AnsaldoSTS
Union Switch & Signal
1000 Technology Drive, Pittsburgh, PA 15219
645 Russell Street, Batesburg, SC 29006

M-3, M-23A, M-23B
Electric Switch Machines
with Independent Point Detection

US&S Part No.
N43925001 (M-3 Left Hand)
N43925002 (M-3 Right Hand)
N43925101 (M-23A Left Hand)
N43925102 (M-23A Right Hand)
N43925201 (M-23B Left Hand)
N43925202 (M-23B Right Hand)

- Installation
- Operation
- Maintenance

SM 9671, Original
January 2008

Proprietary Notice

Important Notice

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

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

Revision History

Rev.	Date	Nature of Revision
Original	January 2008	Initial Issue

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1 General Information

1.1 Introduction

This service manual covers the M-3, M-23A, and M-23B switch machines with independent point detection.

1.2 Description

The M-3, M-23A, and M-23B electric switch machines consist of a motor, a gear train, a cam arrangement for operating the switch and the locking, and a circuit controller that includes a point detector (with or without latchout device). They all use the same base casting and are interchangeable as to mounting and connections in a switch layout, except the additional height of the M-23A and M-23B machines as compared with the M-3, may affect clearance (See dimensions in Figure 3–3 and Figure 3–4). Typical applications are shown in Figure 1–1 and Figure 1–2.

The M-3 switch machine has no facilities for routine hand operation, however there is a removable hand crank mechanism that can be used in an emergency situation or for testing and adjusting of the machine. The M-23A and M-23B machines have dual control features including a hand-throw lever and a selector lever to permit manual operation as well as by power, and it is this provision which requires a different gearbox. 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 and indication. Power operation 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 power operation. In the M-23B machine, however, operation by the hand-throw lever does not provide lock rod protection (i.e., the slide bar and lock box do not move a full stroke and indication cannot be obtained).

Motors and gear ratios are available for operating the machines from 110 volts or 20 volts DC, and these may be changed without changing the gearbox. Two gear ratios are available for the low-voltage (20 VDC) machines; one to provide relatively fast operation as used generally, and the other to provide slower operation for use at locations where current requirements must be held to a minimum. Two gear ratios are used with the high-voltage (110 VDC) motors; one to provide a high speed operation and the other to provide a high throw force.

The machines are completely wired at the factory with the internal wiring connected to the main terminal board in the motor compartment. A typical wiring diagram or working drawing is enclosed with each machine when shipped, showing how external connections are to be made to the main terminal board for a particular application. To allow standardized wiring, provision is made in the circuit controller for arranging it to always have certain contacts indicate Normal, regardless of which end of the operating stroke is established as Normal. The internal wiring includes wires for an electric heater that can be added in the circuit controller. An electric heater for the motor compartment is also available.

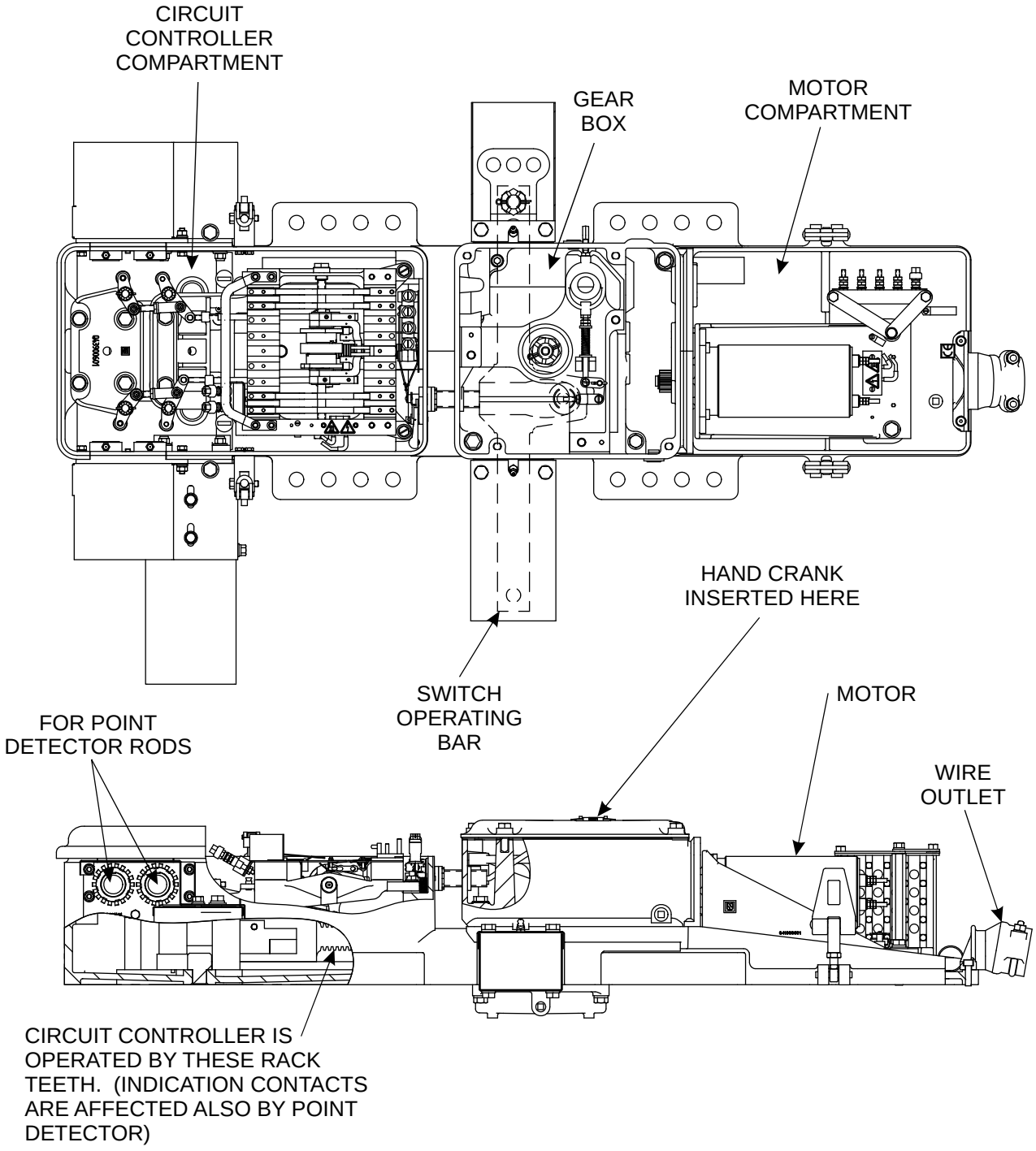

Figure 1–1 - Outline Diagram of the M-3 Switch Machine

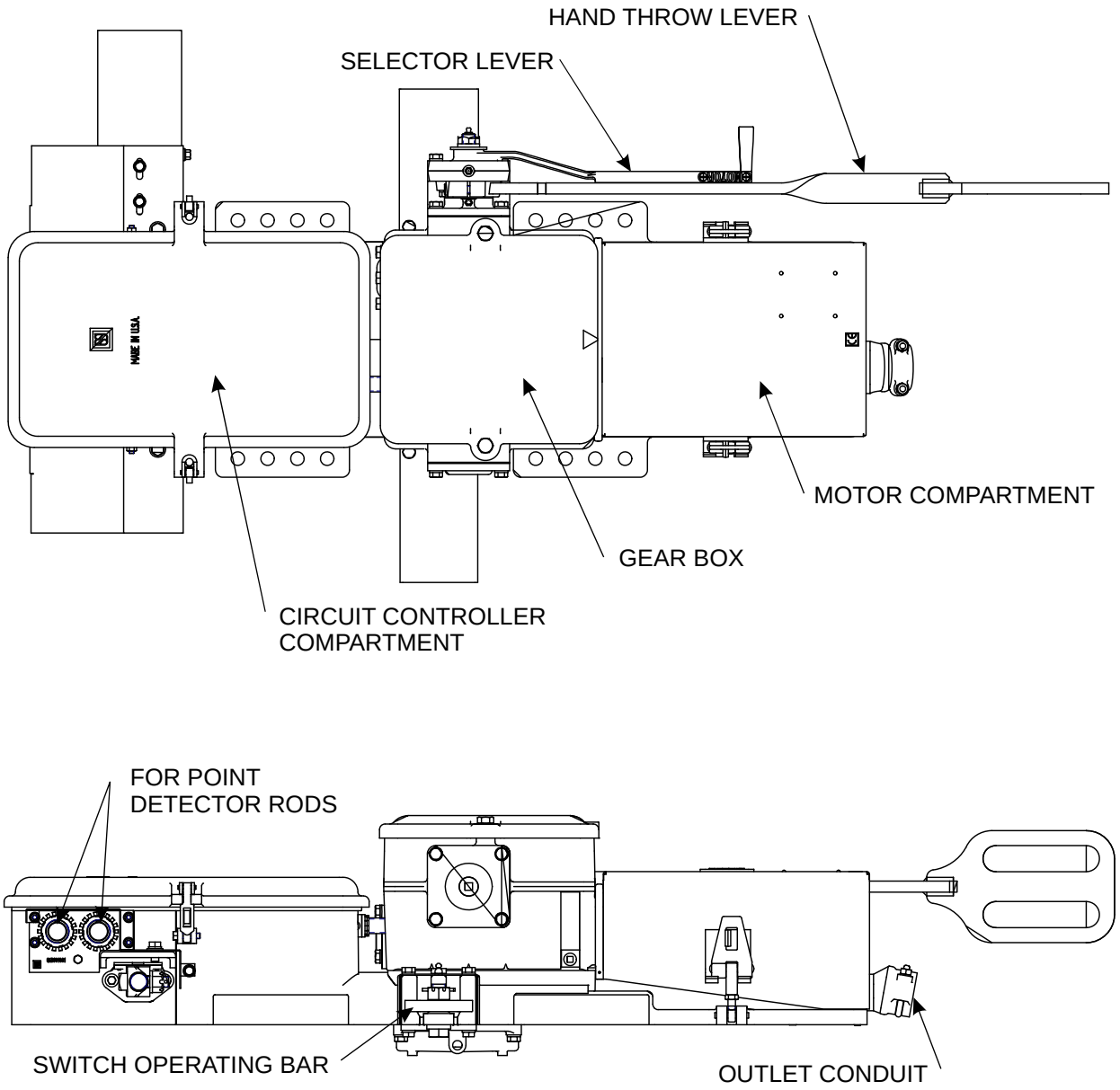

Figure 1–2 - Outline Diagram of the M-23A, M-23B Switch Machines

1.2.1 Operating Mechanism

Referring to Figure 1–1 for the M-3 machine and to Figure 1–2 for the M-23A and M-23B machines, three compartments are provided.

1.2.1.1 Motor Compartment

This compartment houses the motor, the main terminal board, and the optional heater, when installed. It also has a wire outlet for the external wiring. The friction clutch of the gear train projects into this compartment.

1.2.1.2 Gearbox

There are two compartments in the gearbox, one for the spur gear portion of the reduction gearing, and the other for the main crank and worm gear drive. Connection between the spur gears and the worm shaft is through the friction clutch, which projects into the motor compartment as mentioned in Section 1.2.1.1. The friction clutch protects the mechanism from shock at the end of the stroke or when travel is stopped suddenly by an obstruction in the switch point or by lock rod fouling. The gearbox also houses the mechanism for operation by a hand crank (M-3) or by the dual-control mechanism (M-23A and M-23B).

1.2.1.3 Circuit Controller Compartment

This compartment contains the circuit controller, locking features, two independent point detector bars, and a separate set of motor cutout contacts which open the motor circuit and may also control a line circuit whenever the hand crank is inserted in the M-3 machine or the selector lever is operated out of its “motor” position in the M-23A and M-23B machines.

1.2.1.4 Other

In addition to the elements just mentioned, there is a slide bar running lengthwise in the base of the machine. It is driven by the main crank and operates the lock box in the circuit controller compartment. Perpendicular to the mechanism and beneath the slide bar is a switch operating bar which also is driven by the main crank and to which the switch operating rod is connected (see Figure 2–1 and Figure 2–2). The point detector bars and lock rods, operated by connections to the switch points, are supported in the circuit controller compartment.

Switch operation, switch locking, and circuit controller operation are all performed by the vertical main crank in the gearbox. The main crank is driven either by the motor or by the hand operation facilities. Refer to Section 2 for detailed operation of the switch machine.

1.3 Specifications

1.3.1 Physical Characteristics

	M-3	M-23A and M-23B
Length	60-1/4”	60-1/4”
Width	33”	33”
Height	10-1/4”	14”
Weight	850 lbs.	900 lbs.

1.3.2 Operating Characteristics - M-3, M-23A and M-23B

The operating characteristics for the M-3, M-23A, and M-23B switch machines are shown in Table 1-1.

Table 1-1 - Operating Characteristics of the M-3, M-23A, and M-23B Switch Machines

Voltage*	Time**	Gear Ratio	Clutch Setting
110 VDC	3.0 seconds	189:1	15 amperes
110 VDC	4.5 seconds	189:1	14 amperes
110 VDC	8.0 seconds	360:1	10 amperes
20 VDC	15 seconds	360:1	23 amperes
20 VDC	26/34 seconds	528:1	12 amperes

* Voltage at motor terminals.

** Switch over time measured in accordance with AREMA (AAR) Manual Part 12.2.5. These times will vary depending upon motor terminal voltage and machine operating load and conditions.

1.3.3 Electrical Data

1.3.3.1 Motors

The motors used on the M-3, M-23A, and M-23B switch machines are listed in Table 1-2.

Table 1-2 - Motors Used on the M-3, M-23A, and M-23B Switch Machines

Motor Part No.	Motor Voltage
J717216-0301	110 VDC
J717216-0302	20 VDC
J717216-0303	20 VDC
J717216-0304	110 VDC
J717216-0305	110 VDC

1.3.3.2 Heaters

The heaters shown in Table 1-3 work with any switch machine and are dependent on the specific application.

Table 1-3 - Heaters Used on the M-3, M-23A, and M-23B Switch Machines

Heater Part No.	Description
Circuit Controller Compartment Heaters	
N253225	15W, 115V
N438201	15W, 115/230V
N438179	15W, 24V
Motor Compartment Heaters	
N294241	15W, 115V
N294241 & N296578-001	15W, 115/230V
N438178	15W, 24V

2 Principles of Operation

2.1 Switch-Operating and Locking Mechanism

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

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

Assuming that Figure 2–3A shows the Normal position, a reverse movement is started by a clockwise rotation of the main crank.

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

Figure 2–3B shows the relative mid-stroke positions of the switch-operating bar and the slide bar; with the main crank still rotating clockwise but not transmitting motion to the slide bar as Lug 1 has become disengaged from Roller 1. The surfaces of the slide bar are radial to the center of the shaft and prevent the slide bar from moving.

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

The lock box rests on and is operated from an extension of the slide bar as shown in Figure 2–3. During the first 40 degrees of rotation of the main crank, the corresponding motion of the slide bar withdraws the lower locking dog of the lock box from the lower notch of the lock rod, thus unlocking the switch points. The following 140 degrees of rotation of the crank operates the switch, and the lock rod stops with its upper notch aligned to receive the upper locking dog of the lock box. The final 40 degrees of rotation of the crank completes the stroke of the slide bar, driving the upper locking dog into the lock rod notch to lock the switch points in the reverse position.

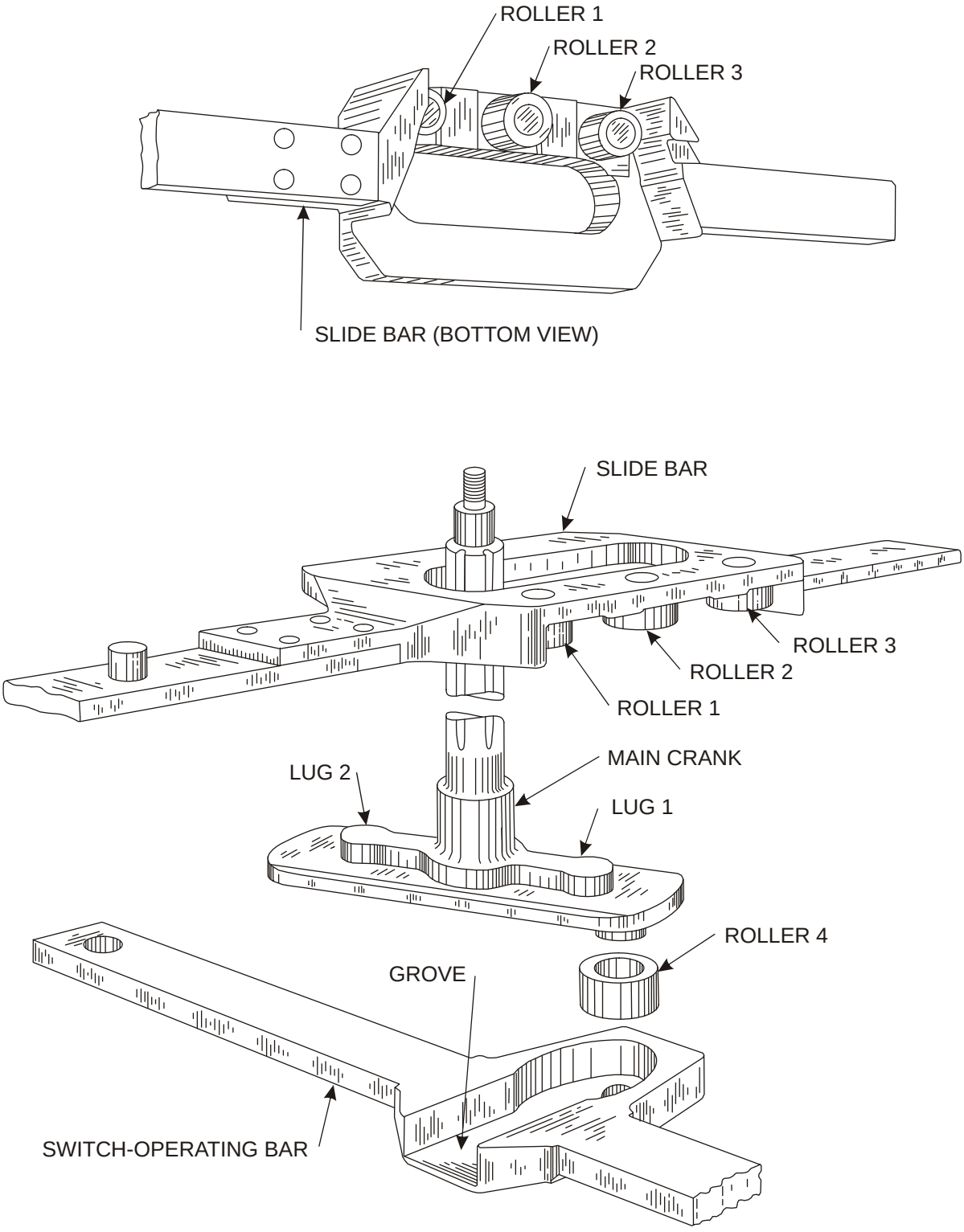

Figure 2–1 - M-23A and M-23B Switch Operating Mechanism

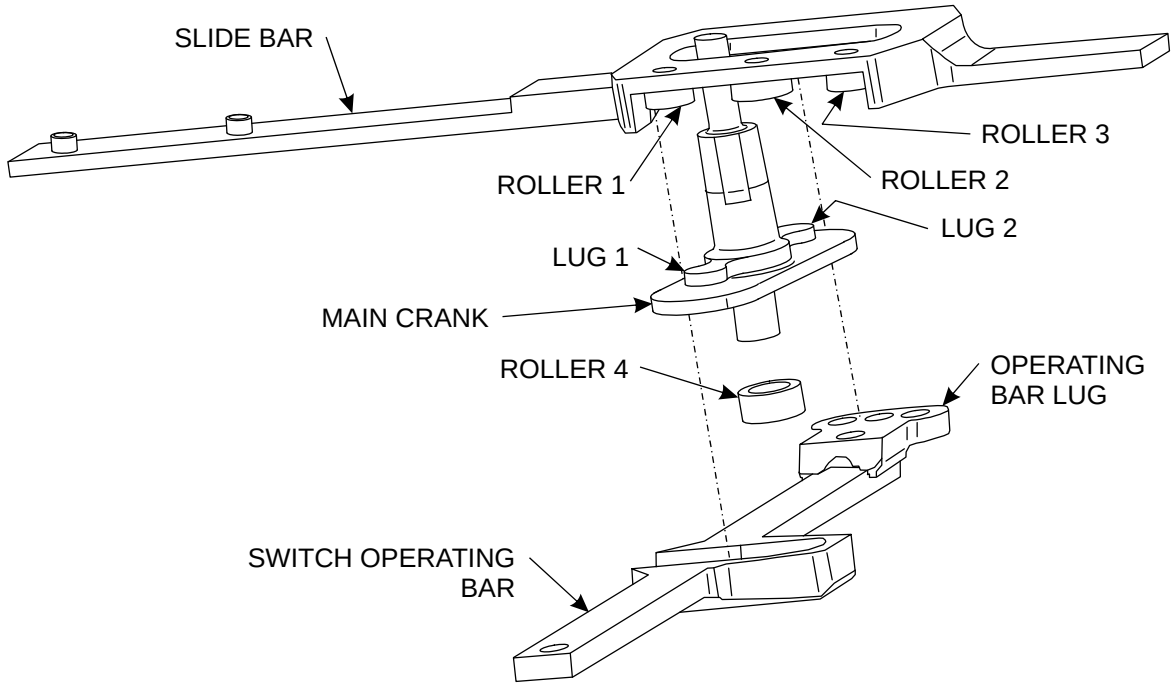

Figure 2–2 - M-3 Switch Operating Mechanism


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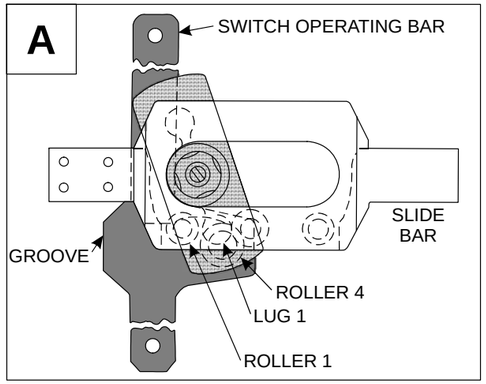
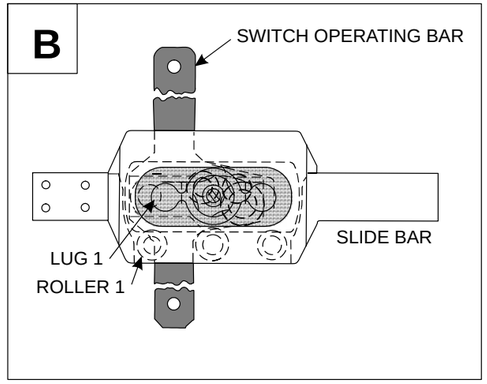
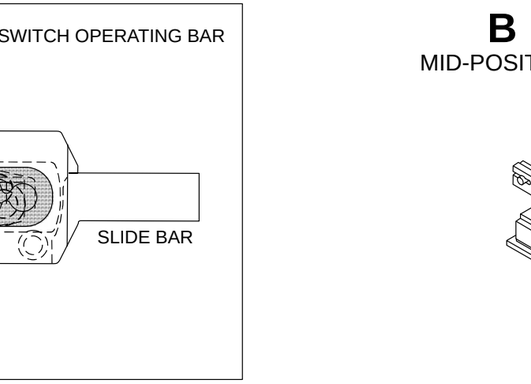
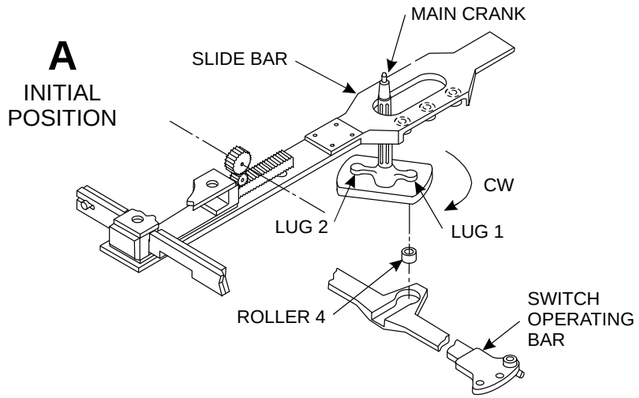
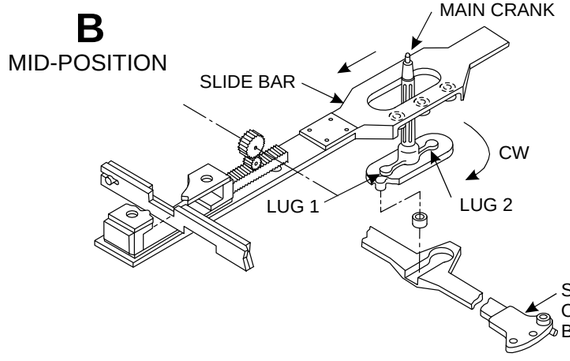










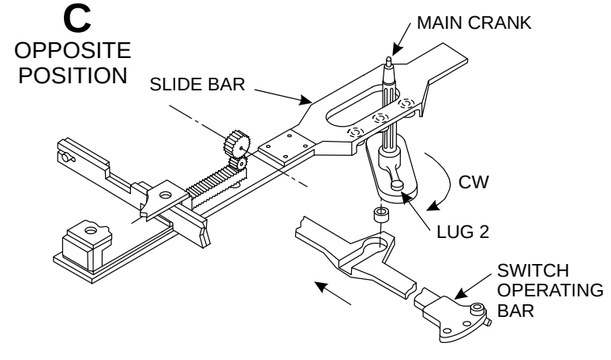
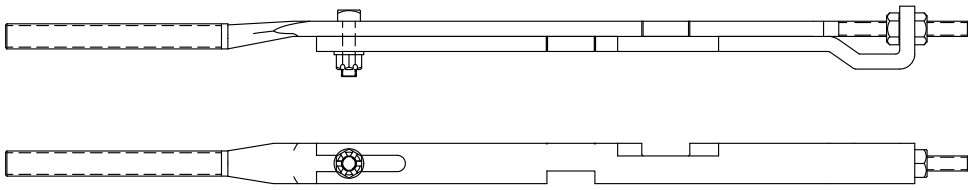


Figure 2–3 - Diagram of Driving Parts



(A) TYPE GENERALLY USED WITH BALL AND SOCKET CONNECTION

(B) TYPE USED WITH RIGID CONNECTION

Figure 2–4 - Adjustable Lock Rods for R.H. and L.H. Operation

2.2 Switch Point Locking

The lock rods in Figure 2–4 are comprised of two rectangular rods side-by-side. Each has a narrow notch only slightly wider than the locking dogs, this narrow notch in one rod being on top and in the other rod on the bottom. To allow for variations in switch throw, the two rods are adjustable longitudinally with respect to each other, and each has a wide notch located alongside the narrow notch of the other. Because the notch is on top of the lock rods for one switch position and on the bottom for the other position, and because 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, of course, is secured by the locking.

The stroke of the slide bar and its lock box is such that the locking dogs provide adequate interlock with only the lock rod that the dog enters first. **Therefore, the lock box and the lock rods must be assembled so that the dogs will enter the narrow notches first.** The procedure for inverting the lock box when necessary is given in Section 3.16.1.

2.3 Circuit Controller

The circuit controller has indication contacts that are operated jointly by the lock box and the point detector mechanism. The contacts are operated in such a manner that the machine, as checked by the lock box, must have completed its throwing and locking stroke in the proper direction, and the

corresponding switch point must be closed properly, as checked by the point detectors, 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 2–5, the circuit controller has a total of eight sets of contacts operated by cams and segments on shaft R which is rotated by the slide bar motion transmitted through the lock box rack teeth, the idler pinion, and the shaft gear. The two sets of contacts at the left side (viewed from lock rod end of the machine, Figure 2–5) and the two at the right side comprise the motor control contacts, while the four intervening sets comprise the indication contacts. The motor control contacts are operated solely by the shaft-carried segments, but the indication contacts are also subject to point detector operation.

The shaft assembly, Figure 2–7, consists of a square shaft on which the two end insulating washers, the four motor control segment insulating bushings, the two eccentric bushings, and the gear each have square holes to force them to rotate with the shaft. To ensure proper relative assembly of the gear and eccentric bushings, the shaft is made with unlike ends so that it can go into the controller only one way. The shaft has one corner flattened for a distance of 2” at one end and 3” at the other end, and the gear and the eccentric bushings have dowel pins that can be assembled only in these flats. With the exception of the indication cams and their coil springs, the two arms of the yoke, and the operating levers, all the parts are pulled up solidly end-to-end by the nuts on the ends of the shaft. The indication cams and their respective springs ride on the gear hub and are held against the gear face by action of the springs and locked in place with set screws. The cams may have either of two operating positions as determined by slots in the cam hub engaging the stud in the gear face. The yoke is free to rotate around the concentric hub portions of the eccentric bushings, and the operating levers are free to rotate around the eccentric portions or be held stationary while the shaft and eccentric bushings rotate.

2.3.1 Indication Contacts

The four sets of indication contacts operate as two pairs, one pair indicating the normal position and the other indicating the reverse position. Each pair is operated by a single cam and both are subject to point detector operation. Wiring and wire nomenclature are standardized so that the left pair of contacts (L, Figure 2–5; Sect. N-N, Figure 2–7) are used to indicate “normal” on all installations. This means that in some applications the left pair of contacts must indicate that end of the stroke that has the slide bar toward the lock rod end of machine, and in other applications must indicate that end of the stroke that has the slide bar toward the motor end of the machine. The right pair of contacts (M, Figure 2–5) similarly must indicate sometimes one end and sometimes the other end of the slide bar stroke, so as to indicate “reverse.”

Referring to Figure 2–6, when cam N has its notch up, the associated “normal” pair of contacts L closes as shown (except when prevented by point detection, as explained later). For a right-hand layout with right-hand point normally closed cam N has its notch up when the slide bar is at that end of its stroke where it is nearest the motor end of the machine. At the same time, cam P is holding its associated pair of contacts up (Sect. P-P and Sect. N-N of Figure 2–7). When the machine is operated towards the opposite end of its stroke, the notch in cam N rotates counterclockwise out from under the follower, forcing the contacts up. While the switch is in transit, both the normal and the reverse indication contacts are up, engaging the shunting strip S (Figure 3–5 through Figure 3–8) to provide a shunt for the indication relay. When the machines leave 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).

Instructions for shifting the cams to reverse the ends of the stroke at which they have their notches up, and for adjustment of the contacts, are given in Sections 3.16.2 and 5.5.5.2, respectively.

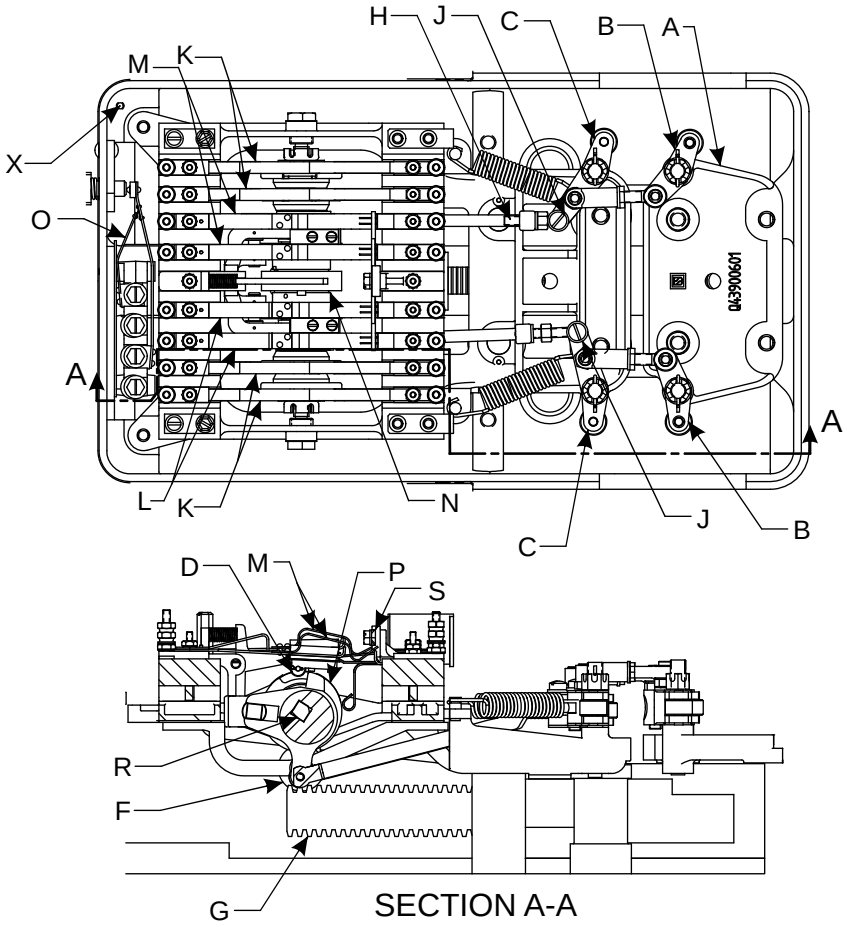
2.3.2 Motor Control Contacts

Of the four sets of motor control contacts (Figure 2–5 and Figure 2–6), the two on the right side (viewed from lock rod end of machine) are open and the two on the left side are closed when the machine is in the position shown. When the machine reaches full opposite position, the closed contacts have been opened to break the motor circuit and the open contacts are closed to provide a circuit for operating the machine back to its original position.

Each set of motor control contacts provides two parallel circuit paths, one through direct contact of opposing spring Fingers F1 and F2 (Figure 2–7) and the other through Finger F1, the conducting segment, and Finger F3. The circuit through the segment opens last, as the notch passes under the “V” end of the Finger F1, Finger F2 being stopped first before the “V” end clears the segment altogether. This arrangement protects the direct finger contact from having to open the motor circuit under normal conditions, yet ensures a circuit in case the segment should become coated with frost.

Referring to Figure 2–7, it will be noted that each motor control segment is nested on the tapered hub of its insulating bushings. The cone engagement has teeth in both elements that prevent the segment from rotating relative to the shaft when the shaft end nuts are pulled up, but that permit the segment to be shifted angularly around the shaft in 4-degree steps when the shaft end nuts are backed off. These segments are set in the factory to provide approximately 1/4” opening between the segment ring and the “V’ end of the contact Finger Fl (Sect. Y-Y and Z-Z) and approximately 1/8” 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 by hand while in MOTOR position).

The motor control contacts are set at the factory to ensure that the switch machine is locked in accordance with AREMA specifications. Ordinarily, readjustment will not be required as long as the assembly remains undisturbed. If an adjustment is required, it would be best to adjust the machine in the maintenance shop. Refer to Section 5.5.5.1 for these procedures.



LEGEND:

A - INDEPENDENT POINT DETECTION FRAME
B - INDEPENDENT POINT DETECTION CRANK ARMS
C - PRIMARY POINT DETECTION CRANK ARMS
D - ROLLER
F - IDLER PINION GEAR
G - LOCK BOX
H - EYE SCREW
J - SCREW
K - MOTOR CONTROL CONTACTS
L - INDICATION CONTACTS (LEFT)
M - INDICATION CONTACTS (RIGHT)
N - INDICATION CAM
O - MOTOR CUTOUT CONTACTS
P - INDICATION CAM
R - SHAFT
S - SHUNTING STRIP
T - BOLTS
X - LATCH

Figure 2–5 - Indication Circuit Controller

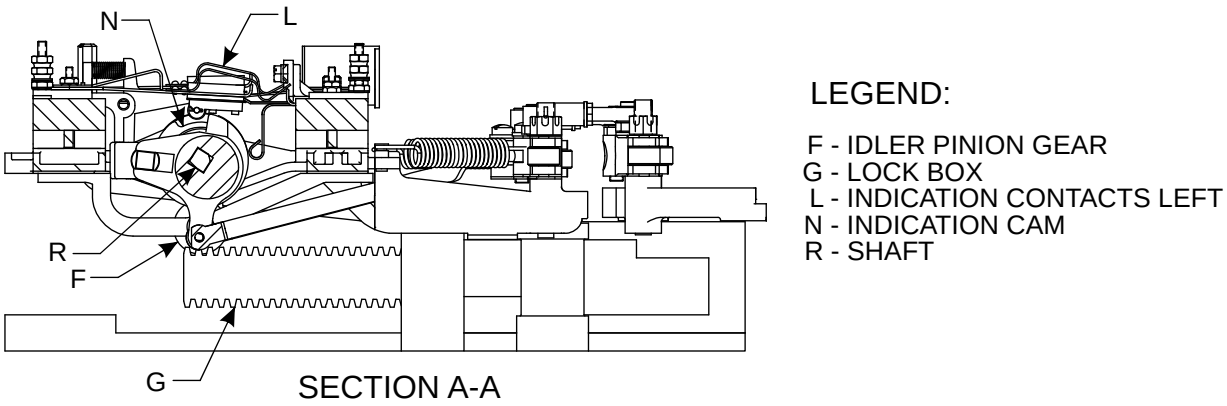


Figure 2–6 - Sectional View of Indication Circuit Controller

2.3.3 IPD Indication Assembly

The independent point detection (IPD) assembly consists of left-hand and right-hand crank arms that are operated by linkage connected to the indication circuit controller crank arms. The IPD crank arms are fully adjustable to give the same operational performance as the indication circuit controller crank arms. The IPD crank arms are adjusted to detect the position of the point detector connecting rod attached to the far switch point.

2.4 Point Detector

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 the action of the point detector bars. Point detector 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 either 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 bars must shift to correspond with the switch operating stroke when the machine is reversed. It also has a latchout feature that will hold the indication contacts open (until reset) when the point detector bars are 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 bars which 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 bars near their 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 bars. The latch is equipped with a “self-restoring” feature (which 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 will reset automatically when the machine is next operated 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 impossible for the machine to complete its stroke in either direction due to lock rod fouling. The latch can also be reset manually.

Major components of the point detector mechanism are shown in Figure 2–5 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 2–8. Mid-stroke positions of the various parts are shown in Figure 2–9. Reverse positions of the various parts are shown in Figure 2–10 while Figure 2–11 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, against the yoke stop on the latch bracket for all controller positions, except when the point detector bars have 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 2–8, Figure 2–9, and Figure 2–10.

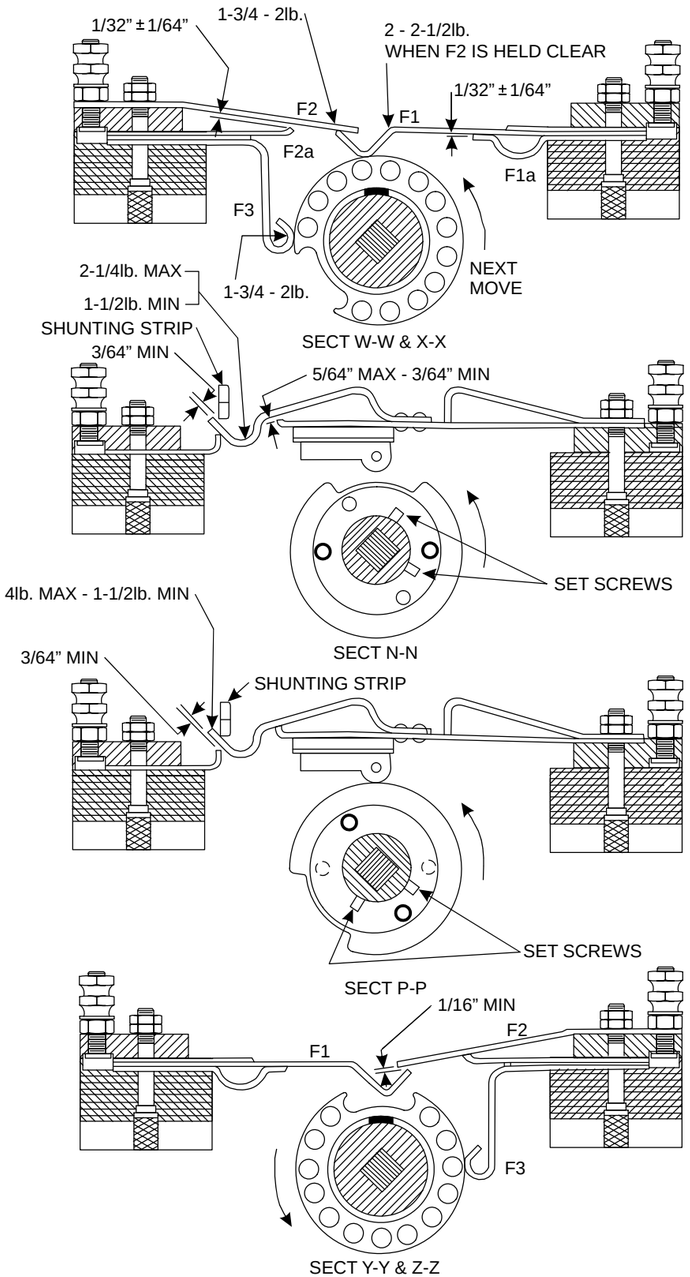
With the switch machine in the normal position, as shown in Figure 2–8, point detector Rollers A and B do not contact the point detector bars, thus preventing wear of point detector parts under traffic conditions. (Refer to Section 3.6 for proper clearance adjustment.) Roller A, however, is in position to deflect the yoke downward should the point detector bars 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 the point detector rollers away from the point detector bars and permit movement of the point detector bars from the normal to reverse position without contacting either roller. Mid-stroke positions are shown in Figure 2–9.

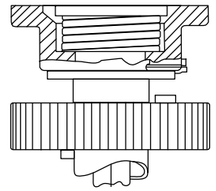
Reverse positions of the parts are shown in Figure 2–10. Both rollers are again clear of the bars, but Roller B is in position to deflect the yoke downward should the point detector bars become displaced.

The latched-out position of the circuit controller is shown in Figure 2–11. In this position, the point detector bars have shifted from their reverse position due to deflection of the switch points caused by improper trailing. The large diameter areas of the point detector bars have 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 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.

* Parts are illustrated for machine in which cams are assembled for Normal end of stroke to be that which places switch points to the right.

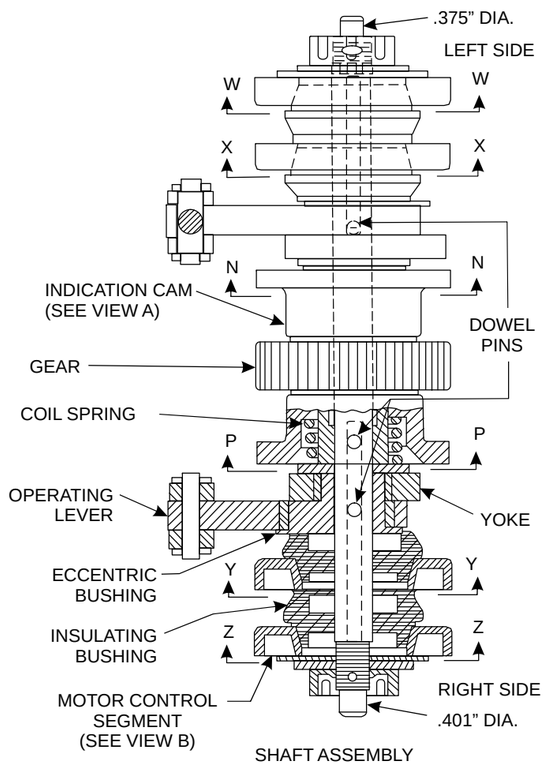
** If the latch doesn't clear the top of the yoke and operate, add sufficient shims under the yoke stop (see Figure 2–11) until the latch operates.

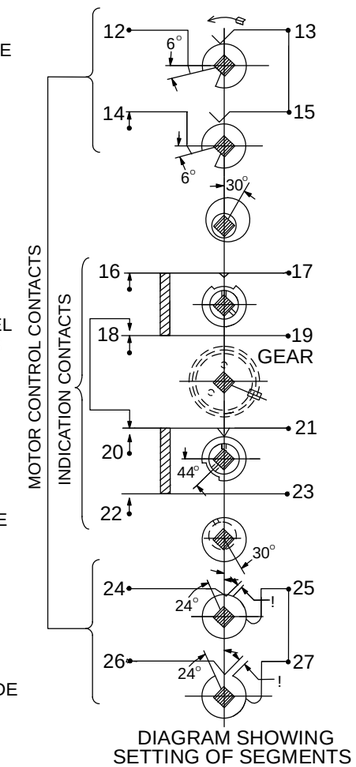


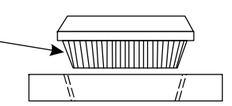


VIEW A
INDICATION CAM

CAN BE SEPARATED FOR REASSEMBLY IN THE OPPOSITE POSITION SIMPLY BY FORCING AGAINST THE SPRING.







90 TEETH
SPACED 4#

VIEW B
MOTOR CONTROL SEGMENT

SEPARATION FOR READJUSTMENT REQUIRES LOOSENING OR REMOVAL OF SHAFT END NUTS.

Figure 2–7 - Circuit Controller Adjustment and Shaft Assembly Diagram

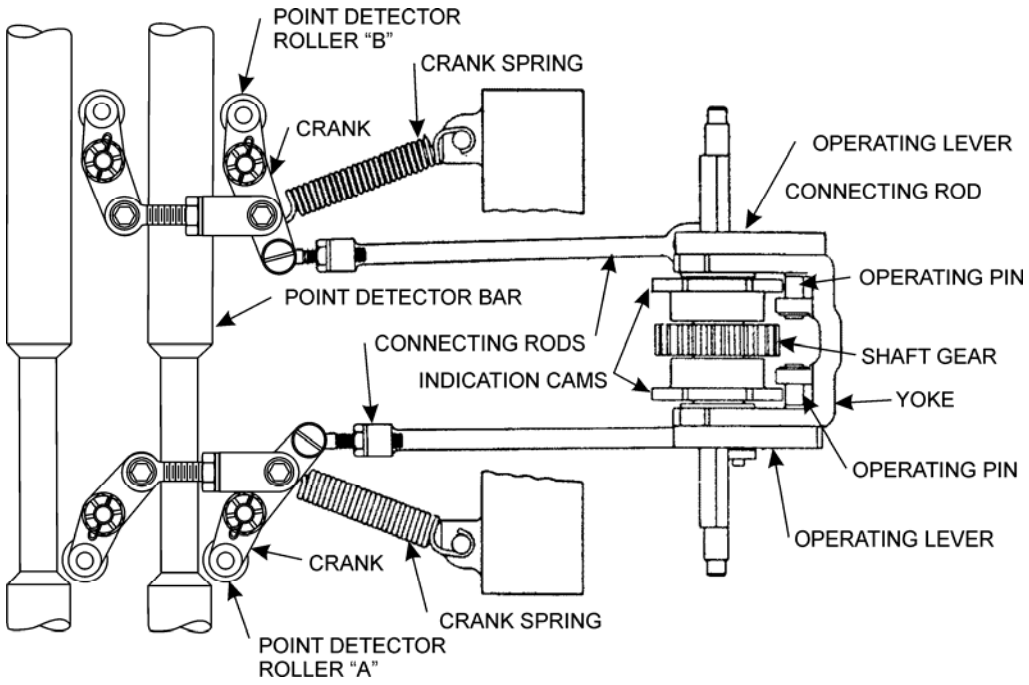


Figure 2–8 - Schematic Diagram of Point Detector – Parts in Normal Position

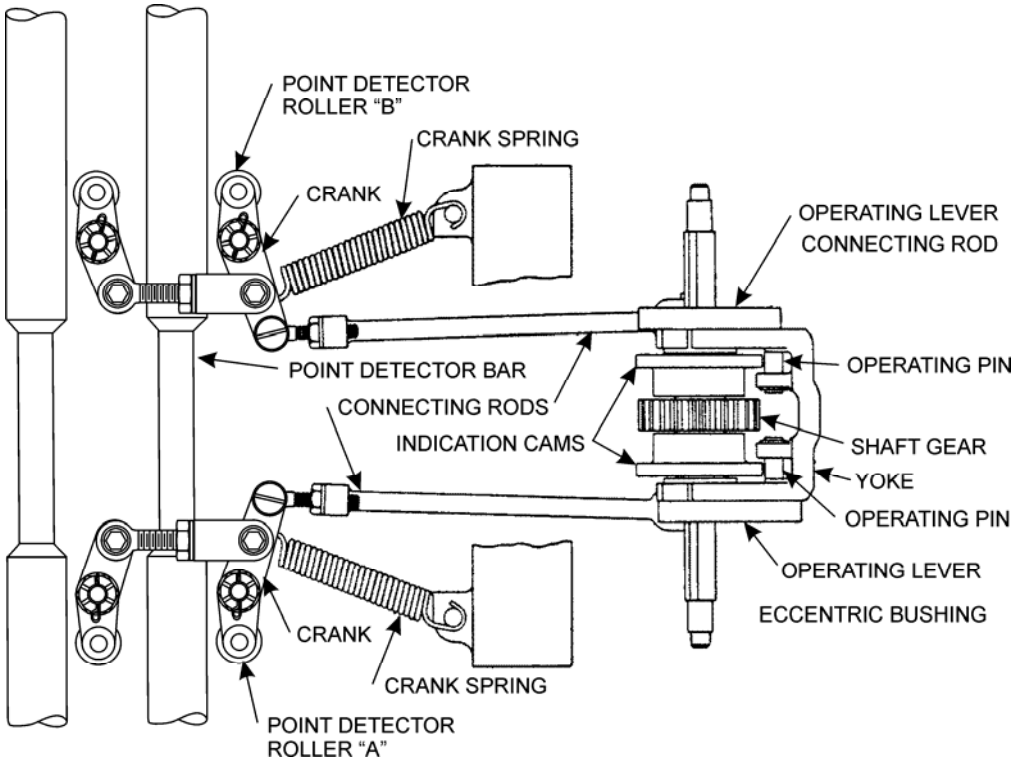


Figure 2–9 - Schematic Diagram of Point Detector – Parts in Mid-Stroke Position

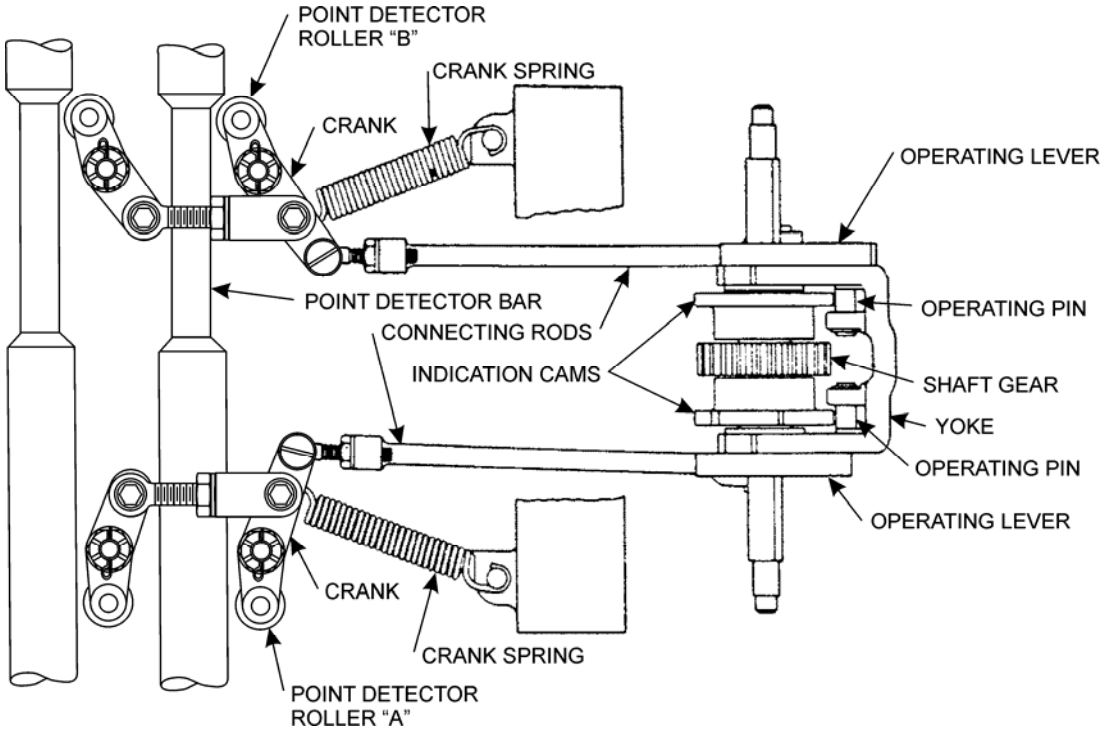


Figure 2–10 - Schematic Diagram of Point Detector – Parts in Reverse Position

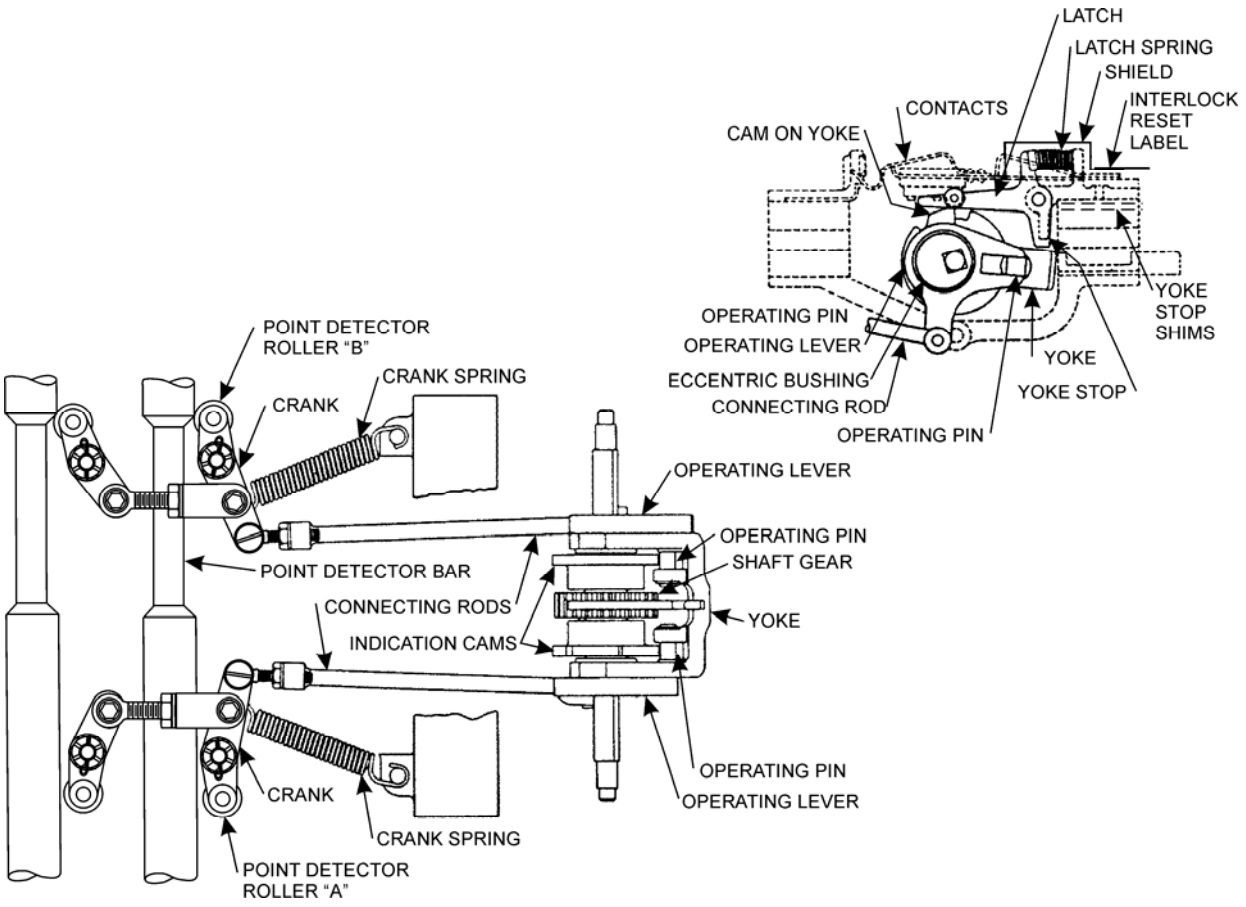


Figure 2–11 - Schematic Diagram of Point Detector – Parts in Reverse Position and Latched-Up

2.5 Gear Train

The reduction gear train between the motor and the worm gear comprises 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 2–12). Note that each reduction gear actually comprises two gears, a large gear and a small gear, made as a unit. The gear ratio is changed by changing out the reduction gears, using the combination indicated in Table 2-1.

The pinion end of the motor is supported in an opening in the clear box which locates the pinion properly relative to the other gear centers. The motor can be removed by taking out the two bolts in the motor bracket at the commutator end. (For detail information on the motor, see Section 2.7.)

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 (see previous paragraph).

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 as will be described.

Table 2-1 - Gear Ratio – Reduction Gear Relationship

Switch Machine M-3, M-23A, or M-23B		110V DC	110 VDC	110 VDC	20 VDC	20 VDC
Nominal Speed*		3.5 sec	4.5 sec.	8 sec.	15 sec.	26 sec.
Gear Ratio		189:1	189:1	360:1	360:1	528:1
Number of Teeth Clutch Gear		43	43	43	43	43
1st Reduction (Figure 2–12)	Gear			32	32	32
	Pinion			16	16	12
2nd Reduction (Figure 2–12)	Gear			41	41	45
	Pinion			22	22	22
Motor Pinion		12	12	12	12	12

* See Operating Characteristics, Section 1.3.2.

The worm shaft meshes with the worm gear on the main crankshaft and is supported at the end adjacent to the controller by a double-row ball bearing that 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, and 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 gearbox bore. The inside diameter provides slight clearance for the worm shaft. The housing has a felt washer and an oil seal to prevent seepage of oil into the friction clutch. The worm shaft is grooved and the housing has ribs to drive alternate friction discs that are compressed by the action of the heavy coil spring. This spring force is contained between the adjusting nut and Oilite thrust plate supported on the tapered shoulder on the worm shaft.

It will be noted that 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 discs.

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 hand hole in the gearbox cover. Motor cutout contacts O (Figure 2–5) 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 hole cover is released, and the crank inserted. 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 someone other than the signal maintainer is authorized to use the hand crank.

⚠ WARNING

In certain cases, particularly on transit properties, the clearance is such that if the hand crank is left in the machine it could come in contact with the vehicle collector shoe, causing a hazardous condition. Do not permit traffic through the switch with the hand crank left in the M-3 Switch Machine, otherwise property damage may result. Always remove hand crank when not in use.

2.6.1 Dual-Control Mechanism (M-23A and M-23B)

As already explained, switch operation, switch locking, and circuit controller operation are all performed by the vertical main crank in the gear compartment shown in Figure 2–12. This 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 to hand-throw position, connection between the selector lever and the selector clutch is made through a coil spring mounted on the selector clutch.

Note

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

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. Observe that the main crank remains engaged with its original connected driving elements until it is engaged with the other elements. The clutch overall height is such that the top tooth must engage the hand throw gear before the bottom teeth can disengage from the worm gear, or vice versa. Thus the main crank is never "floating," but is engaged with either the motor or the hand throw lever at all times.

Note

In as much as the switch-operating mechanism may remain in engagement with the motor rather than with the hand-throw lever when the selector is operated to HAND position, it is necessary to actually operate the switch by the hand-throw lever to assure that the machine is in the hand operation position.

2.6.2 Operation By Selector Lever

Refer to Figure 2–14 for this procedure.

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

The selector clutch assembly, as shown in 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 degrees 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 of course 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.

LEGEND

FOR FIGS. 2-12 & 2-13

A1 - BOLT
A2 - BOLT
A3 - BOLT
A4 - BOLT
B1 - NUT
B2 - WASHER
C - BEARING
C1 - KEY
C2 - BEARING BUSHING
D - PINION
E - COLLAR
F - GEAR
F1 - SET SCREW
G - BOLT
G1 - YOKE BUSHING
H - YOKE SUPPORT
K - LEVER SUPPORT
M - BEARING
N - YOKE
P - PIN
R - FRICTION CLUTCH

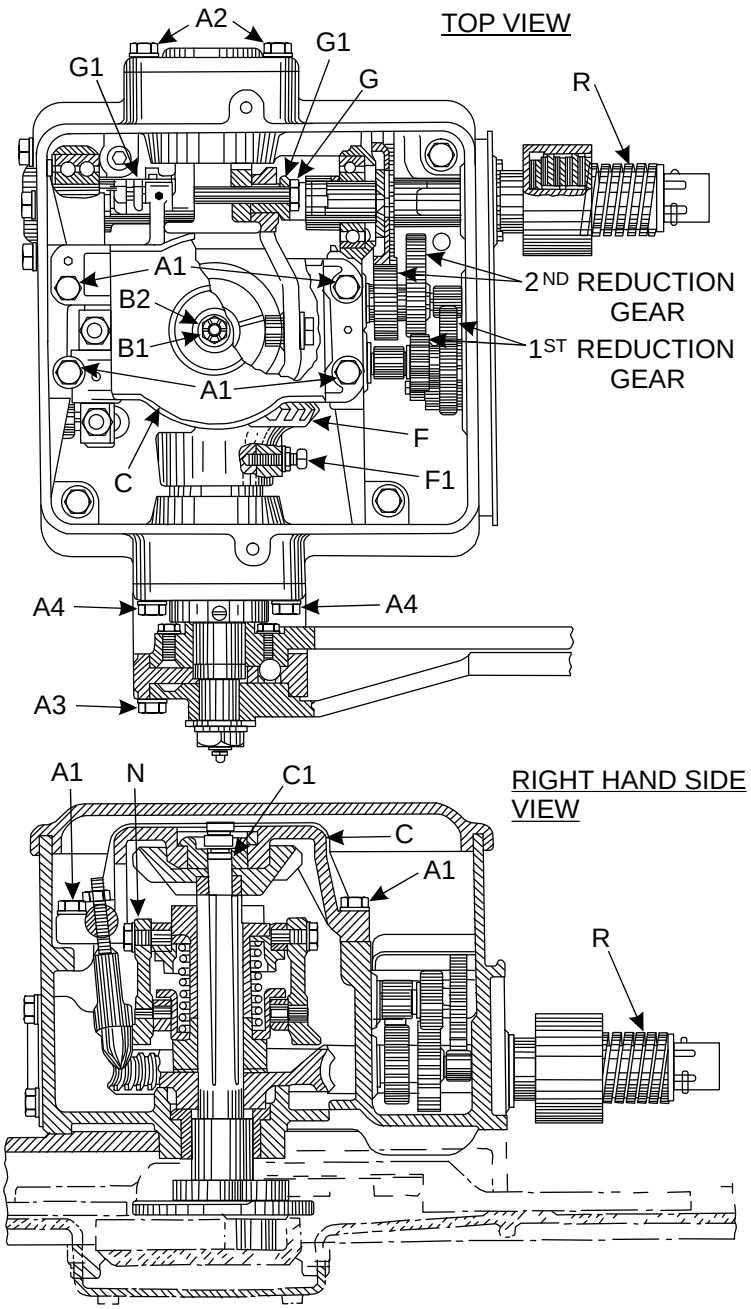


Figure 2–12 - Sectional View of M-23A Gearbox

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 gearbox. 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 as shown in Figure 2–15.

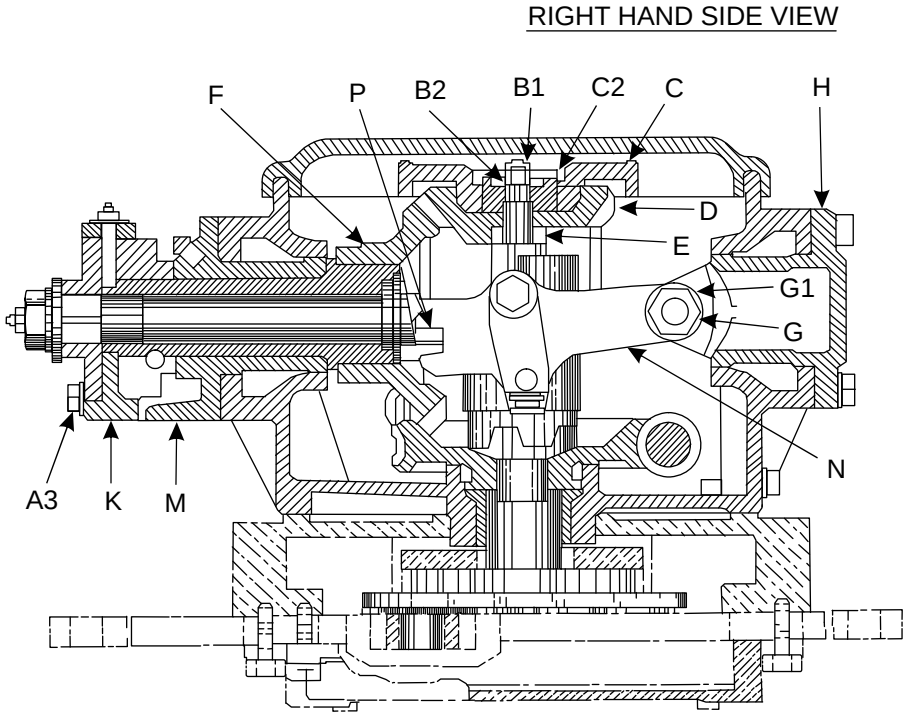


Figure 2–13 - Sectional View of M-23A Gearbox, Looking from Motor End

2.6.3 M-23B Mechanism

The mechanical difference between M-23A and M-23B mechanisms is 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.

2.6.3.1 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, and also to prevent return of the selector lever from its HAND position unless the hand-throw lever is in one or the other of its full-stroke positions. The interlock can also be assembled to require that the hand-throw lever always be returned to Normal before the selector lever can be returned from its HAND position.

Details of the interlock are illustrated in Figure 3–9 and described in Section 3.14. Moreover, it is possible to apply the selector lever to its shaft in either of two ways, 180 degrees 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.

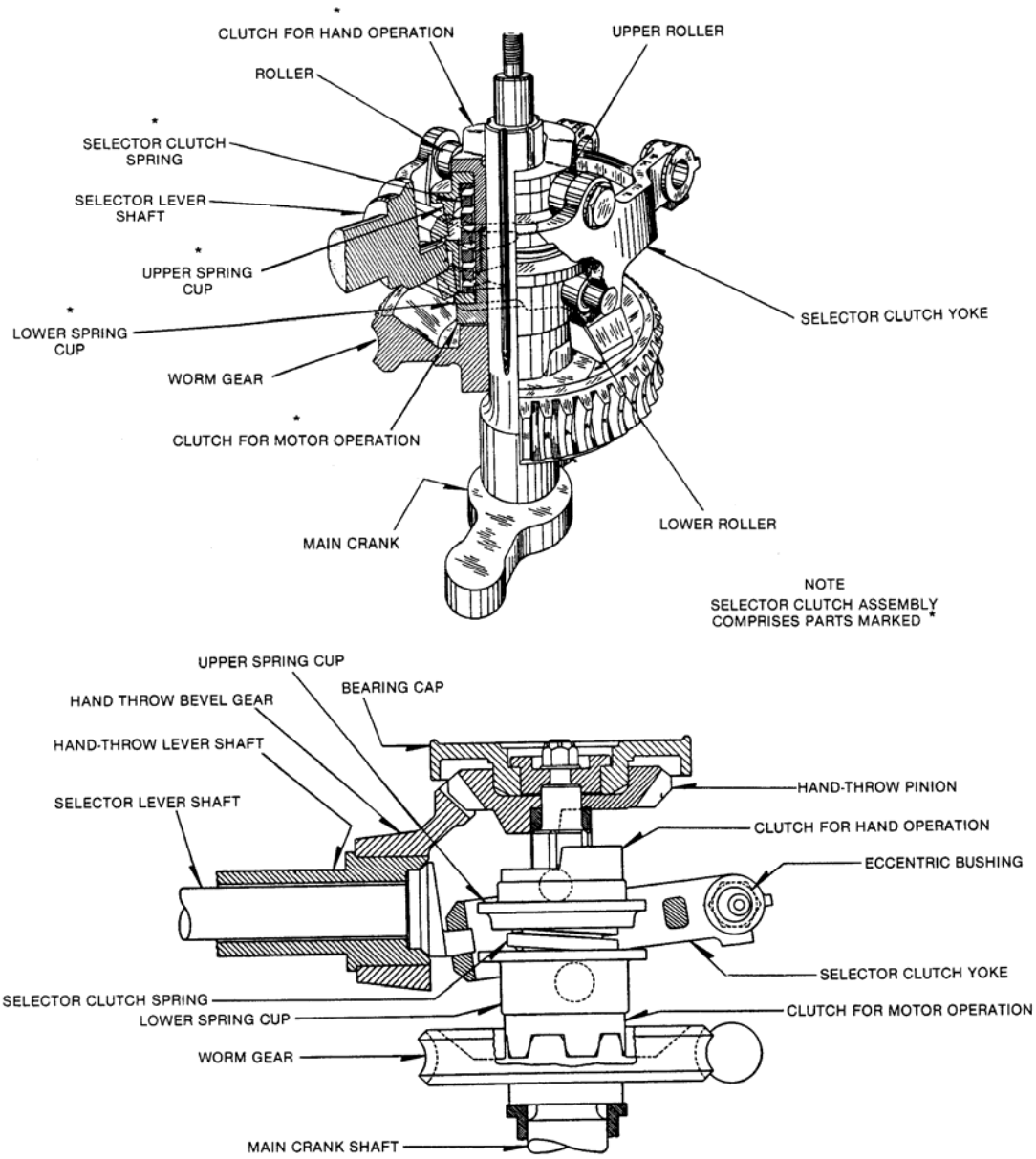


Figure 2–14 - Sectional Views of M-23A Dual-Control Mechanism

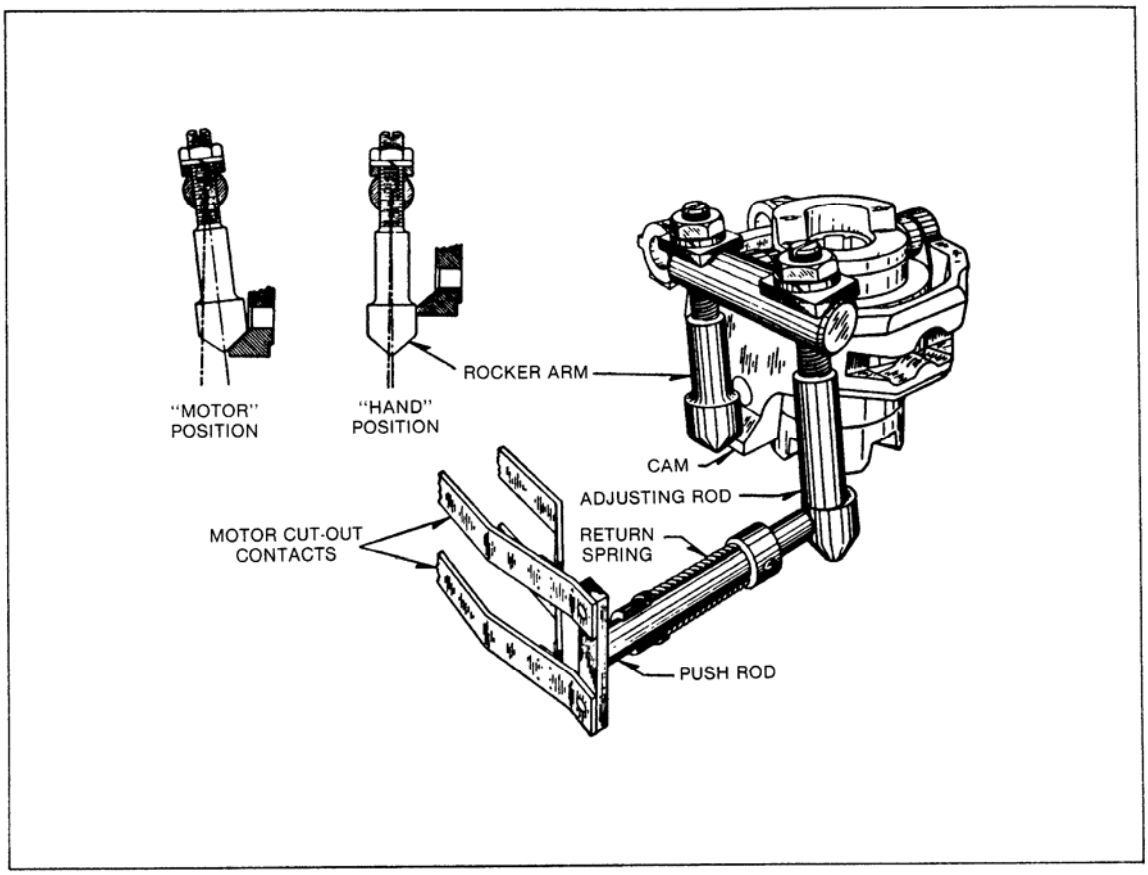


Figure 2–15 - Motor Cutout Contact Assembly (M-23A and M-23B Machines)

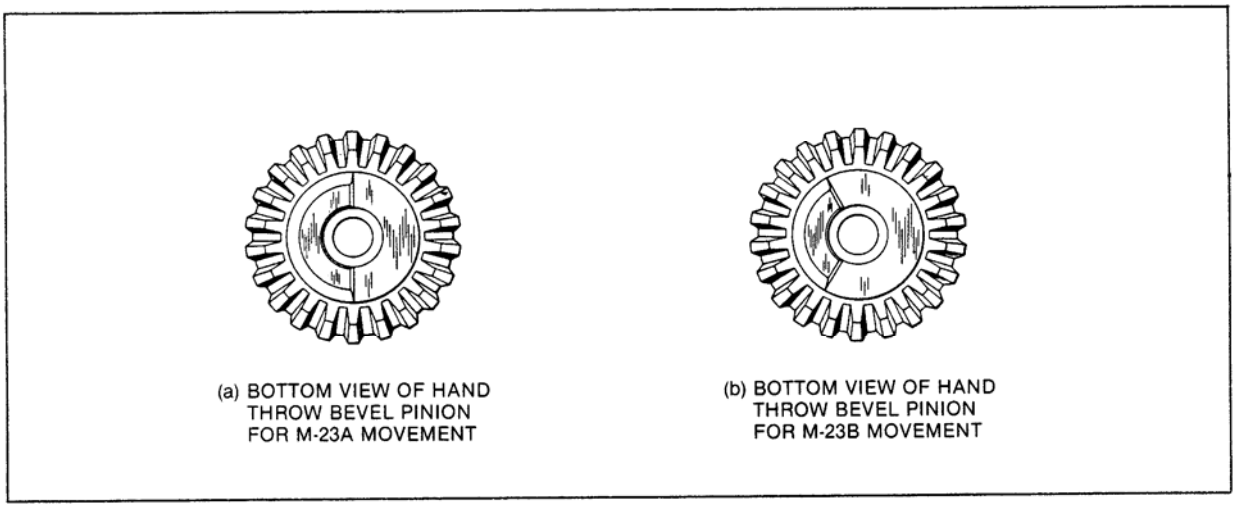


Figure 2–16 - Hand-Throw Bevel Pinions for M-23A and M-23B Switch Machines

2.7 Motor

Two 20-volt and three 110-volt DC motors are available. The 20-VDC motors are used on switch machines having a gear ratios of 360:1 and 528:1. The 110 VDC motor is used on switch machines having a gear ratios of 189:1 and 360:1.

For low voltage motors, under the most adverse conditions of load, temperature, and battery voltage, the. Voltage at the battery terminals should not be less than 20 volts. High voltage DC motors should have not less than 85 volts at the motor terminals. The voltage at the motor terminals should be measured with the clutch slipping. Refer to Section 5.5.4.3 for information on the adjustment to slip the clutch.

2.7.1 Overload Protection

The standard plug-in type relay for the overload protection of DC switch machines is the Style PN-150SO relay.

This relay is used in conjunction with the style PN-150BM switch control relay and the style PP-151 magnetic stick relay for overload and short circuit protection.

Where shelf mounting relays are used, overload protection may be obtained for the DC machines by use of the OR-11 overload relay, and the PN-150SO and PN-152SO relays for switch control.

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 name plate. The thermal resistors of these relays are selected to give proper operation for the value of current at which the clutch slips with overload.

2.8 Heaters

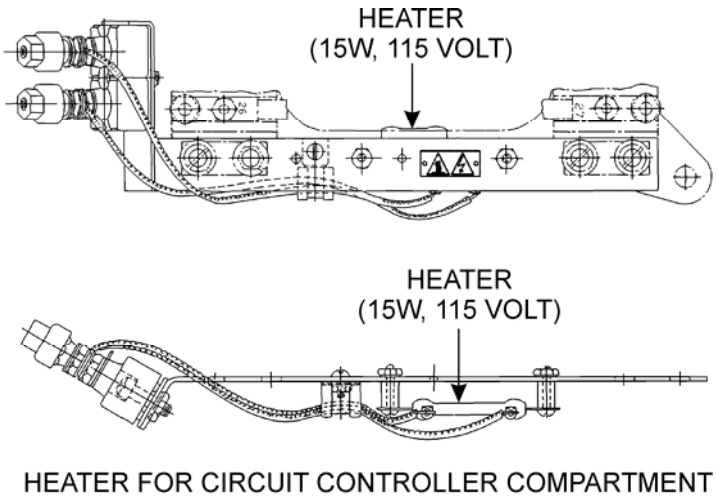
Heaters are available for application in the circuit controller compartment and in the motor compartment.

Optional 15-watt heaters are used in both compartments. They are available for energization by 110 volts, 230 volts, or 24 volts AC or DC. A dual element heater that can be energized by either 110 volts or 230 volts is also available.

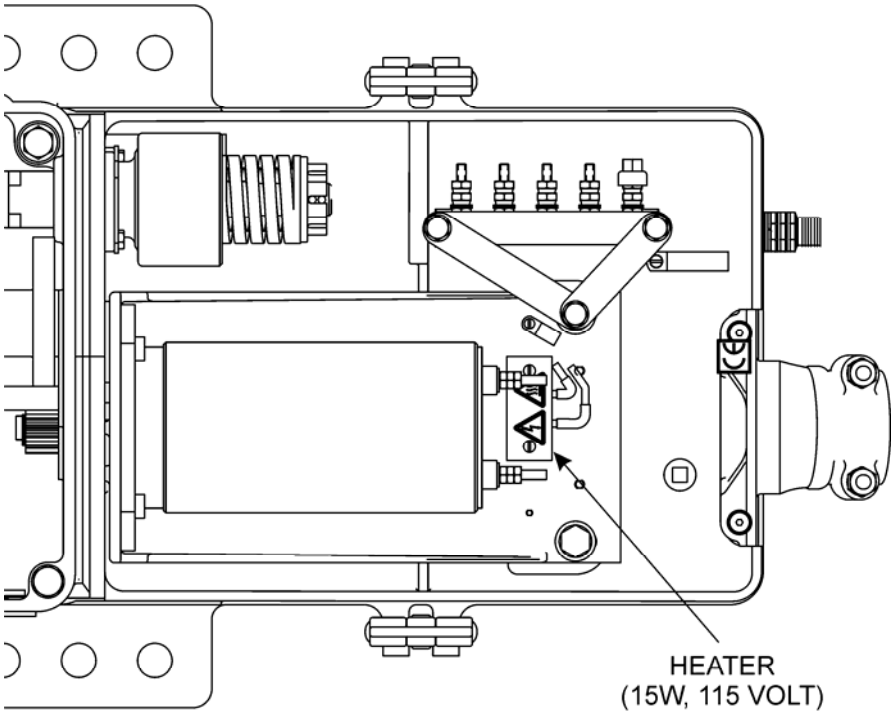
The heater for the controller compartment mounts at the end of the controller opposite the wire inlet as shown in Figure 2–17. It is held in place by the same four screws that fasten, the controller terminal board at that end.

No additional holes are required and terminal space is available on the terminal board. Refer to Figure 3–5A, Figure 3–6A, Figure 3–7A, and Figure 3–8A for wiring arrangements.

The heater for the motor compartment is mounted on the motor assembly cradle as shown in Figure 2–17.



HEATER FOR CIRCUIT CONTROLLER COMPARTMENT



HEATER FOR MOTOR COMPARTMENT

Figure 2–17 - Heaters for Circuit Controller and Motor Compartments

3 Installation and Adjustments

3.1 General Information

In general, the application of the M-3, M-23A, and M-23B switch machines is as shown in Figure 3–1 and Figure 3–2, but detail 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 in the order, but can be changed from right-hand to left-hand or vice versa in the field. Conversion of the M-3 is very simple and no detail instructions are required. Detail instructions for changing the M-23A and M-23B dual-control machines are given in Sections 5.4.10 and 5.5.1.1. After the machine has been properly assembled for the layout, check the following:

1. Two 3/8” pipe plugs are enclosed in a bag tied in the motor compartment. They are for application to two drain holes located in the cover under the crank case compartment (Item 545, Figure 7–1 and Figure 7–2) when the machine is in a location where blowing sand or dust is troublesome, but should not be applied unless this condition prevails – and, if used, should be removed at intervals to drain the compartment, especially prior to freezing weather.
2. Two other drain plugs are located in the base of the switch machine at the bottom of the circuit controller compartment. They are plugged with slotted head bolts with lock washers (Items 45 and 415, Figure 7–1 and Figure 7–2). They are shipped in place, but not fully tightened. Like the pipe plugs, they should be left applied only at locations where blowing sand or dust is troublesome.

3.2 Mounting

Mount and secure switch machine on ties according to the layout plans applying to the particular location. Adjust height of the lever stand so that selector and hand-throw levers on M-23A and M-23B machines are held in a horizontal position parallel with the top of the gearbox.

3.3 Front rod Assembly and Adjustment

1. Assemble switch point lugs, insulation, and point detector connecting rod lug to the switch points per details shown in the layout drawing.
2. Refer to the layout drawing for the correct installation of the Front Rod Assembly and for the switch point gap dimension.
3. If necessary, to obtain the correct switch point gap, loosen the nuts at the serrated end of the Front Rod assembly obtain the desired point opening and re-tighten the nuts. It may also be necessary to loosen the serrated side of the No. 1 switch rod.

3.4 Switch Adjuster Installation (Basket)

1. Remove the mending plate, insulation, and bushings from the No. 1 Switch Rod.
2. Attach the Switch Adjustor Basket to the two halves of the No. 1 Switch Rod using the insulation, bushings, and hardware provided with the Switch Adjustor Basket.

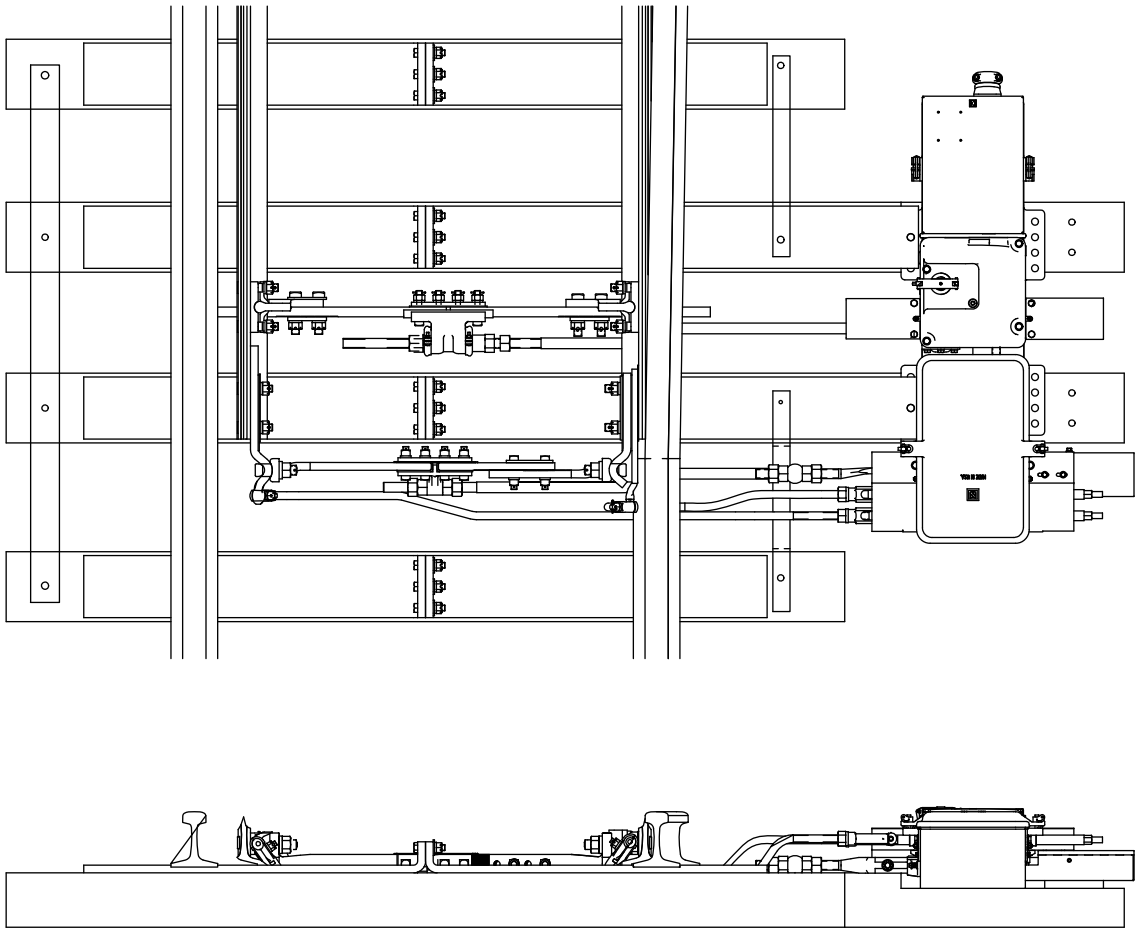


Figure 3–1 - Typical Application of the M-3 Switch Machine

3.5 Switch Rod Installation and Adjustment

Connect the switch-operating rod and adjust the rod nuts at the switch basket to obtain the proper pressure at the switch points. Nothing is gained by excessive pressure.

3.6 Point Detector Bar and Lock Rod Installation and Adjustment

3.6.1 For M3 Switch Machines

1. Remove the protective plugs from the switch machine point detector bushings.
2. Remove the plates that cover the lock rod openings and confirm that the snow cover is assembled to the track side of the switch machine.
3. Remove the circuit controller cover and hand crank machine to mid-stroke and install the point detector bars such that the connection end of the bars are closest to the near stock rail.

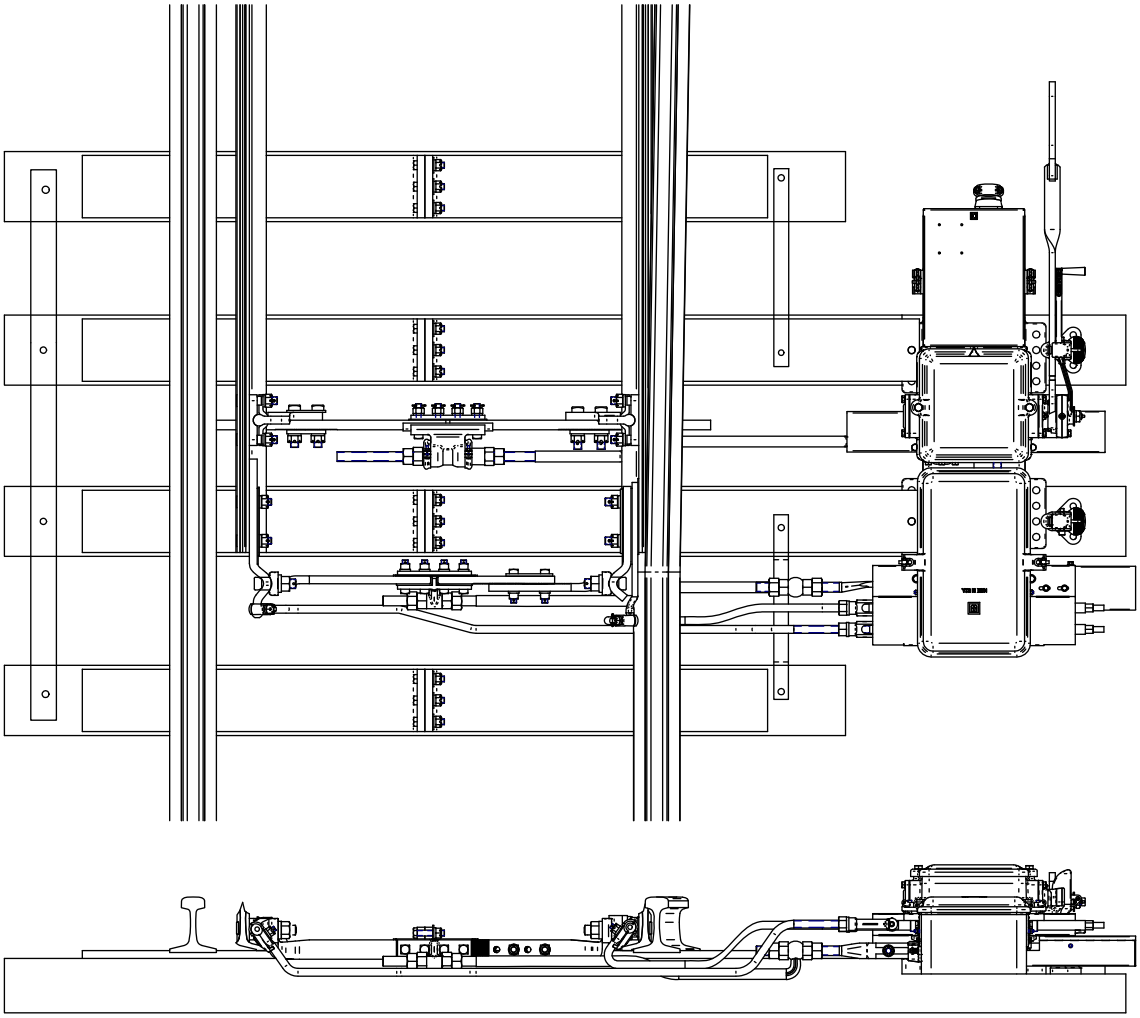
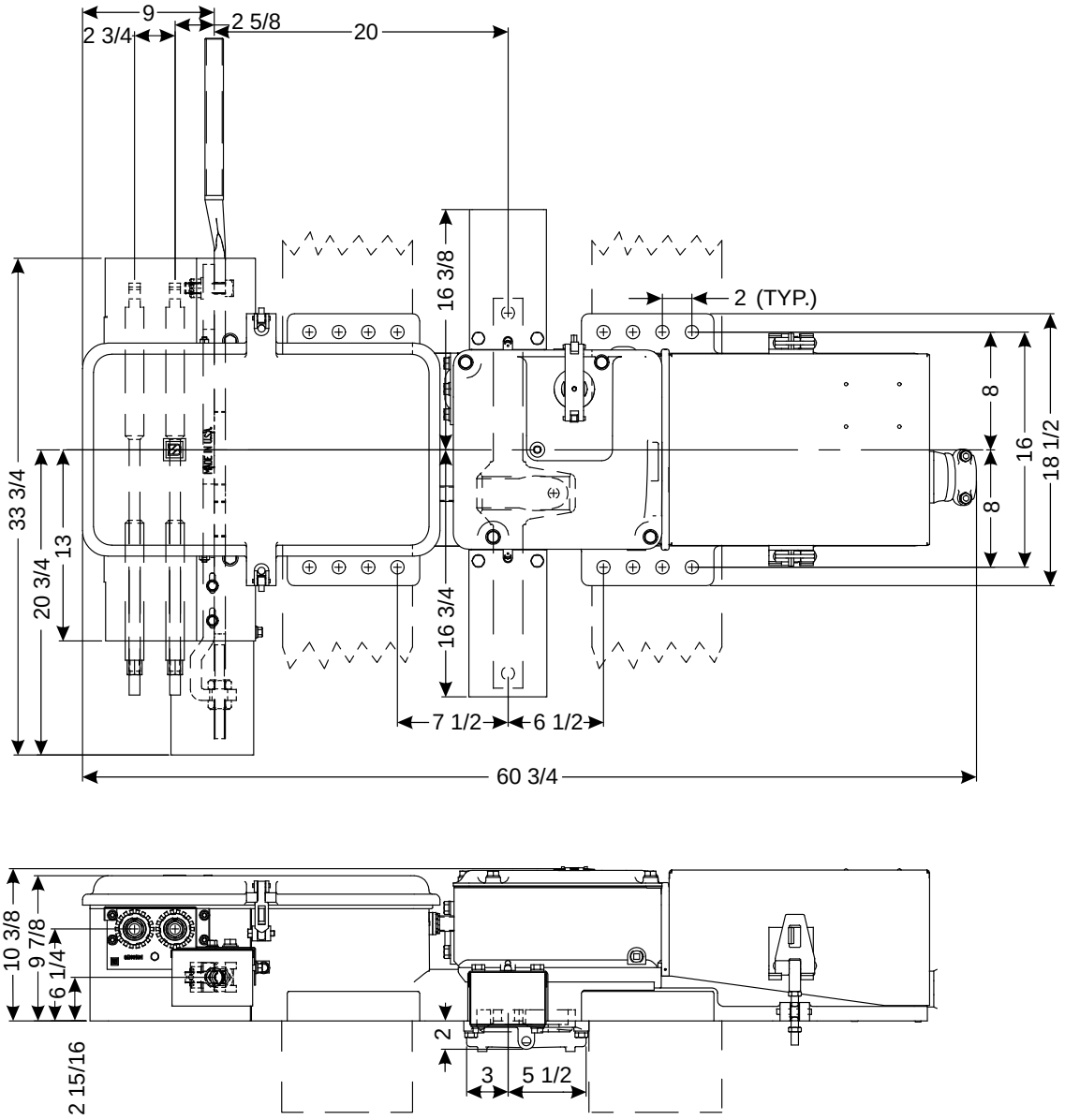


Figure 3–2 - Typical Application of the M-23A, M-23B Switch Machine

4. With the switch machine still in the mid-stroke position, install the internal lock rod assembly such that the lock box dog enters the narrow lock rod notch first. The upper narrow notch can be seen directly. Index marks are provided on the top surface opposite the notched ends for the lower notch. 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.
5. Refer to the layout drawing for installation details. Depending upon the design of the internal lock rod assembly there may be the need to remove clamping hardware prior to installation to the switch machine.
6. Install the Point Detector Connecting Rods, one to each switch point lug and install the opposite end to the internal point detector bars of the switch machine.
7. Install the internal lock rod assembly such that the lock box dog enters the narrow lock rod notch first. The upper narrow notch can be seen directly. Index marks are provided on the top

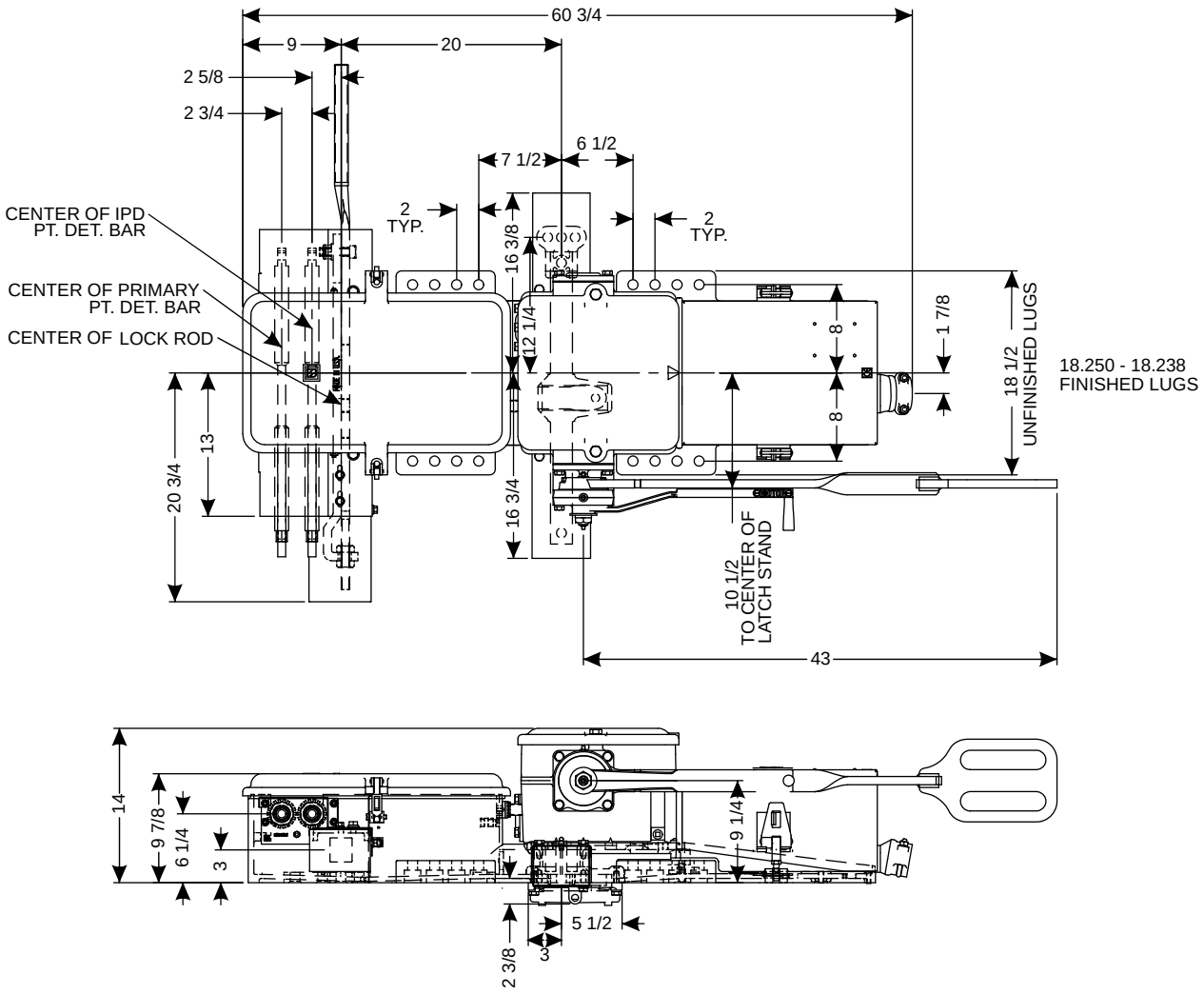
surface opposite the notched ends for the lower notch. Preliminary adjustment should be made by setting the nuts so that the narrow notches are approximately centered on the locking dogs at each end of the stroke.

8. Install the Lock Rod Connecting Rod to the lug of the Front Rod Assembly such that the front rod lug is approximately centered about the threads at the end of the lock rod assembly. Hand tighten the lock rod connecting rod nuts.



NOTE: ALL DIMENSIONS ARE IN INCHES.

Figure 3–3 - Typical M-3 Mounting Plan



NOTE: ALL DIMENSIONS ARE IN INCHES.

Figure 3–4 - Typical M-23A, M-23B Mounting Plan

3.6.2 For M23A and M23B Switch Machines

1. Remove the plates the cover the lock rod openings and confirm that the snow cover is on the track side of the switch machine.
2. Confirm that all electrical power to the switch machine has been disconnected. Remove the circuit controller cover.
3. Place the motor/hand selector lever into the motor position.
4. Insert a 1/2” drive ratchet into the square notch in the friction clutch nut and turn the nut until the switch machine reaches the mid-stroke position.

5. Install the point detector bars such that the connection ends of the bars are closest to the near stock rail.
6. Install the internal lock rod assembly such that the lock box dog enters the narrow lock rod notch first. The upper narrow notch can be seen directly. Index marks are provided on the top surface opposite the notched ends for the lower notch. 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.
7. Refer to the layout drawing for installation details. Depending upon the design of the internal lock rod assembly there may be the need to remove clamping hardware prior to installation to the switch machine.
8. Install the Point Detector Connecting Rods, one to each switch point lug and install the opposite end to the internal point detector bars of the switch machine.
9. Install the Lock Rod Connecting Rod to the lug of the Front Rod Assembly such that the front rod lug is approximately centered about the threads at the end of the lock rod assembly. Hand tighten the lock rod connecting rod nuts.

3.7 Lock Rod Installation and Adjustment

With the covers removed and machine at mid-stroke, apply the lock rods. Be sure that the flat plate snow cover is assembled on the track side (where applicable) when applying the lock rods, and be sure the rods are so assembled 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, in this case refer to instructions in Section 3.16.1. 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 in accordance with AREMA Signal Section on railroad instructions. Check all fasteners to ensure they are tight.

3.8 Point Detector Bar Installation and Adjustment

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

Note

The switch-operating rod, point detector rod, and lock rods should be kept in adjustment to meet AREMA Signal Section or railroad specifications. Refer to Section 5.7.1 for using a gauge to check the point detector between periodic obstruction tests.

Check that indication cam N on the left side of machine center line, as viewed from controller end (see Figure 2–5), has its notch up when machine is in the Normal position, and that indication cam P on the right side has its notch up when machine is in the reverse position. If it is found that these cams are not in agreement with the foregoing, shift them in accordance with instructions in Section 3.16.2.

3.9 Lever Stand Adjustment

(For M-23A and M-23B machines only.) Make final check of adjustment of lever stands to assure that their adjustment permits transfer from power to hand operation under all conditions, as follows:

a. Remove gearbox cover so that the action of the selector clutch, Figure 2–14, and its relation to the hand-throw pinion can be observed as the selector lever is operated from MOTOR to HAND position.

b. With the hand-throw lever in Normal position, operate the machine by power to the Reverse position, then to the Normal position. Operate the selector lever to the HAND position. Check that the selector clutch shifts up, engaging the tooth on the bottom of the hand-throw pinion, and check that the hand-throw lever will operate the machine. If the selector clutch fails to shift up full-stroke, readjust the height of the Normal hand-throw lever stand to bring the clutch teeth into proper alignment.

c. (Procedure of paragraph ‘a’ repeated for opposite end of stroke.) With the hand-throw lever in the Reverse position, operate the machine by power to the Normal position, then to the Reverse position; operate the selector lever to HAND position. Check that selector clutch shifts up engaging the tooth on the bottom of the hand-throw pinion, and check that hand-throw lever will operate the machine. If the selector clutch fails to shift up full-stroke, readjust the height of the Reverse hand-throw lever stand to bring clutch teeth into proper alignment.

d. With hand-throw lever in Normal position, operate the machine by power to the Reverse position. Operate selector lever to the HAND position. The selector clutch should ride against, but not engage, the hand-throw pinion tooth. The selector clutch spring should be compressed, taking up clearance between the upper and lower spring cups. Now operate the hand-throw lever toward the Reverse position. The selector clutch should snap up into engagement with the hand-throw pinion just before the hand-throw lever is fully down in the Reverse lever stand. Check that the hand-throw lever will now operate the machine.

e. (Procedure of paragraph ‘d’ repeated for opposite end of stroke.) With the hand-throw lever in the Reverse position, operate the machine by power to the Reverse position. Operate the selector lever to HAND position. The selector clutch should ride against but not engage 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 is fully down in the Normal lever stand. Check that the hand-throw lever will now operate the machine.

3.10 Obstruction Test

After the point detector bar is installed and adjusted, the points should be subjected to an obstruction test as follows:

1. Run the switch machine to its mid-stroke position.

2. Place a 1/8” (3.2mm) thick end of an obstruction approximately 6” (152mm) back from the tip between the open switch point on the near point.
3. Run the switch machine to close that switch point. The switch machine should provide indication of a closed switch point. The internal lock rod assembly may or may not allow the switch machine to complete its stroke. If interference between the lock rod assembly and the lock box occurs, manually restore the circuit controller to normal operation by removing the circuit controller compartment cover and lifting up on the latch lever in the center of the circuit controller. If indication is not obtained, re-adjust the point detector bar (Section 3.6) and repeat Steps 2 and 3.
4. Place a 1/4” (6.35mm) thick end of an obstruction approximately 6” (152mm) back from the tip between the same open switch point.
5. Run the switch machine to close that switch point. The switch machine will not provide indication of a closed switch point. The internal lock rod assembly will not allow the switch machine to complete its stroke and will latch out the circuit controller. Check and readjust the lock box and the lock rod assembly. (Refer to Section 3.7.)
6. Run the switch machine to its mid-stroke position and place the 3/8” (9.5mm) thick end of an obstruction between the same open switch point.
7. As the gage prevents the switch point from closing against the stock rail the friction clutch in the gear box will slip. The circuit controller in this situation will not send indication of a completed move. The clutch slippage will cause an increase in motor current signaling an overload relay to activate which removes power from the switch machine.
8. Tighten the far point hardware and repeat Steps 1 through 7 for the opposite switch point.

3.11 Final Assembly Inspection

After the switch machine has been installed, adjusted, and inspected, perform a final inspection before putting the switch machine in service.

1. Confirm that all hardware is tight and that all wire connections are secure.
2. Verify that the switch machine gear box is filled with lubricant as recommended in and that initial lubrication of the switch machine has been completed (Section 3.13).
3. Ensure all covers are in place and secure.
4. Check to ensure that the switch points are clear and free from any debris.

3.12 Electric Connections and Control Wiring

In accordance with all applicable railroad safety and operating standards, connect the external wiring to the terminal board in accordance with the wiring diagram for the particular location.

Internal wiring for standard DC low and high voltage switch machines is shown in Figure 3–5A, Figure 3–6A, Figure 3–7A, and Figure 3–8A.

Figure 3–5A and Figure 3–7A are arranged for five wire control intended primarily for permanent magnet motor replacement on existing installations. Figure 3–6A and Figure 3–8A are arranged for three wire control intended primarily for new installations.

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 3–5 through Figure 3–8 are typical circuits for the control of switch machines using the standard PN-150S0, the PN-150BM and the PP-151 Plug-in relays. These typical circuits show wiring of the relays which 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-150BM relay. This is the equivalent of the shelf type DP-25 or the earlier style plug-in type PNP-69. The PP-151 is a magnetic stick relay used for reversing the polarity of the switch motor and keeping the operating winding and stick winding of the overload relay in agreement. The PN-150BM is a biased relay with magnetic heavy duty contacts 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.

Figure 3–5B, Figure 3–6B, Figure 3–7B, and Figure 3–8B are typical switch control circuits using the PP-151 and PN-150BM relay combinations.

Figure 3–5C, Figure 3–6C, Figure 3–7C, and Figure 3–8C are typical switch control circuits using two PN-150BM relays in place of the above combinations.

The DP-25, PNP-69 and PN-150BM relays are capable of breaking stalled switch motor current in excess of 50 amps at 110 volts 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 SM 2378N.

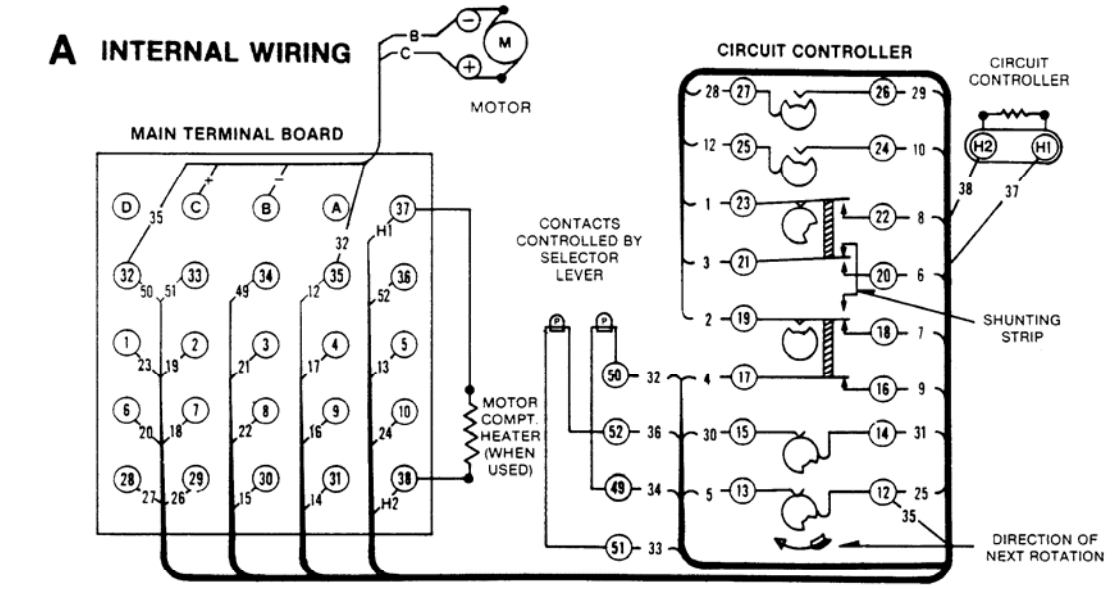
The typical circuits shown are intended to illustrate principles and should not be used as working drawings. Pole changing contacts and other circuits not shown for control of the WR relay should be in accordance with the circuits designed for the specific installation.

For converting from five- to three-wire control (or vice-versa) refer to Section 3.16.4. If the layout calls for a left-hand point normally closed, interchange leads as called for in the note on Figure 3–5, Figure 3–6, Figure 3–7, and Figure 3–8. The circuit controller cams for the indication contacts should also be reversed as outlined in Section 3.16.2.

An internal wiring diagram is enclosed with each switch machine when shipped. Consult US&S for specific field wiring applications.

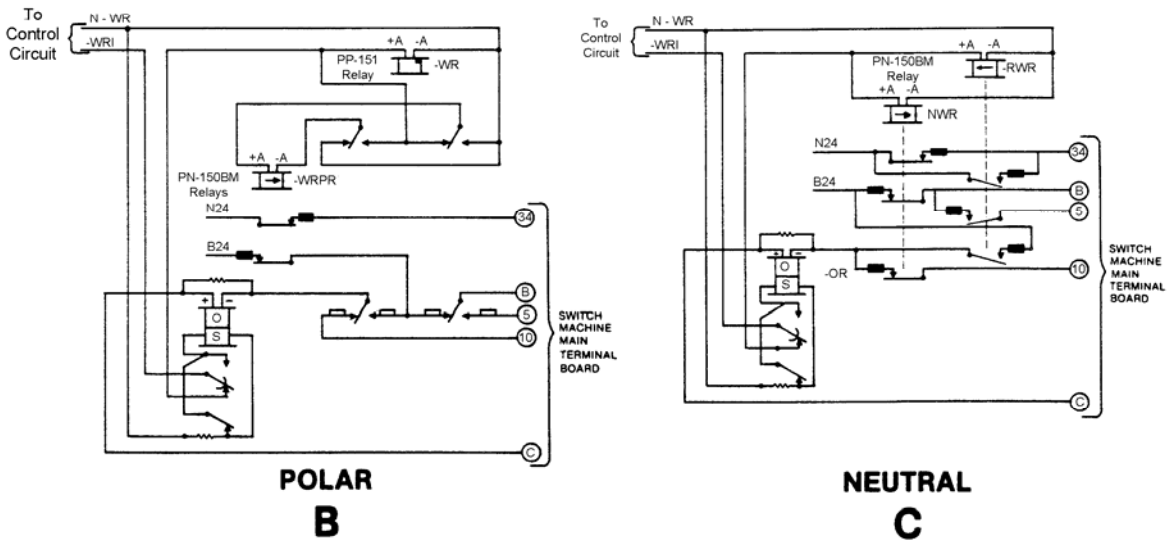
If the latch (see Section 2.4) is arranged to be “self-restoring,” the control and indication circuits should be examined before installing the switch machines to make sure that the circuits will not prevent the machine from operating to restore the latch automatically after a latch-out occurs.

All machines have two leads from the main terminal board to the circuit controller compartment to accommodate the application of a circuit controller heater in the field if the machine is not already so equipped (see Section 2.8).



NOTE: NUMBER IN CIRCLE REPRESENTS NUMBER OF TERMINAL. NUMBER NOT IN CIRCLE SHOWS NUMBER OF TERMINAL TO WHICH OTHER END OF WIRE IS CONNECTED.

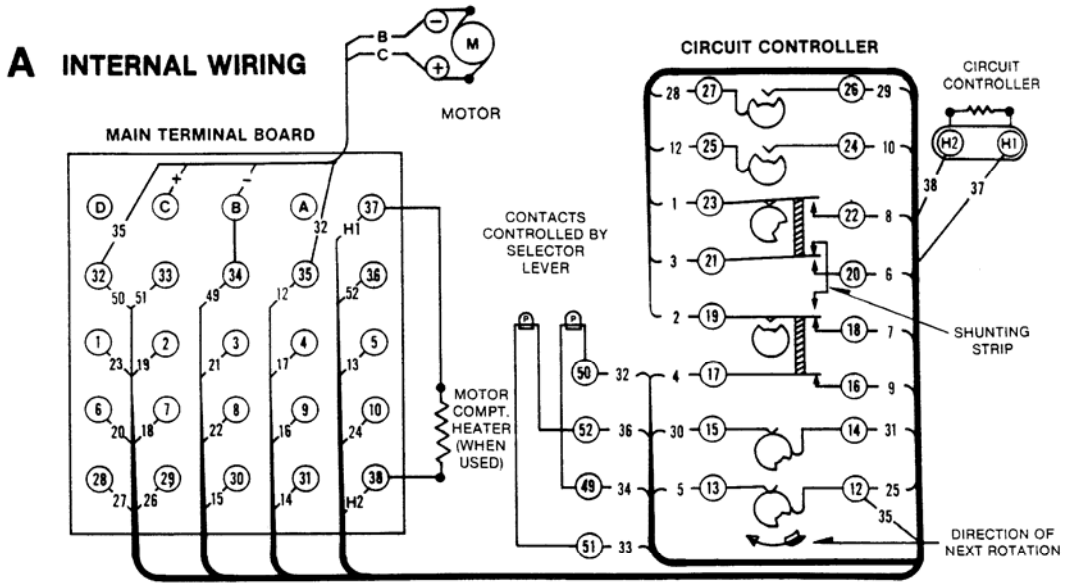
CONTROL WIRING



NOTE: EXTERNAL CONNECTIONS ARE SHOWN TO THE MAIN TERMINAL BOARD FOR A SWITCH HAVING THE RIGHT-HAND POINT NORMALLY CLOSED.

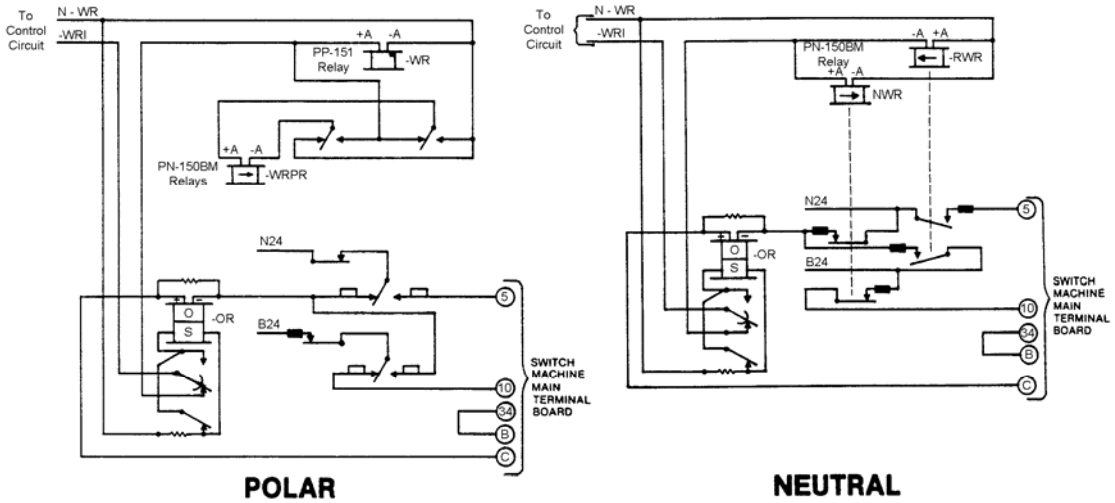
FOR A SWITCH HAVING THE LEFT-HAND POINT NORMALLY CLOSED, INTERCHANGE THE EXTERNAL LEADS TO TERMINALS (B) AND (C) AND TO TERMINALS (5) AND (10) ON THE MAIN TERMINAL BOARD.

Figure 3–5 - M-3/M-23 Low Voltage DC Machines, 5-Wire Control



NOTE: NUMBER IN CIRCLE REPRESENTS NUMBER OF TERMINAL. NUMBER NOT IN CIRCLE SHOWS NUMBER OF TERMINAL TO WHICH OTHER END OF WIRE IS CONNECTED.

CONTROL WIRING



POLAR
B

NEUTRAL
C

NOTE: EXTERNAL CONNECTIONS ARE SHOWN TO THE MAIN TERMINAL BOARD FOR A SWITCH HAVING THE RIGHT-HAND POINT NORMALLY CLOSED.

FOR A SWITCH HAVING THE LEFT-HAND POINT NORMALLY CLOSED, INTERCHANGE THE EXTERNAL LEADS TO TERMINALS (5) AND (10) AND TO TERMINALS (B) AND (C) ON THE MAIN TERMINAL BOARD.

Figure 3–6 - M-3/M-23 Low Voltage DC Machines, 3-Wire Control

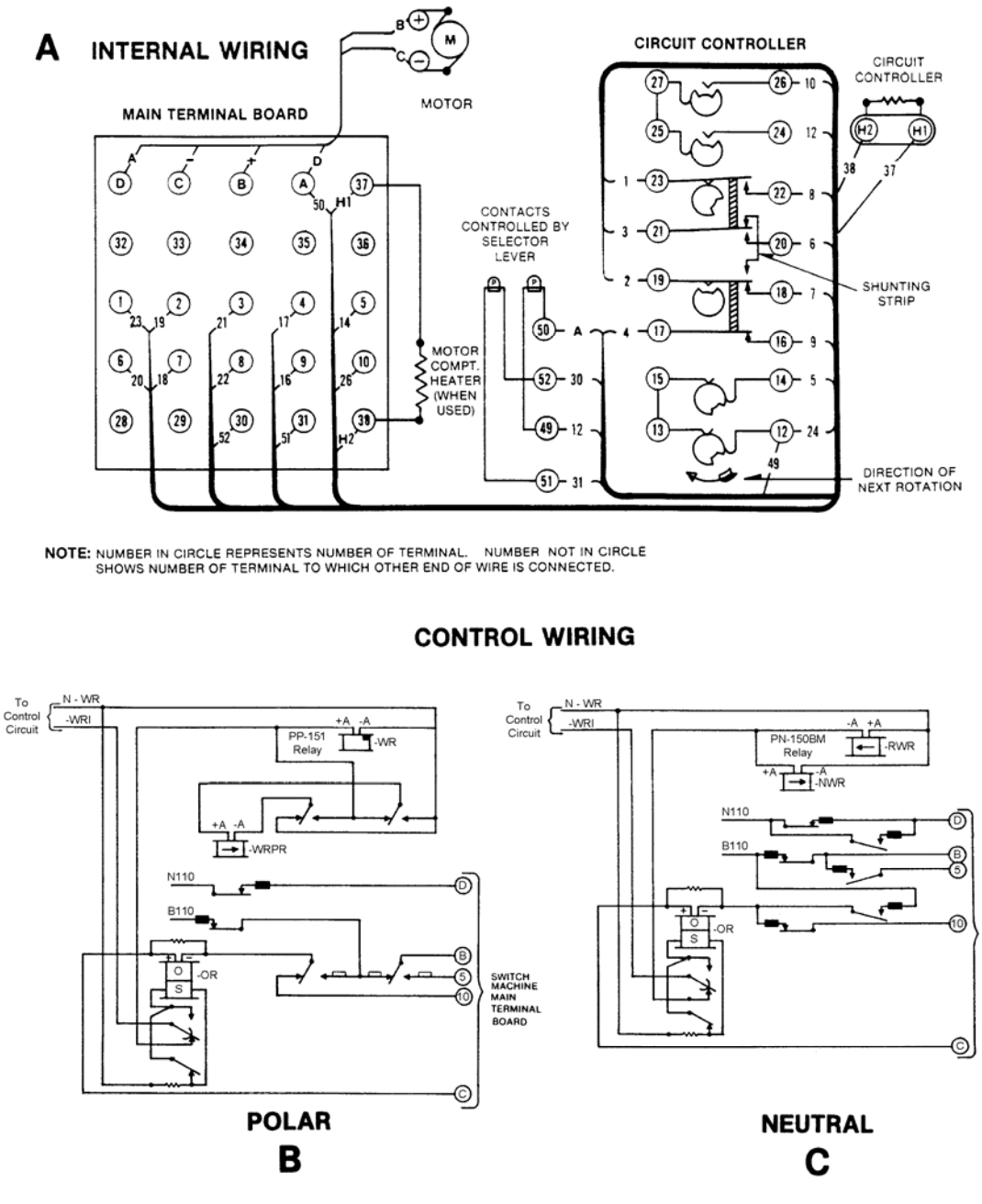
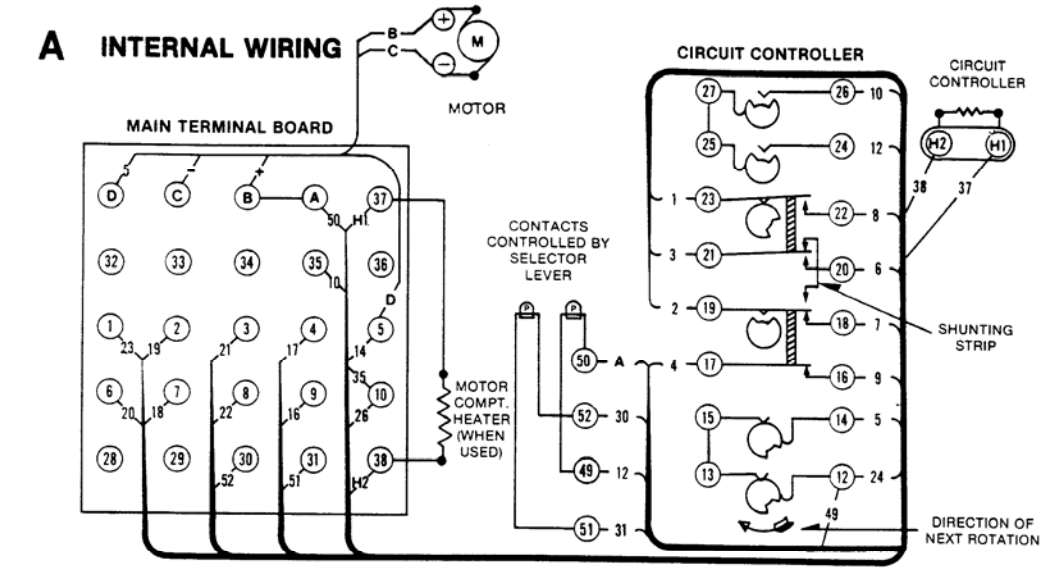
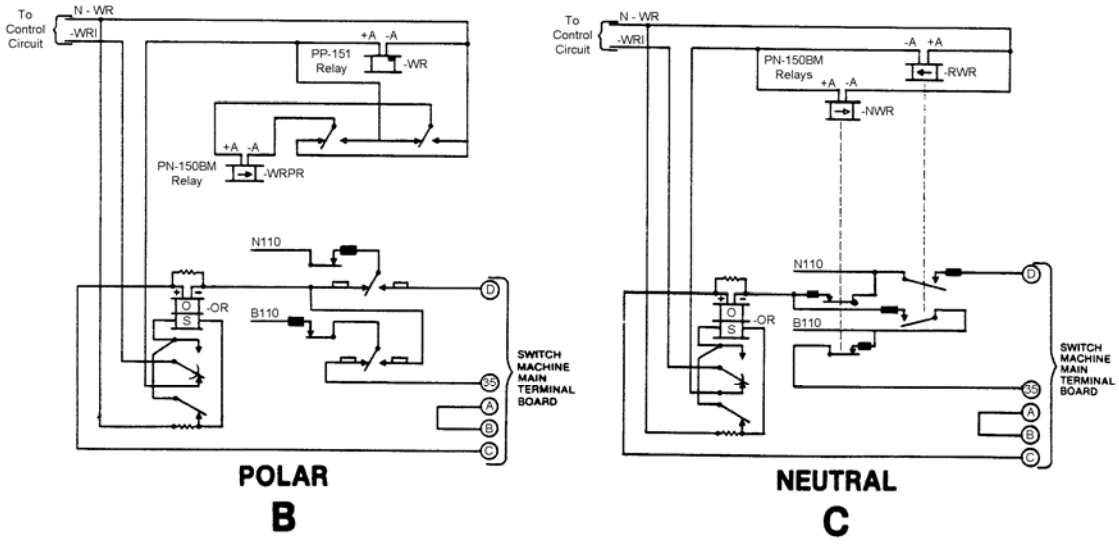


Figure 3–7 - M-3/M-23 High Voltage DC Machines, 5-Wire Control



NOTE: NUMBER IN CIRCLE REPRESENTS NUMBER OF TERMINAL. NUMBER NOT IN CIRCLE SHOWS NUMBER OF TERMINAL TO WHICH OTHER END OF WIRE IS CONNECTED.

CONTROL WIRING



NOTE: EXTERNAL CONNECTIONS ARE SHOWN TO THE MAIN TERMINAL BOARD FOR A SWITCH HAVING THE RIGHT-HAND POINT NORMALLY CLOSED.

FOR A SWITCH HAVING THE LEFT-HAND POINT NORMALLY CLOSED, INTERCHANGE THE EXTERNAL LEADS TO TERMINALS (35) AND (D) AND TO TERMINALS (B) AND (C) ON THE MAIN TERMINAL BOARD.

Figure 3–8 - M-3/M-23 High Voltage DC Machines, 3-Wire Control

3.13 Initial Lubrication

From the one-gallon container of lubricant (Lubriplate 5555) shipped with the machine, apply a light coat of lubricant to the teeth of the spur gear only. Put the remainder of the lubricant into the worm gear compartment to a level no higher than the top of the worm gear. See lubrication chart in Figure 5–3 and Figure 5–4. All other working parts of the machine have been sufficiently lubricated at the factory and do not require additional lubrication at this point.

Note

When applying lubricant, it is not necessary to remove the oil slushing compound with which parts are factory coated to provide protection against corrosion during shipment and storage.

The pins holding the lock rod control rod, point detector, control rod, and operating rod should also be lubricated at this time.

3.14 Lever Position and Interlock

In general, the position of the selector and hand-throw levers will be as shown in Figure 3–9, and the interlock will ordinarily permit the selector lever to be returned to its MOTOR position when the hand-throw lever is in either the Normal or Reverse position. However, certain deviations from these usual standards are feasible. The various arrangements are as follows:

a. Both levers must always be on the field side of the machine, that is, on the left side for L.H. machine for L.H. layout and on the right side for R.H. machine for R.H. layout. To change from R.H. to L.H., or vice versa, see Section 5.5.1.1.

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.

c. For the standard arrangement, the selector lever will be assembled to be toward the motor end of the machine when the lever is in its MOTOR position as in Figure 3–9. When desired, however, the lever can readily be assembled to be toward the circuit controller end of the machine for MOTOR position and the interlock arranged to suit, as described in Section 5.5.1.1. 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 a selector lever can be returned to MOTOR position. Machines will be shipped with option (1) assembly unless order specifies that hand-throw lever must be Normal only.

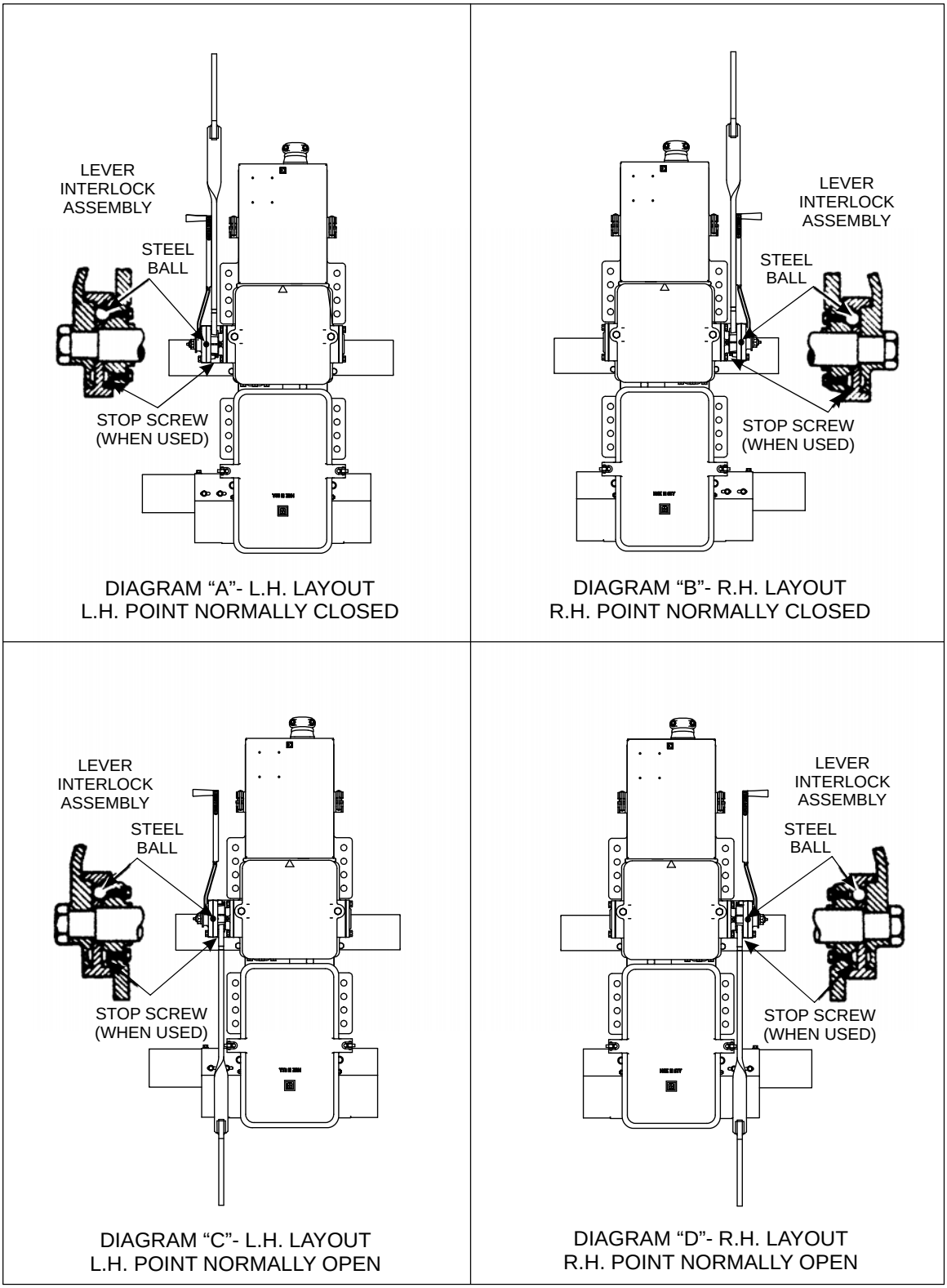


Figure 3–9 - Standard Lever Interlock Assemblies for Style M-23A or M-23B Switch Machines

3.15 Prior To Placing Machine In Operation

a. Check lids for proper fit. Adjust if necessary.

b. Check motor cutout to be certain it is operating properly. Be sure that the crank cannot be inserted without the cutout contacts being latched out. Adjust if necessary per Section 5.7.2.

c. Check wiring for proper connections, etc.

d. Check the clutch adjustment.

With an obstruction of at least 3/8" between the switch point and the stock rail, electrically operate the machine. When the switch point jams against the obstruction, the worm gear and worm shaft will be stopped but the motor should continue to run during the overload time delay period, slipping the friction clutch. Motor current during this period should be within 10% of the values specified in Table 1-1. If necessary, readjust the friction clutch spring to obtain the specified clutch slip current (refer to Section 5.5.4.3).

Note

If the friction clutch slips too easily, the motor current may not operate the overload relay and battery exhaustion might follow. 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 might slip slightly at both ends of the power stroke.

3.16 Supplemental Information

This section provides additional specific information on the following:

a. Changes that may be necessary in the assembly at the time of installation, if the switch machine (as ordered) does not suit conditions at the location.

b. Inverting lock box to agree with lock rod notching.

c. Shifting indication cams to have contacts at left indicate Normal.

d. Converting from high-voltage to low-voltage (or vice versa).

3.16.1 How to Invert Lock Box

As explained in Section 2.1, lock box dogs must enter the 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 necessary to invert the lock box, remove the lock rods and proceed as follows (see Figure 2–5):

Place the machine in the end-stroke position, which brings Lock Box G nearest the motor. Note which one of the Indication Cams, N or P, has its notch up, and that this notch is centered about Roller D. Unscrew Bolts T, which hold the circuit controller to the case. Swing the controller upward, pivoting it about the edge of the case adjacent the wire conduit. Turn Lock Box G upside-down, taking care that it

is replaced properly on the driving studs of the slide bar. Replace circuit controller, checking that Pinion Gear F (Figure 2–6) meshes with the rack teeth on the lock box in such manner as to place the indication cam with its notch up and centered about Roller D the same as it was before the circuit controller was removed. Fasten the circuit controller in place with Bolts T.

3.16.2 How to Shift Indication Cams

> **⚠ WARNING**
>
> Disconnect motor and indication power before shifting the indication cams, otherwise electrical shock or personal injury may result.

Indication cams N and P, Figure 2–5, are arranged so that either cam can have its notch up when the slide bar is at either end of its stroke. This permits standardized wiring by always having the indication contacts on the left side of the circuit controller indicate Normal, regardless of which end of the slide bar and lock box stroke is designated Normal.

Each cam is driven by a stud in the side of the gear 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 an 8-32 Allen Head 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, loosen the 8-32 Allen Head Set Screw (adjacent to slots), then carefully (to avoid distortion of contact springs) insert two screw drivers between the cam and the gear. Force the cam away from the gear against the force of its coil spring, and then rotate the cam to the alternate position until it snaps in place (see Figure 2–7). Tighten set screws in place.

Repeat this process for the other cam. (The two cams must be shifted individually).

3.16.3 Converting from High—Voltage to Low-Voltage (or Vice Versa)

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

The high voltage motor may be replaced by the low voltage motor (or vice versa) by making the required wiring changes. Figure 3–5 and Figure 3–6 show low voltage wiring and Figure 3–7 and Figure 3–8 show high voltage wiring.

3.16.4 Converting from Five- to Three-Wire Control (or Vice Versa)

Conversion of switch machine from five- to three-wire (or vice versa) may be performed in the field by rearranging jumper lead connections on the terminal board. Additional leads necessary for the conversion are supplied with all switch machines in a bag attached to the terminal board. Before any conversion is performed, one must identify what type of control he presently has. High voltage three-wire may be identified by the presence of a jumper from terminals A to B, or A to C. Low voltage three-wire may be identified by a jumper from terminal 34 to C or 34 to B. Five-wire control may be

identified by the absence of the aforementioned jumper connections. See Figure 3–5A to Figure 3–8A for the location of these jumpers. Perform one of the following sequences to accomplish the conversion:

a. Five- to Three-Wire Control, 110 VDC
   1. Remove lead D from A
   2. Add lead D to 5
   3. Add lead 10 to 35
   4. For left hand operation, add lead A to C For right hand operation, add lead A to B

b. Three- to Five-Wire Control, 110 VDC
   1. For left hand operation, remove lead A to C For right hand operation, remove lead A from B
   2. Remove lead 10 from 35
   3. Remove lead D from 5
   4. Add lead D to A

c. Five- to Three-Wire Control, 20 VDC
   1. For left hand operation, add lead C to 34
   2. For right hand operation, add lead B to 34

d. Three- to Five-Wire Control, 20 VDC
   1. For left hand operation, remove lead C from 34
   2. For right hand operation, remove lead B from 34

Note

Control wiring logic must be in correspondence with Figure 3–5 to Figure 3–8.

4 Field Maintenance

⚠ WARNING

Disable the motor control circuit before any work is performed on the switch machine, otherwise electrical shock or physical injury may result.

Note

The field maintenance procedures covered in the following paragraphs are those recommended by US&S. The field maintenance policy of the customer will depend on actual operating experience and capability.

4.1 Preventive Maintenance

The following preventive maintenance procedures are intended to detect possible causes of switch machine failure before an actual failure occurs. Detection of such possible failures is accomplished by a scheduled maintenance process, whereby the switch machine is inspected, cleaned, lubricated, and performance-tested in the field on a periodic basis. The preventive maintenance procedures outlined herein ensure that all switch machine functions are operational.

A recommended schedule for performing preventive maintenance tasks is shown in Table 4-1. The actual time interval will depend on the customers own operating rules and/or experience.

4.1.1 Inspection

Inspection is conducted in two areas: the switch layout area and the switch machine itself. Inspection consists of observing the appearance and integrity of the switch points, switch rods, connecting rods, possible switch obstructions, electrical connections, and the interior of the switch machine. A judgment is then made as to whether a potential or obvious faulty condition exists. When any faulty condition is observed, it is to be corrected immediately.

4.1.2 Switch Layout Inspection

Perform switch layout inspection as follows:

a. Check that ties are well tamped to withstand vibration and strain caused by passing trains.

b. Check that tie plates, tie straps, rail braces, and switch fittings are secure.

c. Check that there are no signs of water accumulation around switch machine (proper drainage exists).

d. Remove any material within layout that could obstruct switch movement.

Table 4-1 - Preventive Maintenance Schedule

Interval	Functional Circuit or Equipment	Maintenance Action			
		Route Insp.	Clean	Lube	Perf.Test
Monthly	Switch Layout	X			
Semi-annually	Switch Machine	X			
Semi-annually	Switch Machine (Circuit Controller Compartment)		X		
Semi-annually	Switch Machine			X	
Monthly	Switch Machine				X

4.1.3 Switch Machine Inspection

Perform switch machine inspection as follows:

a. Remove covers from switch machine circuit controller, gearbox, and motor compartments.

b. Using hand crank for M-3 or hand throw lever for M-23A or B, operate switch back and forth as often as necessary and check for:

   1. Proper and smooth operation of switch points without undue drag or spring and with points riding on all slide plates. Also check for switch point obstructions at this time.
   2. Loose or damaged electrical connections.
   3. Burned, frayed, or broken insulation.
   4. Proper movement of switch machine main crank, slide bar lock box, switch-operating bar, circuit controller shaft, and circuit-controller point-detector connecting rods.
   5. Excessive wear, lost motion, or accumulation of foreign or conductive material.
   6. Excessive or unusual vibration and noise.

c. Electrically operate switch machine and check for:

   1. Smooth movement of switch machine motor and gears; no binding etc., should be noticed.
   2. Conditions listed in step ‘b’, above.

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

e. During semi-annual inspections check for moisture in the compartments. If 3/8-inch pipe plugs are installed in two drain holes located in the crank case compartment, or slotted-head bolts with lock washers are installed in circuit controller compartment, remove plugs and allow whatever moisture is present to drain from compartment.

⚠ CAUTION

Where drain plugs are used, a moisture check should be made prior to anticipated freezing weather. A freeze-up of excessive moisture could result in improper switch machine operation.

f. Reinstall plugs in drain holes.

Note

These pipe plugs should have been installed initially only if the switch machine is in a location where blowing sand or dust is troublesome; otherwise, drain holes should be open. During cold weather, periodically check that the holes are open.

g. Check that motor control contacts, indication contacts, motor cutout contacts, and associated cams and linkages are clean and do not show excessive wear (Refer to Section 4.2).

h. Check that all switch machine parts are properly and adequately lubricated (Refer to Section 5.6).

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

j. Remove two screws securing access plate over motor commutator.

   1. Check that commutator is smooth and clean.
   2. Check that commutator brushes are free in their holders and are not excessively worn.

4.2 Cleaning

Extensive cleaning of the switch machine is not required. However, it is important that the circuit controller compartment be cleaned at the time of inspection to ensure proper electrical operation. Clean the circuit controller compartment as outlined in Sections 4.2.1 and 4.2.2.

4.2.1 Equipment/Materials Required

The following cleaning agents and materials are required to clean the circuit controller compartment:

a. Water-based degreaser

b. Lint-free cloths

4.2.2 Procedure

Clean the circuit controller compartment as follows:

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

b. Repeat step ‘a’ for motor control segments, indication cams, yoke, operating levers, and point detector connecting rods, crank, and crank springs.

c. Dry with a clean lint-free cloth.

Note

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

d. Lubricate cleaned areas per instructions provided in Section 5.6.

4.3 Lubrication

After the switch machine has been inspected and cleaned, it must be lubricated to ensure optimum operation. Refer to Section 5.6.

4.4 Switch Machine Performance Test

Conduct a performance test on the switch layout(s). The performance test should be done in accordance with customer’s operating rules. The test should include mechanical operation of the switch mainline, and electrical tests of power distribution and switch control and indication circuits. Erratic or faulty operation and/or indications should be promptly referred to the proper authority for corrective action.

4.5 Corrective Maintenance

The following paragraphs describe M-3, M-23A and M-23B Switch Machine field level maintenance procedures.

4.5.1 Adjustments

The M-3, M-23A and M-23B switch machine field level adjustment procedures are:

a. Friction clutch adjustment

b. Switch machine to switch adjustment

c. Motor control contacts adjustment

d. Indication contacts adjustment

e. Motor cutout contacts adjustment

4.5.1.1 Friction Clutch Adjustment

A switch machine’s friction clutch (Figure 5–1) must slip at just the right amount of torque. This torque must be more than adequate to carry the switch machine’s operational loading during the driving of the switch points. At the same time, to transmit this torque, the friction clutch should not be so tight as to prevent protection of the mechanism from shock.

To check the friction clutch adjustment, refer to Section 5.5.4.3.

⚠ CAUTION

Friction disks must be kept free of oil, otherwise motor may be damaged due to excessive clutch slippage. If contamination occurs, friction disks must be replaced.

NOTE

If clutch discs are oily and it is found that oil is entering along the shaft, it is recommended that the felt washer and oil seal be renewed in the clutch housing as described in Section 5.5.4.1.

4.5.1.2 Switch Machine to Switch Adjustments

If it is necessary to readjust the switch machine refer to Section 3, Installation and Adjustments, Sections 3.5, 3.6, 3.7, and 3.8.

4.5.1.3 Motor Control Contacts Adjustment

Refer to procedures provided in Section 5.5.5.1.

4.5.1.4 Indication Contacts Adjustment

Refer to procedures provided in Section 5.5.5.2.

4.5.1.5 Motor Cut-Out Contacts Adjustment

Refer to procedures provided in Section 5.7.2

4.6 Repair Procedures

Repair of the switch machine in the field consists of removing and replacing the motor brushes and major switch machine assemblies. It is not recommended that major overhaul or repair to the machine, requiring disassembly to the component part level, be done in the field. The switch machine should be removed from service and sent to the US&S service or repair shop for this level of repair.

To remove the switch machine from service, refer to Section 3, Installation, and reverse the procedure. To remove and replace the brushes and major assemblies, remove and replace:

a. Motor Brushes — Refer to Section 5.4.1 and 5.5.2.

b. DC Motor — Refer to Section 5.4.2 and 5.5.3.

c. Friction Clutch Assembly – Refer to Section 5.4.3 and 5.5.4.

d. Circuit Controller – Refer to Section 5.4.4 and 5.5.5.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5 Shop Maintenance

5.1 Special Tools

The following special tools are required to perform shop maintenance on the switch machine.

TOOLS – Maintenance tools for M-3, M-23A, and M-23B switch machines are listed below. Ordering reference for complete set of tools is X296406-001, Dwg. 012764-0001.

6” Screw driver, slotted
10” Screw driver, slotted
Pr. 6” Slip joint pliers
12 oz. Machinist hammer, ball peen
Insulated socket wrench, 1/2”
Adjustable Crescent wrench
10” Adjustable Crescent wrench
Set hex Sockets
Ratchet wrench, 1/2” drive
Extension bar, 1/2” drive, 10” long
Special pin wrench (for clutch housing packing gland)
Thin head flat wrench (1-5/32” opening)
Allen wrench – 3/16” Hex
Clutch assembly gauge, (hand/motor clutch)
Basket Wrench, 2-1/16” open-end (US&S M322680) or box wrench (US&S J49124401)

5.2 Cleaning

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

⚠ CAUTION

Electrical components, such as the motor, heaters, wiring harness, or circuit controller should never be immersed in the cleaning solution, otherwise damage to these parts will occur.

5.3 Inspection

After cleaning, carefully check case, cover, and other structural components for hairline cracks, breaks, weak points or any other signs of physical damage. During disassembly, carefully check each part for signs of damage. Replace any part found to be defective.

5.4 Disassembly

5.4.1 Removal of Motor Brushes

Refer to Figure 7–1 and Figure 7–2 for this procedure.

Note

When replacing motor brushes, both brushes should be replaced.

For "Blue" Motor Applications (Motors with brush band cover, Type A)

Remove the motor compartment cover (180). Loosen the brush/commutator cover and slide it out of the way to allow access to brushes. Loosen the brush terminal screw and remove the brush lead. Retract the brush spring and remove the brush. Repeat for the other brush.

For "Blue" Motor Applications (Motors with external brush covers, Type B):

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

5.4.2 Removal of Motor

Refer to Figure 7–1 and Figure 7–2 for this procedure.

Remove motor compartment cover (180). Tag and remove wires attached to connections at motor's end (closest to conduit outlet). Position wiring harness out of the way. Remove the 1/2" – 13 x 2-1/2" hex head cap screws (720) at the rear of motor's mounting bracket (commutator end). Remove the associated 1/2" plain and lock washers (415, 695). Remove the 3/8" screws (965) and lock washer (970). Remove the motor support stud (950). Lift the motor assembly (10) up and pull towards conduit outlet until pinion gear on motor shaft is clear of motor opening. If required, remove pinion from shaft and motor from bracket using Allen wrenches.

5.4.3 Removal of Friction Clutch Assembly

Refer to Figure 5–1 for this procedure.

Remove cotter key (11) from clutch adjusting nut (10). Remove clutch adjusting nut (10) from worm shaft. Remove clutch spring (9). Remove two cap screws (13) securing plate. Remove plate and gasket. Pull clutch housing/tubular neck (7) out of engagement with gear hub. Continue to pull until tubular neck is clear of opening in gearbox, exposing worm shaft.

5.4.4 Removal of Circuit Controller

Refer to Figure 7–1 for this procedure.

Remove circuit controller cover (160). Tag and remove wires attached to circuit controller terminals and heater. Position wiring harness out of way by removing the four wire clamps, screws, and lock washers. Remove the two screws and lock washers (20, 410, 740) attached to the feet of the circuit controller nearest the motor compartment. Remove the two screws and lock washers securing the plate (30) located between the point detector cranks. Remove the plate and lift and remove the circuit controller from the compartment. If further disassembly is required see Figure 7–5.

5.4.5 Gearbox Removal, M-3

Refer to Figure 7–1 for this procedure.

Disconnect pull knob from yoke. Remove the two screws located on either side of the cotter key (435) that links the push rods and the motor cutout contact controls. Remove push rod (120) by holding it at the end nearest the motor compartment and pulling it until the opposite end clears the tubing (140). Remove push rod by lifting and pulling it until the pin at the other end clears the hole in the side of the housing. Remove the four screws and washers (380, 195) that secure the gearbox to the base. Lift gearbox from base of switch machine. If further disassembly of the gearbox is required see **Error! Reference source not found.**.

Note

Before proceeding with further disassembly, the maintainer should be thoroughly familiar with the information and illustrations found in Sections 1 and 2. These illustrations will aid in final disassembly of the switch machine.

5.4.6 Removal of Main Crank

For all three machines (M-3, M-23A, and M-23B), it is necessary to take out the main crank through the bottom of the machine. To do this, the bottom cover and the wear plates supporting the operating bar must be removed first, allowing the operating bar and crank roller to drop down. Then rotate crank (turn friction clutch by hand) until 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.

5.4.7 Removal of Selector Clutch

For dual-control machines (M-23A and M-23B), removal of the selector clutch and associated parts can readily be understood from the information given for changing from R.H. to L.H. assembly, or vice versa. However, when reassembling the selector clutch, note that all its overall height, including top and bottom teeth, is 5-9/32 inches max. to 5-17/4 inches min. This dimension is adjustable 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 “hand” portion on the crank splines and turning “motor” portion with screw driver or bar in motor clutch teeth. Splines in both parts must be aligned to permit reassembly. For “timing” of the dual-control gearing upon reassembly, see Section 5.5.1.1.

5.4.8 Removal of Worm Shaft

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

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

5.4.9 Final Disassembly

After removing all major subassemblies per the above paragraphs, continue to disassemble the remaining components by referring to Figure 7–1 or Figure 7–2 and associated parts lists (Table 7-5 and Table 7-6) for parts location and identification. Disassemble only to the degree necessary to repair the switch machine.

5.4.10 Gearbox, Dismantle, M-23A and M-23B

Refer to Figure 2–12 and Figure 2–13 for this procedure.

a. To remove covers for gearbox and motor compartment and use as receptacles for parts removed. Place hand-throw lever in Normal position and selector lever in MOTOR position.

b. Remove 1/2”-13 bolts A1, A2, A3, and A4, securing top bearing C, yoke support H, lever support K, and lever shaft bearing M, respectively.

c. Remove castellated nut B1 and washer B2 from top of main crank and lift top bearing C from dowel pins carefully to prevent bending. Remove the rectangular key C1 (Figure 2–12) from top bearing bushing C2, hand-throw pinion D and spacing collar E on top end of crank. Lift hand-throw lever to vertical position and remove set-screw F1 from hand throw bevel gear F. Remove lever assembly and lift out hand-throw bevel gear.

d. Remove 1/2”-13 x 5-1/2” bolt G, securing yoke eccentric bushings G1 and then remove yoke support H. Positions of eccentric bushings should be noted, and care should be taken to avoid changing their position when removing the bolt.

5.5 Assembly

5.5.1 Reinstallation of Gearbox, M-3

Refer to Figure 7–1 for this procedure.

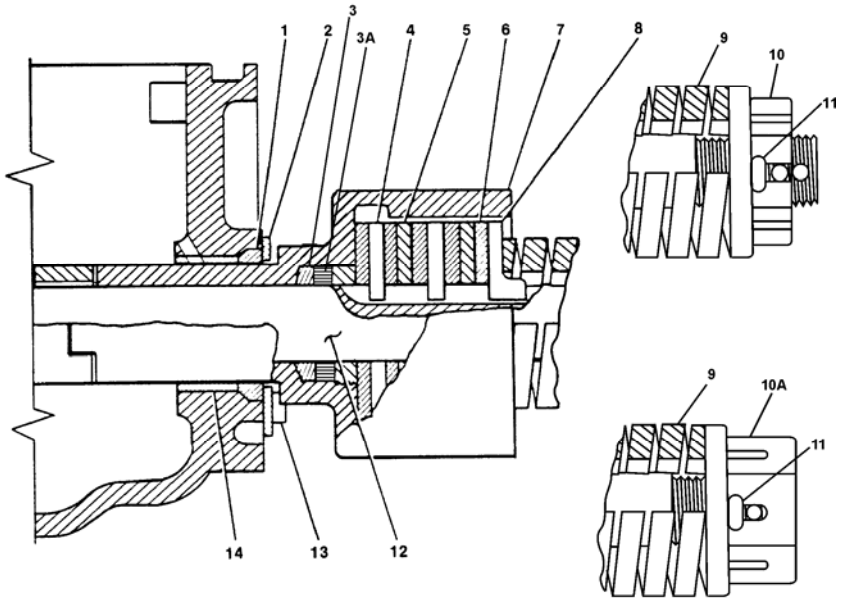
Place gearbox onto switch machine base. Align mounting holes in gearbox with holes in the base. Install four screws and washers (380, 195). Install push rod (120) by inserting the pin into the housing and lowering the push rod. Install push rod (120) by sliding the cutout contact end through the shaft (140). Align the holes at the end of the push rod with their respective swivels and install the two screws. Mount and adjust knob to yoke.

5.5.1.1 Gearbox, Reassembly Dual Control M-23A and M-23B (from R.H. to L.H. or Vice-Versa)

Refer to Figure 2–12 and Figure 2–13 for this procedure.

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

b. Reapply lever assembly to the hub on opposite side of gearbox, 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. With hand-throw lever vertical, reapply set-screw F1 in hand-throw gear F. Reapply 1/2”-13 bolts A2 to secure yoke support H and replace the two top bolts A4 to hold lever shaft bearing M in place.



Item No.	Description	US&S Part No.
1	Gasket	M245192
2	Plate	M147400
3	Felt Washer	J047335
3A	Oil Seal	J7900260003
4	Clutch Plate	M146574
5	Clutch Plate	M146573
6	Clutch Disk	M146650
7	Clutch Housing	M172752
8	Clutch End Plate	M146575
9	Clutch Spring	M239322
10	Clutch Adjusting Nut M-3	M286615
10A	Clutch Adjusting Nut M-23	M438402-001
11	Cotter, 3/16" x 2" (Tin Pl.)	
12	Worm Shaft	M286612
13	Cap Screw, ¼"-20 x ¾" Hex Hd. (Tin Pl.)	
14	Bushing	J790004

Figure 5–1 - Friction Clutch Assembly

c. In order that "Motor" position of selector lever will be toward motor end of machine, as indicated for standard assemblies in Diagram A, B, C, or D of Figure 3–9, selector lever and lever interlock must be reassembled 180° from original position on shaft, as follows:

1. Remove hex nut and washers from end of selector lever shaft and 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 (refer to Figure 3–9). Replace hand-throw lever and fasten in place with clamping bolt.

2. 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 degrees 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 1/2" – 13 bolts, A3, which also secure the bottom of the lever shaft bearing.
3. Operate selector lever to motor position (i.e., toward motor end of machine) and check that it moves yoke N down.
4. Interchange MOTOR and HAND nameplates on selector lever to correspond with these lever positions.

⚠ WARNING

The MOTOR and HAND nameplates must be interchanged on the selector lever to correspond with the lever positions to avoid possible physical injury.

d. Reassemble collar E (with chamfer down) on top of crank and, with hand-throw lever vertical, apply 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 line. With selector lever in MOTOR position, rotate friction clutch housing so that motor clutch teeth are fully engaged.

e. Reapply top bearing assembly and secure with hold down bolts A1. (Motor cutout push rod should be held back to clear the adjusting rod until top bearing is down.)

f. Apply top bearing bushing C2, rectangular key C1, washer B2, and tighten castle nut B1 firmly, then back off to nearest cotter hole and apply cotter, after operating machine by hand-throw lever to be sure that mechanism does not bind.

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

h. Readjust both yoke eccentric bushings as described in Section 5.7.3, then secure by tightening bolt G firmly.

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

j. Check that all bolts are drawn down tightly on lock washers and that all cotters are in place.

k. Replace covers.

5.5.2 Reinstallation of Motor Brushes

Refer to Section 7.12 for this procedure.

Before installing the motor brushes, check that the motor commutator is 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 cleaning the commutator or brushes. These commutators must not be undercut.

For ”Blue” Motor Machines (For motors with brush band cover, Type A)

Brushes are provided with a radius to fit the commutator, therefore sanding of brushes is not recommended. Retract the brush hold down spring, insert a brush into the holder, and release the spring. Terminate the brush lead to the terminal. Repeat for the other brush. Position the brush/commutator cover over the access holes and tighten the screws. Install the motor compartment cover. Operate the switch machine to verify that the brushes are properly installed.

For “Blue” Motor Machines (For motors with external brush covers, Type B)

Fit the brushes to the commutator using No. 00 sandpaper. Install the motor commutator brush in the holder. Install the spring hold down by pushing it into the slot beside the brush and hooking it over the end of the brush holder. Repeat for the other brush. Check that the motor commutator brushes are free in the holders. Install the motor brush/commutator covers with two screws on each cover. Install the motor cover (180). Operate the switch machine motor to verify that the brushes are properly installed.

5.5.3 Reinstallation of Motor

Refer to Figure 7–1 and Figure 7–2 for this procedure.

Lower motor bracket onto base of switch machine so that pinion end of motor is inserted through motor shaft opening. Position motor so that pinion is mated properly with reduction gear. Align mounting holes in motor bracket at commutator end with holes in base of switch machine. Insert two l/2 – 13 x 2” hex head cap screws (720) and two associated 1/2” plain and lock washers (415, 695) in motors mounting bracket (commutator end). Reattach wires to motor connections. Replace motor cover (180).

5.5.4 Reinstallation of Friction Clutch Assembly

Refer to Figure 5–1 for this procedure.

Before assembly, check that the friction discs (6) are free of oil. If clutch discs are oily and it is found that oil is entering along the shaft, it is recommended that the felt pad and oil seal be renewed in the clutch housing. Refer to Section 5.5.4.1. If the felt washer and oil seal are not to be replaced, continue with Sections 5.5.4.2 and 5.5.4.3.

5.5.4.1 Instructions for Replacing Felt Washer and Oil Seal in Clutch Housing

Refer to Figure 5–2 for this procedure.

Measure the length of clutch spring before disassembling and record this dimension as information for reassembling. Swing terminal board out of the way, remove the adjusting nut and clutch spring, and slide the clutch housing off the shaft. Remove the discs and plates.

Remove the old packing and clean the shaft and the inside of the clutch housing by washing with a non-flammable grease solvent. Apply a new felt washer (J047335) and oil seal (J7900260003) to the housing recess and assemble the nut. Using the spanner end of the special wrench, pull down nut only until it is flush with the bottom of the clutch housing. Then the locking screw should be inserted and drawn down securely. Coat rubbing surfaces of packing rings with gearbox lubricant. Assemble housing to the shaft. Clean lubricant from shaft surface inside the clutch space.

Old fabric discs should be discarded and replaced. Old clutch plates should be thoroughly cleaned in a non-flammable grease solvent to remove any accumulation of lubricant, and then reassembled as shown in Figure 5–2. It will be noted that a fabric disc goes in the bottom of the housing, and the first metallic disc is one with teeth engaging the shaft.

5.5.4.2 Assembly of Friction Clutch (Figure 5–1)

Install gasket (1) in gearbox opening. Install plate (2) with two 1/4-20 x 3/4” hex head cap screws (13). Align tubular neck of clutch assembly and worm shaft (12). Insert tubular neck of clutch assembly partially over worm shaft and through gearbox bushing. Align three finger end of tubular neck with matching slots in clutch gear hub. Push tubular neck into gear hub slots until neck/hub is in clutch gear hub. Push tubular neck into gear hub slots until neck/hub is solidly engaged. Install the following items on the worm shaft as follows:

a. Insert clutch disc until it sits against inner wall of clutch housing.

b. Insert clutch plate in groove on worm shaft until it mates with clutch disc.

c. Insert another clutch disc.

d. Insert another clutch plate.

e. Repeat Steps c and d for three remaining clutch discs and two remaining clutch plates.

f. Insert clutch end plate on worm shaft.

Slide clutch spring over worm shaft until it rests against clutch end plate. Install clutch adjusting nut on worm shaft. Tighten clutch adjusting nut in accordance with friction clutch adjustment procedures. Recheck this adjustment after a brief wearing-in period.

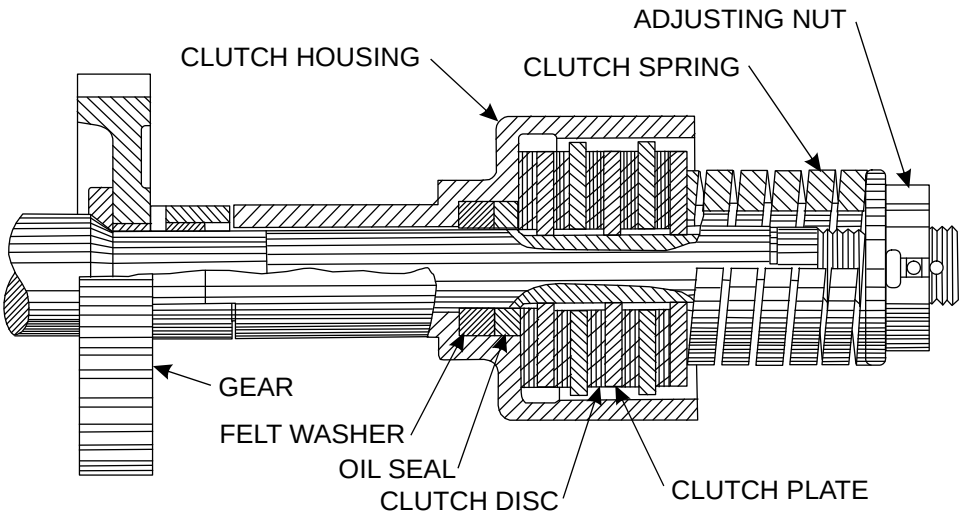


Figure 5–2 - Friction Clutch Assembly

5.5.4.3 Friction Clutch Adjustment

Friction clutch adjustment should be checked to be sure the clutch slips at a torque which will protect the mechanism from shock, yet adequate to carry usual operating loads.

Also, for proper operation of the overload relay the clutch must be maintained to slip at a current value above the minimum current rating of the relay or no protection will be obtained.

To check the friction clutch adjustment, apply a temporary jumper across the binding posts of the pick-up coil on the overload relay (See NOTE) and insert an ammeter in the motor circuit as follows: Connect negative ammeter lead to binding post A on switch machine terminal board and positive ammeter lead to binding post 5 or 10, depending upon switch point position. The average peak current taken by motor with clutch slipping should be within 10% of the nominal value shown in Section 1.3.2 80

for the particular motor and gear ratio involved. The motor current must be checked in both directions. If necessary, remove cotter and screw the friction clutch spring adjusting nut (Figure 5–2) in or out to obtain desired current. After tests are completed, remove temporary jumper from overload relay.

NOTE

In addition to a temporary jumper across the binding post of the pick-up coil on the overload relay called for in the maintenance and adjustment section of this manual, all 6-1/4 amps Fusetrons on the 110 VDC side of a bridge rectifier (if used) should also be temporarily jumpered out.

5.5.5 Reinstallation of New or Rebuilt Circuit Controller

Note

It is necessary that the lock box be toward the motor end before installing a new or rebuilt controller into the switch movement. This is done by operating the movement to the end of its stroke using the hand crank (M-3) or hand-throw lever (M-23A or M-23B).

Using 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. Lower circuit controller into circuit controller compartment (Refer to Figure 7–1 and Figure 7–2). Align mounting holes. Reinstall the two screws and 3/8" lock washers (20, 410, 740) in the holes nearest the motor compartment. Reinstall the plate (30), two 1/2" – 13 x 1" hex head plated steel cap screws and 1/2" plain and lock washers between the point detector cranks. With wire harness within the clamps, reinstall the four wire clamps with four 5/16" x 1-5/8" fil. Hd. Plated machine screws and four 5/16" plain steel lock washers (Ex. H.) tin plated. Refer to tags and reattach harness wires to correct circuit controller terminals and heater connections. Tighten all screws securely and be sure the nearing on the circuit controller meshes properly with the crank teeth on the movement lock box. See that the circuit controller shaft assembly is in the angular position agreeing with that shown in Section Y-Y of Figure 2–7 checking specifically the relation shown in the schematic diagram (Figure 7–5) for setting of segments for contacts 24-25 and 26-27. This should place the cam block of main shaft gear (Item 45) in the position shown in Figure 7–5. The next move should rotate the cam block away from, rather than into, the pinion gear. 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. Before tightening circuit controller frame hold-down bolts, check that full stroke controller shaft rotation gives symmetrical contact relationship at both ends of the stroke. Shift clear tooth engagement, if necessary, to obtain this condition. Install and tighten all hold-down bolts.

5.5.5.1 Motor Control Contacts

The motor control contacts (Figure 2–7) are set at the factory to ensure that the switch machine is locked in accordance with AREMA specifications. Ordinarily, readjustment will not be required as long as the assembly remains undisturbed. If an adjustment is required, proceed as follows:

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

b. With the machine in an unlocked position, insert a 1/2" +0", -.01" x 2" x 24" steel bar into the lock rod slot. Turn the clutch housing by hand until the lock dog bears against the 1/2" wide bar. In this position, the machine is fully locked.

c. Connect an ohm meter or test light across one of the appropriate control contacts.

d. Loosen the nuts which hold the “V” end of Finger F1 and slide the finger in or out until a point where any additional cam rotation will open the contact. Retighten the nuts. When a 15/32” +0”, -.01” x 2” x 24” steel bar is used for the aforementioned test, the contacts should be open.

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

Contact Finger F1 should be adjusted to bear against the segment with 2 to 2-1/2 lbs. Pressure while the Finger F2 is held clear. Adjust finger stop F1a to have 1/32 $\pm$ 1/64” clearance from Finger F1 when the latter is riding the segment. Adjust ringer F2 to bear on Finger F1 with 1-3/4 to 2 lbs. Pressure when Finger F1 is on the segment.

Adjust stop F2a to clear Finger F2 by 1/32 + 1/64” min. When contacts are closed as shown in Sect. W-W and X-X, and to permit Finger F1 to clear Finger F2 by 1/16” minimum when contacts are open as shown in Sect. Y-Y and Z-Z. Adjust Finger F3 to bear on the segment with 1-3/4 to 2 lbs pressure.

5.5.5.2 Contact Pressures and Clearances

Contact pressures and clearances must be in accordance with Sections P-P and N-N of Figure 2–7 and are to be obtained by the following procedure:

a. With switch machine at 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 pounds.

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

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

d. Check 1/8 inch minimum dimension between end of indication contact spring (M) and short circuiting strip. Check 3/64 inch minimum clearances between spring (M) and fixed contact, and between spring (M) and short circuiting strip. No adjustment should be necessary to obtain these dimensions if spring (M) is made properly.

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

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

5.5.6 Assembly, Lever Interlock

The sectional views in Figure 3–9 illustrate the lever interlock assembly. It comprises recesses in both lever hubs and a steel ball carried in a hole in the lever support. In reassembling, BE CAREFUL NOT TO LOSE THE BALL when the lever is taken off.

As can be seen in the diagrams, 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 as shown, 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. While 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^{o} 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, as indicated in Figure 3–9.

When used, the stop screw must be applied to a particular 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 its MOTOR position (see Figure 3–9).

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 3–9).

As previously mentioned, the selector lever can be assembled on the square end of its shaft in either of two positions, 180^{o} 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 applied to 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.

5.6 Lubrication

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

For best results, only lubricants complying with strict specifications are recommended. The recommended lubricants can be purchased in convenient quantities from US&S.

Figure 5–3 and Figure 5–4 identify the areas of the switch machine that need lubrication. These points and the proper lubrication are further described in Adjustments

5.6.1 Point Detector

Point detector rollers should be maintained to clear the small diameter of the point detector bar by not more than 1/32”. If necessary, adjust the eyebolts (12) (Figure 7–5) in or out; screws (53) must first be removed.

Note

The figures referenced in this section show a single point detector rod. This procedure should be done for both point detector rods.

1. Use point detector gauge N295326 (Figure 5–5) to check latch operation in normal and reverse switch positions.
2. Ensure that the point detector latching mechanism is unlatched, i.e., the latch must be clear to allow the yoke to rest against the yoke stop (see Figure 5–6).

Table 5-1. The following steps present the general lubrication requirements for the switch machines.

a. Apply pressure gun grease (US&S PN A041089)
   1. Point detector bar bearings (use gun on grease fittings).
   2. Operating bar wearing plates (use gun on grease fittings).
   3. Selector and hand-throw lever shaft bearings (use gun on grease fittings).
   4. Surfaces of slide bar and lock box and rack G, using brush or paddle for application (a heavy oil, viscosity 120-200, (SAE-140) may be used as an alternate on these surfaces).
   5. Circuit controller trunnions (use gun on grease fittings).

b. Apply medium body motor oil viscosity 130°F 185-220 (SAE-30), to the following parts:
   1. Yoke bearings and point detector linkage.
   2. Spur gear journals (machines are equipped with Oilite bushings).
      a. Holes in box casting.
      b. Holes in reduction gears and in clutch gear.

Note

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

   3. For M-3 machines only:
      a. Main crank shaft – remove oil plug in top cover. Oil will collect in a recess and be led to shaft surfaces needing lubrication.

b. Linkage connections for motor cutout – remove the cover and add a few drops of oil to the linkage.

4. M-3, M-23A and M-23B machines – fill recess on top crank bearing.

c. Apply a light oil (low temperature oil, PN A041119, Texaco Spindura Oil 22, Code 788):

1. to contact segments of indication circuit controller (segments and contact springs should be thoroughly cleaned before application),

2. to motor commutator if brushes chatter (sparingly), and

3. to the crank arms and rollers in the circuit controller.

d. From the container shipped with the machine, apply the gear lubricant [(PN N320264, (Lubriplate)]. This is a low-temperature all-weather lubricant that has little change in consistency with temperature variations. It will retain its lubricating properties at the highest temperatures encountered and not become so stiff at low operating temperatures as to require thinning. If sustained abnormally low temperatures are anticipated, a special lubricant may be ordered. Contact your salesman or the Engineering Department for an ordering reference number.

1. M-3, M-23A, and M-23B machines – Apply a light coat of gear lubricant to spur gear teeth. The gear lubricant must be packed well around the worm gear and the selector clutch in the worm gear compartment. It must be replaced as necessary to keep the worm gear covered.

⚠ CAUTION

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

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

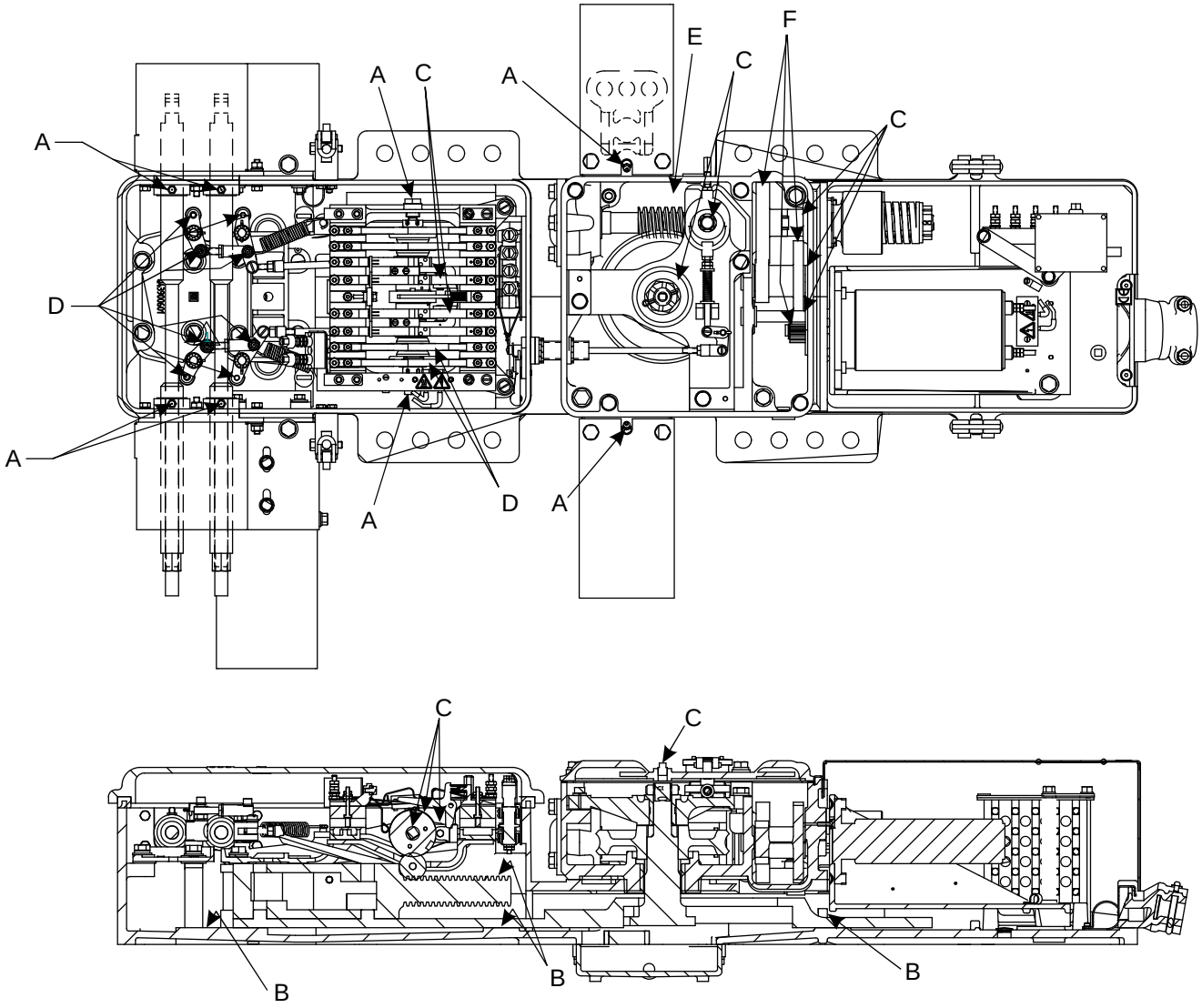


Figure 5–3 - Lubrication Diagram for M-3 Switch Machine

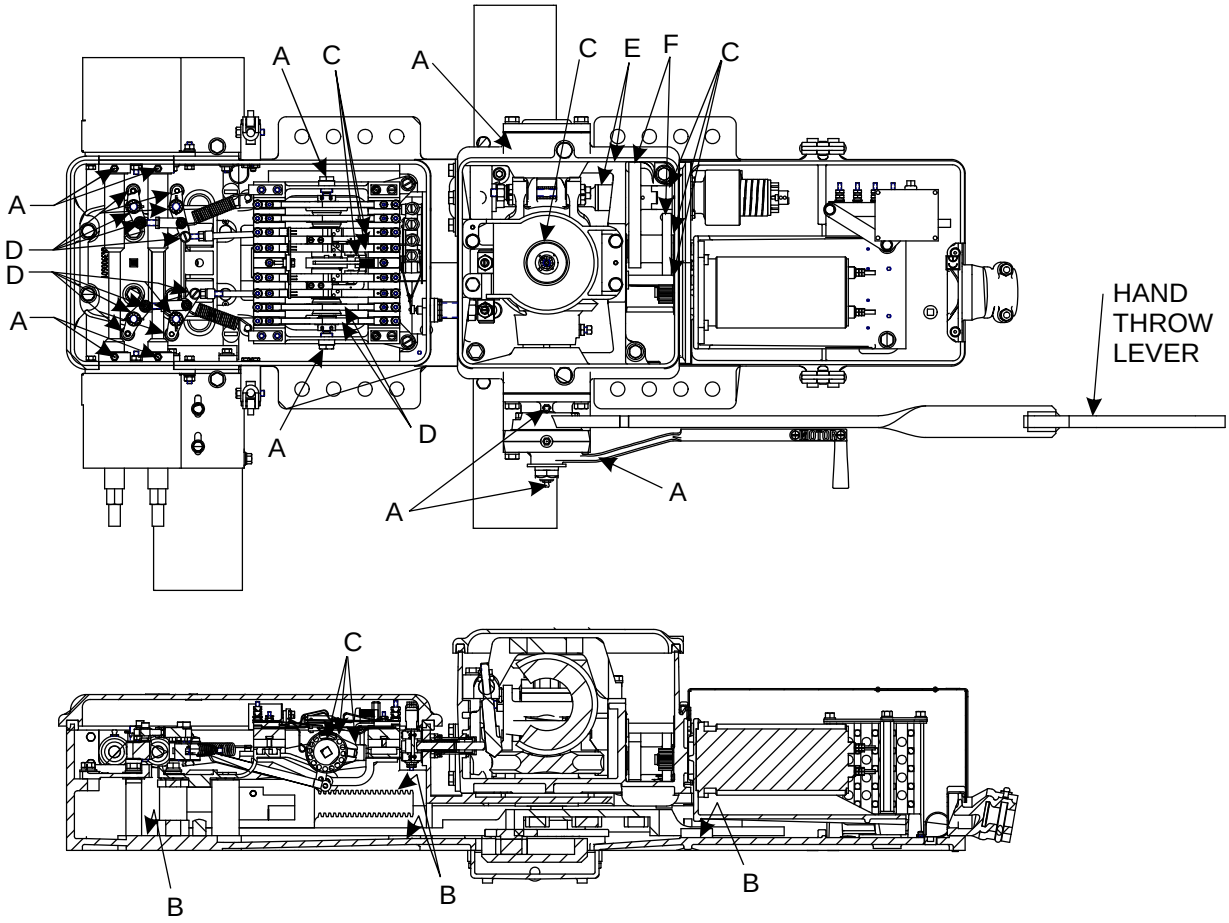


Figure 5–4 - Lubrication Diagram for M-23A, M-23B Switch Machine

5.7 Adjustments

5.7.1 Point Detector

Point detector rollers should be maintained to clear the small diameter of the point detector bar by not more than 1/32”. If necessary, adjust the eyebolts (12) (Figure 7–5) in or out; screws (53) must first be removed.

Note

The figures referenced in this section show a single point detector rod. This procedure should be done for both point detector rods.

1. Use point detector gauge N295326 (Figure 5–5) to check latch operation in normal and reverse switch positions.
2. Ensure that the point detector latching mechanism is unlatched, i.e., the latch must be clear to allow the yoke to rest against the yoke stop (see Figure 5–6).

Table 5-1 - Lubrication Specifications for M-3 and M-23A/M-23B Switch Machines

Point of Application	Type of Lubricant & US&S Part No.	Known Products Complying With Spec	Method	Apply To	Remarks
A	Pressure Gun Grease (PN A041089)	Alemite Solidified Oil #32 (Alemite Temprite) Solidified Oil E.P. (Prime Mfg. Co.)	Grease Gun	Grease Fittings	Apply until surplus is visible at edges of bearing
B	Either Pressure Gun Grease (PN A041089) OR Heavy Oil (Viscosity120 to 200 at 99°C)	Same as above	Grease Gun	Surface	
		Auto. Transmission and rear end lubricant S.A.E. 140 (Texaco Novatex)	Pour	Surface	
C	Medium Body Oil (Viscosity at 130 F, 185 to 220)	Automobile Engine Oil S.A.E. 30	Oil Can	Bearings & Oil Holes	A few drops periodically as required
			Pour	Recess on top crank bearing	Fill recess periodically as required
D	Low Temperature Oil (PN A041119)	Low Temperature Lubricating Oil (Texaco Spindura Oil 22, Code 788)	Oil Can	Surface	Apply very light film to all contact segments at frequent intervals after thorough cleaning
E	Low Temperature Lubricating Oil (PN N320264)	Lubriplate 5555 (Fiske Brothers Refining Co.)	Brush	Spur Gear Teeth	Apply light coat to teeth as required
F	Low Temperature Lubricating Oil (PN N320264)	Lubriplate 5555 (Fiske Brothers Refining Co.)	Pour	Worm Gear Compartment	Pour in. Fill only to top of worm gear

3. Check that the space between the point detector roller and the bevel of the point detector bar is sufficient to permit the insertion of the feeler gage (Figure 5–6). If not, adjust the point detector bar per Section 3.6.
4. Pry the point detector roller out of the way and insert the sleeve gage over the narrow diameter of the point detector bar (Figure 5–7). The sleeve gauge must be tight against the bevel of the point detector bar. The insertion of the sleeve lifts the connecting rod and rotates the yoke so that the latch snaps over the top of the yoke midsection.
5. Swing the latch so that the yoke clears the latch and rests against the yoke stop.
6. Release the latch. The latch must clear the yoke and snap over the top of the yoke midsection. If not, adjust the point detector bar per Section 3.6.

7. Remove the sleeve gage from the point detector bar. With the mechanism latched, all indication contacts should be in the open position (Figure 5–8).
8. Add a sufficient amount of shims as required to enable latch to clear the top of the yoke in both switch positions and latch properly. Check indication contacts in latched positions to ensure that they are open a minimum of 3/64”.

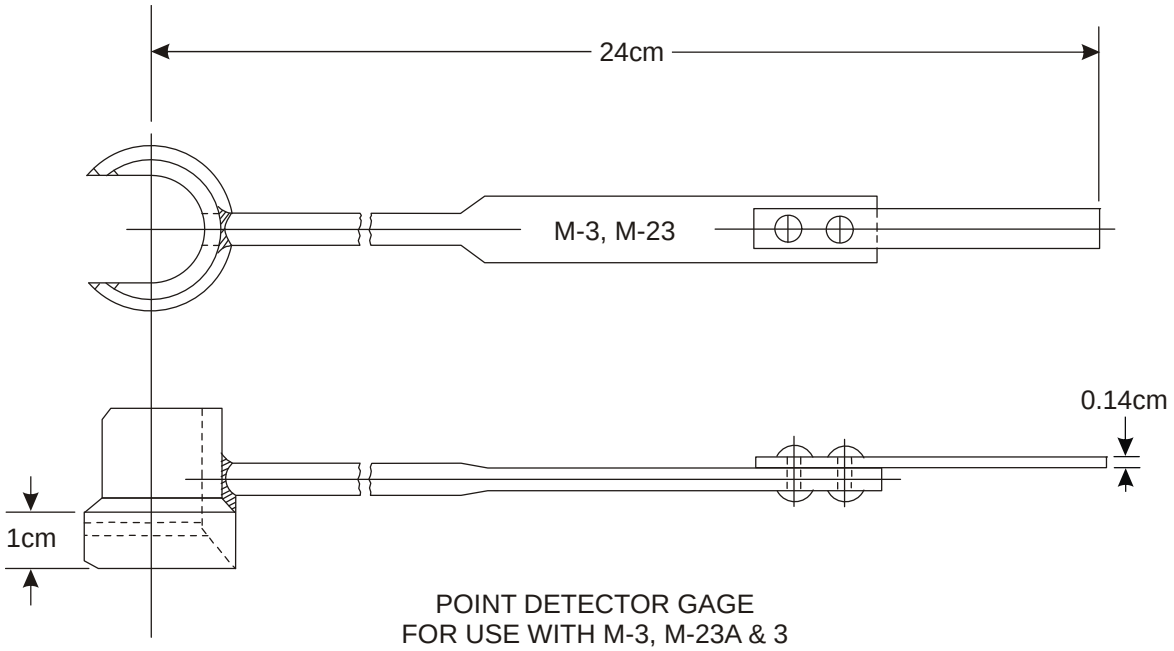


Figure 5–5 - Point Detector Gage N295326

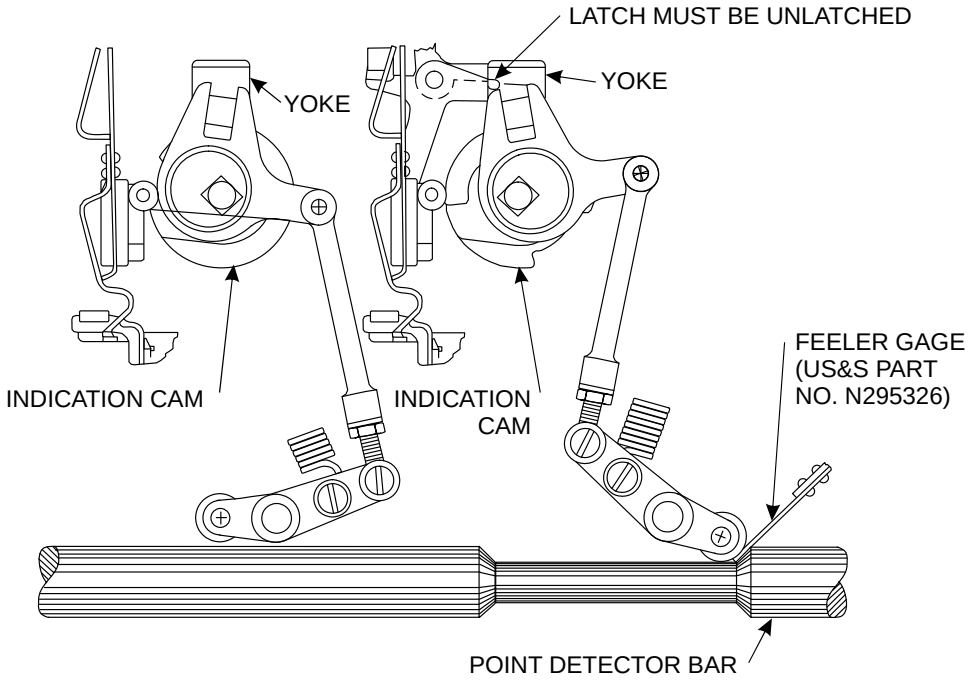


Figure 5–6 - Latch in Unlatched Position

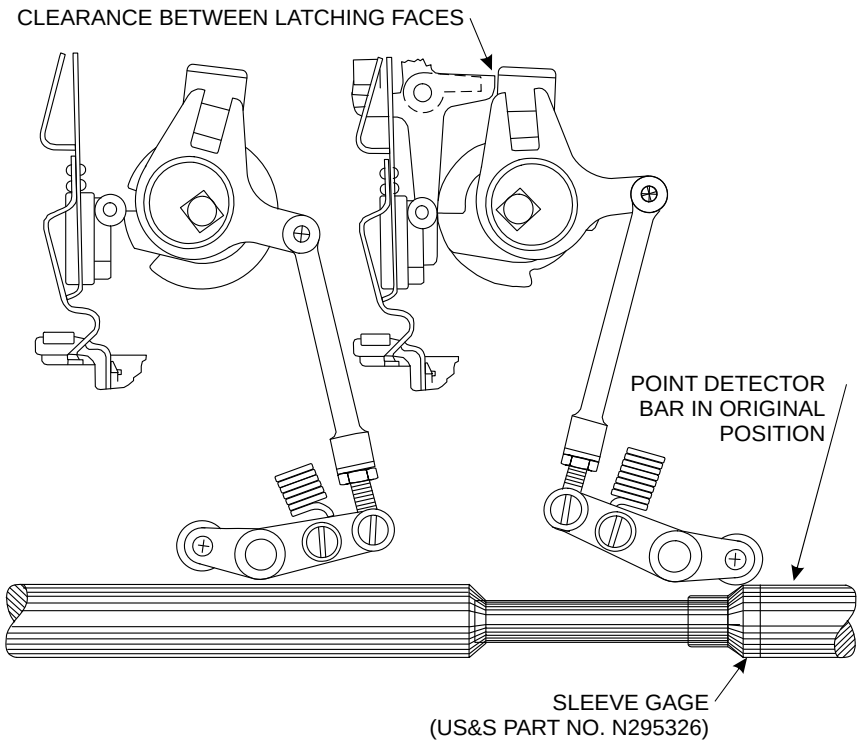


Figure 5–7 - Inserting the Sleeve Gage

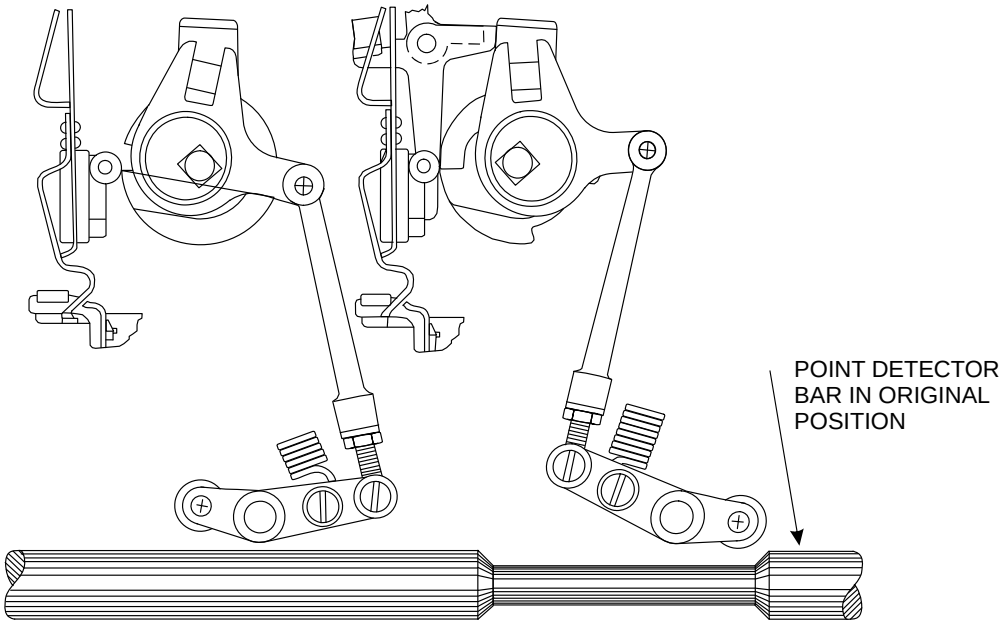


Figure 5–8 - Contacts in the Open Position

5.7.2 Motor Cutout Contacts

Refer to Figure 5–9 for this procedure.

5.7.2.1 M-3 Switch Machine Motor Cutout Contacts

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

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

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

With the hand crank cover closed and hasp in the staple notch, adjust the contact springs (K) so that there is 1/16” clearance between the contact insulation (J) and the push rod (F). With this clearance the contacts will be closed with a pressure of approximately three pounds. In order to adjust the contacts, a “T” shaped spring bender is required in order to get at the bottom contact.

5.7.2.2 M-23A and M-23B Switch Machine Motor Cutout Contacts

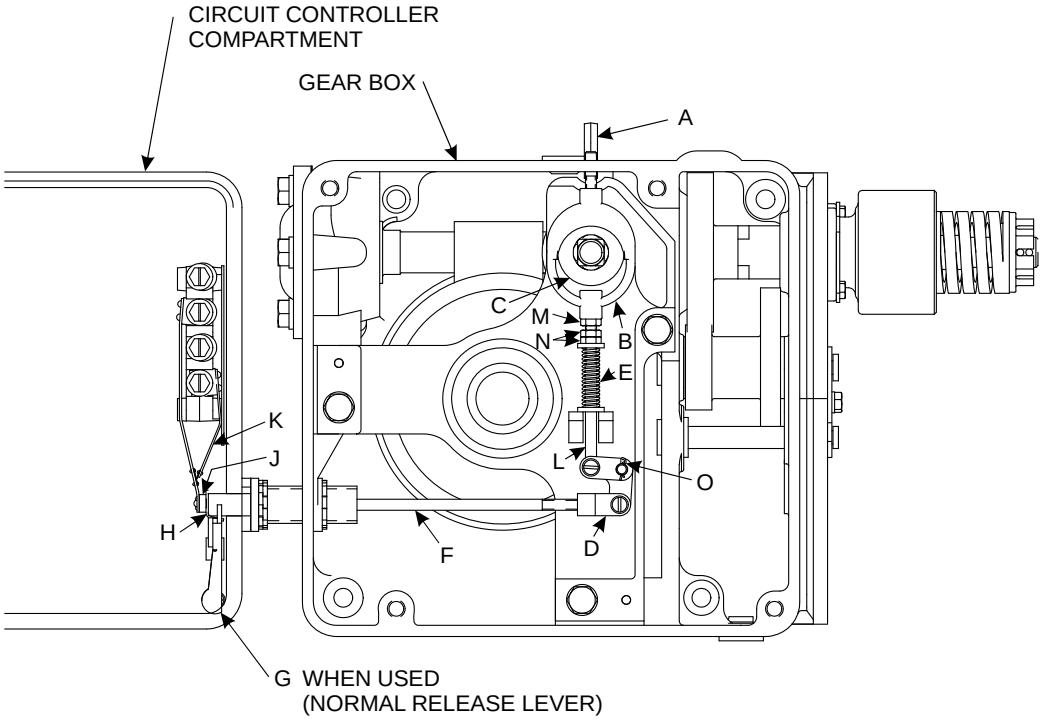
Motor cutout contact for the Styles M-23A and M-23B should open when the selector lever is lifted 6” out of MOTOR position, measured at the hand-grip, and be open 1/8” min. To 3/16” max. when the selector lever is in the HAND position. When the selector lever is in MOTOR position, the end of the

push rod should be 1/16” clear of the contact operating bar and the contacts should be closed with 1-1/2 lb. min. to 2 lb. max. pressure.

Adjustment of the closed pressure, when necessary, is made by careful use of a spring bender. The linkage which affects the operation should be maintained in adjustment as follows: With selector lever in MOTOR position, the rocker arm (Figure 2–15) should be screwed up or down, as necessary, to just touch the machined cam surface on the selector yoke. Then the adjusting rod should be turned so that its eccentric head holds the end of the push rod 1/16” clear of the contact operating bar.

5.7.3 Selector Clutch Adjustment

Selector clutch adjustment should be checked occasionally. When the selector lever is in 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 the eccentric bushings G1 (Figure 2–12). Referring to Figure 2–12 and Figure 2–14, it will be noted that the selector clutch yoke has one end supported on and driven by the finger on the selector lever shaft, and its other end pivots on eccentric bushings C1 (Figure 2–12) held fixed by through bolt G. When this bolt is loosened, however, 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 “+”, and when the eccentric bushings are turned to bring the “+” mark up, this will lift the yoke and its rollers. The flat on other side of the “N” is stenciled “-”. The two eccentric bushings should be kept turned a like degree “+” or “-” to avoid twisting the yoke. Then tighten pivot bolt to hold adjustment. When necessary to adjust the eccentric bushings, check that top rollers are free from bearing on the upper spring cup while the selector clutch is fully down, and in addition, check that the rollers are not too high. To do this, operate the selector lever to MOTOR position when the worm gear is not in position to receive the selector clutch, so that the teeth of “clutch for motor operation,” Figure 2–14, ride on top of the corresponding teeth of the worm gear. In doing this, insert 1/8” length of a #14 soft copper wire between the opposed teeth. The eccentric bushings should be adjusted the same degree “+” or “-” so that (with their 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” thickness. Also check that upper rollers are free to turn when selector clutch is fully engaged with the worm gear.



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

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

Figure 5–9 - Adjustment of Motor Cutout Contacts (Style M-3 Machine)

6 Troubleshooting

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

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

Problem	Cause	Solution
Motor power is present from the wayside yet motor does not run.	A. Hand crank cover is in the open or un-locked position.	1. Close the hand crank cover such that the hasp is in the staple recess. 2. Depress the motor cutout contact restoring the latch in the circuit controller compartment.
	B. Motor cutout contacts are open.	1. Confirm that the hand crank cover, located on the gear box cover, is closed and that the hasp is in the staple notch. 2. Depress the motor cutout contact restoring latch in the circuit controller compartment. 3. Check adjustment of motor cutout contacts. Readjust per Section 5.7.2 and Figure 5–9.
	C. Motor cutout contacts are broken.	1. Visually inspect the motor cutout contacts and if they are broken or cracked, replace them. (This is **not** recommended as a field service procedure and should be done in the Service Shop only) 2. Remove the wire leads from the motor cutout and the circuit controller. 3. Remove the hardware and lift out the circuit controller. Refer to Section 5.4.4 and Figure 7–1. 4. Remove the hardware from the cutout contact assembly. 5. Install a new motor cutout contact assembly. 6. Adjust per Section 5.7.2. 7. Reinstall circuit controller. Refer to Section 5.5.5.
	D. Wire harness is severed or wire terminals are loose or broken.	1. Perform a “point to point” continuity test on each wire lead. Tighten any loose connections and replace damaged wire(s) or terminal(s).
	E. Motor control contacts are out of adjustment, damaged, or broken.	1. Confirm the contact pressure. Refer to Section 5.5.5.1. 2. Replace any damaged contact spring(s).
	F. Motor stopped running.	1 Check for sufficient brush length and that motor commutator is smooth and free of grease. Refer to Section 5.5.2. 2. Replace the motor brushes. Refer to Section 5.5.2. 3. If Steps 1 and 2 do not restore motor operation then replace the motor. Refer to Section 5.4.2 for motor removal.

Problem	Cause	Solution
	G. General failure of the circuit controller.	1. Remove the switch machine from service and take it to a service shop for an overhaul or replacement of the circuit controller. See switch machine assembly Drawing 438254.
Motor runs but not in the proper direction causing the friction clutch to slip.	A. Incorrect motor polarity.	1. Reverse the motor wires. Refer to the Control Wiring Diagram, Figure 3–8.
	B. Control circuit is incorrect.	1. Check all wiring connections against the circuit diagram.
Switch machine operates and locks, however no indication is given.	A. Indication contact springs are out of adjustment.	1. Confirm contact spring pressures and gaps. Refer to Section 5.5.5.2.
	B. Indication contact springs broken.	1. Replace with new indication contact spring assemblies. Refer to Section 5.5.5.2.
	C. Obstruction between switch points and stock rail.	1. Remove the obstruction. Check for damage to the switch points, layout connecting rods, and switch machine. 2. Cycle the switch machine several times to confirm normal operation of the switch machine. Confirm that the switch points are against the stock rail.
	D. Point detector bar is broken.	Replace the point detector bar as follows. (Refer to the layout drawing for the switch installation.) 1. Remove the connection to the point detector connecting rod. 2. Remove the broken point detector bar. 3. Check the switch machine for any visible signs of damage. 4. Replace with a new point detector bar. The bar must slide freely in its bushings. 5. Reconnect the point detector bar to the point detector connecting rod. 6. Readjust the point detector bar to both near and far closed switch points.
	E. Point detector bar is out of adjustment.	1. Readjust the point detector bar. Refer to Section 5.7.1.
	F. Point detector connecting rod is broken.	Replace the point detector connecting rod as follows: 1. Remove the connection at the switch machine. 2. Remove the connection at the layout point detector lug. 3. Replace and reconnect the connecting rod to the point detector lug and the switch machine point detector bar. 4. Readjust per Section 5.7.1.
	G. The latch out device was not reset from a prior incident.	1. Reset the latchout device in the circuit controller compartment.
	H. The rail braces are loose allowing for movement of the stock rail.	1. Tighten the rail braces.

Problem	Cause	Solution
Switch machine operates, however the machine does not lock – clutch slips.	A. Lock rod connecting rod is out of adjustment.	Adjust the lock rod as follows: 1. Close the far switch point. 2. Loosen the hardware to allow for independent movement of the lock rods. 3. Adjust the lock rod so that the notch in the lock rod assembly is roughly centered about the lock box dog. Refer to Figure 2–2. 4. Tighten the connecting rod hardware for the far point connection. 5. Repeat the above process for the near point side. 6. Tighten the lock rod assembly hardware to lock the adjustment.
	B. Lock rod connecting rod is broken.	Replace the lock rod connecting rod as follows: 1. Remove the field side jam nuts at the threaded end of the lock rod connecting rod assembly. 2. Remove the jam nuts at the threaded end of the switch machine internal lock rod assembly. 3. Hand crank the switch machine to its mid-stroke position. 4. Remove and replace the lock rod connecting rod assembly. 5. Replace all hardware removed above. 6. Readjust per the lock rod adjustment solution above.
	C. Switch machine internal lock rod assembly is out of adjustment.	Adjust the lock rod assembly as follows: 1. Close the far switch point. 2. Loosen the hardware to allow for independent movement of the lock rods. 3. Adjust the lock rods so that the notch in the lock rod assembly is roughly centered about the lock box dog. Refer to Figure 2–2. 4. Tighten the connecting rod hardware for the far point connection. 5. Repeat the above process for the near point side. 6. Tighten the lock rod assembly hardware to lock the adjustment.

Problem	Cause	Solution
	D. Switch machine internal lock rod assembly is broken.	Replace the internal lock rod assembly as follows: 1. Loosen the jam nuts that lock the position of the threaded end of the lock rod connecting rod to the front rod assembly lug. 2. Hand crank the switch machine to its mid-stroke position. 3. Separate the lock rod connecting rod from the switch machine lock rod assembly. 4. Remove the lock rod assembly from the field side of the switch machine. 5. Replace the lock rod assembly with a new lock rod assembly (Figure 2–4). 6. Reconnect the lock rod assembly to the lock rod connecting rod. (Refer to the layout drawing for the switch installation.) 7. Readjust per the lock rod adjustment solution above.
	E. Obstruction between the switch points and the stock rail.	1. Clear out any obstructions. 2. Cycle the switch machine several times to ensure normal operation. 3. Inspect the layout and switch machine for signs of damage.
	F. Switch machine mounting hardware is loose.	1. Tighten all mounting hardware.
	G. Friction clutch discs have become contaminated. (oil, grease, etc.)	1. Replace all clutch plates and discs. Section 5.4.3 and Section 5.5.4.

7 Parts List

7.1 M-3 Switch Machine Assemblies

Table 1-1 lists the M-3 IPD switch machine assemblies.

Table 7-1 - M3 Switch Machine Assemblies

Part Number		Speciality Items	Motor Assembly	Gear Box	Speed	Control Circuit Wiring
Left Hand	N43925001	A, B, M (Table 7-4)	N4511611708 (110 VDC)	N287485 (189:1)	3 sec.	3-Wire
Right Hand	N43925002					

7.2 M-23A Switch Machine

Table 7-2 lists the M-23A IPD switch machine assemblies.

Table 7-2 - M23A Switch Machine Assemblies

Part Number		Speciality Items	Motor Assembly	Gear Box	Speed	Control Circuit Wiring
Left Hand	N43925101	I, M (Table 7-4)	N4511611701 (110 VDC)	N287073 (189:1)	5 sec.	3-Wire
Right Hand	N43925102			N2870760001 (189:1)		

7.3 M-23B Switch Machine

Table 7-3 lists the M-23B IPD switch machine assemblies.

Table 7-3 - M23B Switch Machine Assemblies

Part Number		Speciality Items	Motor Assembly	Gear Box	Speed	Control Circuit Wiring
Left Hand	N43925201	I, M (Table 7-4)	N4511611701 (110 VDC)	N287076 (189:1)	5 sec.	3-Wire
Right Hand	N43925202			N2871760001 (189:1)		

7.4 Speciality Items

Table 7-4 lists the speciality items available for the M-3, M-23A, and M-23BIPD switch machine assemblies.

Table 7-4 - Speciality Items

Reference	Description
A	15W, 115V Heater (N253225, B12845-Sh.1) in Circuit Controller Compartment
B	15W, 115V Heater (N294241, 9065-Sh.413) for Motor Compartment
C	15W, 115/230V Heater (N438201, B12845-Sh.1) in Circuit Controller Compartment
D	15W, 115/230V Heater (N294241 & N296578-001, 9065-Sh.413) for Motor Compartment
E	15W, 24V Heater (N438179, B12845-Sh.1) in Circuit Controller Compartment
F	15W, 24V Heater (N438178, 9065-Sh.413) for Motor Compartment
G	Switch Machine without Main Terminal Board
H	Use circuit Controller without Point Detector Latch
I	Paint Aluminum
J	15W, 115V Heater N296580-004, 9065-Sh. 413 for Motor Compartment
K	For Left Hand Machine Set Up for Right Hand Indication, Stencil Machine “L.H.FAR PT. CL.”
	For Right Hand Machine Set Up for Left Hand Indication, Stencil Machine “R.H.FAR PT. CL.”
L	Use Crank Case Cover (Item 175) N146290-002 C9190-Sh. 4 (Item 545) J032902 Not Required
M	Use Circuit Controller without Latch Cam Block

7.5 M-3 IPD Switch Machine Parts List

Table 7-5 lists the parts for the M-3 IPD switch machine assembly. Refer to Figure 7–1 for the location of the items on the assembly.

Table 7-5 - M-3 IPD Switch Machine Parts List

Item	Description	Part Number
5	Base, M3 Independent Point Detector Switch Assembly	N43900103
10	Motor Assembly	PN4511611708
15	Circuit Controller	N4518170502
20	Screw, 3/8” – 16 x 1-1/4” Hex Head	J507372
25	Name Plate, Aluminum	J063117
30	Plate, 1/8” x 1”, Cf Steel	M146595
35	End Cover, Weldment	R43901803
40	Lug	M4516144502
45	Screw, 1/2” – 13 x 1/2” Round Head	J507366
50	Roller, 2” Cf Steel Round	M108315

Item	Description	Part Number
55	Roller, 1 – 3/4” Steel	M074737
60	Bar, Locking	N178100
65	Slide Bar Cam	R146444
70	Roller, 2 – 1/8 Steel Alloy	M061066
75	Bar, Operating	M146441
80	Lug, Switch Point	M146443
85	Wearing Bracket	M189024
90	Key, 3/8 x 1 Steel	M146782
95	Tubing, Rgd PVC 30” L	J034421
100	Conduit, Outlet Component	N238223
105	Terminal Board	N184425
110	Bolt, 3/8” – 16 x 8”, Hex Head	J507369
115	Support, Terminal Board Ci	M172662
120	Rod, Push Component	N180861
125	Strap, 1/8” x 7/8” Steel	M162242
130	Contact, Motor	N226029
135	Bolt, 7/8” – 9 x 3”, Hex Head	J460113
140	Pipe, Smls Steel Tubing	M146723
145	Gasket, 1/4” Felt	M147398
150	Washer	M147409
155	Lock, Yale	PN301050
160	Cover, IPD Controller	N43901301
165	Hood, .0677” x 48” x 120” Steel	M148141
170	Pin, Bronze Phos Round	M209199
175	Crank, Case	M146290
180	Cover, Motor Comp	N289299001
185	Cover, End Closed	R159272
190	Washer - 10 flt Steel Coml	J475077
195	Washer	M002423
200	Washer	M286594
205	Spring, Steel for Lock Movement	M181001
210	Point Detector Bushing Plate, Right Hand Side	M43901402
215	Point Detector Bushing Plate, Left Hand Side	M43901502
220	Cover, Lock Rod, Cast Iron	M165752
225	Plate, 3/16” x 1.7” Steel	M165751
230	Spring, Steel, C No. 12 Wire	J068431

Item	Description	Part Number
235	Screw, 10 - 32 x 1/2” Fl Head	J052091
240	Bushing, IPD Point Detector	M43901901
245	Nut, 2” – 1/8” Steel Round Lock	M223351
250	Collar, 2” Round Cf Steel	M074741
255	Nut, 1/8” Jam	M074742
260	Operating Crank	M071158
265	Cable Clamp, Ch18	J700934
270	Washer	M067454
275	Gear Box Cover	PN152633
280	Cutout, Trigger Component	N146670
285	Stud, 5/16” Steel Round	M146675
290	Nut, 5/16” – 18 UNC 2B Jam	J048007
295	Latch, C. Brass Cutout	M186209
300	Stud, 1/4” Steel Hex	M181032
305	Harness	N281550002
310	Lead	N281552
320	Terminal Connector	M120343
325	Terminal Connector	M022725
330	Clamp, Harness	J703005
335	Controller Frame Comp	N43900701
340	Lock Rod Guide	M43900401
345	Washer, W 08 Sk Lock	J047821
350	Fitting, 1610 Alem Hyd	J039137
355	Lug, Bung Cap W – 14x	J320015
360	Rivet – 1/8” x 1/4” Round Alum	J049910
365	Screw, 1/4” – 20 x 3/4” Fil Head	J052025
370	Screw, 10 – 32 x 9/16” Fil Head	J522151
375	Screw – 3/8” – 16 x 1-1/4” Hex Socket	J0523620003
380	Screw, 1/2” – 13 x 2” Hex Head	J050098
385	Screw, 1/2” – 13 x 3/4” Hex Head	J050086
390	Screw, Cap 1/2” – 13 x 1” Hex Head	J050088
395	Screw, 1/2” – 13 x 1-1/4” Hex Head	J050090
400	Screw, 1/2” – 13 x 1-1/2” Hex Head	J050092
405	Screw, 1/2” x 1-1/2” Sch	J050236
410	Washer, Lock, 3/8” Steel, Ex	J047768
415	Washer, Lock, 1/2” Plate Steel	J047769
420	Washer, Lock, 7/8” Steel, Ex	J047773

Item	Description	Part Number
425	Left Hand/Right Hand IPD Crank	N43900501
430	Nut, 7/8” – 9 UNC 2B Heavy	J048136
435	Cotter Pin, 1/8” x 3/4”, Spring Steel	J048618
440	Cotter Pin, 3/16” x 2”, Spring Steel	J048636
445	Plug, 1/4”, Steel, Galv	J032901
450	Nut, Lock, 3/4”, Conduit	J048415
455	Fitting, 1610 B, Hyd Alem	J039142
460	Screw, 5/16” x 2-1/4”, Hex Head	J050194
465	Stud, IPD Controller	M43900901
475	Washer, 5/16” Steel Plate	J047642
480	Eyebolt, IPD Controller	M43901001
485	Slushing Compound, M-7646	A041390
490	Lubrication, Brake Cylinder, M-7651-2	A041353
495	Tape, .010, M-7136-50	A773010
500	Service Manual	S009671
505	Tag	N4516402902
510	Resistor, 800 Ohms, 30 Watts	N294241
515	Tag	S000333
520	Clamp, Cable, Burndy, Hp 8n	J700590
525	Screw, 8 – 32 x 1-1/4” Round Head Steel	J525111
530	Screw, 8 – 32 x 1/2” Fil Head	J052256
540	Heater Comp	PN253225
545	Plug, 1/8”, Square Head, Steel	J032900
550	Plastic Bag, 60f-0406	J078399
555	Tag Form	S000169
560	Pivot Block, IPD Controller	M43901101
565	Cable Clamp, 3 Pos Ring, 1 – 1/2” Dia. Max	J700589
570	Washer, Lock, No 10, SS	J4751210109
575	Tag Form	S001857
580	Cap Screw, Socket Head, 5/16” – 18 x 1/2”L, Zp	J5000810198
585	Nut, 3/8” – 24 Hex Jam	J480294
595	Cap Screw, Hex Head, 3/8” – 24 x 3/4”L, Clear Zp	J5000810197
600	Hasp, M.I. Cast	N072832
605	Tag, Instruction	S000264
615	Screw, 3/8” x 1-1/2” Hex Head	J050057
620	Pin, Roll – 1/8”D x 7/8”L	J487025

Item	Description	Part Number
625	Screw, 1/4” – 20 x 3/4” Hex Head, SS	J5000970112
630	Nut, 1/2” – 20 Thick, Slotted	J048057
635	Washer, Plate, Flat Steel	J475186
640	Cotter Pin, 3/34” x 1” SS	J048613
645	Screw, 5/16” x 1-1/2” Hex Head	J050042
650	Washer, 5/16” SAE Std Plate	J047897
655	Wire, Tag 12”, Bundle	S705.11
660	Washer, 3/8”, Steel Plate	J047502
665	Washer, Nord Lock, 5/16”, Nl8SS	J4751210153
670	Cover, Point Detector IPD Field Side Left Hand (for Left Hand Switch Machines)	M43901702
	Cover, Point Detector IPD Field Side Right Hand (for Right Hand switch Machines)	M43901701
675	Pt Bar Cover Track Side Left Hand (for Left Hand Switch Machines)	M43902002
	Pt Bar Cover Track Side Right Hand (for Right Hand switch Machines)	M43902001
680	Plate, Cover	M397927001
685	Stud, Hasp	M387732
690	Washer, Lock 1/4” Steel, Med	J047775
695	Washer, 1/2”Plate SAE	J4751200140
700	Mechanism Comp, M-3	PN287485
705	Spacer, 3/8” Round Brass	J725920
710	Plate, Cover	M4516112401
715	Nut, Molded	J048300
720	Screw, 1/2” – 13 x 2-1/2”, Hex Head	J050101
740	Washer, Flt SS, Com 3/8”	J475126
930	Label, Heat, Hot Surface Symbol	J0759550064
935	Label, Electrical Shock Hazard Symbol	J0759550065
945	Label, “CE” Mark	J0759550063
950	Stud, Motor Support	M41000904
955	Strap, 1/8” x 7/8” x 4.26”	M162242001
960	Strap, 1/8” x 7/8” x 3.09”	M162242002
965	Screw, 3/8” – 16 x 3/4”, Hex Head	J050051
970	Washer, Lock, 3/8”, SS	J4751210113
975	Plug, 1/2” Pipe, Steel	J032904
980	Washer, Lock, 5/16” Plate, Steel	J047526
985	Nut, 5/16” – 18 UNC 2B	J048006
990	Washer, 3/8” SAE Steel Plate	J047886

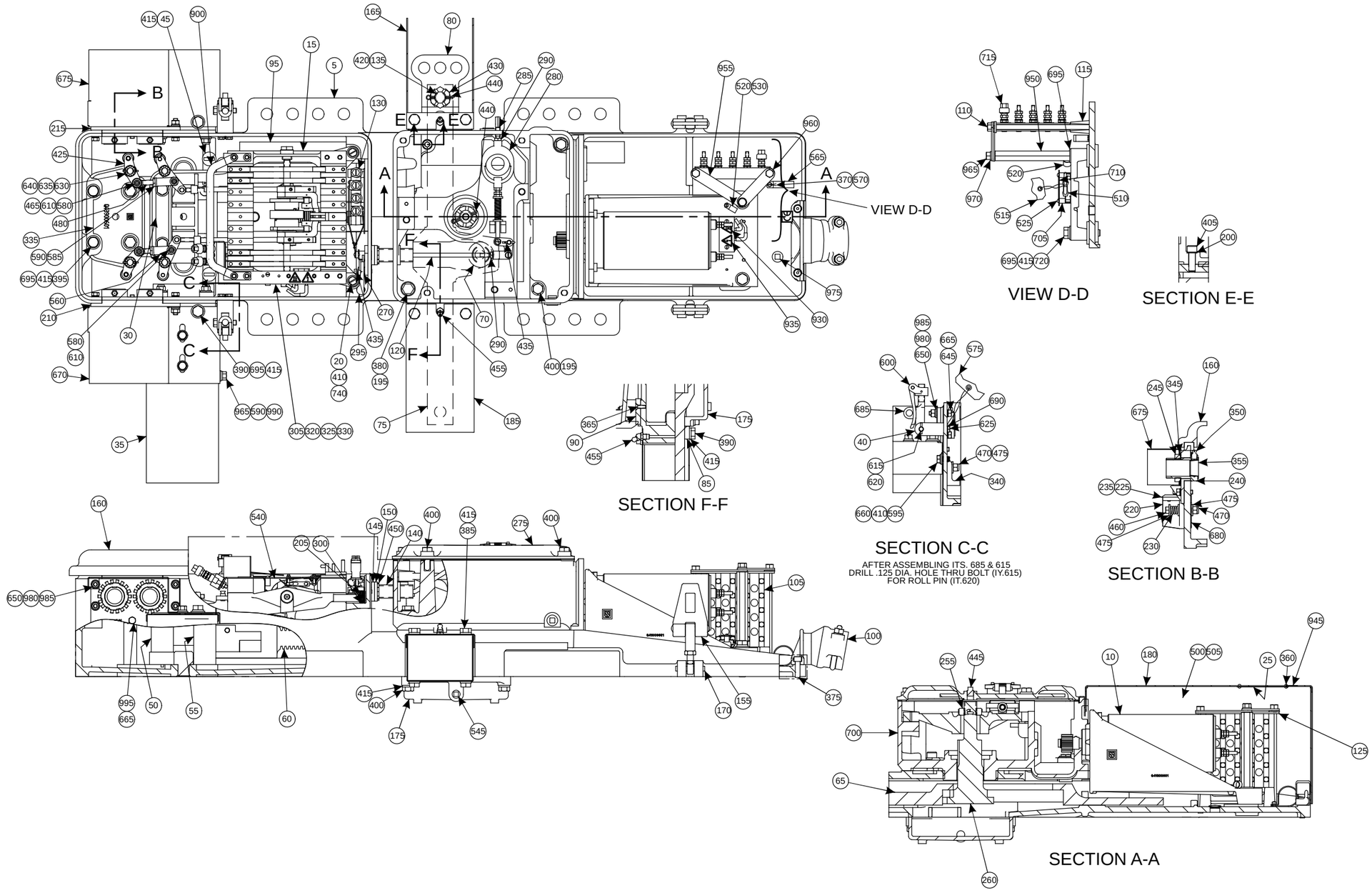


Figure 7–1 - M-3 IPD Switch Machine

7.6 M-23A and M-23B IPD Switch Machine Parts List

Table 7-6 lists the parts for the M-23A and M-23B IPD switch machine assemblies. Refer to Figure 7–2 for the location of the items on the assembly.

Table 7-6 - M-23A and M-23B IPD Switch Machine Parts List

Item	Description	Part Number
5	Base, M23 IPD Switch Assembly	N43900104
10	110 VDC Motor Assembly	N4511611701
15	Circuit Controller	N4518170503
20	Screw, 3/8” -16” x 1-1/4”, Hex Head	J507372
25	Name Plate, Aluminum	J063117
30	Plate,1/8” x 1”, Cf Steel	M146595
35	End Cover, Weldment	R43901803
40	Lug	M4516144502
45	Screw, 1/2” -13 x 1/2” Round Head	J507366
50	Roller, 2” Cf Steel, Round	M108315
55	Roller, 1-3/4”, Steel	M074737
60	Bar, Locking	N178100
65	Slide Bar Cam	R146444
70	Roller, 2-1/8”, Steel Alloy	M061066
75	Bar, Operating	M146441
80	Lug, Switch Point	M146443
85	Wearing Bracket	M189024
90	Key, 3/8” x 1” Steel	M146782
95	Tubing, Rgd, PVC, 30” L	J034421
100	Conduit, Outlet Component	N238223
105	Board, Terminal	N184425
110	Bolt, 3/8” -16 x 8”, Hex Head	J507369
115	Terminal Board Support, Ci	M172662
125	Strap,1/8” x 7/8”, Steel	M162242
130	Contact, Component	N226028
135	Bolt, 7/8” -9 x 3”,Hex Head	J460113
140	Nipple, 3/4”, Brass Tubing, Pipe	M286599
145	Gasket, 1/4”, Felt	M147398
150	Washer	M147409
155	Lock, Yale	PN301050
160	Cover, IPD Controller	N43901301

Item	Description	Part Number
165	Hood, .0677” x 48” x 120”, Steel	M148141
170	Pin, Bronze Phos, Round	M209199
175	Crank, Case	M146290
180	Cover, Motor Comp	N289299001
185	Cover, End Closed	R159272
190	Washer, 10 flt Steel, Coml	J475077
195	Washer	M002423
200	Washer	M286594
210	Point Detector Bushing Plate, Right Hand Side	M43901402
215	Point Detector Bushing Plate, Left Hand Side	M43901502
220	Cover, Lock Rod, Cast Iron	M165752
225	Plate, 3/16” x 1.7” Steel	M165751
230	Spring, Steel, C No 12 Wire	J068431
235	Screw,10 – 32 x 1/2”, Fl Head	J052091
240	Bushing, IPD Point Detector	M43901901
245	Nut, 2-1/8” Steel Rd, Lock	M223351
265	Cable Clamp, Ch18	J700934
305	Harness	N281550002
310	Lead	N281552
320	Terminal Connector	M120343
325	Terminal Connector	M022725
330	Clamp, Harness	J703005
335	Controller Frame Comp	N43900701
340	Lock Rod Guide	M43900401
345	Washer, W 08, Sk Lock	J047821
350	Fitting, 1610, Alem Hyd	J039137
355	Lug, Bung, Cap W-14x	J320015
360	Rivet, 1/8” x 1/4”, Round Alum	J049910
365	Screw, 1/4” -20 x 3/4”, Fil Head	J052025
370	Screw, 10 – 32 x 9/16”, Fil Head	J522151
375	Screw, 3/8” -16 x 1-1/4”, Hex Socket	J0523620003
380	Screw, 1/2” – 13 x 2”, Hex Head	J050098
385	Screw, 1/2” – 13 x 3/4”, Hex Head	J050086
390	Screw, Cap, 1/2” -13 x 1”, Hex Head	J050088
395	Screw, 1/2” – 13 x 1-1/4”, Hex Head	J050090
400	Screw, 1/2” – 13 x 1-1/2”, Hex Head	J050092

Item	Description	Part Number
405	Screw, 1/2” x 1-1/2”, Sch	J050236
410	Washer, Lock, 3/8”, Steel, Ex	J047768
415	Washer, Lock, 1/2”, Plate Steel	J047769
420	Washer, Lock, 7/8”, Steel, Ex	J047773
425	Left Hand/Right Hand IPD Crank	N43900501
430	Nut, 7/8 – 9, UNC 2B Hvy	J048136
440	Cotter Pin, 3/16” x 2”, Spring Steel	J048636
450	Nut, 3/4”, Conduit Lock	J048415
455	Fitting,1610B, Hyd Alem	J039142
460	Screw, 5/16” x 2-1/4”, Hex Head	J050194
465	Stud, IPD Controller	M43900901
475	Washer, 5/16”, Steel Plate	J047642
480	Eyebolt, IPD Controller	M43901001
485	Slushing Compound, M-7646	A041390
490	Lubrication, Brake Cylinder, M-7651-2	A041353
495	Tape, .010, M-7136-50	A773010
500	Service Manual	S009739
505	Tag	N4516402902
545	Plug, 1/8”, Square Head, Steel	J032900
550	Plastic Bag, 60f-0406	J078399
555	Tag Form	S000169
560	Pivot Block, IPD Controller	M43901101
565	Cable Clamp, 3 Pos Ring, 1-1/2” Dia. Max	J700589
570	Washer, Lock, No 10, SS	J4751210109
575	Tag Form	S001857
580	Cap Screw, Socket Head, 5/16” – 18 x 1/2” L,Zp	J5000810198
585	Nut, 3/8” – 24, Hex Head, Jam	J480294
590	Washer, Lock, 3/8” Steel, Med	J047779
595	Cap Screw, Hex Head, 3/8” – 24 x 3/4” L,Clear Zp	J5000810197
600	Hasp, M.I. Cast	N072832
605	Tag, Instruction	S000264
615	Screw, 3/8” x 1-1/2”, Hex Head	J050057
620	Pin, Roll, 1/8”D x 7/8”L	J487025
625	Screw, 1/4” – 20 x 3/4”, Hex Head, SS	J5000970112
630	Nut,1/2-20, Thick Slotted	J048057
635	Washer, Plate Flat, Steel	J475186

Item	Description	Part Number
640	Cotter Pin, 3/32” x 1” SS	J048613
645	Bolt, 5/16” x 1-1/2” Hex Head (for Left Hand Switch Machines)	0.00165265
	Screw, 5/16” x 1-1/2”, Hex Head (for Right Hand Switch Machines)	J050042
650	Washer, 5/16”, SAE, Std Plate	J047897
655	Wire, Tag, 12” Bundle	S705.11
660	Washer, 3/8”, Steel Plate	J047502
665	Washer, Nord Lock, 5/16”,Nl8SS	J4751210153
670	Cover, Point Detector IPD Field Side Left Hand (for Left Hand Switch Machines)	M43901702
	Cover, Point Detector IPD Field Side Right Hand (for Right Hand Switch Machines)	M43901701
675	Point Bar Cover, Track Side, Left Hand (for Left Hand Switch Machines)	M43902002
	Point Bar Cover, Track Side, Right Hand (for Right Hand Switch Machines)	M43902001
680	Plate, Cover	M397927001
685	Stud, Hasp	M387732
690	Washer, Lock, 1/4” Steel, Med	J047775
695	Washer, 1/2” Plate, SAE	J4751200140
700	Gear Box, M23A, Left Hand	N287073
	Gear Box, M23A, Right Hand	N2870730001
	Gear Box, M23B, Left Hand	N287076
	Gear Box, M23B, Right Hand	N2870760001
715	Nut, Molded	J048300
720	Screw, 1/2” – 13 x 2-1/2” Hex Head	J050101
740	Washer, Flt,Com, 3/8”, SS	J475126
745	Rod, Motor Cutout	N286607
750	Bushing, 1-1/8”, Hex Steel	M308325
755	Lever, Selector	M274597
760	Hand Throw Lever	R43925601
765	Motor Plate	M287198
770	Plate, Hand	M287199
775	Ball, 3/4”, Std, Steel	J066012
780	Screw, 3/8” – 16 x 1/2” Hex Head	J050049
785	Screw, 1/4” – 20 x 7/16” Fil Head	J052174
790	Screw, 1/2” – 13 x 1-3/4”	J050237
800	Coil, Spring	M286589
805	Bushing, 1/2” x .502 Oilite Bearing	M399589

Item	Description	Part Number
945	Label, “CE” Mark	J0759550063
950	Stud, Motor Support	M41000904
955	Strap, 1/8” x 7/8” x 4.26”	M162242001
960	Strap, 1/8” x 7/8” x 3.09”	M162242002
965	Screw, 3/8” – 16 x 3/4”, Hex Head	J050051
970	Washer, Lock, 3/8”, Steel, Ex (for M-23A Switch Machines)	J047768
	Washer, Lock, 3/8”, Steel, Ex (for M-23B Switch Machines)	J4751210113
975	Plug, 1/2”, Pipe, Steel	J032904
980	Washer, Lock, 5/16”, Plate Steel	J047526
985	Nut, 5/16” – 18, UNC 2B	J048006
990	Washer, 3/8”, SAE, Plate Steel	J047886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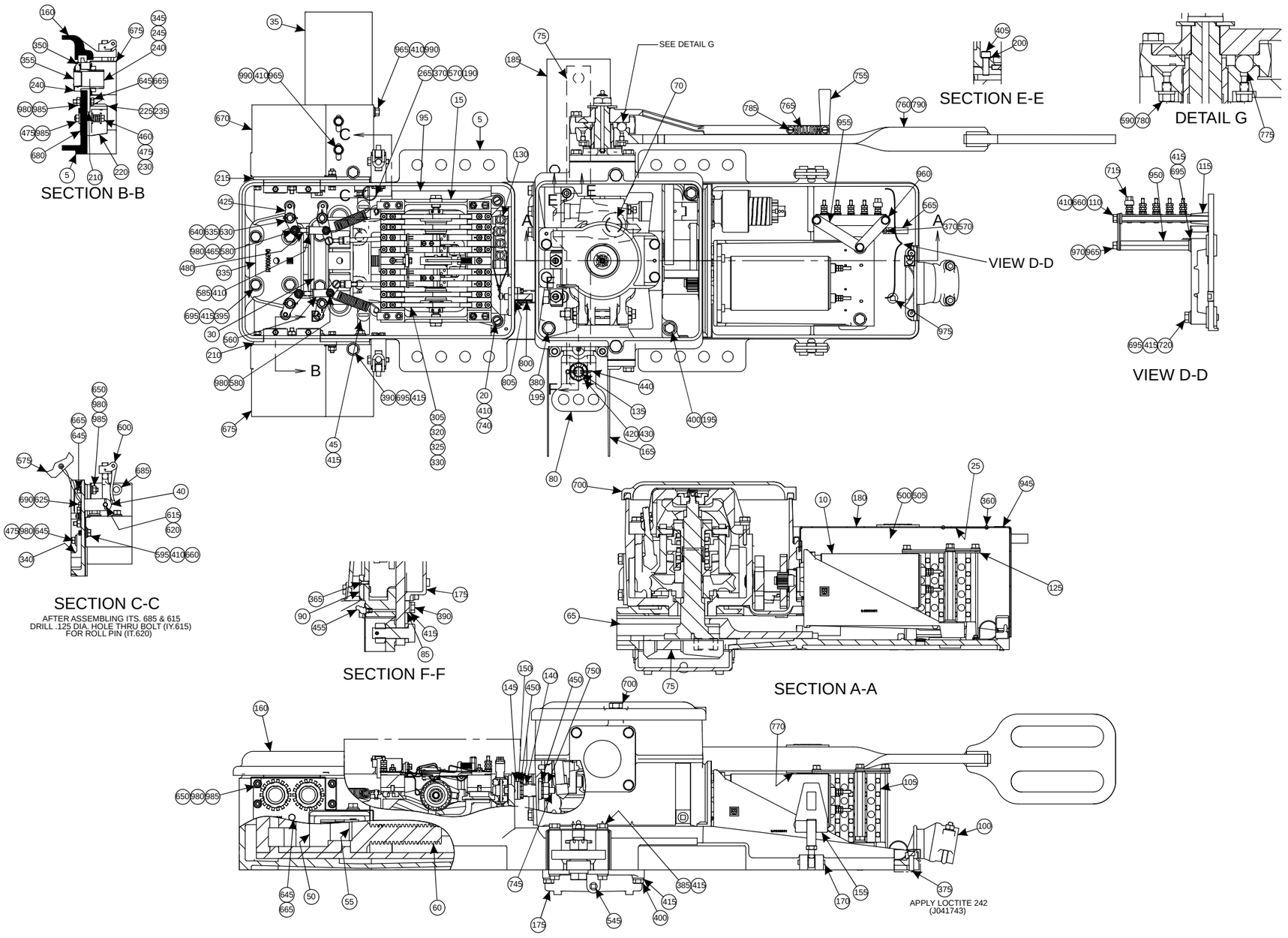

Figure 7–2 - M-23A and M-23B IPD Switch Machine

7.7 M-3 Gearbox

Table 7-6 lists the parts for the gearbox used on the M-3 IPD switch machine assemblies. Refer to Figure 7–3 for the location of the items on the assembly.

Table 7-7 - M-3 IPD Switch Machine Gearbox Parts List

Item	Description	Part Number
5	Gear Box Comp	N287085
10	Bearing, Top Component	PN146606
15	Shaft, Worm	M286612
20	Housing Clutch	N172752
25	Plate, End	M146575
30	Plate, Clutch	M146574
35	Clutch, Plate	M146573
40	Disc, Lining 3/16” Thk	M146650
45	Spring, Steel, Friction Clutch	M239322
50	Nut, Adj.	M286615
55	Gasket, Felt	J047335
60	Washer	M245192
65	Plate, .0966” x 48” x 120” Steel	M147400
70	Gasket, 1/32” x 36”, Vellm	M147410
75	Cap, Bearing Cast Iron	M274596
80	Gear, Clutch	N286583
85	Gear, Bevel	M286995
90	Gear, Bevel	M146377
95	Shaft, 3/4” Dia., Steel	M149700
100	Reduction Gear	M286576
120	Shaft, End Plate	M286587
125	Pin, 1/4” x 1-1/4” Dowel	J048925
130	Bushing, Oilite, 2" Dia x 1/4"	J079694
140	Gear, Shaft	M292426
145	Hasp, Lug	M165738
150	Screw, 1/4” – 20 x 3/4” Hex Head, SS	J5000970112
155	Screw, 5/16” x 3/4” Hex Head	J050036
160	Screw, 1/2” – 13 x 1-1/4” Hex Head	J050090
165	Screw,1/2” – 13 x 1-1/2” Hex Head	J050092
170	Washer, 5/16” Plate Lock Steel	J047526
175	Washer, 1/2” Plate Steel Lock	J047783

Item	Description	Part Number
180	Plug, 1/2” Pipe, Steel	J032904
185	Bearing, Ball, Angular Contact, D-Row, 35mm	J066032
190	Bearing, Ball Single Row	J066246
195	Washer, Wh-07, Skf Lock	J047810
200	Nut, N 07, Skf Lock	J048575
205	Key, 9wdf 3/4” x 3/16”	J048755
210	Cotter Pin, 3/16” x 2”, Spring Steel	J048636
215	Ring, External Retaining	J790076
220	Seal, Garlock 556 Ol	J790261
225	Worm Gear	M074805

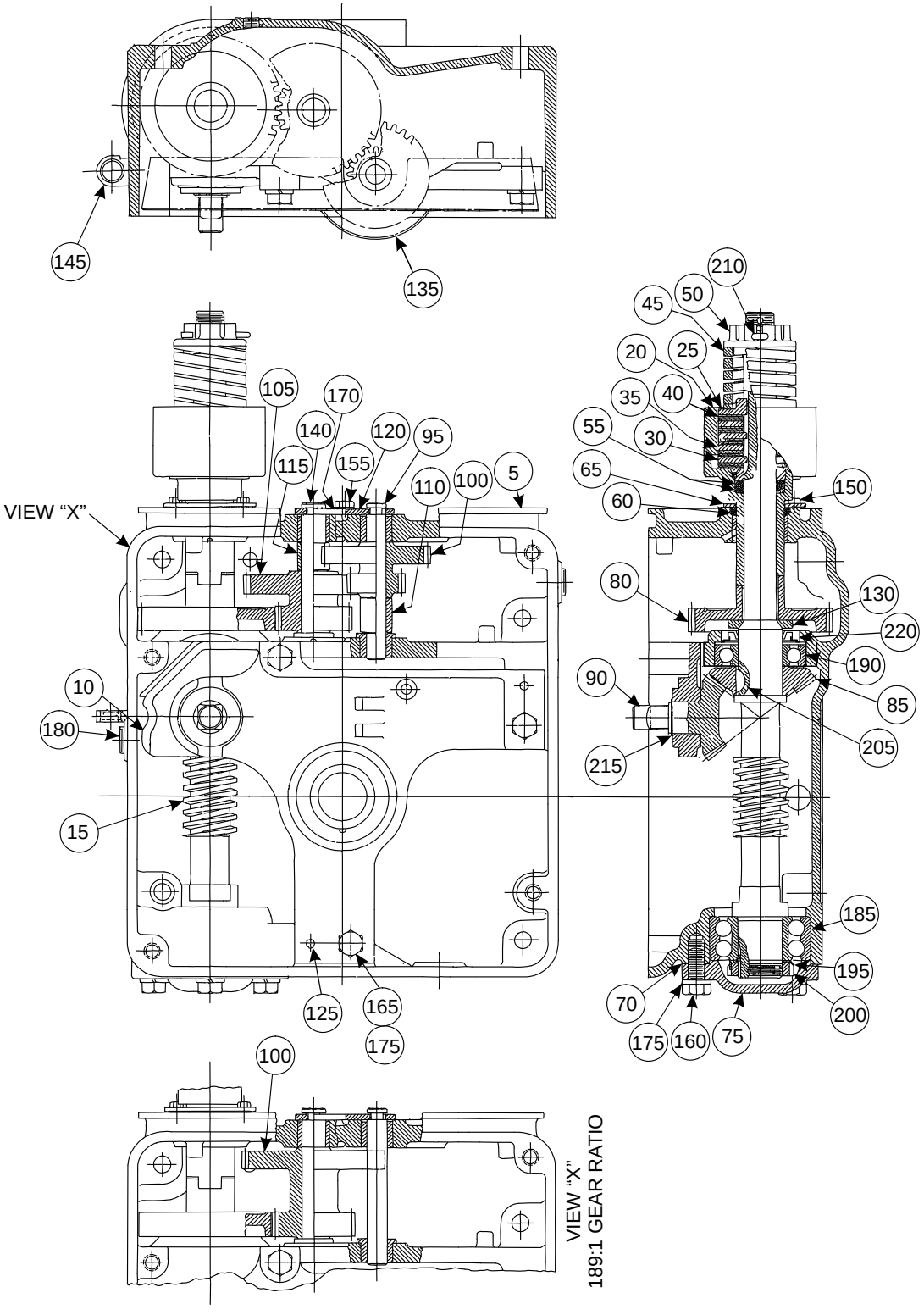

Figure 7–3 - M-3 IPD Switch Machine Gearbox

7.8 M-23A and M-23B Gearbox

Table 7-8 lists the parts for the gearbox used on the M-23a and M-23B IPD switch machine assemblies. Refer to Figure 7–4 for the location of the items on the assembly.

Table 7-8 - M-23A and M-23B IPD Switch Machine Gearbox Parts List

Item	Description	Part Number
1	Gear, Box Component	N286623
2	Top Bearing	M274599
3	Shaft, Worm	M286612
4	Clutch Housing	N172752
5	Plate, End	M146575
6	Plate, Clutch	M146574
7	Clutch, Plate	M146573
8	Disc, Lining, 3/16” Thick	M146650
9	Spring, Steel Friction Clutch	M239322
10	Nut, Friction Clutch Adjust	M438402001
11	Gasket, Felt	J047335
12	Washer, Felt	M245192
13	Plate,.0966” x 48” x 120” Steel	M147400
14	Gasket, 1/32” x 36”, Vellm	M147410
15	Cap, Bearing Cast Iron	M274596
16	Gear, Clutch	N286583
17	Sleeve, 1-5/8” Steel Round	M286593
18	Gear, Worm	M286620
19	Gear,Bevel (for M-23A Switch Machine)	M286616
	Gear,Bevel (for M-23B Switch Machine)	M286617
20	Gear, Bevel, Hand Throw	M286611
21	Crank, Main	M302731
22	Hand Throw Lever Shaft	M286618
23	Lever, Shaft	M286619
24	Shaft, 3/4” Dia. Steel	M149700
25	Reduction Gear	M286576
26 – 28	Not Used	NA
29	Shaft,End Plate	M286587
30	Pin, 1/4” x 1-1/4”, Dowel	J048925
31	Bushing, 2.5” Dia. Brass	M169502
32	Key, 3/16” x 3/8” Steel	M174967

Item	Description	Part Number
33		
34	Bushing, 1-5/8", Steel Round	M169503
35	Coupling Comp	PN302735
36	Clutch Shifter Yoke	PN286622
37	Roller, 7/8" Dia. Steel	M217537
38	Roller, 1" Dia. Steel	M217538
39	Stud, Upper Roller	M261981
40	Yoke, Eccentric Bushing	M261980
41	Cover, Gear Train	M286603
42	Shaft, 1" Cp Steel Round	M286596
43	Washer	M286584
44	Cam, Follower Rod	M286614
45	Cutout, Rod Adjuster	M286613
46	Washer	M286595
47	Screw,1/2" – 13 x 6" Hex Head	J050251
48	Gasket, 1/64 Seigelite Ppr	M286585
49	Yoke Support	M274598
50	Bearing, Lever Shaft	M274603
51	Gear, Shaft	M292426
52	Lever, Support	M274602
53	Gearbox Cover	N288677
54	Bushing, Oilite, 2" Dia x 1/4"	J079694
55	Seal, Garlock 556 OL	J790261
56	Fitting,1610 Alem Hyd	J039137
57	Washer, 7/8" Steel Plate	J047508
58	Washer, 7/8" Steel Lock, Med	J047742
59	Screw, 3/8" – 16" x 1-1/2" Square	J050621
60	Nut, 3/8" - 16 UNC 2B Jam	J048010
61	Washer, Lock, 3/8", SS	J047779
62	Nut, 7/8" - 9 UNC 2B Jam	J048069
63	Cotter, 3/16" x 2" Spring Steel	J048636
64	Screw, 1/2" – 13 x 2-1/2" Hex Head	J050101
65	Screw, 1/2" – 13 x 4-3/4" Hex Head	J050107
66	Screw, 5/8" – 11 x 2" Hex Cap	J050115
67	Screw,1/2" – 13 x 1-1/2" Hex Head	J050092
68	Screw, 1/2" – 13 x 1-3/4" Hex Head	J050095

Item	Description	Part Number
69	Screw, 1/2” – 13 x 1-1/4” Hex Head	J050090
70	Screw, 1/4” – 20 x 3/4” Hex Head SS	J050016
71	Screw, 5/16” x 3/4” Hex Head	J050036
72	Washer, 5/16” Plate, Lock, Steel	J047526
73	Nut, 1/2-13 UNC 2B Heavy	J048013
74	Bearing, Ball, Angular Contact, D-Row, 35mm	J066032
75	Bearing, Ball Single Row	J066246
76	Washer, W-07, Skf Lock	J047810
77	Nut, N-07, Skf Lock	J048575
78	Nut, 1/2” – 20 Castellated	J048057
79	Pin, Cotter, 3/32" x 1" SS	J048613
80	Plug, 1/2” Pipe, Steel	J032904
81	Nut, 1/2” – 13 UNC 2B Jam	J048016
82	Washer, 1/2” Plate Steel, Lock	J047783
83	Washer, 9/16” SAE, Lt Tp	J047877

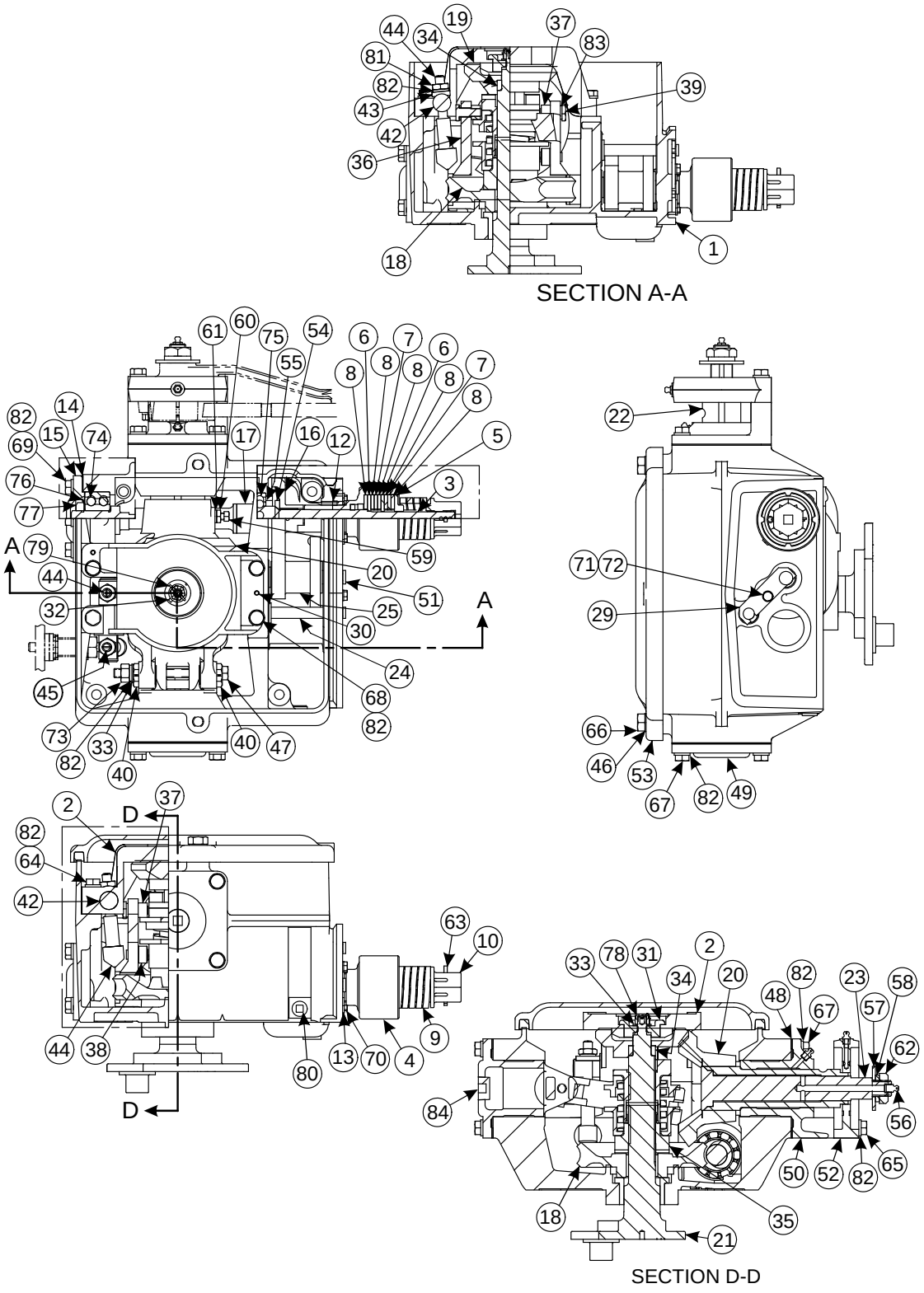

Figure 7–4 - M-23A/M-223B IPD Switch Machine Gearbox

7.9 IPD Circuit Controller

Table 7-9 lists the parts for the circuit controller used on the M-3, M-23A, and M-23B IPD switch machine assemblies. Refer to Figure 7–5 for the location of the items on the assembly.

Table 7-9 - M-3, M-23A, and M-23B IPD Switch Machine Circuit Controller Parts List

Item	Description	Part Number
1	Frame, Complete	PN284499
2	Idler Bearing (Includes Ref. 59)	PN338004
3	Bracket	M284493
4	Yoke, Complete	PN284681
5	L.H. Crank	PN284650
6	R.H. Crank	PN284649
7	Connecting Rod	PN338005
8	Latch	M284495
9	Eccentric Bushing	PN284653
10	Coil Spring	M142167
11	Short Circuiting Strip Support	M074427
12	Eye Bolt	M164921
13	Spring, Lever	J068952
14	Terminal Board	J077705
15	Terminal	M146475
16	Terminal Connector	M146476
17	Terminal Connector	PN146478
18	Insulation	M142173
19	Terminal Post	M138723
20	Nut	M026545
21	Terminal Post	M048854
22	Washer	J047818
23	Nut	J480300
24	Spring Indication	N284721
25	Spring	M074783
26	Spring	M138718
27	Spring	M074777
28	Spring	M045269
29	Spring	M172380
30	Short Circuiting Strip	M175725
31	Stud	M152038

Item	Description	Part Number
32	Plate	M146775
33	Screw	M056236
34	Trunnion	M055305
35	Trunnion	M285410
36	Nut	M050258
37	Washer	M042627
38	Washer	M042585
39	Washer	M048692
40	Contact Segment	M045942
41	Insulating Bushing	J078019
42	Indication Cam	M284494
43	Washer	J475180
44	Cam Spring	J068281
45	Gear	PN284679
46	Main Shaft	M282431
47	Screw	J050731
48	Pin, Operating	M285389
49	Washer	J475186
50	Nut, Hex.	J048005
51	Latch Pin	M284718
52	Screw	M285432
53	Screw	M236061
54	Shim	M134595
55	Contact Spring	M251938
56	Stop Spring	M251939
57	Stop Spring	M251940
58	Spring Seat	M285393
59	Screw	J052362
60	Washer	M339088
61	Soft Black Iron W-18	A043025
62	Bolt, 5/16-18x3/4 Hex Hd.	M451358-3324
63	Lock Washer	J047767
64	Washer	J047766
65	Lock Washer	J4751210113
66	Cotter Pin	J048686
67	Cotter Pin	J048613

Item	Description	Part Number
68	Cotter Pin	J486001
69	Fitting, Hyd. 90 degree Ell. 1/8 NPT	J039150
70	Retaining Ring	J790074
71	Fiber Washer	M056203
72	Nut	J480301
73	Shim (.016”)	M451161-4902
74	Shim (.026”)	M451161-4903
75	Nut	J048057
76	Washer	J047526
77	Heater., Complete	PN253225
78	Screw	J052219
79	Washer	J475120-0113
80	Tie Bar, Long	N439065
81	Tie Bar, Short	N439066
82	Gear	N294584

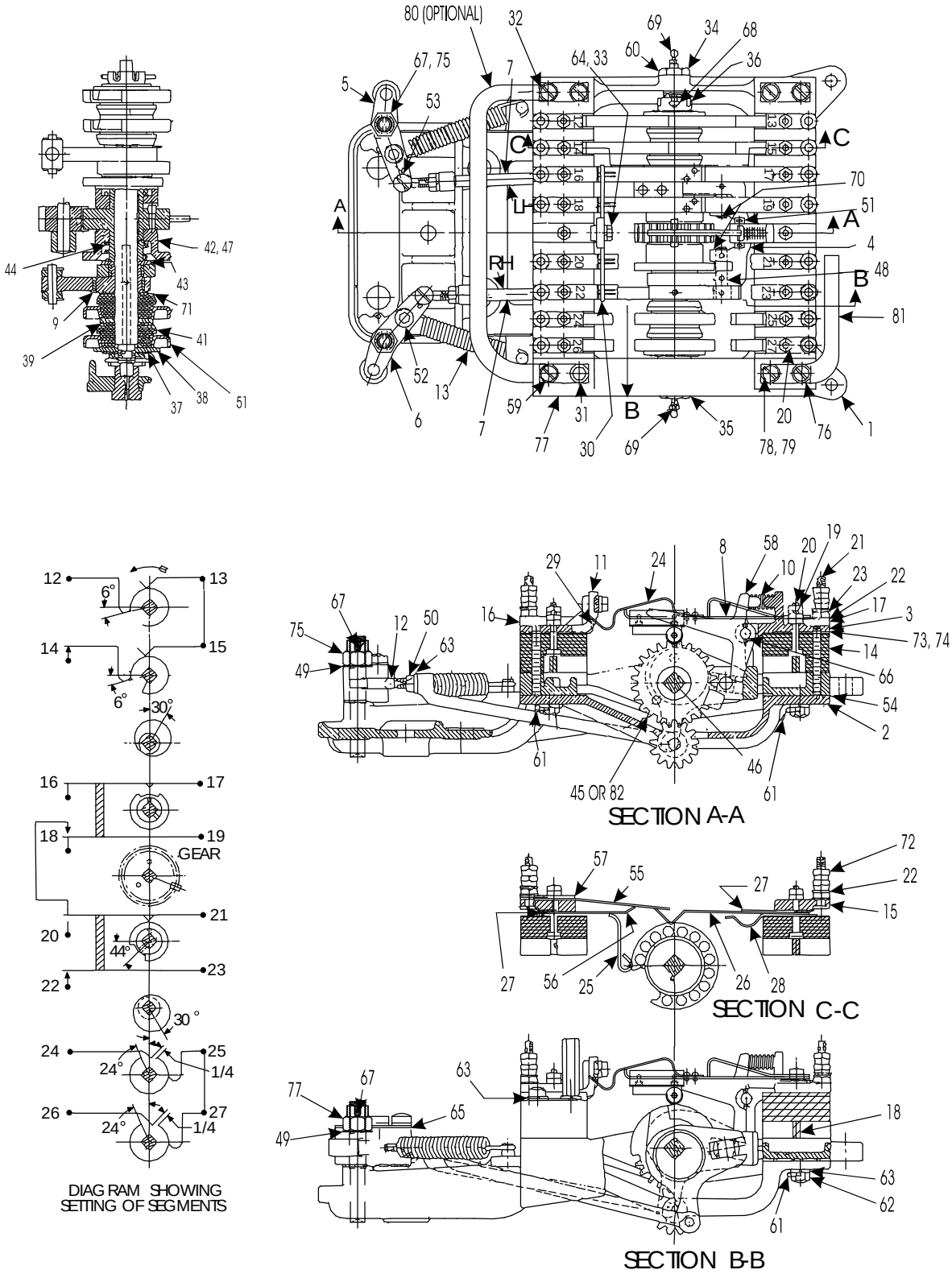

Figure 7–5 - M-3, M-23A, and M-23B IPD Switch Machine Circuit Controller Parts Location

7.10 Standard Base Complete For M-3, M-23A and M-23B

Table 7-10 lists the bases used on the M-3, M-23A, and M-23B IPD switch machine assemblies.

Table 7-10 - Standard Bases for the IPD Switch Machine

Machine	Arranged for Special Equipment	Part Number
M-3	Standard Base	N43900103
M-23A/M-23B	Machined Mounting Lugs	N43900104

7.11 Motor Assembly

Table 7-11 lists the part on the motor assemblies used on the M-3, M-23A, and M-23B IPD switch machine assemblies. Refer to Figure 7–6 for the location of the items on the assembly.

Table 7-11 - M-3, M-23A, and M-23B IPD Switch Machine Motor Assembly Parts List

Item	Description	Part Number
5	Motor Frame Adapter	M41000602
10	“Blue” Motor-Electric 110 VDC (189:1 Gear Ratio)	J717216-0301
	“Blue” Motor-Electric 20 VDC (360:1 Gear Ratio)	J717216-0302
	“Blue” Motor-Electric 20 VDC (528:1 Gear Ratio)	J717216-0303
	“Blue” Motor-Electric 110 VDC (189:1 or 360:1 Gear Ratio)	J7172160304
	“Blue” Motor-Electric 110 VDC (189:1 or 360:1 Gear Ratio)	J7172160305
	Brush Replacement Kit	See Section 7.12
	Spring Replacement Kit	See Section 7.12
25	Screw, 3/8” x 1 Fl Head, SS	J5001240002
30	Gear	M4511611601
35	Key, 3/16” Steel, Square	M4511611305
40	Screw, 10 – 32 x 1/4” Allen Head	J507363
45	External Retaining Snap Ring	J792852
65	Lock Washer, 5/16” External Countersink	J4751430001
70	Lock Washer, 3/8” External Countersink	J4751430002

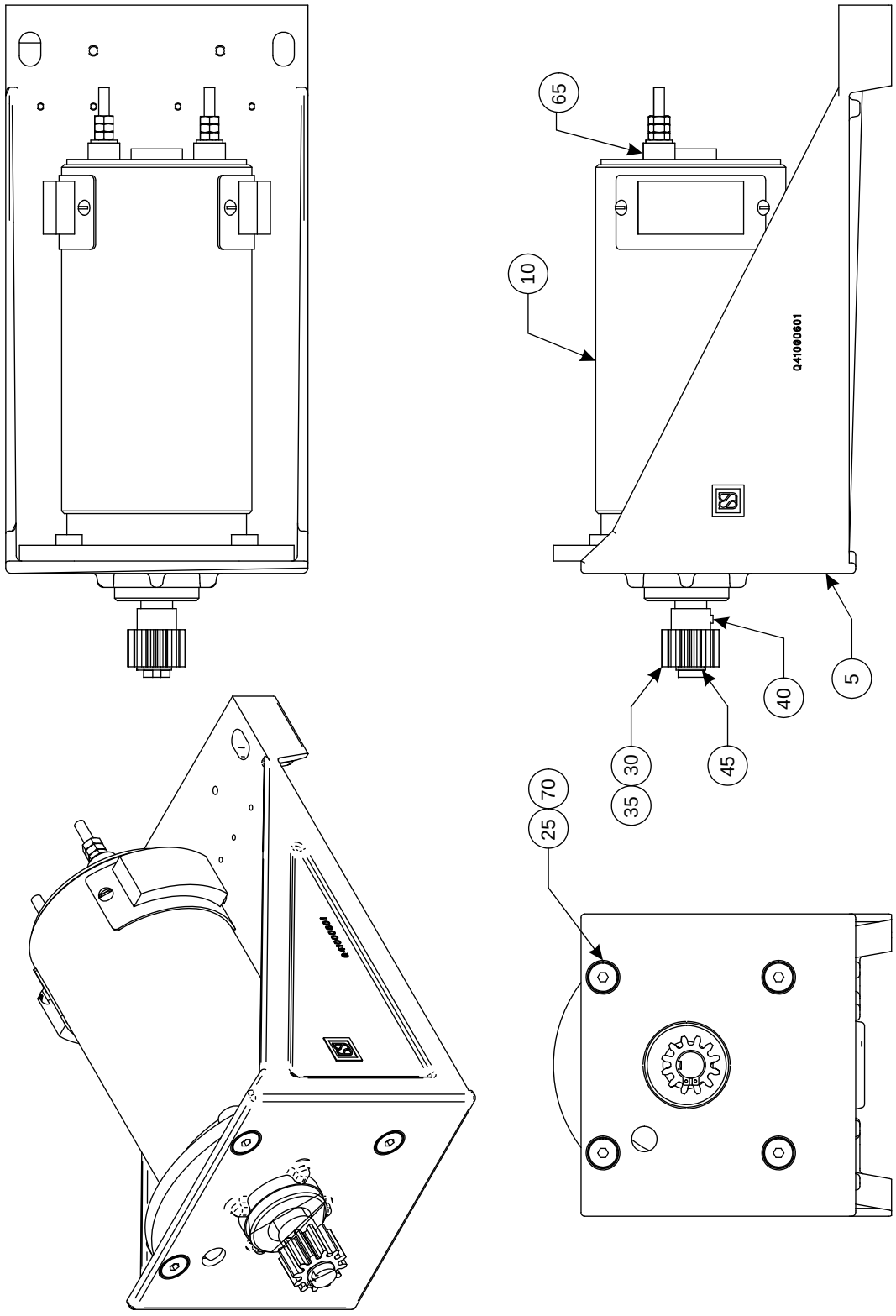

Figure 7–6 - Motor Assembly

7.12 Motor Brushes

Table 7-11 lists the part on the motor assemblies used on the M-3, M-23A, and M-23B IPD switch machine assemblies.

Table 7-12 - Brush Sets used on the M-3, M-23A, and M-23B IPD Switch Machines

Motor Part Number	Brush Kit Part Number	Spring Kit Part Number
J717216-0301	X41000004	X41000005
J717216-0302	X41000006	X41000007
J717216-0303	X41000006	X41000007
J717216-0304	J0642050004	J680206
J717216-0305	J0642050004	J680206

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 at 1-800-652-7276 or by e-mail at railteam@switch.com.


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