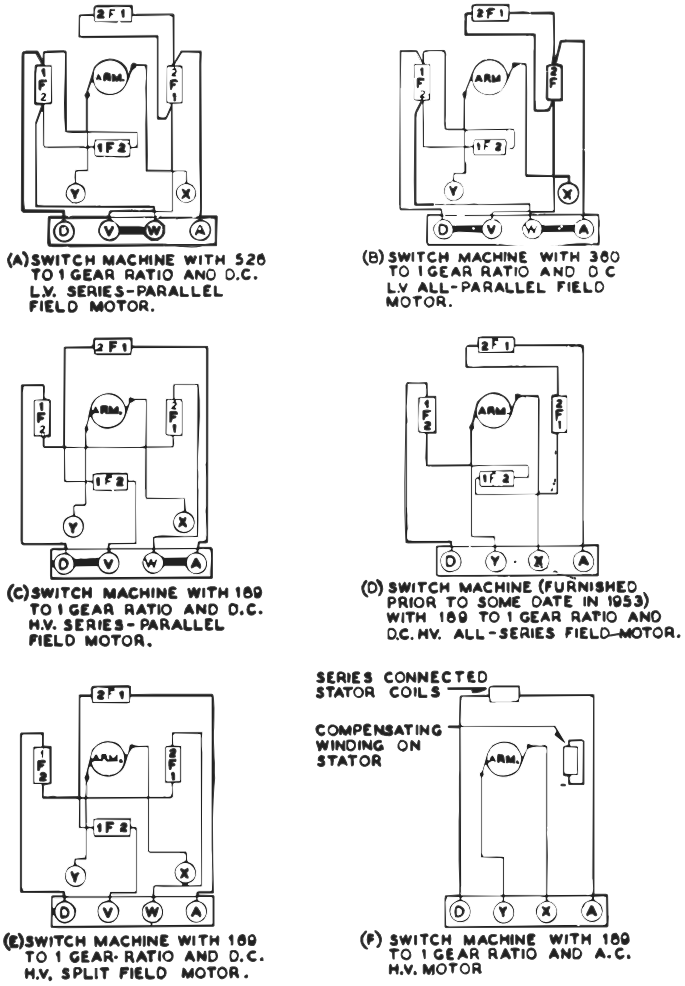


Figure 2-17. Typical Motor Connections

2.9. Overload Protection

The standard plug-in type relay for the overload protection of dc switch machines is the US&S PN-150SO relay. For the protection of ac switch machines, US&S PA-150SO plug-in type relay is used.

These relays are used in conjunction with the PN-150BM switch control relay and the PP-151 magnetic stick relay for overload and short circuit protection. Formerly used and still available for replacement purposes are the plug-in type ORP-60 overload relay for dc machines and the plug-in type ORP-66 for ac machines.

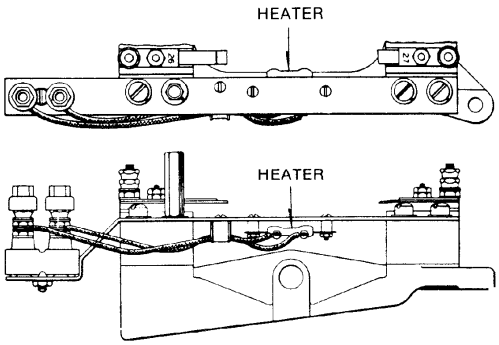
Where shelf-mounting relays are used, overload protection can be provided for the dc machine by using an OR-11 overload relay and dc overload protection can be provided by an OR-20 overload relay.

In ordering a switch overload relay, the current at which the clutch is set to slip or the gear ratio of the machine and the type of the machine with which it is to be used should be specified. The gear ratio is stamped on the switch machine nameplate. The thermal resistors of these relays are selected to give proper operation for the value of current at which the clutch slips with overload. The OR-20 should be ordered for the voltage and frequency of the machine and the order must specify whether the control is by relay or type "F" controller.

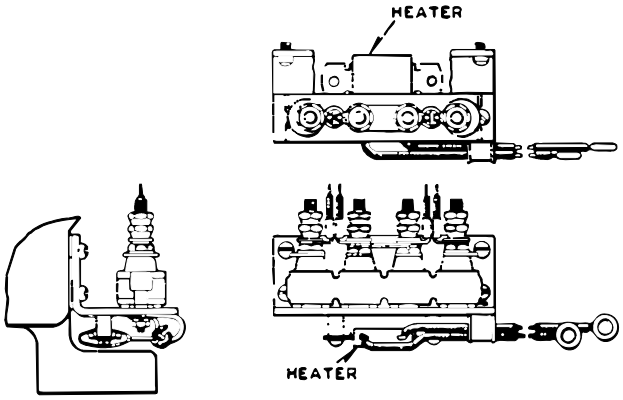
2.10. Heaters

Heaters are available for all switch machines. The heater for the circuit controller compartment mounts at the end of the controller opposite the wire inlet (see Figure 2-18). It is held by the four screws that hold the circuit controller terminal boards at that end of the compartment. No additional holes are required and terminal space is usually available on the main terminal board. See Figure 2-19, Figure 2-22, and Figure 2-25 for wiring.

A heater is also available for the motor compartment. It is mounted on the underside of the bracket for the motor terminal board (see Figure 2-18). Two holes must be drilled and tapped in the bracket. Wire leads are terminated on the same binding posts on the main terminal board for the circuit controller heater. Usually 15 W heaters, energized by 110 VAC, are used.



Heater for Circuit Controller



(B) HEATER FOR MOTOR COMPARTMENT

Figure 2-18. Heaters for Circuit Controller and Motor Compartments

2.11. Wiring

Internal wiring for standard dc low- and high-voltage switch machines is shown in Figure 2-19, Figure 2-22, and Figure 2-25. Internal wiring for ac switch machines is also shown in Figure 2-22. The circuit controller indication cams are shown for a switch having the right-hand point normally closed and in normal position. There is no difference due to the side of the track on which the machine is placed.

Figure 2-21 and Figure 2-24 show typical circuits for the control of switch machines using the standard PN- I50SO, PN-I5OBM, and PP-151 plug-in relays. Figure 2-20,Figure 2-23, Figure 2-26 show typical circuits using the shelf relays DP-25, OR-11 and the earlier style plug-in types PNP-69 and ORP-60 relays. These typical circuits show wiring of the relays that corresponds to the internal wiring diagrams for standard dc switch machines as applied to single switches.

The current style of plug-in switch control relay is the PP- 151 used in conjunction with the PN-15OBM relay. This is the equivalent of the shelf type DP-25 or the earlier style plug-in PNP-69 relay. 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-l5OBM is a biased relay with magnetic heavy-duty contacts and is used for closing the switch motor circuit and opening it under abnormal conditions. These two relays in combination are also self-checking because of the bias feature on the PN-150BM relay. The DP-25, PNP-69, and PN-l5OBM relays are capable of breaking stalled switch motor current in excess of 50 A at 110 V dc.

For switch machine installations with shelf type relays, the DP-25 is used. It is available with two neutral magnetic blowout contacts for a double break switch motor circuit. Conversion of the DP-25 relay with one magnetic blowout contact (without low-voltage neutral contacts) to one having two magnetic blowout contacts can be accomplished by following Service Specification SU-2378-N.

The PNP-69 and PNP-61A relays are used in switch machine installations with the earlier type plug-in relays. The PNP-69 relay has two neutral magnetic blowout contacts and is used to control double break switch motor circuits. The PNP-61A relay has one neutral magnetic blowout contact and is used to control single break switch motor circuits.

The Styles PP- 151 and PN-15OBM plug-in relays and the DP-25 relay for shelf mounting are also available for the control of switch machines using ac motors having series-connected stator coils. PNP-69 and PNP-61A plug-in relays were formerly used for this purpose.

The typical circuits shown are intended to illustrate principles and should not be used as working drawings. Pole changing contacts and other circuits not shown for control of the WR relay should be in accordance with the circuits designed for the specific installation.

No change is ever required in the internal wiring, as all internal and external wires go directly to the main terminal board. If the layout calls for a left-hand point normally closed, change leads as called for in the notes shown in Figure 2-20, Figure 2-21, Figure 2-23, Figure 2-24, and Figure 2-26. The circuit controller cams for the indication contacts should also be reversed as outlined in Section 6.2.

A wiring diagram or a working drawing is enclosed with each switch machine when shipped. The wiring diagram enclosed (if not an actual working drawing) is intended to illustrate a typical installation. However, working drawings should be followed for a specific installation. Notes on the typical wiring diagram, when enclosed, cover variations required for a few typical types of switch indication and the manner in which jumpers on the main terminal board and shunting strips should be arranged.

Switch machines with split field motors are only supplied for dc high voltage application. It is recommended that switch machines having split field motors be used only where the WR relays are de-energized while the switch is electrically locked, such as in relay interlocking. Also, a double break motor circuit should be used.

If the latch (see Section 2.4.3, Point Detector) is arranged to be "self-restoring," the control and indication circuits should be examined before installing the switch machines to make sure that the circuits will not prevent the machine from operating to restore the latch automatically after a latch-out occurs.

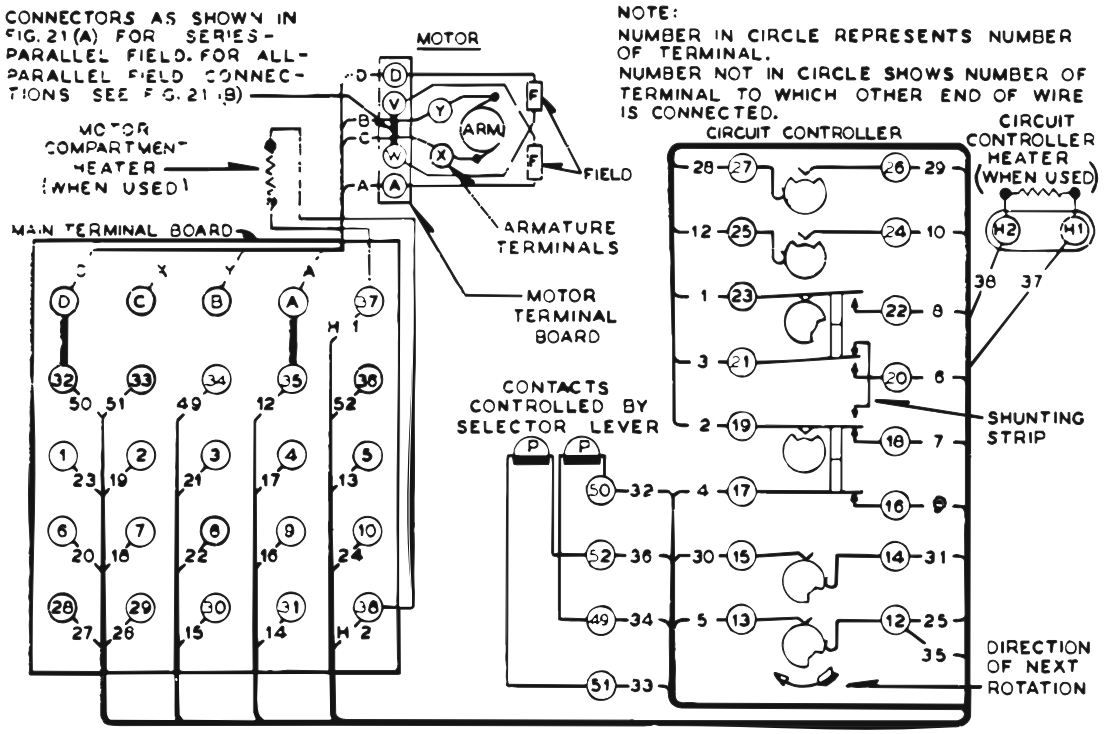


Figure 2-19. Wiring Diagram for DC Low-Voltage Switch Machine With Series-Parallel or All Parallel Motor

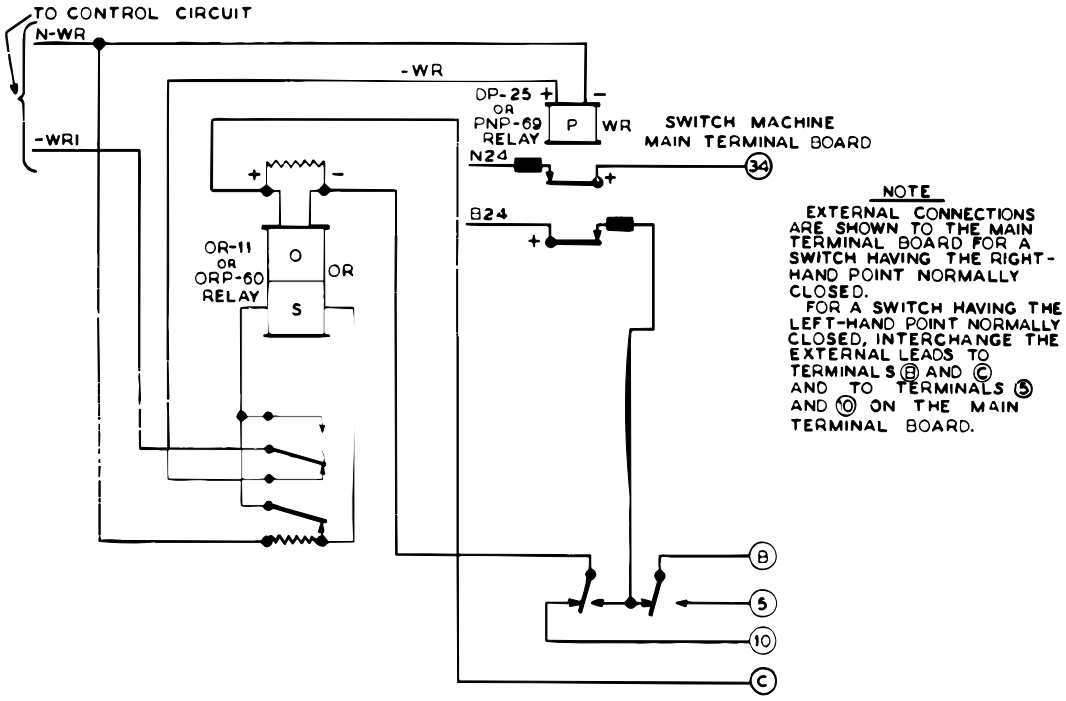


Figure 2-20. Typical Circuit for Control of DC Low-Voltage Switch Machine With Series-Parallel or All-Parallel Field Motor (Figure 2-19) Using DP-25 or PNP-69, and OR-11 or ORP-60 Relays

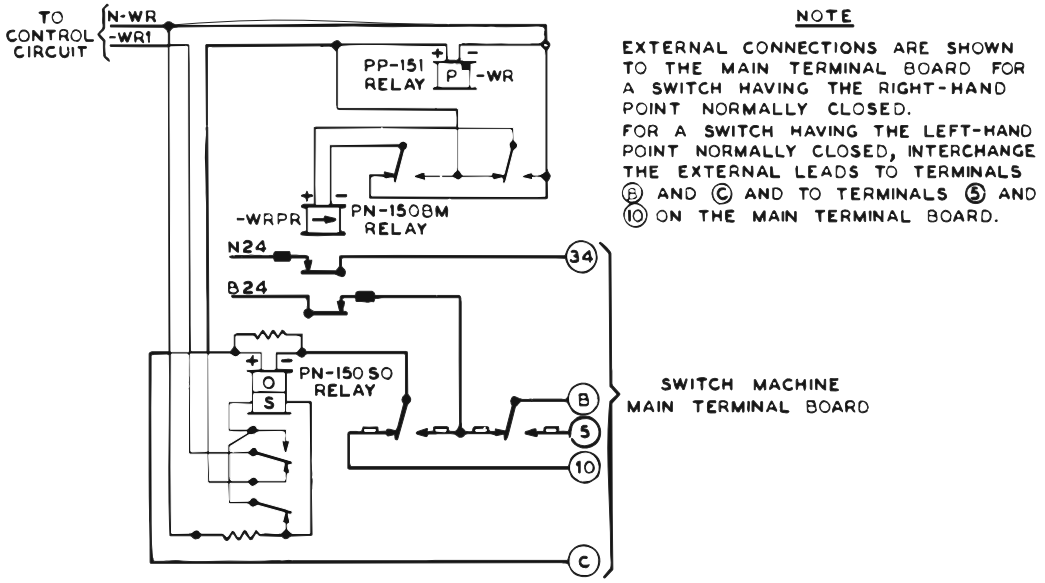


Figure 2-21. Typical Circuit for Control of DC Low-Voltage Switch Machine With Series-Parallel or All-Parallel Field Motor (Figure 2-19) Using PP-51, PN-150BM, and PN-150SO Relays

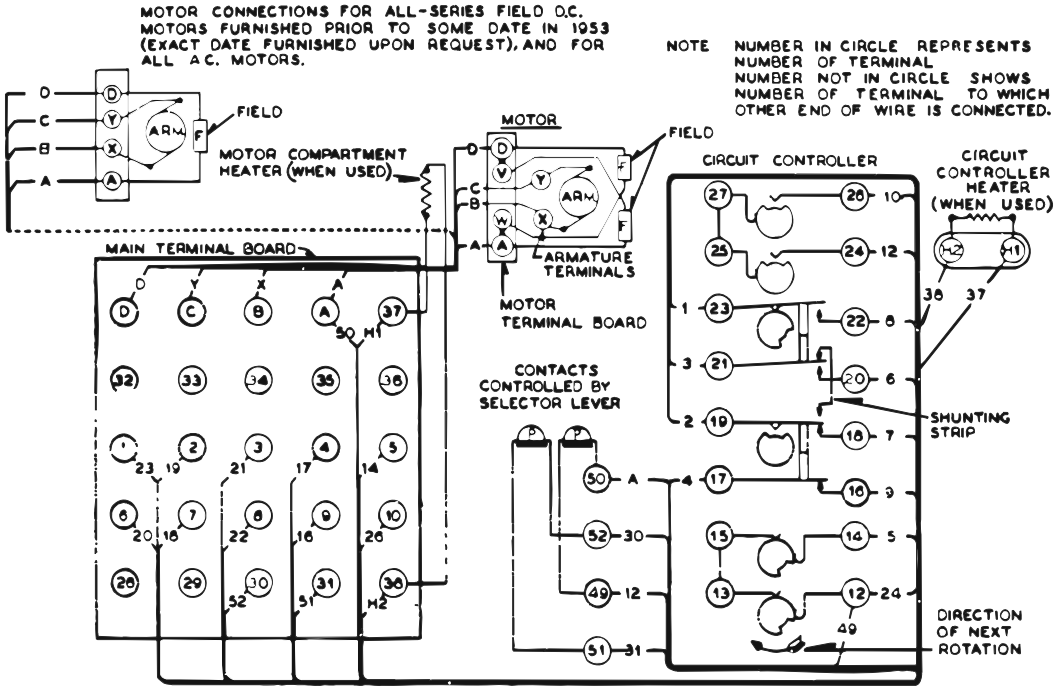


Figure 2-22. Wiring Diagram for AC High-Voltage Switch Machine and DC High-Voltage Switch Machine With Series-Parallel Field Motor

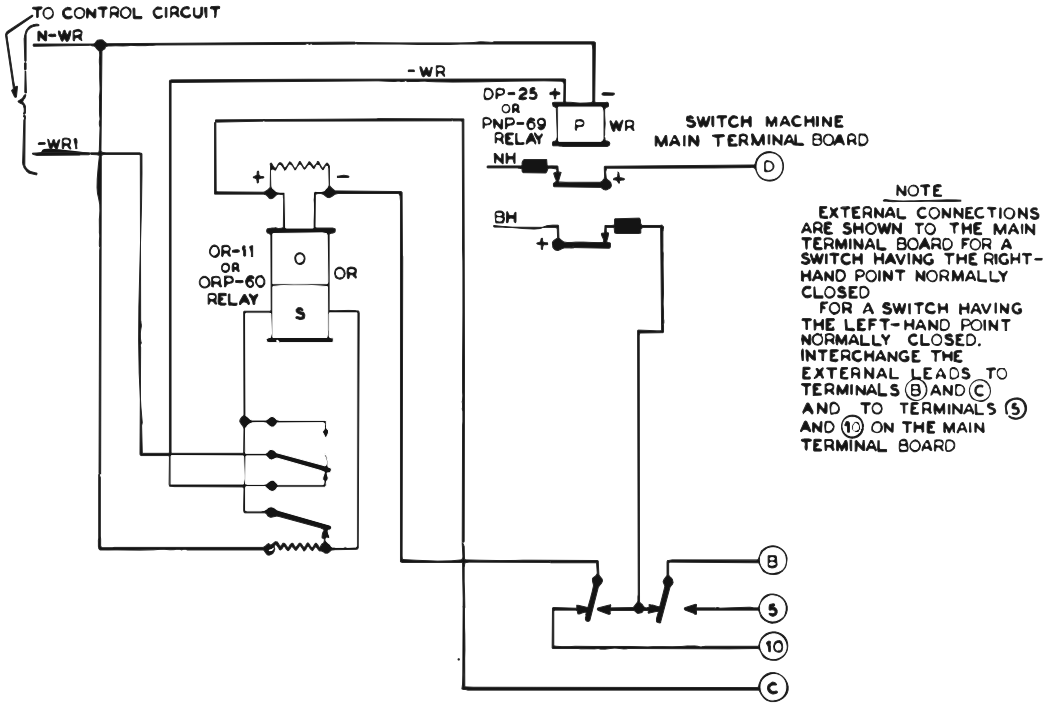


Figure 2-23. Typical Circuit for Control of DC High-Voltage Switch Machine With Series-Parallel Field Motor (Figure 2-22) Using DP-25 or PNP-69, and OR-11 or ORP-60 Relays

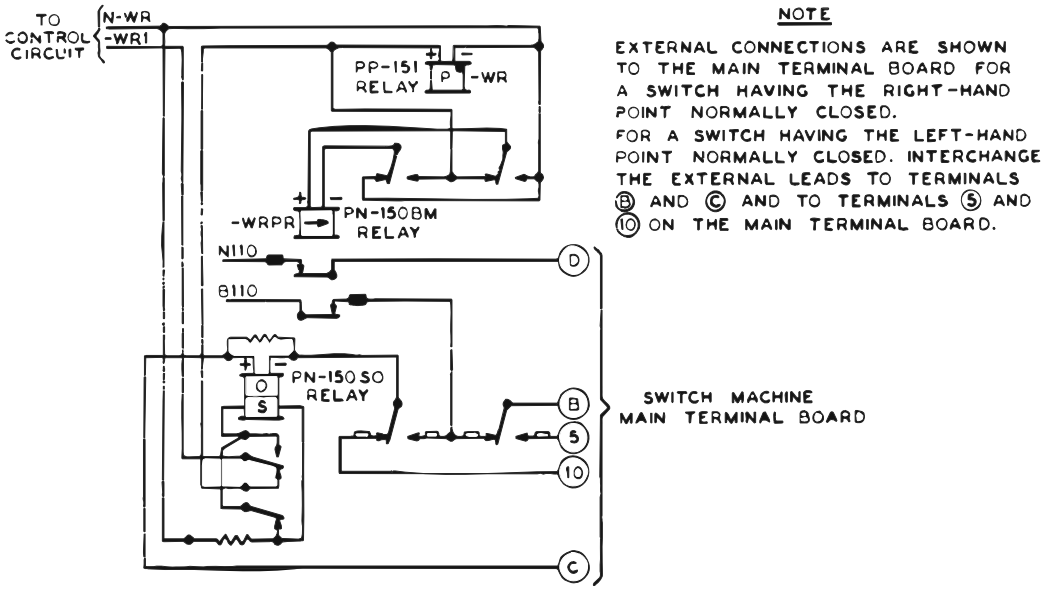


Figure 2-24. Typical Circuit for Control of DC High-Voltage Switch Machine With Series-Parallel Field Motor (Figure 2-22) Using PP-51, PN-150BM, and PN-150SO Relays

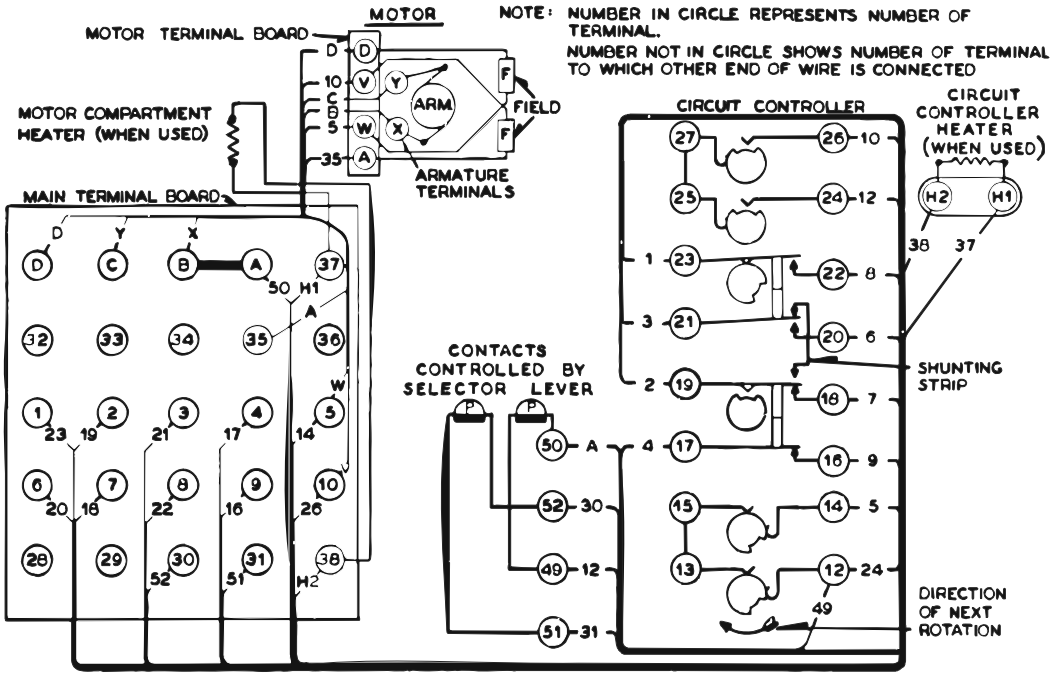


Figure 2-25. Wiring Diagram for DC High-Voltage Switch Machine With Split Field Motor

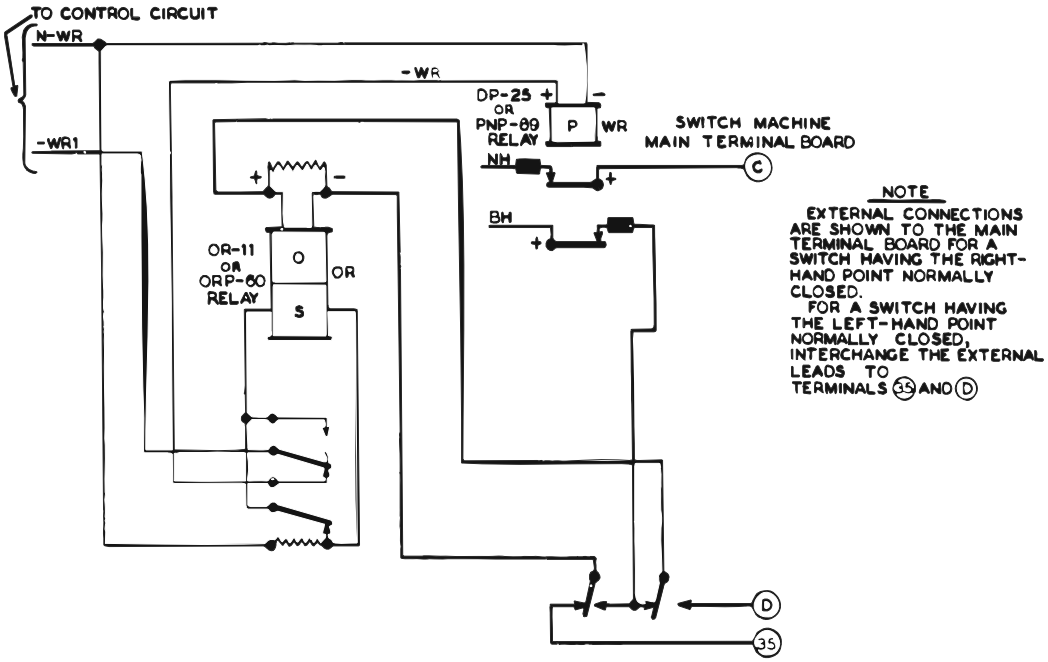


Figure 2-26. Typical Circuit for Control of DC High-Voltage Switch Machine With Split Field Motor (Figure 2-25) Using DP-25 or PNP-69, and OR-11 or ORP-60 Relays

3. INSTALLATION

3.1. General Information

Typical installations of the M-3, M-23A, and M-23B switches are shown in Figure 3-1 and Figure 3-2. However, detailed mounting plans approved by the railroad should be followed when installing the machine. Mounting dimensions are shown in Figure 3-3 and Figure 3-4.

Switch machines are assembled at the factory to suit particular layouts when sufficient information is provided by the customer but can be changed from right-hand to left-hand or vice versa in the field. Conversion of the M-3 is simple and no detailed instructions are required. Detailed instructions for changing the M-23A and M-23B dual-control machines are Section 6.4.

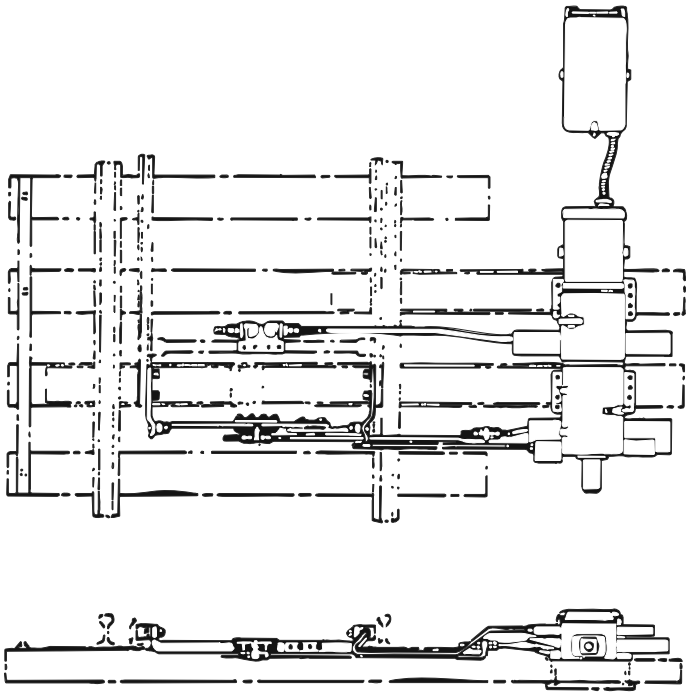


Figure 3-1. Typical Installation of M-3 Switch Machine

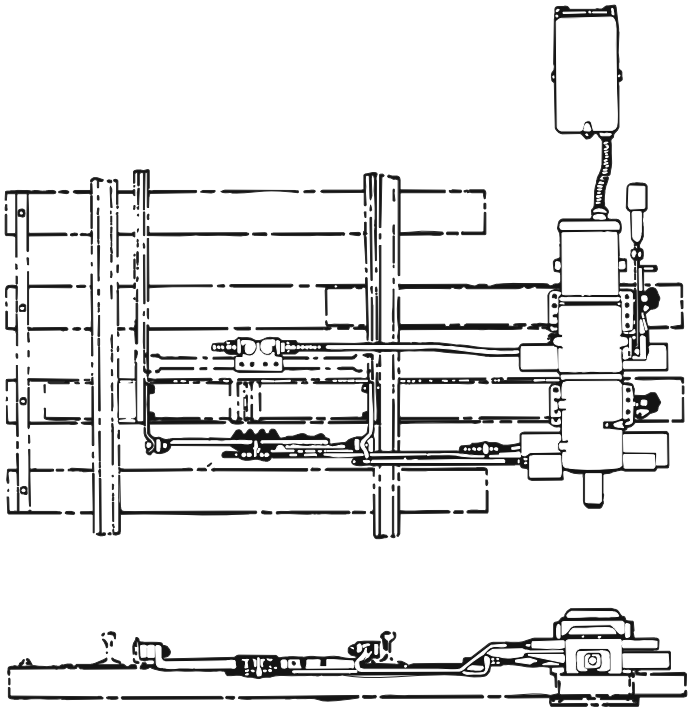


Figure 3-2. Typical Installation of M-23A Switch Machine

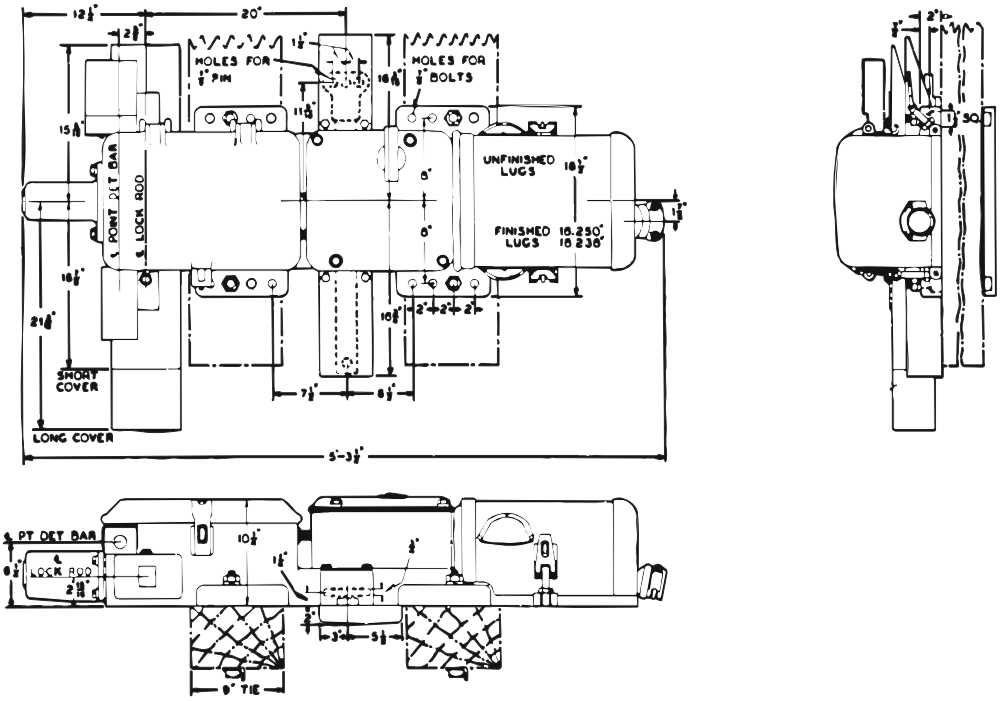


Figure 3-3. Typical M-3 Switch Machine Mounting Plan (Right-Hand Assembly with Adjacent Point Closed)

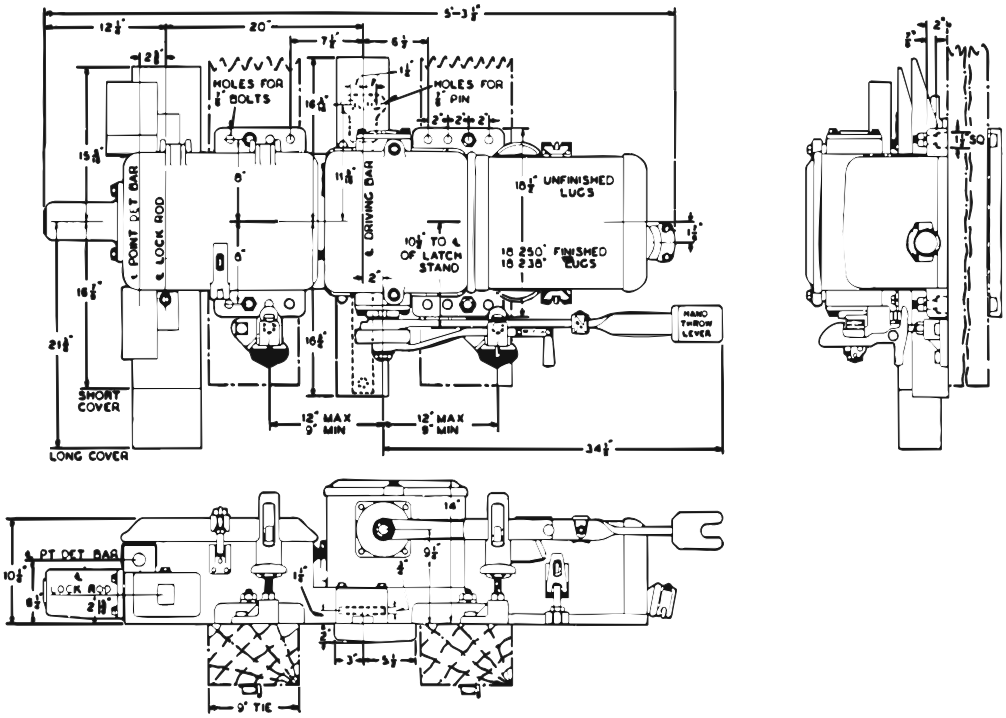


Figure 3-4. Typical M-23A or M-23B Switch Machine Mounting Plan (Right-Hand Assembly with Adjacent Point Closed)

3.2. Installation Procedure

Follow the procedures provided below in Section 3.2.1 through Section 3.2.12 in the order listed to install the switch machine.

3.2.1. Mounting

Mount and secure switch machine on railroad ties according to the layout plans of the particular location.

3.2.2. Drain Plug Installation (Only Where Required)

NOTE

Drain plugs are provided for machines installed where blowing sand or dirt could enter the drain holes and cause mechanical failure. The plugs should only be installed in locations where this condition is present.

CAUTION

If drain plugs are installed, they must be periodically removed to drain water from the compartments, especially prior to freezing temperatures. Water accumulation, especially with freezing temperatures, could cause equipment damage.

3.2.2.1. Motor Compartment Drain Plugs

Two 3/8 in. pipe plugs are supplied in a bag in the motor compartment. They are provided to plug two threaded drain holes located under the crank case compartment (identified as "Z" in Figure 4-1 and Figure 4-2). Install these plugs only if machines are located where blowing sand or dirt could enter the machine and cause a failure. See note and caution statements above.

3.2.2.2. Circuit Controller Compartment Drain Plugs

Two slot-head bolts with lock washers function as drain plugs in the circuit controller compartment (identified as "X" in Figure 4-1 and Figure 4-2). These bolts are shipped in place but not fully tightened. Tighten these bolts only if machines are located where blowing sand or dirt could enter the machine and cause a failure. If this condition does not apply, remove the bolts. See note and caution statements above.

3.2.3. Wiring

Connect the external wiring to the terminal board according to the wiring diagram for the particular installation.

3.2.4. Initial Gear Lubrication

Gear lubricant (M-7652-2) is provided in a container shipped with the machine. Apply a light coat of this lubricant to the teeth of the spur gear (also see 4.1.4). Put the remainder of the lubricant into the worm gear compartment only. (Before leaving the factory, all other working parts of the machine are sufficiently well lubricated to be placed in service.)

NOTE

When applying lubricant it is not necessary to remove the black compound that coats some parts. This compound was applied to provide protection against corrosion during shipment and storage.

3.2.5. Position Indication of Hand-Throw Lever (M-23A and M-23B only)

Apply letters "N" (NORMAL) and "R" (REVERSE) to the hand-throw lever to correspond with the switch position.

3.2.6. Hand-Throw Lever Stands Adjustment (M-23A and M-23B only)

Adjust the height of the hand-throw lever stands so that the hand-throw and selector levers rest in a horizontal position parallel to the cover of the gear box.

3.2.7. Switch-Operating 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. Do not apply excessive pressure at switch points.

3.2.8. Lock Rod Installation and Adjustment

The flat plate snow cover must be assembled on the track side (where applicable) when installing the lock rods. With the circuit controller cover removed and the machine at mid-stroke, install the lock rods. Ensure that the rods are assembled such that the locking dogs in the lock box will enter the narrow notches first. In some instances it may be necessary to invert the lock box to suit the rod notches (see Section 6.1).

Preliminary adjustment 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. (This requires that the M-23B machine be operated by power or by turning the friction clutch housing by applying a ratchet wrench to the clutch adjusting nut with the selector lever in the MOTOR position and power disconnected.) 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 according to the applicable instructions in the AREMA signal manual or to applicable railroad instructions.

3.2.9. Point Detector Bar Installation and Adjustment

Install the point detector bar and its connecting rod (first remove shipping closures from the machine). Adjust to check switch point according to instructions in the AREMA signal manual or to railroad instructions. When making adjustments, work first with adjustment for the far switch point, using the nuts on the track end of the point detector bar. Then, adjust for the near switch point working at the field end of the point detector bar.

3.2.10. Indication Cam Check

Check that indication cam N (see Figure 2-9) has its notch up when machine is in the normal position. Check also that cam P (see Figure 2-8) has its notch up when machine is in the reverse position. If these cams are not in the correct positions, adjust following the instructions provided in Section 6.2.

3.2.11. Final Adjustment of Hand-Throw Lever Stands (M-23A and M-23B Only)

Make final check of adjustment of hand-throw lever stands to assure that transfer from power to hand operation is possible under all conditions. Follow the five steps listed below.

1. Remove gear box cover so the action of the selector clutch and its relation to the hand-throw pinion can be observed (see Figure 2-14).

2. With the hand-throw lever in NORMAL position, operate the machine by power to the reverse position, and then to the normal position. Move the selector lever to the HAND position. Check that the selector clutch shifts up and engages the tooth on the bottom of the hand-throw pinion. Also, check that the hand-throw lever will operate the machine. If the selector clutch fails to shift up full-stroke, adjust the height of the normal hand-throw lever stand to bring the clutch teeth into proper alignment.

3. (Repeat of step 2 for opposite end of stroke.) With the hand-throw lever in REVERSE position, operate the machine by power to normal position, then to reverse position. Move the selector lever to the HAND position. Check that the selector clutch shifts up and engages the tooth on the bottom of the hand-throw pinion. Also, check that the hand-throw lever will operate the machine. If the selector clutch fails to shift up full-stroke, adjust the height of the reverse hand-throw lever stand to bring the clutch teeth into proper alignment.

4. With the hand-throw lever in NORMAL position, operate the machine by power to the reverse position. Move the selector lever to the HAND position. The selector clutch should ride against but not engage the hand-throw pinion tooth. Also, the selector clutch spring should be compressed, taking up clearance between the upper and lower spring cups. Next, move the hand-throw lever toward the reverse. The selector clutch should snap up into engagement with the hand-throw pinion just before the hand-throw lever reaches the reverse position lever stand. Check that the hand-throw lever will now operate the machine.

5. (Repeat of step 4 for opposite end of stroke.) With the hand-throw lever in REVERSE position, operate the machine by power to normal position. Move the selector lever to the HAND position. The selector clutch should ride against but not engage the hand-throw pinion tooth. Move the hand-throw lever toward the normal position. The selector clutch should snap up into engagement with the hand-throw pinion just before the hand-throw lever reaches the normal position lever stand. Check that the hand-throw lever will now operate the machine.

3.2.12. Check of Operation With Obstruction (Friction Clutch Check)

With an obstruction between the switch point and the stock rail, operate the machine by power. When the switch point jams against the obstruction, the worm gear and worm shaft should stop but the motor should continue to run during the overload time delay period, slipping the friction clutch. Motor current during this period should be within 10% of the values specified in Table 4-3. If necessary, adjust the friction clutch spring to obtain the specified clutch slip current (see section 4.2.1.2 for clutch adjustment procedure).

4. FIELD MAINTENANCE

4.1. Preventive Maintenance

Preventive maintenance procedures include inspection, cleaning, drain plug removal, and lubrication. Procedures for adjustment are provided in Section 4.2, Corrective Maintenance.

A recommended schedule for performing preventive maintenance tasks is shown in Table 4-1. The actual interval between procedures should depend upon switch machine usage and customer experience.

Table 4-1. Recommended Preventive Maintenance Schedule

Interval	Equipment	Inspect	Clean	Lubricate	Performance Test	See for Procedure
6 months	Switch installation area	X				Section 4.1.1.1
6 months	Switch machine	X				Section 4.1.1.1
6 months	Switch machine circuit controller compartment		X	X		Section 4.1.2
6 months	Switch machine			X		Section 4.1.4
1 month	Switch machine				X	Section 4.1.4

4.1.1. Inspection

4.1.1.1. Switch Installation Area Inspection

1. Check that ties are well tamped to withstand forces caused by passing trains.
2. Check that tie plates, tie straps, rail braces, and switch fittings are secure.
3. Check that there is proper drainage and no sign of water accumulation around the switch machine.
4. Remove any material that could obstruct switch movement.

Switch Machine Inspection

1. Remove covers from switch machine circuit controller, gear box, and motor compartments.
2. Using hand crank (for M-3) or hand-throw lever (for M-23), operate switch back and forth as often as necessary and check for:
   - Proper and smooth operation of switch points without undue drag or spring. Check that points ride on all slide plates. Check for switch point obstructions.
   - Loose or damaged electrical connections.

- Burned, frayed, or broken insulation.
- Proper movement of switch machine main crank, slide bar lock box, switch-operating bar, circuit controller shaft, and circuit-controller point-detector connecting rods.
- Excessive wear, lost motion, or accumulation of foreign or conductive material.
- Excessive or unusual vibration and noise.

3. Electrically operate switch machine and check for:

   - Smooth movement of switch machine motor and gears: no binding, etc. should be noticed.
   - Conditions listed in step 2, above.

4. Check that there are no signs of moisture accumulation within switch machine compartments.

5. Check for moisture in the compartments. If drain plugs are installed in motor and circuit controller compartments, remove plugs and allow any moisture to drain. Reinstall plugs. See Section 4.1.3 for detailed procedure.

6. Check that motor control contacts, indication contacts, motor cutout contacts, and associated cams and linkages are clean and do not show excessive wear (see Section 4.1.2).

7. Check that all switch machine parts are properly and adequately lubricated (see Section 4.1.4).

8. Check that conduit between switch machine motor compartment and junction box is not damaged.

9. Remove two screws securing access plate over motor commutator. Check that commutator is smooth and clear. Check that commutator brushes are free in their holders and are not excessively worn.

4.1.2. Cleaning

The circuit controller compartment should be cleaned at the time of inspection to assure proper electrical operation.

4.1.2.1. Circuit Controller Compartment Cleaning Materials Required

- Degreaser
- Lint-free cloths

4.1.2.2. Circuit Controller Compartment Cleaning Procedure

1. Dampen a lint-free cloth with degreaser. Wipe motor control, indication, and motor cutout contact springs free of any accumulated dirt. Dry with a clean, lint-free cloth.

2. Repeat step 1 for motor control segments, indication cams, yoke, operating levers, point detector connecting rods, crank, and crank springs.

3. Lubricate cleaned areas following the procedure provided in Section 4.1.4.

NOTE

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

4.1.3. Drain Plug Removal (Only Where Required)

CAUTION

If drain plugs are installed, they must be periodically removed to drain water from the compartments, especially prior to freezing temperatures. Water accumulation, especially with freezing temperatures, could cause equipment damage.

NOTE

Drain plugs are provided for machines installed where blowing sand or dirt could enter the drain holes and cause mechanical failure. The plugs should only be installed in locations where this condition is present.

4.1.3.1. Motor Compartment Drain Plug Removal

Two 3/8 in. pipe plugs are located under the crank case compartment (identified as "Z" in Figure 4-1 and Figure 4-2). These plugs should only be installed if machines are located where blowing sand or dirt could enter the machine and cause a failure. Periodically (especially before freezing temperatures occur), remove these plugs to drain water that may have accumulated in the compartment. See note and caution statements in Section 4.1.3 above.

4.1.3.2. Circuit Controller Compartment Drain Plug Removal

Two slot-head bolts with lock washers function as drain plugs in the circuit controller compartment (identified as "X" in Figure 4-1 and Figure 4-2). These bolts should only be installed if machines are located where blowing sand or dirt could enter the machine and cause a failure. Periodically (especially before freezing temperatures occur), remove these bolts to drain water that may have accumulated in the compartment. See note and caution statements in Section 4.1.3 above.

4.1.4. Lubrication

NOTE

Regular and systematic lubrication is recommended. The period between lubrication depends upon the frequency of operation and environmental conditions and therefore must be established by the railroad.

Before leaving the factory, all working parts of the machine except the worm gear compartment are well lubricated. Non-painted and non-plated parts are coated with a special lubricant to protect 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 ordered from US&S.

Detailed lubrication information is provided by the list ("A" through "E") below. For lubrication application locations, see Figure 4-1 for the M-3 machine and Figure 4-2 for the M-23A and M-23B machines. Table 4-2 summarizes the detailed information provided in the list below.

A. <u>Pressure gun grease (M-7650-0l).</u> (See points of application identified by "A" in Figure 4-1 and Figure 4-2) Apply to:

Point detector bar bearings. Apply to grease fittings. Apply until surplus is visible at edges of bearings.

Operating bar wearing plates. Apply to grease fittings.

Selector and hand-throw lever shaft bearings. Apply to grease fittings. Apply until surplus is visible at edges of bearings.

B. <u>Pressure gun grease (M-7650-0l) or a heavy oil with viscosity of 120-200 at 210 °F (SAE 140).</u> (See points of application identified by "B" in Figure 4-1 and Figure 4-2) Apply to:

Surfaces of slide bar, lock box, and rack. Use a brush or paddle for application.

C. <u>Medium body motor oil with viscosity of 185-220 at 130 °F (SAE 30).</u> (See points of application identified by "C" in Figure 4-1 and Figure 4-2). Apply to:

Motor bearings. Apply to oil cup at both ends of the shaft.

Indication circuit controller trunnion, yoke bearings, and point detector linkage.

Spur gear journals (machines are equipped with Oilite bushings). Apply to holes in box casting, reduction gears, and clutch gear.

NOTE

Apply oil sparingly to clutch gear bearing to prevent seepage through clutch shaft packing to friction disks.

Top crank bearing. Fill recess. <u>The machine).</u> (See points of application identified by "E" in Figure 4-1 and Figure 4-2). This is a low-temperature, all-weather lubricant that changes little in consistency with temperature variation. It will retain its lubricating properties at the highest and lowest temperatures encountered. It does not require thinning at low temperatures. Apply to:

Spur gear teeth. Apply a light coating.

Worm gear compartment. Pack well around worm gear and selector clutch. This will require about 5 lb. of lubricant. It must be replaced as necessary to keep the worm gear covered.

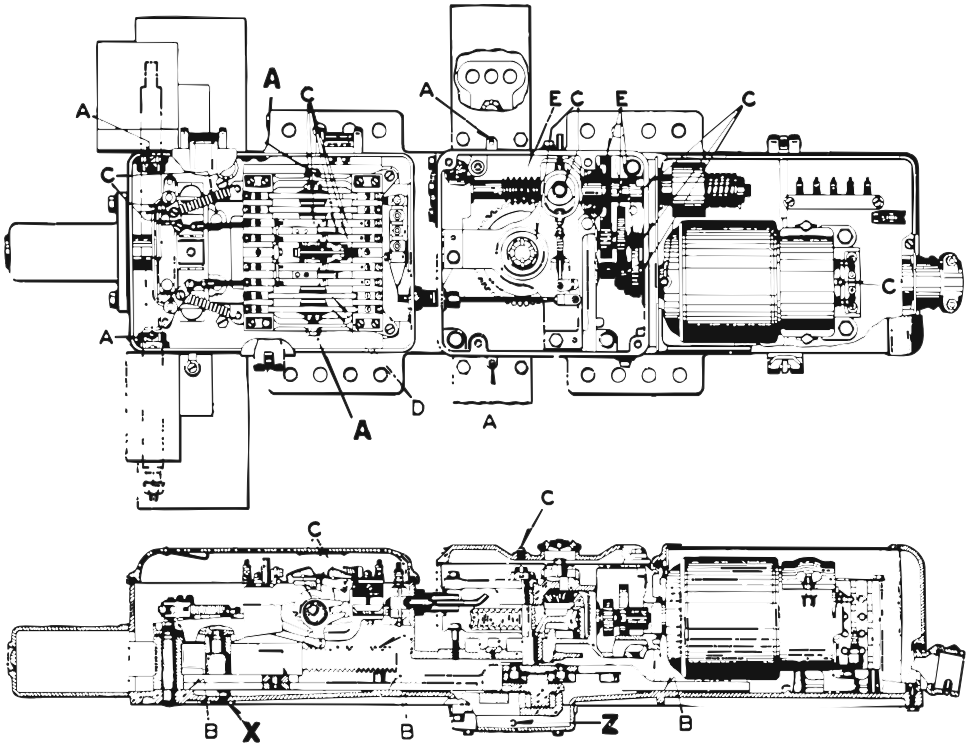


Figure 4-1. Lubrication Locations for M-3 Switch Machine

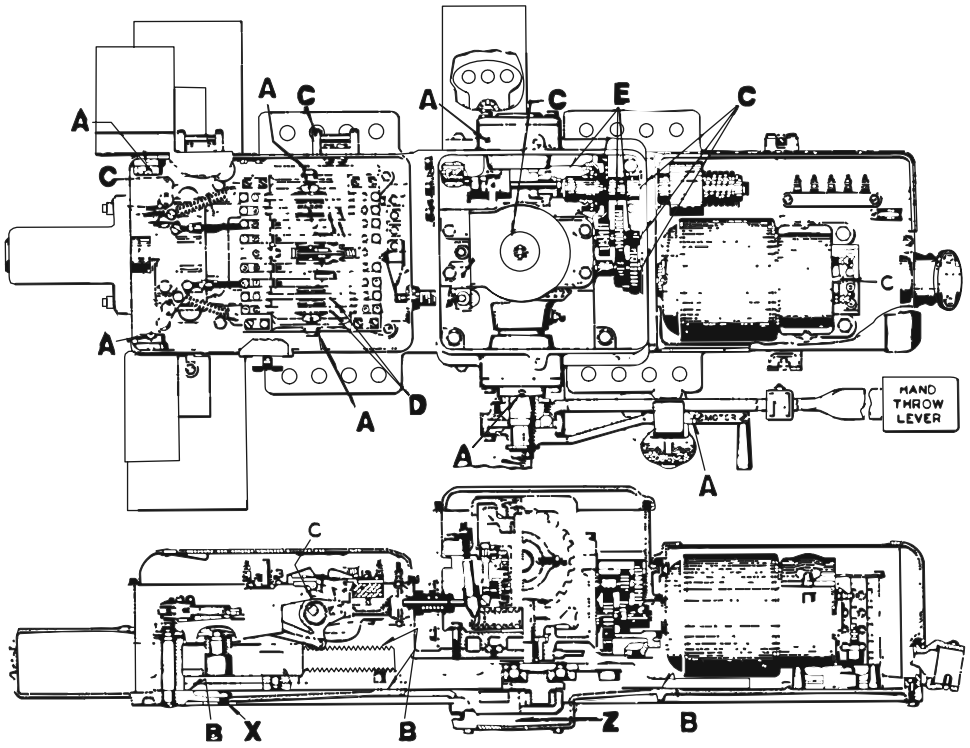


Figure 4-2. Lubrication Locations for M-23A and M-23B Switch Machines

Table 4-2. Lubrication Summary

Point of Application (See Figure 4-1 and Figure 4-2)	Lubricant (US&S Part Number)	Products that Meet Lubricant Specification	Application Method	Point of Application	Notes
A	Pressure gun grease (M-7650-01)	Alemite Solidified Oil #32	Grease gun	Grease fittings	Apply until surplus visible at bearing edges
B	Pressure gun grease (M-7650-01) or heavy oil with viscosity of 120-200 at 210 °F	Alemite solidified oil #32 or SAE 140 oil	Grease gun or pour or paddle	Surface	-
C	Medium body oil with viscosity of 185-220 at 130 °F	SAE 30 oil	Pour	Bearings, oil cups,	A few drops periodically as required.
				Recess on top of crank bearing	Fill periodically as required
D	Low temperature oil (M-7610-02)	-	Pour	Surface	Apply very light film on all contact segments at frequent intervals after thorough cleaning
E	Low temperature lubricating oil (M-7652-2)	"Stazon M"	Pour	Spur gear teeth	Periodically as required.
				Worm gear compartment	Keep worm gear completely covered. Approximately 5 lb. of lubricant required.

4.2. Corrective Maintenance

Field corrective maintenance procedures include only a limited set of adjustments. Major overhauls and repairs requiring disassembly to the components level are not recommended for field maintenance. For these procedures, the machine should be removed from service and sent to the shop for repair. See 5 for shop maintenance.

4.2.1. Adjustment

4.2.1.1. Switch-Operating Rod, Point Detector Rod, and Lock Rod Adjustment

The switch-operating rod, point detector rod, and lock rods should be kept in adjustment to meet applicable AREMA signal manual or railroad specifications. SM 5453 provides instructions for using a point detector gage to check point detector operation.

4.2.1.2. Friction Clutch Adjustment

NOTE

Careful friction clutch adjustment is important to assure proper operation of the switch machine. If the friction clutch slips too easily, the motor current may not operate the overload relay. If the friction clutch adjustment is too tight, unnecessary wear on mechanical parts may occur due to absence of shock protection. In ordinary operation without obstruction of the switch points, the clutch should slip slightly at both ends of the power stroke.

Friction clutch adjustment should be checked periodically to assure that the clutch slips at a torque that will protect the mechanism from shock, yet be adequate to sustain normal operating loads. Also, the clutch must slip at the proper torque to assure correct operation of the overload relay. Follow the procedure listed below to check friction clutch adjustment.

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

2. If "Fusetrons" are installed on the 110 V dc side of a bridge rectifier, connect a temporary jumper across these fuses.

3. Insert an ammeter in the motor circuit by connecting the negative ammeter lead to binding post A on switch machine terminal board and the positive ammeter lead to binding post 5 or 10, depending upon switch point position.

4. With an obstruction between the switch point and the stock rail, operate the machine by power. When the switch point jams against the obstruction, the worm gear and worm shaft will be stopped but the motor should continue to run, slipping the friction clutch.

5. Current drawn by the motor with clutch slipping should be within 10% of the nominal value shown in Table 4-3 for the particular motor and gear ratio of the machine.

Table 4-3. Friction Clutch Slip Adjustment

Motor Voltage	Gear Ratio	Current Drawn (See Note)	Nominal Speed (seconds)
110 V ac	189:1	12 A	3.0
110 V dc	189:1	12 A	3.5
20 V dc	528:1	12 A	15.0
20 V dc	360:1	20 A	8.0

NOTE

The motor current listed for gear ratio 189:1 must be checked in both directions and set for minimum of 12.0 A. Current draw may vary by approximately 1.0 to 3.0 A due to mechanical alignments and motor characteristics.

6. If the current is not within the specified range, remove cotter pin and adjust the friction clutch spring nut in or out to obtain desired current. Replace the cotter pin (use new cotter pin).

7. Remove temporary jumpers.

The clutch components are naturally subject to wear, which changes the slip current, and thus require readjustment. When adjustment requires the nut to be placed to the limit at which it can be held by a cotter pin, the fabric disks should be replaced (see Section 5.2.1 for replacement procedure).

5. SHOP MAINTENANCE

5.1. Adjustment

5.1.1. Point Detector Linkage Adjustment

Point detector rollers should clear the smaller diameter of the point detector bar by not more than 1/32 in. (see Figure 2-12). If necessary, adjust by adjusting eyebolts (H in Figure 2-8). Screws identified as J in Figure 2-8 must first be removed to adjust eyebolts.

5.1.2. Motor Control Contact Adjustment

Motor control contacts (located in the circuit controller) are factory-set to provide approximately 1/4 in. opening between the segment ring and the "V" end of contact finger Fl (see Sect. Y-Y and Z-Z in Figure 5-1), and provide approximately 1/8 in. margin against opening under F3 (see Sect. W-W and X-X in Figure 5-1) when the machine is at full-stroke (operated as far as it will go by rotating the friction clutch while in MOTOR position). Ordinarily, no readjustment will be required as long as the assembly is not disturbed.

If necessary, small adjustment of the opening can be made by loosening the bolt that holds the "V" end of finger Fl and sliding the finger in or out, then re-tightening the bolt. Contact finger Fl should be adjusted to push against the segment with 2.0 to 2.5 lb. force while finger F2 is held clear. Adjust finger stop Fla to have 1/32 ±1/64 in. minimum clearance from finger Fl when F1 is riding on the segment. Adjust finger F2 to push on finger Fl with 1.75 to 2.0 lb. force when finger Fl is on the segment. Adjust stop F2a to clear finger F2 by 1/32 ±1/64 in. minimum when contacts are closed as shown in Sect. W-W and X-X, and to permit finger Fl to clear finger F2 by 1/16 in. minimum when contacts are open as shown in Sect. Y-Y and Z-Z. Adjust finger F3 to push on the segment with 1.75 to 2.0 lb. force.

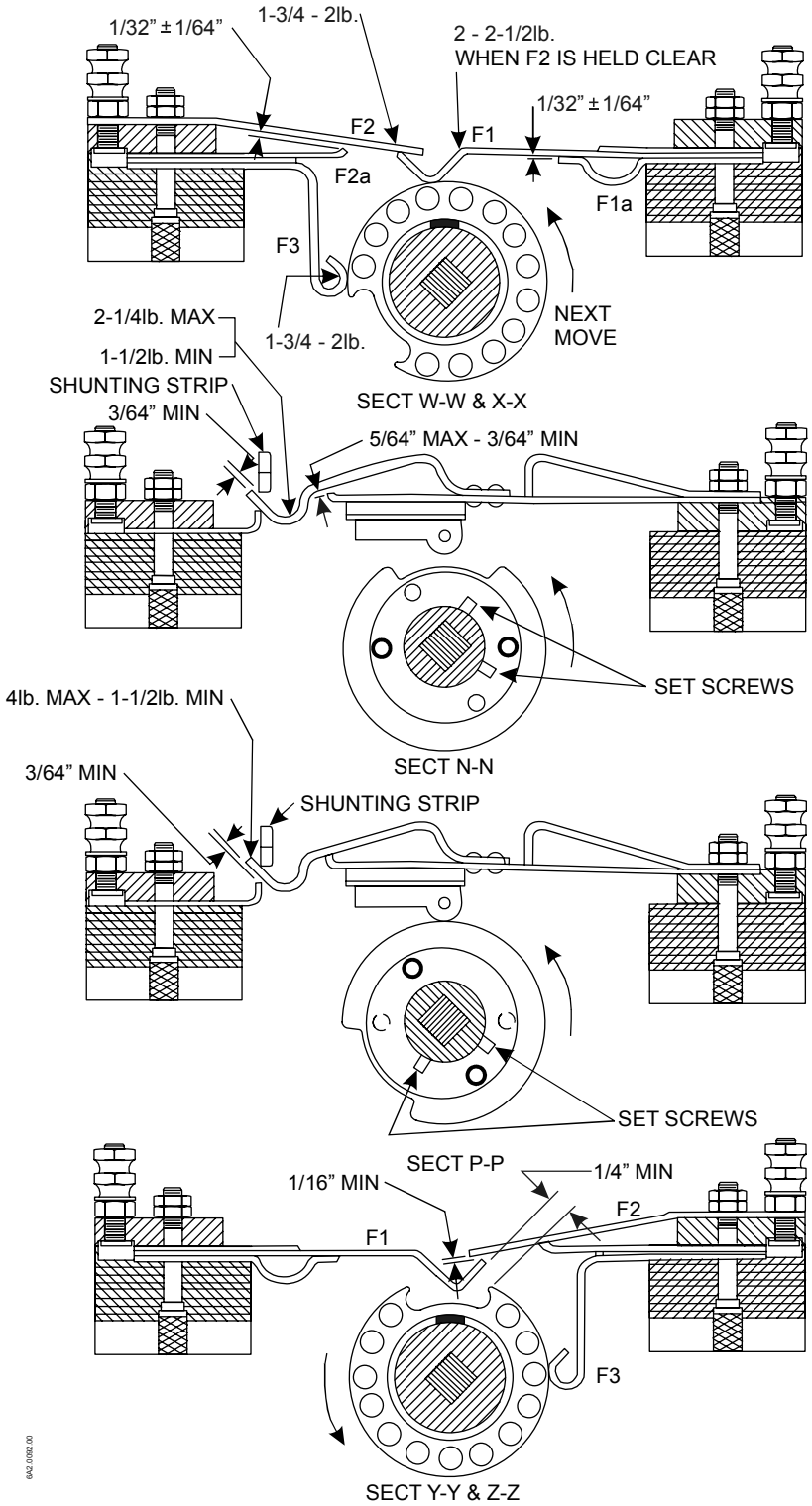


Figure 5-1. Circuit Controller Adjustment (Sectional Views of Figure 5-2)

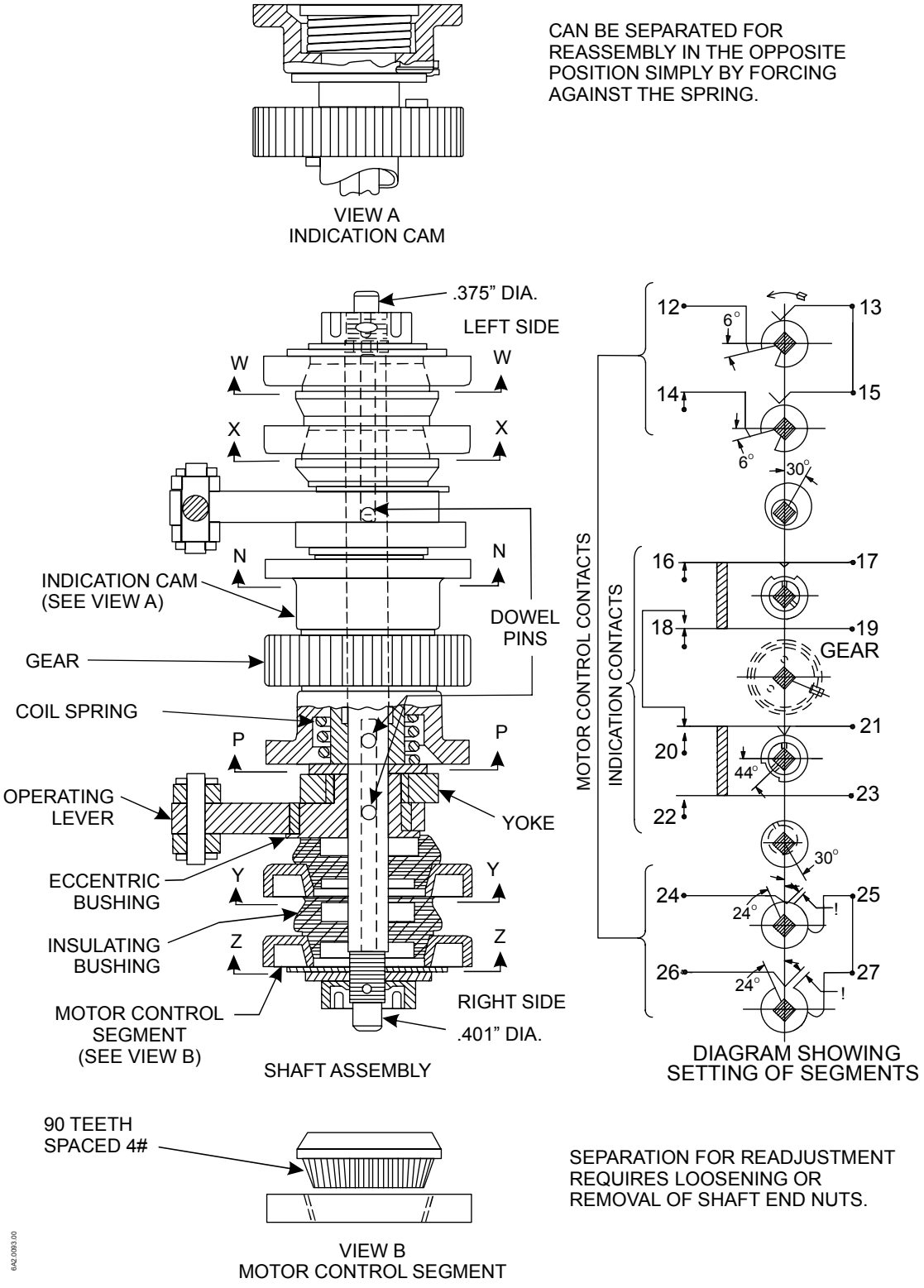


Figure 5-2. Circuit Controller Shaft Assembly

Contact forces and clearances must be in accordance with Figure 5-1, Sections P-P and N-N, and are attained by following the steps listed below.

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

2. Check clearance between cam and roller with roller in cam notch. Clearance must be between 3/64 inch to 5/64 inch. If clearance is not within this range, re-adjust reinforcing spring to obtain correct clearance. Repeat the previous step to recheck reinforcing spring break away load.

3. Check that slotted ends of contact springs (M) are in alignment, and push evenly on fixed contact W and on short circuiting strip S. Also check that 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 1/8 in. minimum dimension between end of indication contact springs (M) and short circuiting strip S. Check for 3/64 in. minimum clearances between springs (M) and fixed contact, and between springs (M) and short circuiting strip S.

5. With contacts at indicating position, check gap clearances at Y. Clearances should be 3/64 in. to 5/64 in. Check contact force between indication contact springs (M) and fixed contacts with spring scale at X. Contact force should be 1.5 to 2.25 lb. Adjust reinforcing spring breakaway load if necessary. Recheck to make sure breakaway load is 8 to 11 lb.

6. With contacts "made" against short circuiting strip S, check at front end of contact fingers for a load of 1.5 to 4 lb.

5.1.3. Motor Cutout Contact Adjustment for M-3 Switch Machine

See Figure 5-3 for a detail view of the motor cutout contact and actuator arrangement.

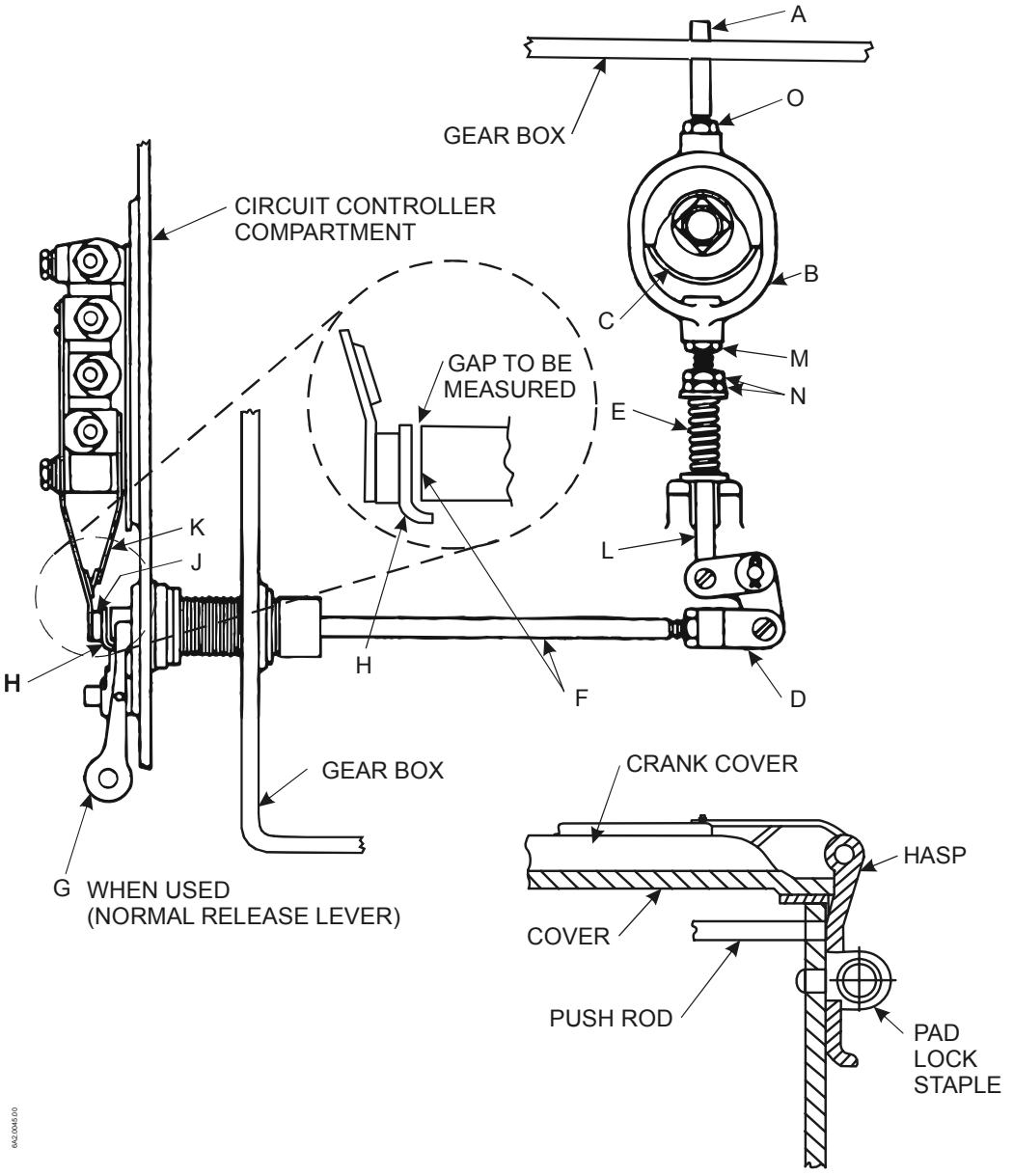
1. Remove the circuit controller cover.

2. With the hand crank cover closed (padlock hasp seated in the staple notch), check that the plunger end of the pushrod (F) clears the contact actuator bracket (H) by 1.6 to 3.1 mm (see enlarged view).

3. Release the padlock hasp and open the hand crank cover. Install the hand crank onto the top of the crankshaft. Check that the motor cutout contact(s) are open by at least 1.6 mm. Check that the motor cutout latch (G) is actuated.

4. Remove the hand crank.

5. If the condition in Step (2.) and/or (3) is not met, adjust the motor cutout linkage as follows:



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	Locknut

Figure 5-3. Adjustment of Motor Cutout Contacts

6. Remove power from the machine.

7. Latch the padlock hasp onto the staple. Ensure that the hasp is fully seated in the staple notch. Measure the exposed length of pushrod (A).

8. Remove the gear box cover.

9. Check the length of spring (E). The total length (including washers) should be 16 mm. Adjust nuts (N) as necessary to obtain this length. (This ensures that the spring will not act as a stop by becoming fully compressed.)

10. Depress pushrod (A) to the distance measured in Step (6.). With the pushrod (A) in this position, the yoke (B) should be about 16 mm from the machined stop surface of the top bearing (C). If not, loosen locknut (O) and adjust the pushrod (A) to obtain this clearance. (This adjustment ensures maximum travel of the linkage.)

11. Reinstall the gearbox cover using only two of the bolts removed in Step (8.).

12. Latch the padlock hasp onto the padlock staple. Ensure that the hasp is fully seated in the machined notch of the staple.

13. Check the adjustment of the pushrod (A) by pressing on the latched padlock hasp. There should be about 16 mm free play between the edge of the staple notch and the front of the hasp, then a solid connection should be felt.

14. If necessary, repeat Steps (8.) through (13.) to adjust the free play to about 16 mm, then tighten the pushrod locknut (O).

15. Reinstall the gearbox cover using the bolts removed in Step (8.). Latch the padlock hasp onto the padlock staple. Ensure that the hasp is fully seated in the staple notch.

Repeat Steps (2.) through (5.) (as necessary) until satisfactory adjustment is obtained.

Reinstall the circuit controller cover using the hardware removed in Step (1.)

If required, restore power to the machine.

5.1.4. Motor Cutout Contact Adjustment for M-23A and M-23B Switch Machines

The motor cutout contact for the M-23A and M-23B machines should open when the selector lever is lifted 6 in. (measured at the hand-grip) out of the MOTOR position. The contacts should open 1/8 in. to 3/16 in. when the selector lever is in the HAND position. When the selector lever is in MOTOR position, the end of the push rod should be 1/16 in. clear of the contact operating bar and the contacts should be closed with 1.5 to 2.0 lb. force.

Adjustment of the contacts-closed force, when necessary, is made by careful use of a spring bender. Use the following procedure to adjust. With selector lever in MOTOR position, adjust

the rocker arm (see Figure 2-15) up or down as necessary to just touch the machined cam surface on the selector yoke. Then, the turn the adjusting rod so that its eccentric head holds the end of the push rod 1/16 in. clear of the contact operating bar.

5.1.5. Selector Clutch Adjustment

Selector clutch adjustment should be checked periodically. When the selector lever is in the MOTOR position and the selector clutch teeth are in full engagement with the teeth on top of the worm gear so the motor drives the crank, the top rollers on the operating yoke should be just clear of the upper spring cup.

This relation can be varied by adjusting eccentric bushings Gl (see Figure 6-1). Referring to Figure 2-14 and Figure 6-1, note that the selector clutch yoke has one end supported on and driven by the finger on the selector lever shaft. The other end pivots on eccentric bushings GI (see Figure 6-1). These bushings are held fixed by through-bolt G. When this bolt is loosened, the eccentric bushings may be rotated to raise or lower the center line for the pivot holes in the yoke arms, thus affecting the elevation of the yoke rollers. The eccentric bushings have hexagonal heads for application of an adjusting wrench.

On each eccentric bushing, one flat is stenciled “N,” which will be on top when the eccentric is in its mean position. The adjacent flat on one side of the “N” is stenciled “+.” When the eccentric bushings are turned to bring the “+“ mark up, this will lift the yoke and its rollers. The flat on the other side of the “N” is stenciled “-.“ The two eccentric bushings should be at a similar angle of rotation to avoid twisting the yoke. Then, tighten the pivot bolt to hold the adjustment.

Also check that top rollers are free from pushing on the upper spring cup while the selector clutch is fully down. In addition, check that the rollers are not too high. To perform these checks, operate the selector lever to the MOTOR position when the worm gear is not in position to receive the selector clutch so that the teeth of the “clutch for motor operation” (see Figure 2-14) ride on top of the corresponding teeth of the worm gear. In doing this, insert 1/8 in. length of a #14 AWG soft copper wire between the opposed teeth. The eccentric bushings should be adjusted. the same degree + or - so that (with the through-bolt tight) when the selector lever is thrown to horizontal position for MOTOR operation, the force between the opposed teeth will crush the wire to not more than 1/32 in. thickness. Also check that upper rollers are free to turn when selector clutch is fully engaged with the worm gear.

5.2. Corrective Maintenance

5.2.1. Clutch Felt Packing Replacement

The friction disks must be kept free of oil. If clutch disks are oily and it is found that the oil is entering along the shaft, it is recommended that the felt packing be replaced. To replace felt packing, follow the procedure listed below.

1. Swing terminal board out to provide access. Measure the length of clutch spring before disassembly. Record this dimension for use in re-assembly.

2. Remove the cotter pin, adjusting nut, and clutch spring. Slide the clutch housing off the shaft.

3. Remove the fabric disks and clutch plates.

4. Remove the small lock screw using special tool N173641 and remove the packing gland nut. Remove the old felt packing.

5. Clean the shaft and the inside of the clutch housing using a non-flammable grease solvent.

6. Install two new felt packing disks (part no. J047335).

7. Place the packing gland nut in position. Using the spanner end of special tool N173641, pull down nut only until it is flush with the bottom of the clutch housing. Then, insert the locking screw and tighten it securely.

8. Coat rubbing surfaces of packing rings with gear box lubricant.

9. Clean shaft surface. Install housing on the shaft.

10. Old fabric disks should be replaced. Clean old clutch plates thoroughly using a non-flammable grease solvent to remove any accumulation of lubricant. Inspect old clutch plates and replace if damaged or excessively worn.

11. Reassemble fabric disks and clutch plates as shown in Figure 5-4. Notice that a fabric disk is first in the stacking order, and that a metallic clutch plate is last in the stacking order and contacts the clutch spring.

12. Install the clutch spring and adjusting nut. Adjust the nut so the spring length is as recorded in step 1.

13. Check friction clutch adjustment and adjust if necessary following the procedure of Section 4.2.1.2. Install new cotter pin.

14. After a brief wearing-in period, recheck friction clutch adjustment and adjust if necessary following the procedure of Section 4.2.1.2.

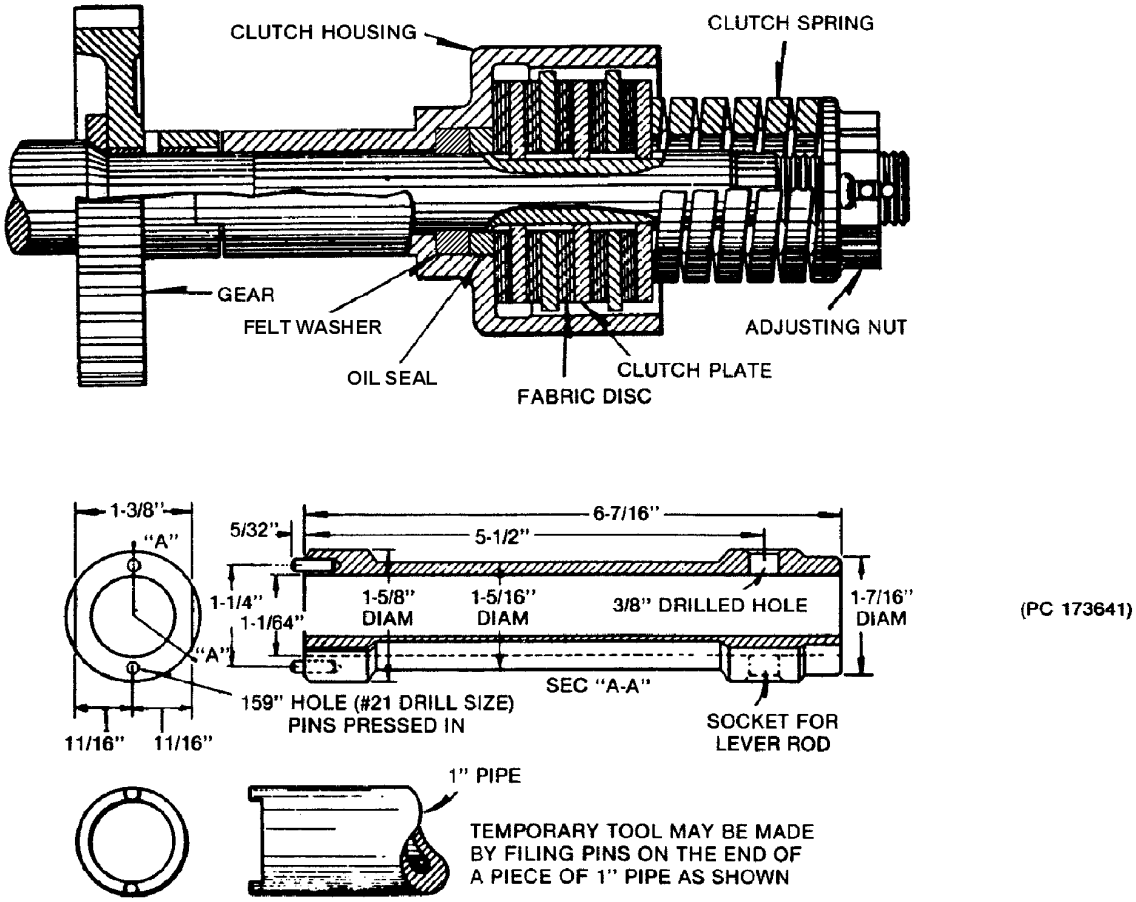


Figure 5-4. Friction Clutch Assembly and Special Tool for Installing Gland Nut

5.2.2. Motor Commutator Cleaning

The motor commutator should be kept smooth and free from grease and oil. To dress the commutator, use a fine-grain commutator stone or a piece of No. 00 sandpaper. Never use emery cloth for the commutator or brushes. Commutators should not be undercut.

The brushes should be free in their holders and the pressure should be maintained between 3/4 and 1 lb. When new brushes are installed, be sure to use the proper grade and fit the brushes to the commutator using No. 00 sandpaper.

5.3. Maintenance Tools List

Maintenance tools are listed below. Ordering reference for complete set of tools is SBM UO296406, Drawing 12764-Sh. 1.

- 6 in. screw driver
- 10 in. screw driver

- 6 in. slip joint pliers
- 12 oz. machinist's hammer
- Insulated socket wrench
- 6 in adjustable wrench
- 10 in. adjustable wrench
- Set of hex sockets
- Ratchet wrench
- Extension bar
- Special tool N173641 (for installing gland nut)
- Thin head flat wrench (l to 2 in. opening)
- Allen wrench, 3/8 in.
- Clutch assembly gage

6. SUPPLEMENTAL MAINTENANCE INFORMATION

Information is provided in this section for:

- Changes that may be necessary at time of installation if the switch machine as ordered does not suit particular conditions at the installation site. Instructions are provided for the following modifications:
- Inverting lock box to correspond with lock rod notching.
- Shifting indication cams to have contacts at left indicating normal position.
- Changing dual-control mechanism from a right-hand to a left-hand assembly or vice-versa.
- Changing dual-control interlock between selector and hand-throw lever, or changing MOTOR position of selector lever.
- Dismantling for overhaul or to replace certain parts.
- Converting from high-voltage to low-voltage or vice-versa.

WARNING

Before starting any of the procedures provided in this section, disable power to the switch machine. Failure to do so could result in serious personal injury or loss of life.

6.1. Inverting Lock Box

As described in Section 2.3, lock box dogs must enter narrow notches of the lock rod before reaching the wide notch. In some cases it may be necessary to invert the lock box to obtain this condition. When lock box inversion is necessary, follow the procedure listed below.

1. Place the machine in the end stroke position that brings lock box G nearest to the motor. Note which one of the indication cams, N or P, has its notch up. (See Figure 2-8.)

2. Remove bolts (T) that hold the circuit controller to the case. Swing the controller up pivoting it about the edge of the case adjacent to the wire conduit.

3. Turn lock box G upside-down. Make sure that it is placed properly on the driving studs of the slide bar.

4. Replace circuit controller. Check that pinion gear F (see Figure 2-9) meshes with the rack teeth on the lock box in such a manner to place the indication cam notch-up and centered about roller D (same as when circuit controller was removed).

5. Attach the circuit controller with bolts (T).

6.2. Shifting Indication Cams

To permit standardized wiring and 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, the indication cams (N and P in Figure 2-8) are arranged so that either cam can have its notch up when the slide bar is at either end of its stroke.

As previously described (Section 2.4), each cam is driven by a stud in the side of the gear and has two slots so that it can be engaged with its corresponding stud in either of two positions. The cams are held engaged with their respective studs by spring force and a set screw (adjacent to slots) that is tightened against the gear hub after adjustments have been made.

To shift the cams from one position to the other, follow the procedure listed below.

1. Loosen the set screw (No. 8-32 allen head, adjacent to slots). Then, carefully (to avoid distortion of contact springs) insert two screw drivers between the cam and the gear.

2. Move the cam away from the gear against the force of its coil spring.

3. Rotate the cam to the alternate position until it snaps in place (see Figure 5-1).

4. Tighten set screws in place.

5. Repeat steps 1-4 for the other cam. The two cams must be shifted individually.

6.3. Installing A New Or Rebuilt Circuit Controller

To install a new or rebuilt circuit controller, follow the procedure listed below.

1. Remove old circuit controller. Lower new circuit controller into circuit controller compartment (see Figure 7-1). Align mounting holes.

NOTE

When removing the old circuit controller, it is necessary to operate the switch movement by crank (M-3) or hand-throw lever (M-23A and M-23B) to gain access to all four hold-down bolts. Before installing a new or rebuilt circuit controller, it is necessary that the lock box is toward the MOTOR end of the switch.

2. Reinstall the two screws (81), and lock washers, in the holes nearest to the MOTOR compartment.

3. Reinstall the plate (9), two screws (6), and two lock washers between the point detector cranks.

4. With wire harness within the clamps, reinstall the four wire clamps with the four screws and four lock washers.

5. Refer to tags and reattach harness wires to correct circuit controller terminals and heater connections. Tighten all screws securely. Make sure that the gearing on the circuit controller meshes properly with the crank teeth on the lock box.

6. By use of the hand crank (M-3) or hand-throw lever (M-23A or M-23B), operate the movement to the end of its stroke. This places the slide bar and lock box toward the MOTOR.

7. Check that the circuit controller shaft assembly is in the angular position agreeing with that shown in Section Y-Y of Figure 7-5. Checking specifically that the relation shown in the figure for correct setting of segments for contacts 24-25 and 26-27. This should place the cam block (item 57) of main shaft gear (item 56) in the position shown in the figure. The next move should rotate the cam block away from, rather than into, the pinion gear (item 59).

8. Install at least three of the circuit controller frame hold-down bolts, but do not tighten. By use of the hand crank or hand throw lever, operate the movement slowly, checking that the cam block moves in the proper direction.

9. Before tightening circuit controller frame hold-down bolts, check that full-stroke controller shaft rotation yields a symmetrical contact relationship at both ends of the stroke. Shift gear tooth engagement, if necessary, to obtain this condition. Install and tighten all hold-down bolts.

10. Insert a tie wire is in the form of a “figure 8” through each pair of idler bolt heads.

6.4. Changing Dual-Control Mechanism from Right-Hand to Left-Hand Assembly (and Vice Versa)

To change a dual-control mechanism from right-hand to left-hand, or vice versa, follow the procedure listed below. Steps 1 through 6 describe the disassembly procedure. Steps 7 through 17 describe the re-assembly procedure. (See Figure 6-1 and Figure 6-2. References are made to these figures throughout the procedures.)

Disassembly Steps

1. Remove covers for gear box and MOTOR compartment. Place hand-throw lever in NORMAL position and selector lever in MOTOR position.

2. Remove Al, A2, A3, and A4 securing top bearing C, yoke support H, lever support K, and lever shaft bearing M.

3. Remove nut B1 and washer B2 from top of main crank and lift top bearing C from dowel pins carefully, to prevent bending.

4. Remove rectangular key C1 from top bearing bushing C2, hand-throw pinion D, and spacing collar E on top end of crank.

5. Lift hand-throw lever to vertical position and remove set screw Fl from hand-throw bevel gear F. Remove lever assembly and lift out hand-throw bevel gear.

6. Remove bolt G securing yoke eccentric bushings Cl and then remove yoke support H. Note positions of eccentric bushings. Care should be taken to avoid changing their positions when removing the bolt.

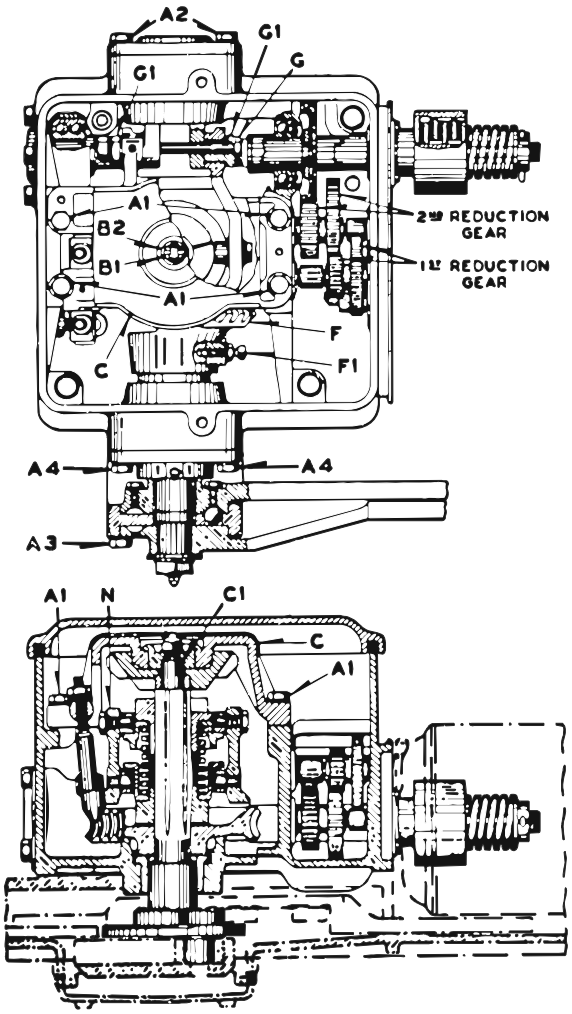


Figure 6-1. Sectional Views of M-23A Gear Box (Right-Hand Installation)

Reassembly Steps

1. Transfer yoke support H to the other hub, rotate yoke 180°, and reapply eccentric bushing bolt G without disturbing eccentric bushing positions.

2. Reinstall lever assembly to the hub on opposite side of gear box with shaft splines entering hand-throw gear F and with eccentric pin P on selector shaft entering the slot on the end of the yoke.

3. With hand-throw lever vertical, reinstall set screw Fl in hand-throw gear F. Reinstall bolts A2 to secure yoke support H and replace the two top bolts A4 to hold lever shaft bearing M in place.

4. In order that the MOTOR position of the selector lever will be toward the motor end of machine (as indicated for standard assemblies in the four diagrams of Figure 6-3), selector lever and lever interlock must be reassembled 180° from original position on shaft, as follows:

   a. Remove hex nut and washers from end of selector lever shaft. Slide selector lever and lever support K from the shaft. Be careful not to lose steel ball in lever support.

NOTE

> If stop screw is used in hub of hand-throw lever, it will be necessary to remove this lever also and interchange stop screw and cap screw (see Figure 6-3). Then, re-install hand-throw lever and fasten in place with clamping bolt.

   b. Reassemble lever support K with hole for the ball on motor side of shaft. Insert steel ball and reassemble selector lever on shaft so that lever will be 180° from its original position. (Stop screw, if used, may require positioning hand-throw lever to align recess with hole in lever support so that ball will not interfere when selector lever is applied. Replace hex nut and washers on end of shaft to hold selector lever in place, and fasten lever support K with the two bolts A3, which also secure the bottom of the lever shaft bearing.

   c. Operate selector lever to MOTOR position (toward motor end of machine) and check that it moves yoke N down.

   d. Interchange MOTOR and HAND nameplates on selector lever to correspond with the new lever positions.

5. Reassemble collar E (with chamfer down) on top of crank and, with hand-throw lever vertical, install hand-throw bevel pinion D, engaging tooth marked R (for right-hand assembly) or L (for left-hand assembly) with punched, marked master tooth space on hand-throw gear F. Carefully place hand-throw lever in NORMAL position. Be sure that bevel pinion remains in time. With selector lever in MOTOR position, rotate friction clutch housing so that motor clutch teeth are fully engaged.

6. Reinstall top bearing assembly and secure with hold-down bolts Al. (Motor cutout push rod should be held back to clear the adjusting rod until top bearing is down.) Install top bearing bushing C2, rectangular key Cl, washer B2. Tighten nut B1 firmly, then back off to nearest cotter pin hole and install new cotter pin, after operating machine by hand-throw lever to be sure that mechanism does not bind.

7. Check adjustment of motor cutout push rod. Contacts should open when end of selector lever has been raised approximately 6 in. from the horizontal MOTOR position.

8. Readjust both yoke eccentric bushings as described in Section 5.1.5, then secure by tightening bolt G firmly.

9. Check that machine can be operated by power, and also that it shifts to hand-throw operation from both normal and reverse positions.

10. Check that all bolts are tight on lock washers and that all cotters pins in place.

11. Replace covers.

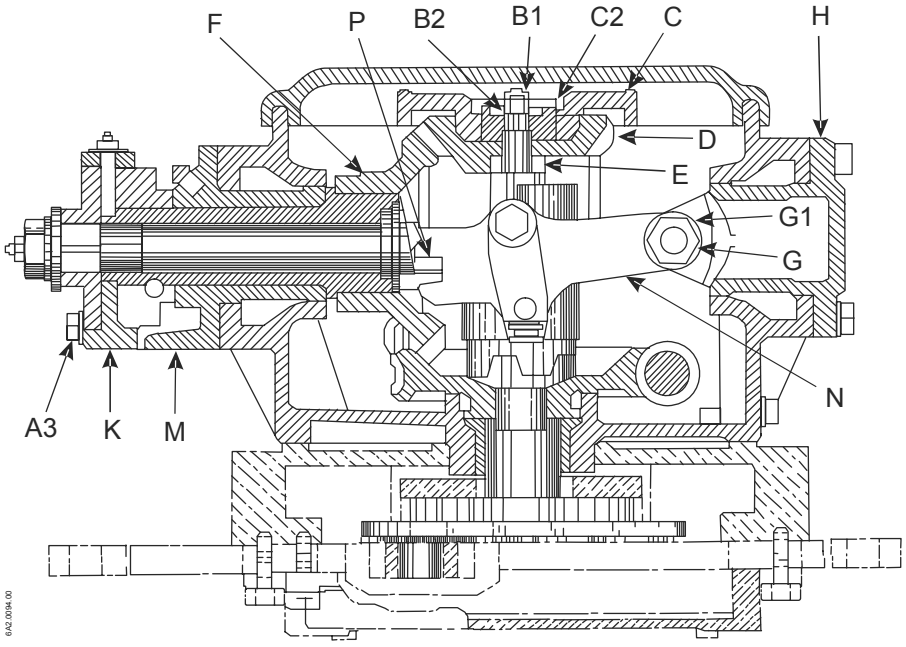


Figure 6-2. Sectional View from Motor End of M-23A Gear Box (Right-Hand Installation)

6.5. Changing Selector Lever Position and Selector Lever Interlock

In general, the positions of the selector and hand-throw levers will be as shown in Figure 6-3, and the interlock will ordinarily permit the selector lever to be returned to the MOTOR position when the hand-throw lever is in either the normal or reverse position.

Certain deviations from the usual standards are possible. The various arrangements are (each reference letter, A through D, corresponds with one of the four diagrams in Figure 6-3):

A. Both levers must always be on the field side of the machine; that is, on the left side for left-hand machine for left-hand layout and on the right side for right-hand machine for right-hand layout. To change from right-hand to left-hand, or vice versa, see Section 6.4.

B. The hand-throw lever will always move the switch in the direction to close the near point when the lever is operated toward the motor end of the machine. This characteristic cannot be changed. The cast markers "N" and "R"; however, may be attached to the hand-throw lever to show either "N" or "R" for this position.

C. For the standard arrangement the selector lever is assembled to be toward the motor end of the machine when the lever is in its MOTOR position as shown in Figure 6-3. When desired, however, the lever can readily be reassembled to be toward the circuit controller end of the machine for MOTOR position. The interlock can be arranged to suit. The cast MOTOR and HAND marker plates on the selector lever are interchangeable.

D. The lever interlock can be arranged to either: (1) allow the selector lever to be returned to MOTOR position when the hand-throw lever is in the NORMAL or the REVERSE position; or (2) require the hand-throw lever to be in NORMAL position only before the selector lever can be returned to MOTOR position. Machines are shipped with option (1) assembly unless order specifies that hand-throw lever must be "normal only."

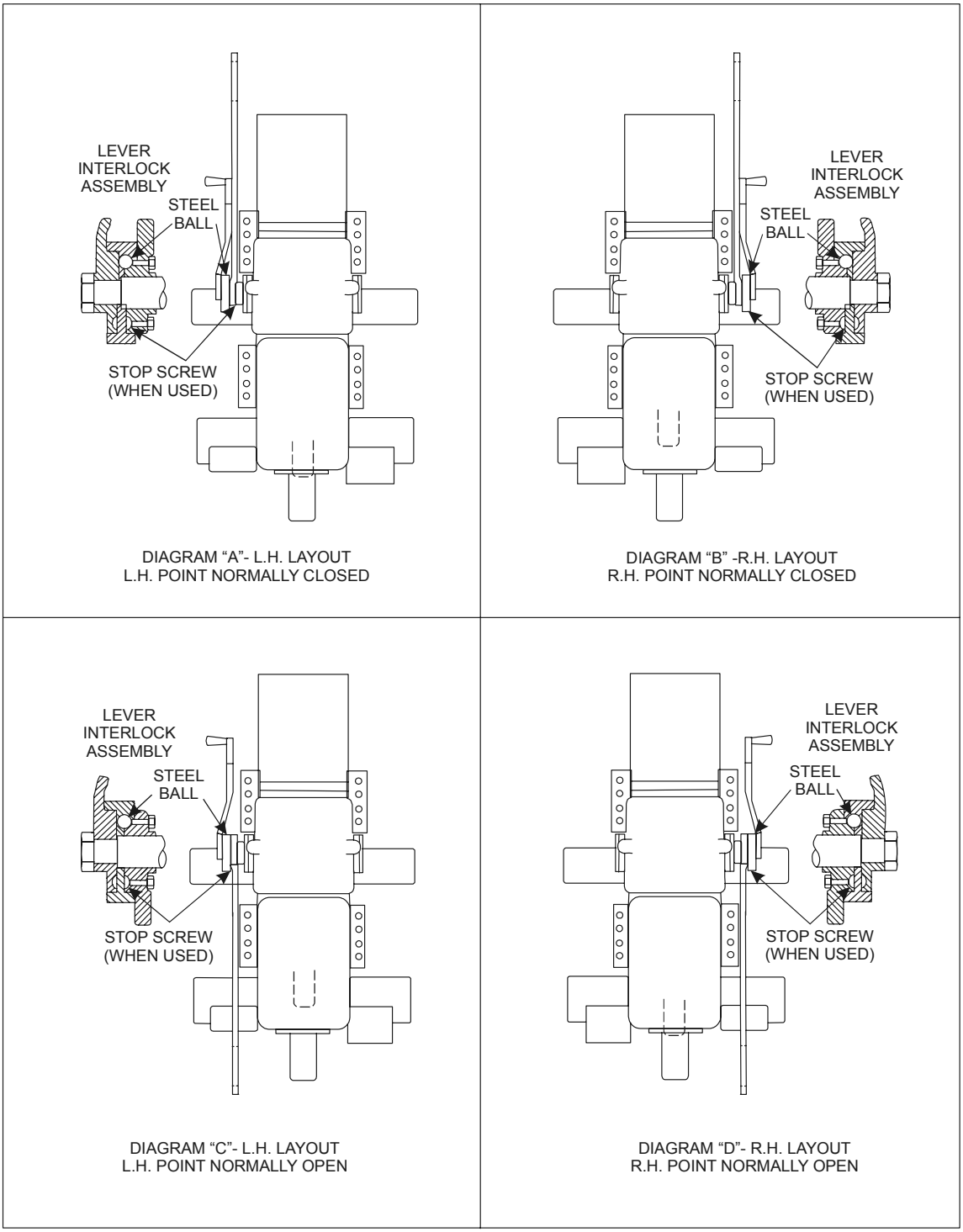


Figure 6-3. Standard Lever Interlock Assemblies for M-23A and M-23B Switch Machines

6.5.1. Selector Lever Assembly

The lever interlock assembly (see Figure 6-3) includes recesses in both lever hubs and a steel ball carried in a hole in the lever support. When reassembling, be careful not to lose the ball when the lever is taken off.

The diameter of the ball is greater than the thickness of the wall of the lever support. Thus, with the selector lever in the MOTOR position, part of the ball is held in the recess of the hand-throw lever and thereby prevents operation of the hand-throw lever.

Reversing the selector lever aligns the ball recess in its hub to permit the ball to shift out of the recess in the hand-throw lever hub, thereby releasing the hand-throw lever. When the hand-throw lever is at any position between the ends of its stroke, the ball is held in the recess in the selector lever hub and thereby locks the selector lever.

The hand-throw lever hub has two ball recesses 180° apart so that at either end of the lever stroke one of the recesses will be aligned with the ball to unlock the selector lever. If it is desired to make it compulsory that the hand-throw lever be in the NORMAL position before allowing the selector lever to be operated, one of the ball recesses in the hand-throw lever must be plugged by the use of a stop screw (M287186), as shown in Figure 6-3.

When the stop screw is used, it must be installed in the specified recess in the hand-throw lever hub, as follows. With the hand-throw lever in the NORMAL position, the stop screw must be in the recess on the side of the shaft opposite to the side the selector lever is on when in the MOTOR position (see Figure 6-3).

The lever support can be assembled with the hole for the ball on either side of the lever shaft center. However, it must be assembled so that the hole for the ball is on the same side of the shaft as the selector lever is in for MOTOR position (see Figure 6-3).

As previously mentioned, the selector lever can be assembled on the square end of its shaft in either of two positions, 180° apart, so as to have the MOTOR position of the lever either toward the motor compartment or toward the circuit controller compartment. Machines are shipped from the factory with the selector lever assembled for MOTOR position toward the motor compartment. If the lever assembly is reversed in the field, the transfer must be made while the crank finger on the end of the shaft is at the bottom of its stroke to force the selector clutch down toward its MOTOR position. Be sure to reassemble the lever support to shift the hole for the ball to meet the requirements in the preceding paragraph. Similarly, if a stop screw is installed in one of the ball recesses in the hand-throw lever hub as previously described, it must be shifted so as to be on the side of the shaft opposite to that for MOTOR position of the selector lever.

6.6. Dismantling Tips

6.6.1. Main Crank Removal

When the main crank is removed, it must be removed through the bottom of the machine. To do so, first remove the bottom cover and the wear plates supporting the operating bar. This allows the operating bar and crank roller to drop down. Then, rotate the crank by turning the friction clutch by hand until the bottom end is crosswise of machine. Unscrewing the nut at the top of the main crank shaft will then permit the crank to drop out through the bottom. Removal of the main crank will release the worm gear and the slide bar.

6.6.2. Selector Clutch Removal

For dual-control machines (M-23A and M-23B), removal of the selector clutch and associated parts can be understood from the information given for changing from right-hand to left-hand assembly, or vice versa. However, when reassembling the selector clutch note that its overall height, including top and bottom teeth, is 5 9/32 in. maximum to 5 17/64 in. minimum. This dimension is adjusted by turning the top and bottom parts of the clutch assembly with respect to each other. This can best be done by inverting and placing the "hand portion" on the crank splines and turning the "motor portion" with a screw driver, or with a bar in the motor clutch teeth. Splines in both parts must be aligned to permit reassembly. For proper alignment of the dual control gearing upon reassembly, see Section 6.4.

6.6.3. Worm Shaft Removal

To remove the worm shaft, it is necessary to take the gear box off the base casting, otherwise the end of the shaft would strike the wall of the circuit controller compartment.

6.6.4. Slide Bar Removal

The slide bar can be removed through the motor compartment, after first removing the lock box and the motor.

6.7. Conversion From High-Voltage To Low-Voltage (or Vice Versa)

Conversion from high-voltage to low-voltage operation (or vice versa) involves changing the motor, gear ratio, and wiring. The desired gear ratio may be obtained by changing the reduction gearing according to the description provided Section 2.5.

The high-voltage motor may be replaced by the low-voltage motor (or vice versa). The connections at the motor terminal board and the main terminal board must be as shown in Figure 2-19 for the low-voltage motor or with Figure 2-22 or Figure 2-25 for the high-voltage motor (see Section 2.8).

Complete wire harnesses may be ordered to facilitate conversion. Two wire harnesses are available: one for any low-voltage machine and another for any high-voltage machine.

7. PARTS LIST

Table 7-1. Parts List for M-3 Switch Machine (See Figure 7-1)

Item	Description	Part No.
2	Base for M-3 switch machine, arranged for telephone jack, complete	N291056
2a	Base for M-3 switch machine, with machined mounting lugs, complete	N294752
3	M-3 gear box, 360:1 gear ratio, complete (see Figure 7-3)	N287484
3a	M-3 gear box, 189:1 gear ratio, complete (see Figure 7-3)	N287485
3b	M-3 gear box, 528:1 gear ratio, complete (see Figure 7-3)	N287486
4	Low-voltage dc motor, 20 V dc, complete (for 8.0 and 15.0 second operation)	N150293
4a	High-voltage dc motor, 110 V dc, complete	N306349
4b	AC motor, 110 V ac, 60 Hz, complete	N073173
4c	Motor brush for item 4	J064068
4f	Motor brush for item 4a	J064066
4g	Motor brush for item 4b	J064111
5	Circuit controller, complete (see Figure 7-5 and Figure 7-6)	See Table 7-5 and Table 7-6
6	Screw	J507372
7	Name plate	J063117
8	Screw, round hd, tin pl, no. 6 x 1/4 in. lg	J052607
9	Plate	M146595
10	Gasket	M146738
11	Washer	M147408
12	Bolt	J507366
13	Guide roller	M108315
14	Guide roller	M074737
15	Locking bar	N178100
16	Slide bar cam (includes items 103, 104, and 105)	R146444
17	Operating roller	M06106-6
18	Operating bar	M146441
19	Operating bar lug	M146443
20	Wearing bracket	M189024
21	Key	M146782
22	Conduit	J034421
23	Conduit outlet	N238223
24	Terminal board	N184425
24a	Terminal board only	M100704
25	Bolt	J507369
26	Terminal board support	MI72662
27	Motor cutout push rod	N180861
28	Strap	M162242
29	Motor cutout contact	N226029
30	Bolt	J460113
30A	Nut	J048136
30B	Washer	J047773

Item	Description	Part No.
30C	Cotter pin	J048634
31	Pipe nipple	M146723
32	Felt washer	M147398
33	Washer	M147409
34	Lock nut	J04 8415
35	Slide bar cover	M074911
36	Circuit controller cover (includes item 111, gasket)	N146698
37	Operating bar cover	M148141
38	Operating bar cover	M159272
39	Crank case cover	M146290
40	Motor cover (includes item 112, gasket)	N2892 99
41	Clip	J700934
42	Bushing	J475077
43	Bolt	J050034
44	Bolt	J0500 86
45	Bolt	J050092
46	Bolt	J050092
47	Bolt	J050092
48a	Washer	M286594
49	Latch	M186209
50	Spring	M181001
51	Spring Stud	M181032
52	Lock Rod Cover	N269671
53	Locking Screw Complete	N242122
54	Lock Rod Cover	M165752
55	Plate	M165751
56	Spring	J068431
57	Point Detector Bar Cover	N296126
58	Point Detector Bar Cover	N296125
59	Lock nut	M223351
60	Bushing	M296122
61	Lock washer	J047821
62	Lubricating fitting, 1/8 in. pipe thread, straight	J039137
63	Washer	N218713
64	Screw, machine, round hd, no. 12-28 x 1 1/8 in., tin pl (use item 64a, nut)	N218713
64a	Nut	M035216
65	Collar	M074741
66	Nut	M074742
67	Crank	M071158
68	Worm gear	M074805
69	Washer	M067454
70	Cotter pin	J048618
71	Gear box cover	N152633
71a	Gorlock gasket for Item 71, gear box cover	J047286
71b	Neoprene gasket for Item 71, gear box cover	J047286-00l
72	Motor cutout trigger	N146670

Item	Description	Part No.
73	Push rod	M146675
74	Nut	J048007
75	Wire harness for low voltage machines (not shown)	N281548
75a	Wire harness for high voltage machines (not shown)	N281550
76	Wire clamp for wire harness (not shown)	J703005
77	Cover plate	M296066
78	Screw	J052025
80	Lock washer	J047769
81	Bolt	J050088
83	Bolt	J050091
84	Cotter pin	J048636
85	Pipe plug	J032901
86	Lubricating fitting, 1/8 in. pipe thread	J039142
87	Bolt	J050045
88	Screw	J052091
89	Pipe plug	J032902
90	Long closed lock rod cover	N242439
90a	Long closed lock rod cover (to be used with lock rods having adjustment on field side similar to AREMA drawing 1587)	N242441
91	Cover plate	M165904
92	Ventilator	M070109
93	Stud	M074735
94	Stud	M074736
95	Lock rod support	M074738
96	Hinge lug	N285692
97	Adjustable hasp	N272961
98	Eccentric stud	M285680
99	Stud	M147534
100	Hasp	N301050
101	Pin	M209199
102	Rivet	J049475
103	Stud for item 16	M076018
104	Roller for item 16	M076019
105	Roller for item 16	M076020
106	Binding post (only)	M115706
107	Nut	J480301
108	Washer	J047818
109	Nut	J480300
110	Tag (not shown, orders should specify marking)	M142777
111	Gasket, 62 in. long	A067035
112	Gasket (orders should specify length)	M320440
113	Yoke	M146671
114	Rod	M146674
115	Crank	M146673
116	Screw jaw	M146677
117	Spring	M074790

Item	Description	Part No.
118	Washer	M065762
119	Machine screw	J052202
120	Screw	J522151
121	Wire harness clamp	J700963
122	Hand crank	M146694

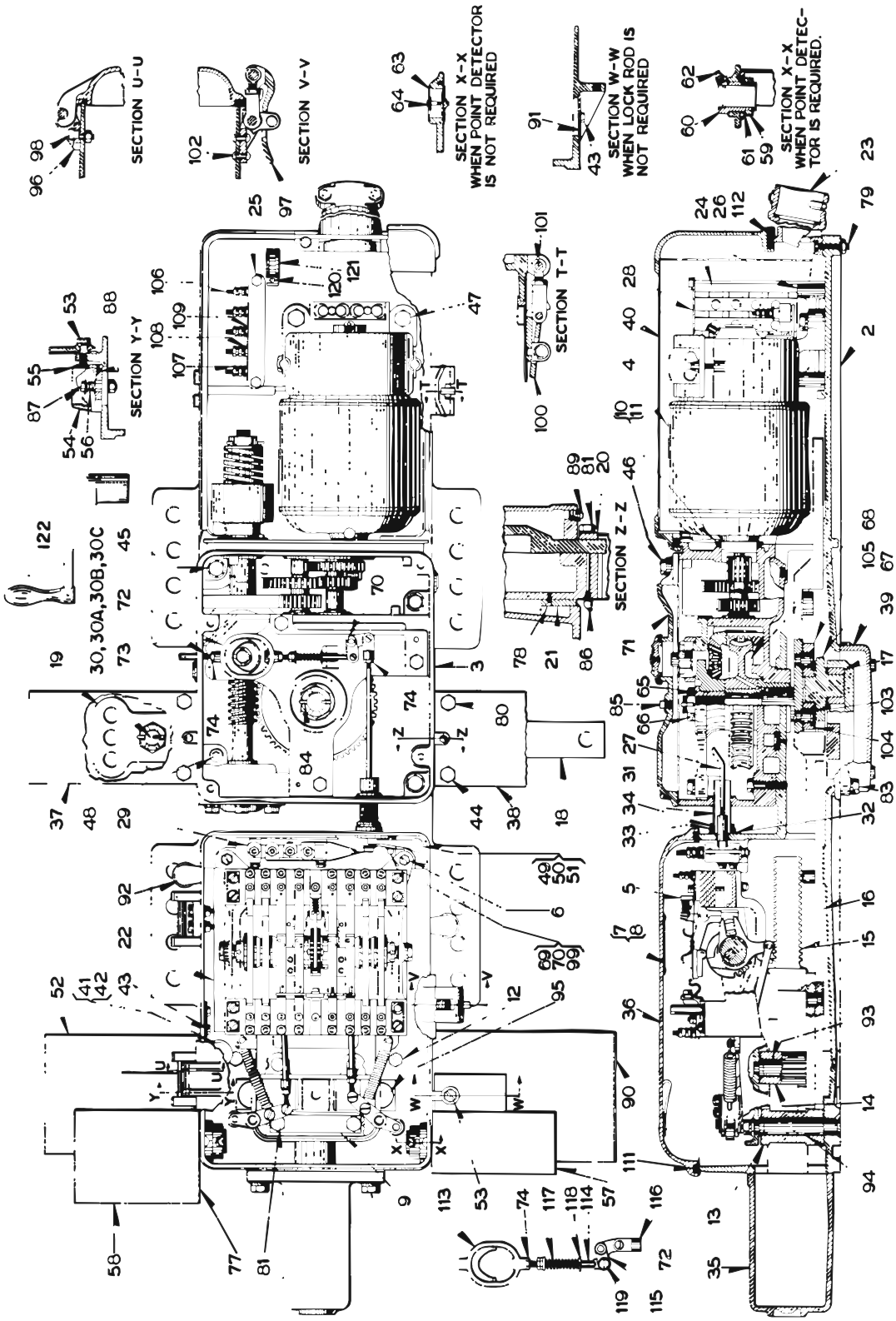


Figure 7-1. M-3 Electric Switch Machine

Table 7-2. Parts List for M-23A and M23B Switch Machines (See Figure 7-2)

Item	Description	Part No.
2	Base, complete, for M-23A and M-23B switch machines, standard	N291057
2a	Base, complete, for M-23A and M-23B switch machines, machined mounting lugs	N293975
3	M-23A gear box, 360:1 gear ratio, left-hand, complete (see Figure 7-3)	N287072
3a	M-23A gear box, 360:1 gear ratio, right-hand, complete (see Figure 7-3)	N287072-0001
3b	M-23A gear box, 189:1 gear ratio, left-hand, complete (see Figure 7-3)	N287073
3c	M-23A gear box, 189:1 gear ratio, right-hand, complete (see Figure 7-3)	N287073-0001
3d	M-23A gear box, 528:1 gear ratio, left-hand, complete (see Figure 7-3)	N287074
3e	M-23A gear box, 528:1 gear ratio, right-hand, complete (see Figure 7-3)	N287074-0001
3f	M-23B gear box, 360:1 gear ratio, left-hand, complete (see Figure 7-3)	N287075
3g	M-23B gear box, 360:1 gear ratio, right-hand, complete (see Figure 7-3)	N287075-0001
3h	M-23B gear box, 189:1 gear ratio, left-hand, complete (see Figure 7-3)	N287076
3i	M-23B gear box, 189:1 gear ratio, right-hand, complete (see Figure 7-3)	N287076-0001
3j	M-23B gear box, 528:1 gear ratio, left-hand, complete (see Figure 7-3)	N287077
3k	M-23B gear box, 528:1 gear ratio, right-hand, complete (see Figure 7-3)	N287077-0001
4	Low-voltage dc motor, complete, 20 V dc (for 8.0 and 15.0 second operation)	N150293
4a	High-voltage dc motor, complete, 110 VDC	N306349
4b	AC motor, complete, 110 V ac, 60 Hz	N073173
4c	Motor brush for item 4	J064068
4f	Motor brush for item 4a	J064066
4g	Motor brush for item 4b	J064111
5	Circuit controller, complete (see Figure 7-5 and Figure 7-6)	See Table 7-5 and Table 7-6
6	Screw	J507372
7	Name plate	J063117
8	Screw, self tapping	J052655
9	Plate	M146595
10	Gasket	M146738
11	Washer	M147408
12	Bolt	J507366
13	Guide roller	M108315
14	Guide roller	M074737
15	Locking bar	N178100
16	Slide bar cam (includes items 103, 104, and 105)	R146444
17	Operating roller	M06106-6
18	Operating bar	M146441
19	Operating bar lug	M146443
20	Wearing bracket	M189024
21	Key	M146782
22	Conduit	J034421
23	Conduit outlet	N238223
24	Terminal board	N184425
24a	Terminal board only	M100704
25	Bolt	J507369
26	Terminal board support	MI72662

Item	Description	Part No.
27	Motor cutout push rod	N180861
28	Strap	M162242
29	Motor cutout contact	N226028
30	Bolt	J460113
30A	Nut	J048136
30B	Washer	J047773
30C	Cotter pin	J048634
31	Pipe	M286599
32	Felt washer	M147398
33	Washer	M147409
34	Lock nut	J04 8415
35	Slide bar cover	M074911
36	Circuit controller cover (includes item 109, gasket)	N149924
37	Operating bar cover	M148141
38	Operating bar cover	M159272
39	Crank case cover	M146290
40	Motor cover (includes item 112, gasket)	N2892 99
41	Clip	J700934
42	Bushing	J475077
43	Bolt	J050034
44	Bolt	J050098
45	Bolt	J050092
46	Bolt	J050092
46a	Lock washer	J047503
47	Screw	J050223
47a	Washer	M286594
48	Motor cutout push rod spring	M286589
49	Lock rod cover	N269671
50	Locking screw	N242122
51	Lock rod cover	M165752
52	Plate	M165751
53	Spring	J068431
54	Point detector bar cover	N296126
55	Point detector bar cover	N296125
56	Lock nut	M223351
57	Selector lever	M274597
58	Hand-throw lever	R43 5598
59	Cap screw, knurled socket head, 1/2-13 x 1 3/4 in.	J050237
60	MOTOR plate	M287198
61	HAND plate	M287199
62	Screw	J052174
63	Wire harness for low voltage machines (not shown)	N281548
64	Wire harness for high voltage machines (not shown)	N281550
64a	Wire clamp (not shown)	J703005
65	Heater, 15 W, for circuit controller compartment (not shown)	N253225
66	Bushing	M296122

Item	Description	Part No.
67	Cover plate	M296066
68	Bolt	J050086
69	Letter “N”	M152893
70	Letter “R”	M152894
71	Bolt	J050060
71a	Nut	J048356
72	Screw	J052025
73	Screw	M302256
73a	Jam nut	J048010
74	Bolt	J050088
76	Bolt	J050091
77	Screw	J522151
78	Steel ball,3/4 in. dia.	J066012
79	Bushing	M308325
80	Lubrication fitting, 1/8 in. pipe thread	J039142
81	Bolt	J050044
82	Screw	J052091
83	Bushing	M304622
84	Pipe plug	J032902
85	Lock washer	J047810
86	Lubrication fitting, 1/8 in. pipe thread	J239137
87	Cable clamp	J700589
88	Long closed lock rod cover	N242439
88a	Long closed lock rod cover (to be used with lock rods having adjustment on field side similar to AREMA drawing 1587)	N242441
89	Bolt	J050049
89a	Lock washer	J047768
90	Stop off screw	M287186
91	Stud	M074735
92	Stud	M074736
93	Lock rod support	M074738
94	Hinge lug	N285692
95	Adjustable hasp	N272960
96	Eccentric stud	M285680
97	Hasp	N301050
98	Pin	M209199
99	Rivet	J049475
100	Rivet	J049452
101	Binding post (only)	M115706
102	Nut	J480301
103	Washer	J047818
104	Nut	J480300
105	Tag (specify marking) (not shown)	M142777
106	Stud for item 16	M076018
107	Roller for item 16	M076019
108	Roller for item 16	M076020
109	Gasket, 62 in. long	A067035

Item	Description	Part No.
110	Gasket (specify length)	M320440
111	Screw, machine, round head, tin pl., no. 12-28 x 1 1/8 in.	J52614
111a	Nut (for item 111)	M035216
112	Washer	N218713
113	Cover plate	M165904
114	Ventilator	N070109

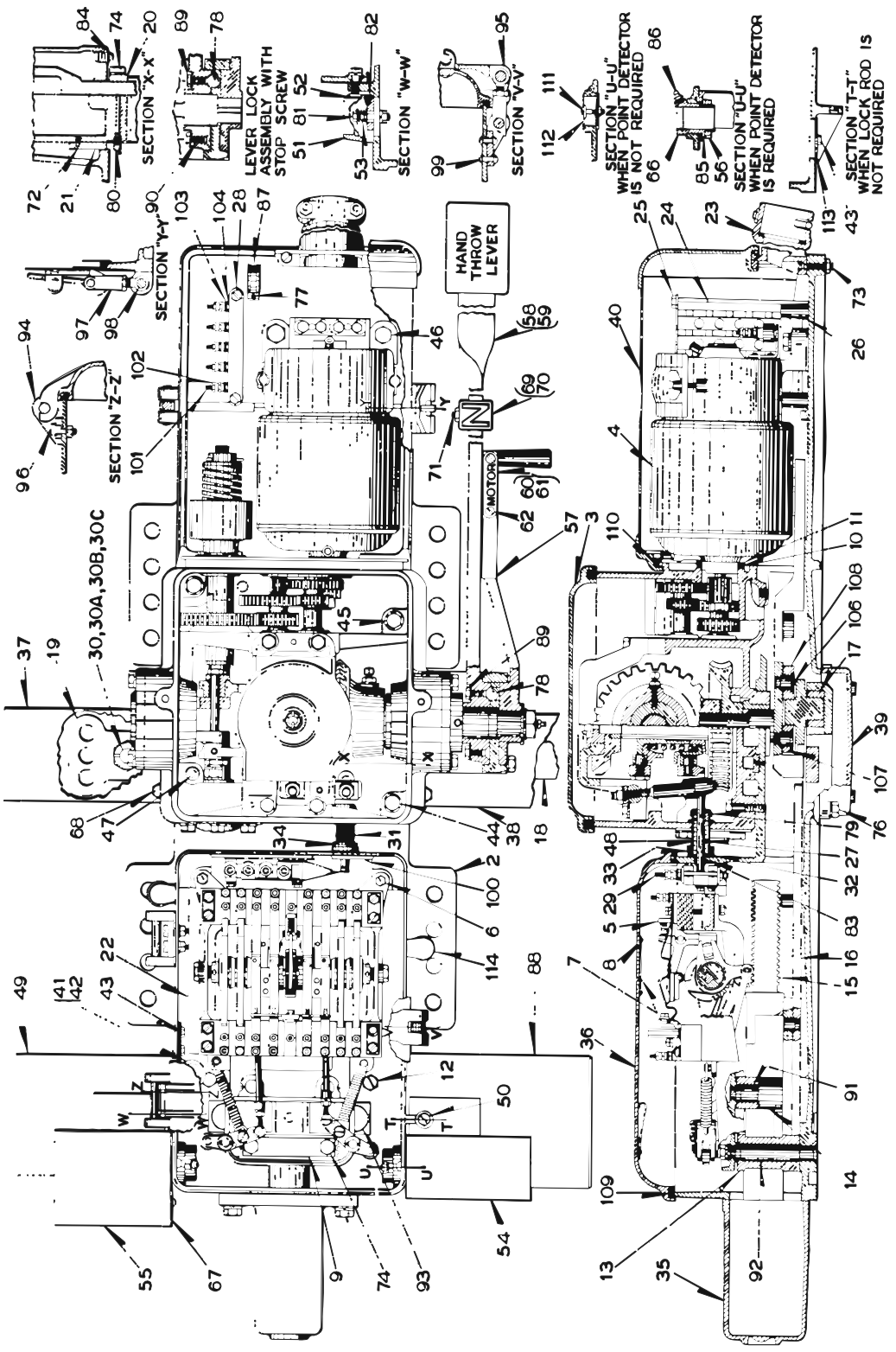


Figure 7-2. M-23A and M-23B Electric Switch Machine

Table 7-3. Parts List for M-3 Switch Machine Gear Box (See Figure 7-3)

Item	Description	Part No.
2	Gear box (includes bushings, items 44 to 49)	N287085
3	Top bearing	N146606
3a	Top bearing (for NYCT low-profile application only)	N146606001
4	Worm shaft	M286612
5	Clutch housing	N172752
6	Clutch end plate	M146575
7	Clutch plate	M146574
8	Clutch plate	M146573
9	Clutch disk	M146650
10	Clutch spring	M239322
11	Clutch adjusting nut	M286615
12	Felt gasket	J047335
13	Washer	M245192
14	Plate	M147400
15	Cotter pin	J048636
16	Gasket	M147410
17	Bearing cap	M274596
18	Clutch gear, complete (includes bushing, item 51)	N286583
19	Hand crank bevel gear	M286995
20	Hand crank bevel pinion	M146377
21	Shaft	M149700
22	First reduction gear (360:1 gear ratio)	M286577
22a	First reduction gear (528:1 gear ratio)	M286579
23	First reduction gear (189:1 gear ratio)	M286576
24	Second reduction gear (360:1 gear ratio)	M286578
24a	Second reduction gear (528:1 gear ratio)	M286580
25	Spacer	M286591
26	Spacer	M286592
27	Shaft end plate	M286587
28	Dowel pin	J048925
29	Oilite bushing	J079694
30	Gear train cover	N451161-2102
31	Shaft end plate	M292426
32	Lug hasp	M165738
33	Screw	J5000970112
34	Screw	J050036
34a	Lock washer	J047526
35	Screw	J050090
36	Screw	J050092
36a	Lock washer	J047783
37	Pipe plug, 1/2 in.	J032904
38	Ball bearing	J066032
39	Ball bearing	J066246
40	Lock washer, shake proof	J047810

Item	Description	Part No.
41	Lock nut	J048575
42	Key	J048755
43	Retaining ring	J790076
44	Oilite bushing	J790008
45	Oilite bushing	J790007
46	Oilite bushing	J790004
47	Oilite bushing for crank (not shown)	J790262
48	Oilite bushing	J790291
49	Oilite bushing	J790290
50	Oil seal	J790261
51	Worm Gear	M074805

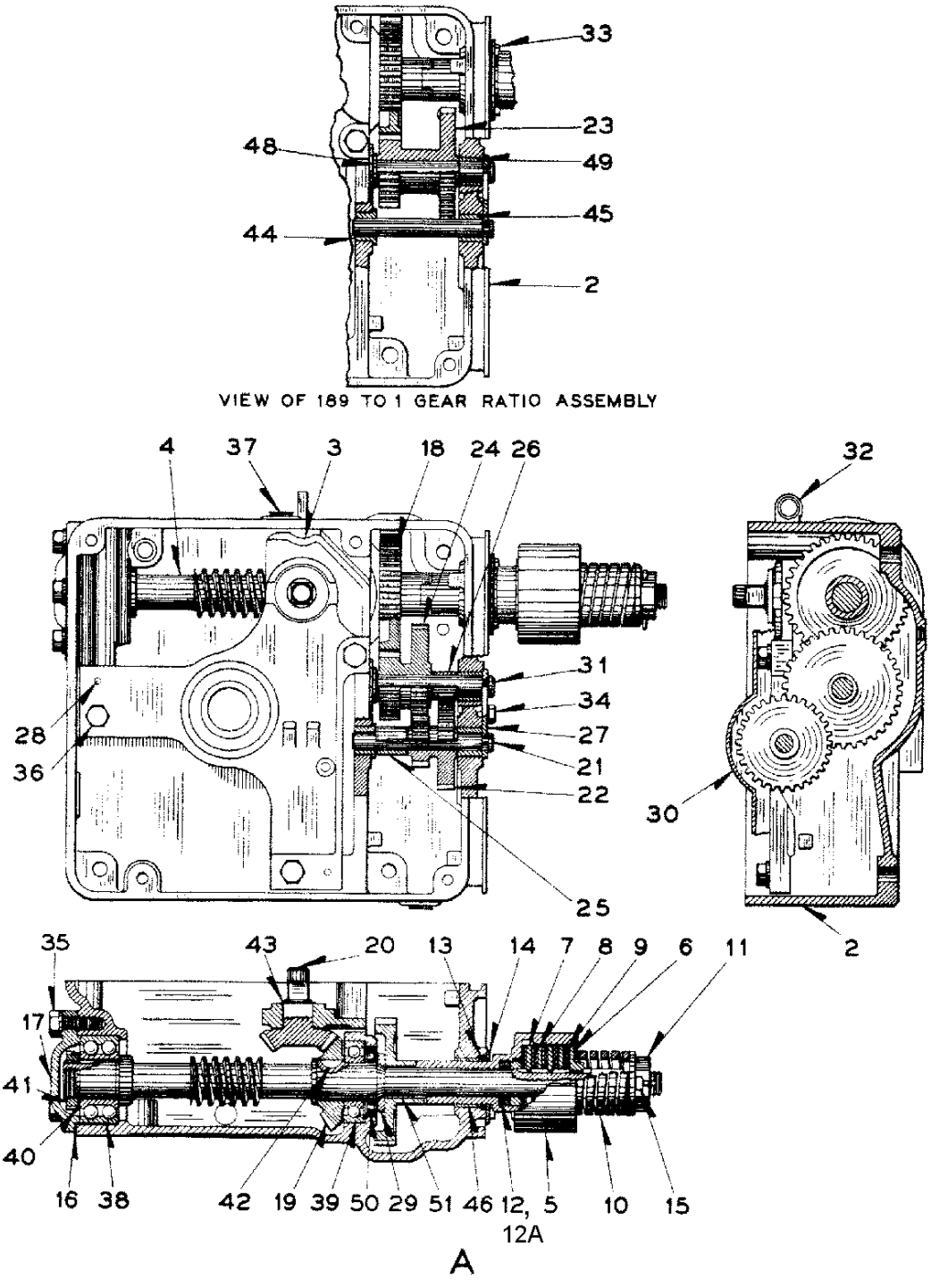


Figure 7-3. Gear Box for M-3 Switch Machine

Table 7-4. Parts List for M-23A and M23-B Switch Machine Gear Box (See Figure 7-4)

Item	Description	Part No.
2	Gear box (includes bushings, items 81 to 86)	N286623
3	Top bearing	M274599
4	Worm shaft	M286612
5	Clutch housing	M172752
6	Clutch end plate	M146575
7	Clutch plate	M146574
8	Clutch plate	M146573
9	Clutch disk	M146650
10	Clutch spring	M239322
11	Clutch adjusting nut	M438402001
12	Cotter pin	J048636
13	Felt gasket	J047335
14	Washer	M245192
15	Plate	M147400
16	Gasket	M147410
17	Bearing cap	M274596
18	Clutch gear (includes bushing, item 88)	N286583
19	Spacer	M286593
20	Worm gear	M286620
21(A)	Hand-throw bevel pinion for M-23A machines	M286616
21(B)	Hand-throw bevel pinion for M-23B machines	M286617
22	Hand-throw bevel gear	M286611
23	Main crank (5 spline)	M302731
23a	Main crank (10 spline)	M286608
24	Hand-throw lever shaft	M286618
25	Selector lever shaft	M286619
26	Shaft	M149700
27	First reduction gear (360:1 gear ratio)	M286577
27a	First reduction gear (528:1 gear ratio)	M286579
28	First reduction gear (189:1 gear ratio)	M286576
29	Second reduction (360:1 gear ratio)	M286578
29a	Second reduction gear (528:1 gear ratio)	M286580
30	Sleeve (not used with 189:1 gear ratio gear box)	M286591
31	Sleeve (not used with 189:1 gear ratio gear box)	M286592
32	Shaft end plate	M286587
33	Dowel pin	J048925
34	Bushing	M169502
35	Key	M174967
36	Washer	J475187
37	Castle nut	J048057
38	Cotter pin	J048613
39	Bushing	M169503
40	Selector clutch (for 5-spline main crank)	N302735
40a	Selector clutch (for 10-spline main crank)	M286672

Item	Description	Part No.
41	Selector clutch yoke	N286622
42	Roller	M217537
43	Roller	M217538
44	Roller stud	M261981
45	Eccentric bushing	M261980
46	Screw, hex head, 1/2-13 x 6 in.	J050251
46a	Washer	J475187
47	Gear train cover	N286603
48	Shaft	M286596
49	Cam follower rod	M286614
49a	Washer	M286584
50	Cutout rod, adjustment	M286613
51	Cap screw, hex head, cad pl., 5/8-11 x 2 in.	J050115
51a	Washer	M286595
52	Gasket	M286585
53	Yoke support	M274598
54	Lever shaft bearing	M274603
55	Shaft	M292426
56	Lever support	M274602
57	Gear box cover	N288677
58	Washer	J079694
59	Lubrication fitting, 1/8 in. pipe thread	J039137
60	Washer, flat, cad. pl., 7/8 in.	J047508
61	Lock washer, cad. pl., 7/8 in.	J047742
62	Jam nut, cad. pl., 7/8 in.	J048069
63	Set screw, square head, 3/8-16 x 1 1/2 in.	J050621
63a	Jam nut, hex head, cad. pl., 3/8-16 in.	J048010
63b	Lock washer, cad. pl., 3/8 in.	J4751210113
64	Cap screw, hex head, cad. pl., 1/2-13 x 4 3/4 in.	J050107
64a	Lock washer, cad. pl., 1/2 in.	J047783
65	Cap screw, hex head, cad. pl., 1/2-13 x 1 1/2 in.	J050092
65a	Lock washer, cad. pl., 1/2 in.	J047783
66	Cap screw, hex head, cad. pl., 1/2-13 x 1 3/4 in.	J050095
66a	Lock washer, cad. pl., 1/2 in.	J047783
67	Cap screw, hex head, cad. pl., 1/2-13 x 1 1/4 in.	J050090
67a	Lock washer, cad. pl., 1/2 in.	J047783
68	Cap screw, hex head, tin pl., 1/4-20 x 3/4 in.	J5000970112
69	Cap screw, hex head, cad. pl., 5/16-18 x 3/4 in.	J050036
69a	Lock washer, cad. pl., 5/16 in.	J047526
70	Ball bearing (double row)	J066032
71	Ball bearing	J066246
72	Lock washer	J047810
73	Lock nut	J048575
74	Pipe plug	J032904
75	Clutch for 5-spline main crank (for hand operation)	N302734
75a	Clutch for 10-spline main crank (for hand operation)	N286671

Item	Description	Part No.
76	Clutch for 5-spline main crank (for motor operation)	M302732
76a	Clutch for 10-spline main crank (for motor operation)	M286669
77	Upper clutch cup	M292411
78	Clutch spring	M253753
79	Lower clutch cup	M218627
80	Gasket, 1/2 in. sq. x 4-5 in. long	J067035
81	Bushing	J790008
82	Bushing	J790007
83	Bushing	J790004
84	Bushing	J790262
85	Bushing	J790291
86	Bushing	J790290
87	Oil seal	J790261
88	Bushing	J790328

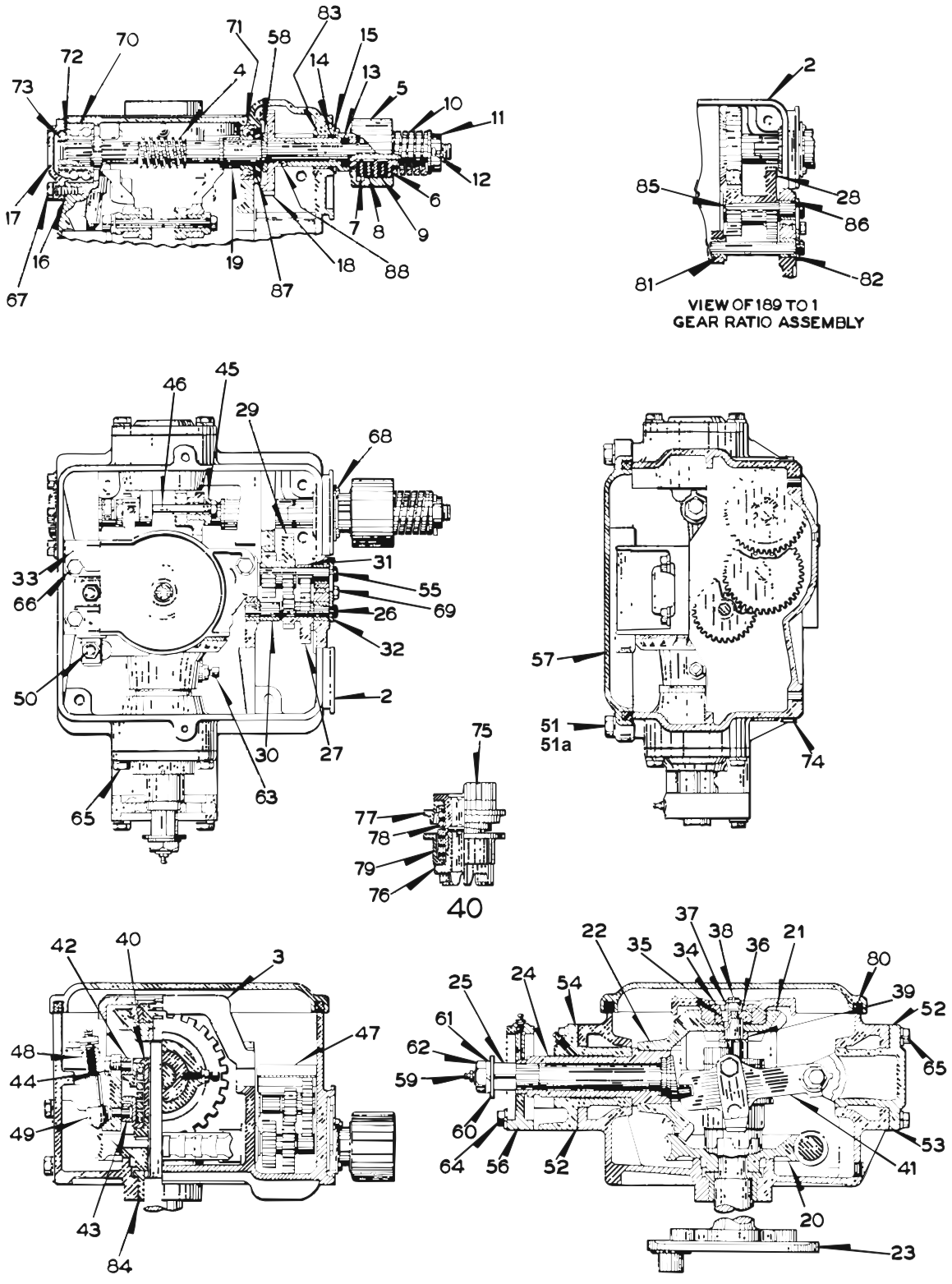


Figure 7-4. Gear Box for M-23A and M-23B Switch Machines

Table 7-5. Parts List for Circuit Controller With Selective Point Detector for M-3, M-23A, and M-23B Switch Machines (See Figure 7-5)

Item	Description	Part No.
A	Indication circuit controller with selective point detector for M-3, M-23A, and M-23B switch machines	N285638
Aa	Indication Circuit Controller without point detector latch	N285638-00l
2	Frame	N284499
3	Idler bearing	N338004
4	Bracket	M284493
5	Yoke (includes bushings, items 6 and 7)	N284681
6	Bushing	M284717
7	Bushing (for use with pin, item 64) (not shown)	M284682
8	Left-hand crank (includes roller and pin, items 9 and 10)	N284650
9	Roller	M284423
10	Pin	M284851
11	Right-hand crank (includes roller and pin, items 9 and 10)	N284649
12	Operating lever (includes bushing, item 13)	N338005
13	Bushing	J079235
14	Latch	M284495
15	Eccentric bushing	N284653
16	Spring	M142167
17	Short circuiting strip support	M074427
18	Connecting rod	M282430
19	Eye rod	M164921
19a	Lock washer	J047767
19b	Hex nut	J048005
20	Spring	J068952
21	Terminal board	J077705
22	Terminal block	M146475
23	Terminal block	M146476
24	Terminal block with pin	N146478
25	Insulation	M142173
26	Binding post	M138723
27	Nut	M026545
28	Binding post	M138724
29	Binding post	M048854
30	Washer	J047818
31	Nut	J480300
32	Nut	J480301
33	Contact spring	N328502
34	Contact spring	M074783
35	Contact spring	M138718
36	Reinforcing spring	M074777
37	Reinforcing spring	M138696
38	Reinforcing spring	M045269
39	Contact spring	M172380
40	Short circuiting strip	M175725

Item	Description	Part No.
41	Stud	M152038
42	Plate	M146775
43	Screw	M056236
44	Trunnion	M055305
45	Trunnion	M285410
46	Castellated nut	M050258
47	Cotter pin, stainless steel, 1/8 x 1 1/2 in.	J486001
48	Washer	M042627
49	Washer	M042585
50	Washer	M048692
51	Contact segment	M045942
52	Insulating bushing	J078019
53	Indication cam	M284494
54	Washer	J475180
55	Cam spring	J068281
56	Gear (includes cam block, item 57, and screw, item 58)	N284679
57	Cam block	M284683
58	Screw	J052308
59	Pinion	M074796
60	Main shaft	M282431
61	Pinion shaft	M338002
62	Pin	M285389
63	Washer	J475186
64	Latch pin	M284718
65	Pin	M284684
66	Screw	M285432
67	Screw	M236061
68	Shim	M134595
69	Contact spring	M251938
70	Stop spring	M251939
71	Stop spring	M251940
72	Spring seat	M285393
73	Screw	J052362
74	Bolt	M451358-3324
74a	Lock washer	J047767
74b	Tie wire	A043025
75	Cotter pin	J048686
76	Cotter pin	J048689
78	Retaining ring	J790074
79	Fiber washer	M056203
80	Material required to add selective point detector to existing M-2, M-22A, and M-22B controllers equipped with non-selective point detection (not shown)	N285903
81	Material required to add selective point detection to existing M-2, M-22A, and M-22B controllers not previously equipped with point detection (not shown)	N305415
82	Material required to add selective point detection to existing M-3, M-	N305405

Item	Description	Part No.
	23A, and M-23B controllers made without point detector (not shown)	
83	Heater, 25 W, 115 V, 500 Ohm	N245984
83a	Heater, 15 W, 115 V, 800 Ohm	N253225
83b	Heater, 15 W, 230 V, 3200 Ohm	N285999
84	Bracket	M245983
85	Resistor, 500 Ohm, 115 V, 25 W (for item 83)	N296576
85a	Resistor, 800 Ohm, 115 V, 15 W (for item 83a)	N296577
85b	Resistor, 3200 Ohm, 230 V, 15W (for item 83b)	N296578
86	Terminal block	
86a	Terminal block with binding posts	M108571
87	Insulated nut	J048300
88	Screw	J525107
89	Clamp	J700690
90	Screw	J052201
91	Screw	J052530

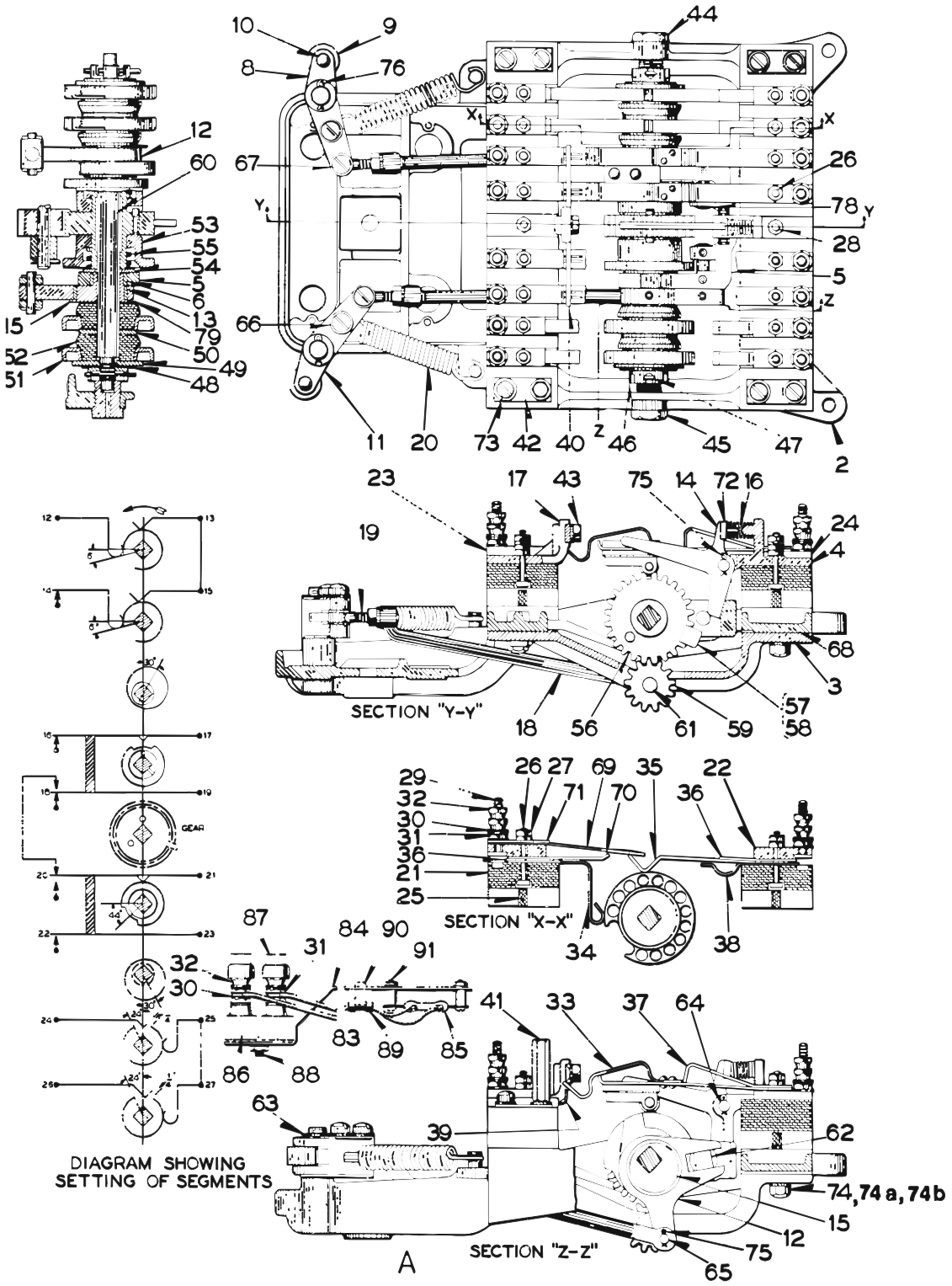


Figure 7-5. Circuit Controller <u>With</u> Selective Point Detector for M-3, M-23A, and M-23B Switch Machines

Table 7-6. Parts List for Circuit Controller Without Selective Point Detector for M-3, M-23A, and M-23B Switch Machines See Figure 7-6

Item	Description	Part No.
A	Indication Circuit Controller Without Selective Point Detector for M-3, M-23A, and M-23B Switch Machines	N294621
2	Frame	N284499
3	Idler Bearing	M284492
4	Short Circuiting Strip Support	M074427
5	Terminal Board	M138698
6	Terminal Block	M146475
7	Terminal Block	M146476
8	Terminal Block with Pin	N146478
9	Insulation	M142173
10	Binding Post	M138723
11	Nut	M026545
12	Binding Post	M138724
13	Binding Post	M048854
14	Washer	J047818
15	Nut	J480300
16	Nut	J480301
17	Contact Spring	N284721
18	Contact Spring	M074783
19	Contact Spring	M138718
20	Reinforcing Spring	M074777
21	Reinforcing Spring	M138696
22	Reinforcing Spring	M045269
23	Contact Spring	M172380
24	Short Circuiting Strip	M175725
25	Stud	M152038
26	Plate	M146775
27	Screw	M056236
28	Trunnion	M055305
29	Trunnion	M285410
30	Castellated Nut	M050258
32	Washer	M042627
33	Washer	M042585
34	Washer	MO48692
35	Contact Segment	M045942
36	Insulating Bushing	J078019
37	Indication Cam	M284494
38	Cam Spring	M074784
39	Gear	N294584
40	Pinion	M074796
41	Main Shaft	M282431
42	Pinion Shaft	N338002
43	Shim	M134595
44	Contact spring	M251938

Item	Description	Part No.
45	Stop spring	M251939
46	Stop spring	M251940
47	Spacer	M294620
51	Fiber washer	M056203

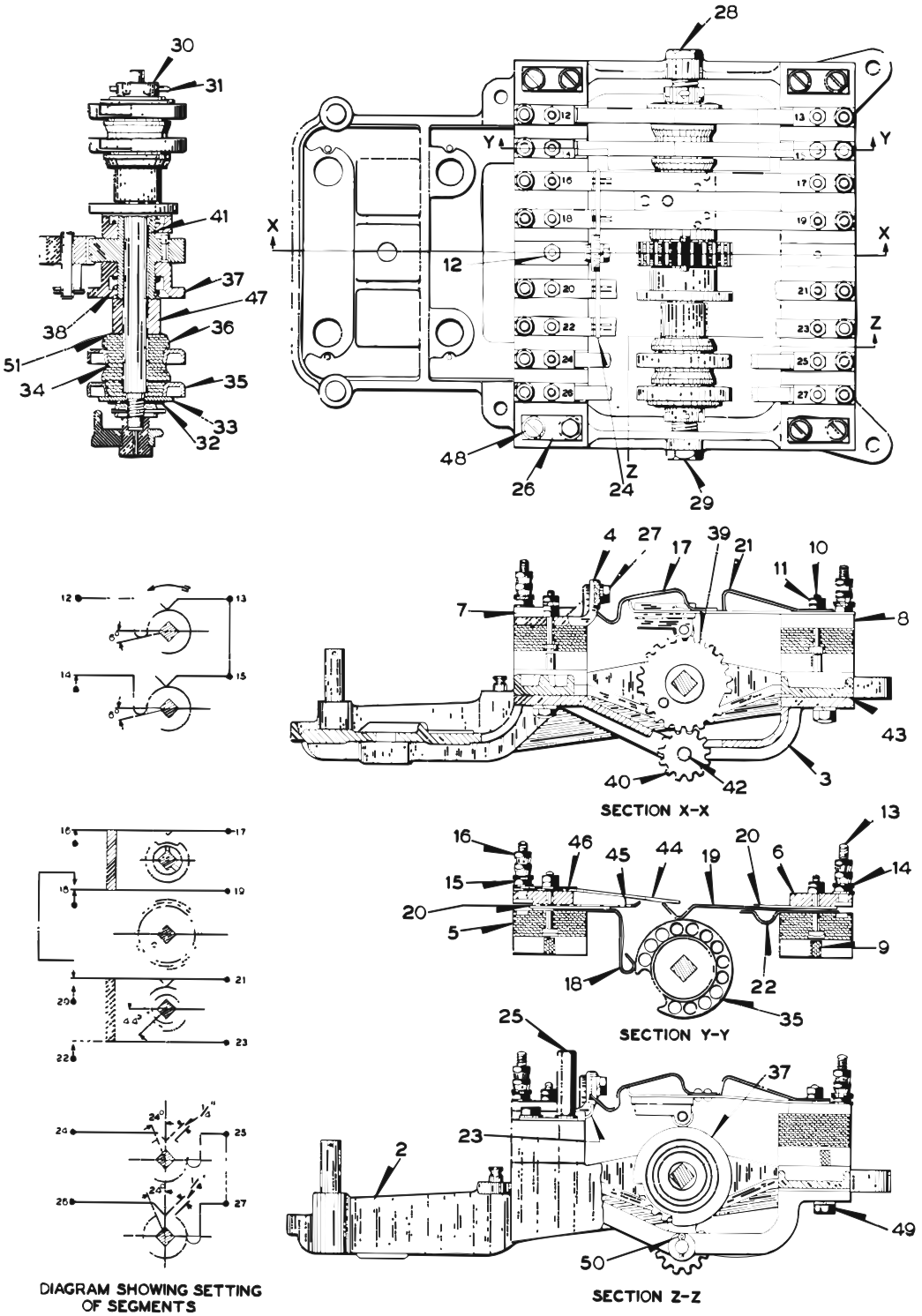


Figure 7-6. Circuit Controller Without Selective Point Detector for M-3, M-23A, and M-23B Switch Machines

8. RAIL TEAM AND TECHNICAL SUPPORT

The Rapid Action Information Link Team (RAIL Team) is a group of experienced product and application engineers ready to assist you to resolve any technical issues concerning this product. Contact the RAIL Team in the United States at 1-800-652-7276 or by e-mail at railteam@ansaldo-sts.us.

End of Manual