Installation

Table of Contents

Qualified Persons

⚠ WARNING

Only qualified persons knowledgeable in the installation, operation, and maintenance of overhead and underground electric transmission and distribution equipment, along with all associated hazards, may install, operate, and maintain the equipment covered by this publication. A qualified person is someone trained and competent in:

- The skills and techniques necessary to distinguish exposed live parts from nonlive parts of electrical equipment
- The skills and techniques necessary to determine the proper approach distances corresponding to the voltages to which the qualified person will be exposed
- The proper use of special precautionary techniques, personal protective equipment, insulated and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment

These instructions are intended only for such qualified persons. They are not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment.

Read this Instruction Sheet

NOTICE

Thoroughly and carefully read this instruction sheet and all materials included in the product's instruction handbook before installing or operating the Mark VI Circuit-Switcher. Become familiar with the Safety Information on pages 3 through 4 and Safety Precautions on page 5. The latest version of this publication is available online in PDF format at **sandc.com/en/contact-us/product-literature/**.

Retain this Instruction Sheet

This instruction sheet is a permanent part of the Mark VI Circuit-Switcher. Designate a location where users can easily retrieve and refer to this publication.

Proper Application

⚠ WARNING

The equipment in this publication is only intended for use in the switching and protection of capacitor banks and substation transformers. The application must be within the ratings furnished for the equipment. The ratings for this Mark VI Circuit-Switcher are listed on the nameplate on the side of the Mark VI CS-1A Switch Operator. They can also be found in S&C Specification Bulletin 712-31.

Understanding Safety-Alert Messages

Several types of safety-alert messages may appear throughout this instruction sheet and on labels and tags attached to the product. Become familiar with these types of messages and the importance of these signal words:

⚠ DANGER

"DANGER" identifies the most serious and immediate hazards that will likely result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ WARNING

"WARNING" identifies hazards or unsafe practices that can result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ CAUTION

"CAUTION" identifies hazards or unsafe practices that can result in minor personal injury if instructions, including recommended precautions, are not followed.

NOTICE

"NOTICE" identifies important procedures or requirements that can result in product or property damage if instructions are not followed.

Following Safety Instructions

If any portion of this instruction sheet is unclear and assistance is needed, contact the nearest S&C Sales Office or S&C Authorized Distributor. Their telephone numbers are listed on S&C's website **sandc.com**, or call the S&C Global Support and Monitoring Center at 1-888-762-1100.

NOTICE

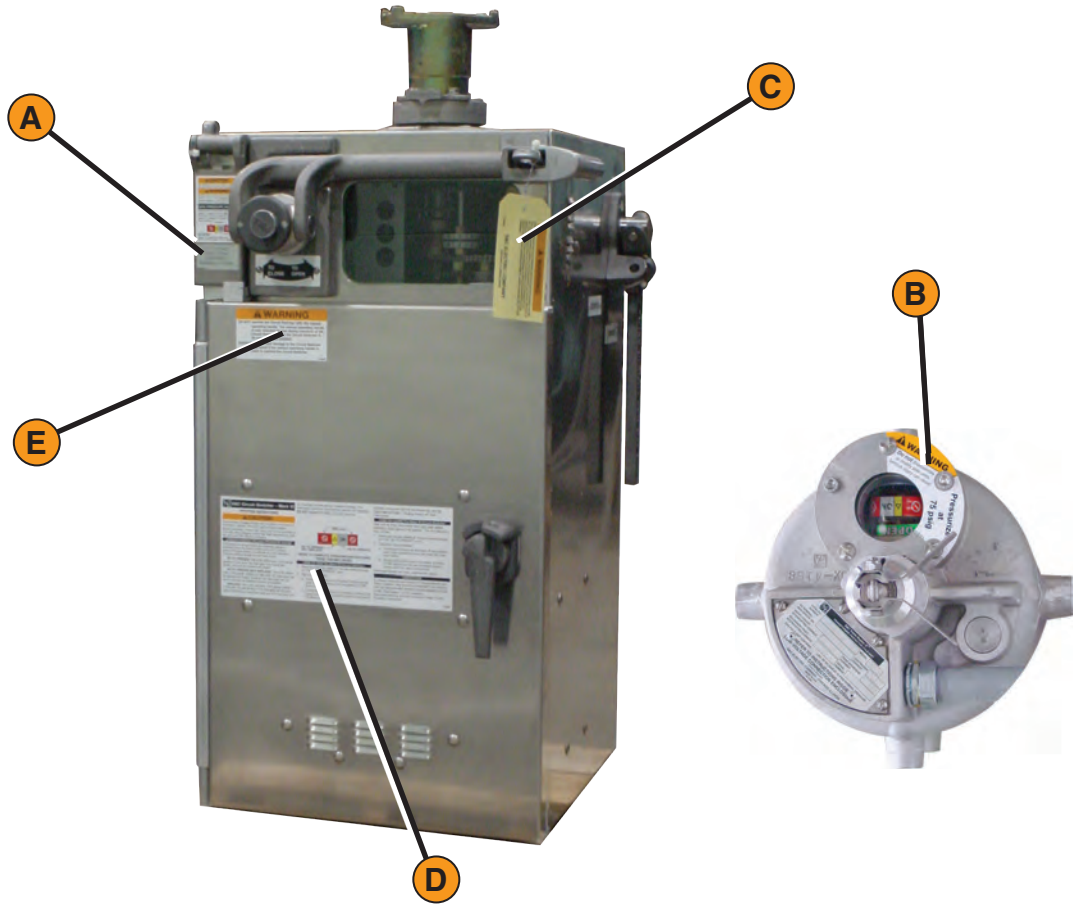
Read this instruction sheet thoroughly and carefully before installing the S&C Mark VI Circuit-Swtcher.

Replacement Instructions and Labels

If additional copies of this instruction sheet are required, contact the nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

It is important any missing, damaged, or faded labels on the equipment be replaced immediately. Replacement labels are available by contacting the nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

Location of Safety Labels



Reorder Information for Safety Labels

Location	Safety Alert Message	Description	Part Number
A	⚠ WARNING	Use push button control to open or close . . .	G-9025
B	⚠ WARNING	Do not disassemble or modify . . .	G-7015-5
C	⚠ WARNING	Do not operate the Circuit-Switcher with . . .	G-9024
D	⚠ WARNING	Unauthorized changes should not be made . . .	G-9027
E	⚠ WARNING	Do not operate the Circuit-Switcher with . . .	G-9026
F	*NOTICE*	This contactor or relay has been blocked...	G-3684R4●■
G	*NOTICE*	The S&C Instruction Sheet is a permanent part...	G-3733R2■
H	*NOTICE*	Auxiliary switch cams are individually adjustable.	G-4746R2■

● Label should be removed before placing the circuit-switcher in service.

■ Label is inside the operator and not visible in photo.

⚠ DANGER

Mark VI Circuit-Switchers operate at high voltage. Failure to observe the precautions below will result in serious personal injury or death.

Some of these precautions may differ from your company's operating procedures and rules. Where a discrepancy exists, follow your company's operating procedures and rules.

1. **QUALIFIED PERSONS.** Access to substation switching equipment must be restricted only to qualified persons. See "Qualified Persons" on page 2.
2. **SAFETY PROCEDURES.** Always follow safe operating procedures and rules.
3. **PERSONAL PROTECTIVE EQUIPMENT.** Always use suitable protective equipment such as rubber gloves, rubber mats, hard hats, safety glasses, and flash clothing in accordance with safe operating procedures and rules.
4. **SAFETY LABELS.** Do not remove or obscure any of the "DANGER," "WARNING," "CAUTION," or "NOTICE" labels.
5. **ENERGIZED COMPONENTS.** Always consider all parts live until de-energized, tested, and grounded. Voltage levels can be as high as the peak line-to-ground voltage last applied to the unit. Units that have been energized or installed near energized lines should be considered live until tested and grounded.
6. **GROUNDING.** The Mark VI Circuit-Switcher must be connected to a suitable earth ground at the base of the utility pole, or to a suitable building ground for testing, before energizing the switch and at all times when energized.

   The ground wire(s) must be bonded to the system neutral, if present. If the system neutral is not present, proper precautions must be taken to ensure the local earth ground, or building ground, cannot be severed or removed.
7. **CIRCUIT-SWITCHER POSITION.** Always confirm the **Open/Close** position of circuit-switchers by visually observing the position of the blades. Switches may be energized from either side and with the blades in either position.
8. **MAINTAINING PROPER CLEARANCE.** Always maintain proper clearance from energized components.
9. **OPERATION.** Circuit making and breaking is involved in the normal operation of this interrupter switch and, as a result, "partway" opening or closing is undesirable. To operate, follow the operating procedure as outlined in S&C Instruction Sheet 712-501.

Inspection

Examine the shipment for external evidence of damage as soon after receipt as possible, preferably before removal from the carrier's conveyance. Check the bill of lading to make sure all listed shipping skids, crates, and containers are present.

If there is visible loss and/or damage:

1. Notify the delivering carrier immediately.
2. Ask for a carrier inspection.
3. Note condition of shipment on all copies of the delivery receipt.
4. File a claim with the carrier.

If concealed damage is discovered:

1. Notify the delivering carrier within 15 days of receipt of shipment.
2. Ask for a carrier inspection.
3. File a claim with the carrier.

Also, notify S&C Electric Company in all instances of loss and/or damage.

Packing

An S&C reference drawing (RD) is contained in a water-resistant envelope attached to the insulator on one of the three circuit-switcher disconnect pole-units and inside the Mark VI CS-1A Switch Operator. A packing list is also included. Use the packing list to confirm all parts have been received before starting the installation.

The Mark VI Circuit-Switcher shipment includes all three phases of the integral disconnect mounted on a frame, on a single skid. Each phase is factory-assembled and adjusted. Drive-train components, vertical and interphase shafts, couplings, mounting hardware, and a temporary hand adapter for adjusting the integral disconnects—all individually identified—are included on the skid.

The vertical and interphase shafts are cut to length. Three interrupters are packed in a separate crate along with associated mounting hardware. Three interrupter charging motors and their associated mounting hardware are packed in a separate crate.

The Mark VI CS-1A Switch Operator is shipped on a separate skid.

The S&C Mounting Pedestal is of square steel tube construction. When specified, it is mounted on a separate skid. If furnished, options such as a grounding switch or pre-insertion inductors are shipped in their own crates.

⚠ WARNING

Do not disassemble or modify the interrupters. The interrupters are pressurized at 75 PSIG. **Serious injury can result.**

Storage

NOTICE

The Mark VI CS-1A Switch Operator is equipped with a space heater that must be energized during storage to prevent condensation and corrosion within the operator enclosure.

If the circuit-switcher must be stored before installation, keep it in a clean, dry, corrosion-free area to protect it from damage. Make sure each skid rests firmly on the ground and is reasonably level. Shoring under the skids can be necessary if the ground is uneven.

If storing outdoors, connect control power to the space heater inside the Mark VI CS-1A Switch Operator per the wiring diagram furnished. Inspect the circuit-switcher regularly when storing for prolonged periods.

NOTICE

A crane or other suitable lifting device is required to install the Mark VI Circuit-Switcher. Make sure an appropriate lifting device is available at the installation site before beginning the circuit-switcher installation.

Before Starting

Cut the steel straps binding the mounting pedestal and support brackets to the skid.

Installing the Mounting Pedestal and Mounting Frame

⚠ WARNING

The foundations for the S&C Mounting Pedestal must be designed to meet the loading limits specified in the appropriate S&C Information Bulletin 712-60. **Failure to meet these loading limits can result in equipment damage and personal injury.**

STEP 1. Install the pedestal as follows:

(a) Before lifting, make sure the grounding pad is positioned properly for the installation and the support arms are positioned in the correct direction. Refer to the accompanying reference drawing (RD) for details. See Figure 1.

(b) Install the support arms to the nut plates inside the pedestal using four ⅝–11×2¼-inch hex-head cap screws and flat washers furnished. (Pedestals less than 12 feet (366 cm) in height will have their support arms pre-installed.)

(c) Attach lifting slings to the eyebolts provided and lift into place onto the pre-installed anchor bolts, nuts, and flat washers. After positioning the pedestal, loosely secure a flat washer and nut to each anchor bolt. Remove the lifting slings.

(d) Adjust the lower set of anchor-bolt nuts to plumb and level the pedestal. The upper set of anchor-bolt nuts should remain loosely attached. See Figure 2.

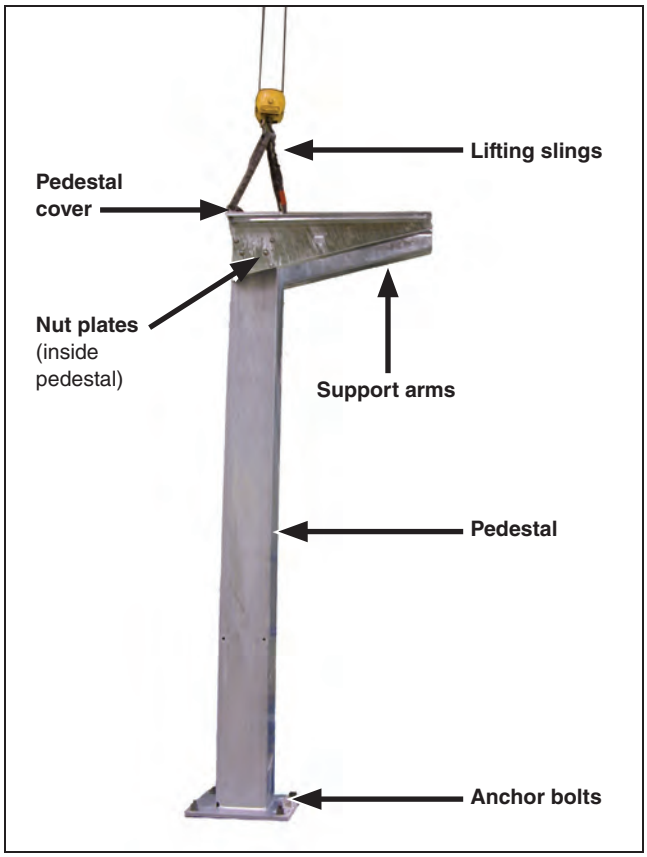


Figure 1. Attach lifting slings to the eyebolts provided and lift the pedestal into place on the installed foundation.

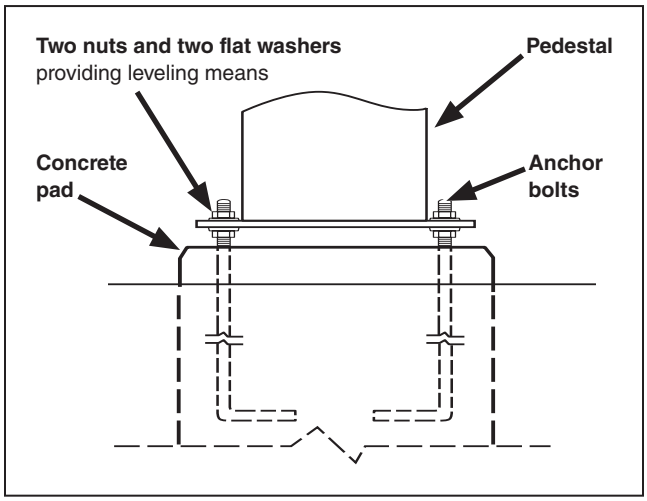


Figure 2. Adjust the anchor-bolt nuts to plumb and level the pedestals.

STEP 2. Place a pedestal cover on top of the pedestal, and align it with the holes on the pedestal.

STEP 3. The disconnect pole-units will be preassembled to the mounting pedestal frame. Install the frame as follows:

(a) Attach a lifting sling to the eyebolts mounted on the four corners of the mounting pedestal frame. See Figure 3.

(b) Unbolt the frame from the wooden shipping skid. Carefully lift the frame into position on top of the mounting pedestal as shown on the reference drawing (RD). Avoid sudden stops and starts. The frame with disconnect pole-units weighs approximately 2000 lbs.

(c) Loosely bolt the mounting pedestal frame to the support arms using four ⅝–11×2-inch galvanized-steel hex-head cap screws, flatwashers, and nuts furnished.

(d) Using a level, verify the mounting pedestal frame is horizontal, both lengthwise and side to side. Adjust the anchor bolts as necessary to achieve this condition, and then tighten all bolts for the mounting pedestal frame to a torque of 50-60 ft.-lbs.

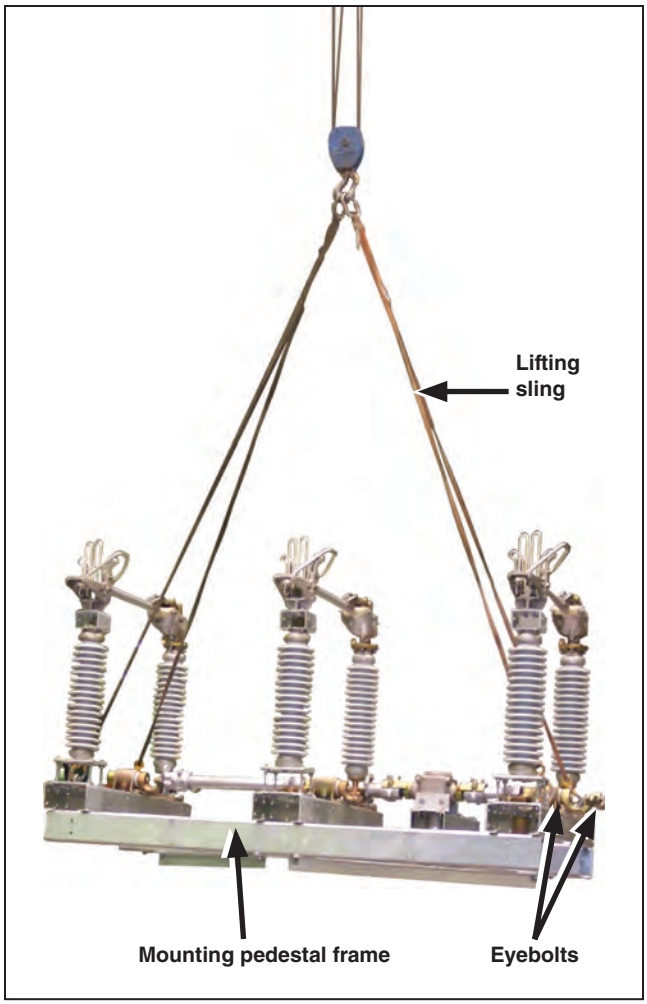


Figure 3. Attach a lifting sling to the eyebolts mounted on the four corners of the mounting pedestal frame. Unbolt the frame from the wooden shipping skid.

STEP 4. Check the lower set of anchor-bolt nuts at the mounting pedestal to verify each is in contact with the bottom of the plate. Hand-tighten these anchor-bolt nuts as needed. See Figure 4.

STEP 5. Securely tighten the upper set of anchor-bolt nuts. See Figure 4. Remove the eyebolts from the mounting pedestal frame.

STEP 6. Install the interrupter mounting brackets as follows:

(a) Locate the four mounting holes at the hinge end of the disconnect pole-unit base. Place one interrupter mounting bracket along the base, and align it as shown in Figure 5.

(b) Secure the bracket using four ⅝–11×2¼-inch hex-head galvanized steel cap screws, lockwashers, and nuts furnished.

(c) Install a second interrupter mounting bracket on the opposite side.

STEP 7. Install the interrupter support bracket between the two interrupter mounting brackets using the ⅝–11×2¼-inch hex-head galvanized steel cap screws furnished. See Figure 6.

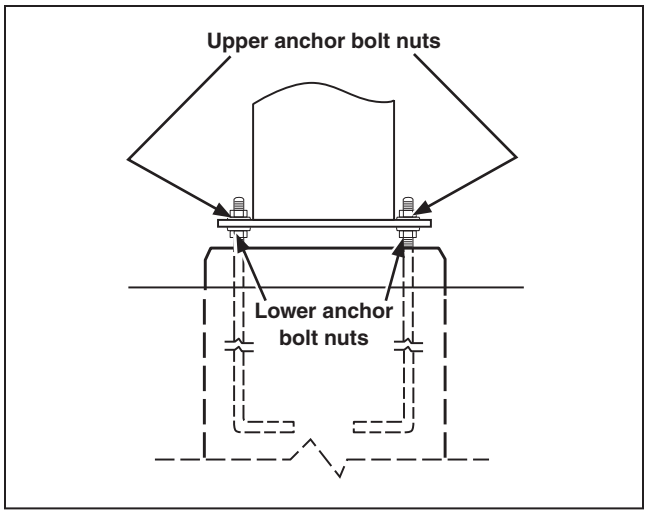


Figure 4. Hand-tighten lower nuts and securely tighten the upper set of anchor-bolt nuts at each mounting pedestal.

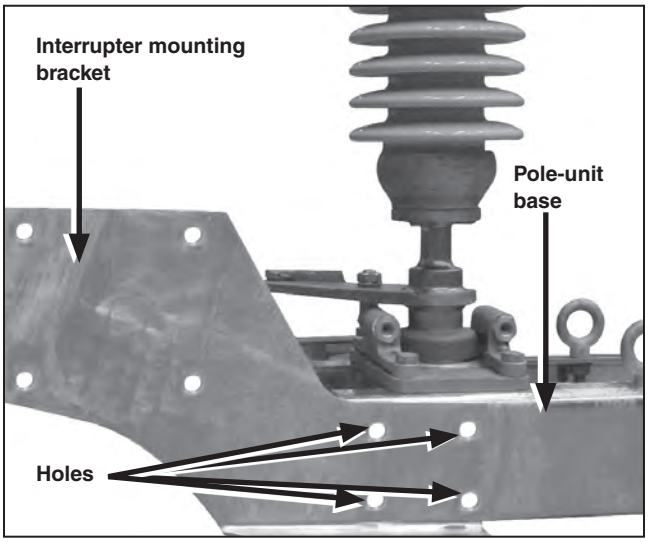


Figure 5. Install the interrupter mounting brackets to the disconnect base.

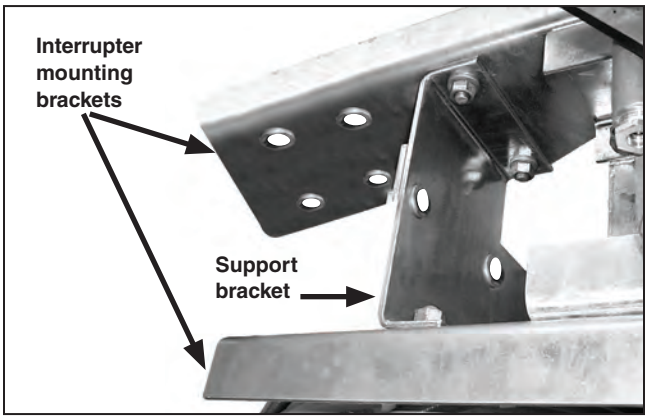


Figure 6. Install the interrupter support bracket between the interrupter mounting brackets.

Installing the Interrupters, Motor Brackets, and Buswork

Repeat Step 1 through Step 11 on page 15 for each interrupter.

STEP 1. Remove the interrupter from its shipping crate and lift it using the following procedure:

NOTICE

Lift the interrupter only by its lifting bracket. **Lifting it by any other means can damage the interrupter.**

(a) Wrap a lifting sling around the lifting bracket at the top of the interrupter.

(b) Carefully raise the interrupter upward. The foam wrappings around the top, mid-section, and base should come off as the interrupter is lifted. Remove these wrappings if they do not come off by themselves. Do not remove the shipping brace at this time. See Figure 7, Figure 8, and Figure 9.

NOTICE

DO NOT remove the shipping brace around the base of the interrupter at this time. **Damage to the operating shaft can occur.**

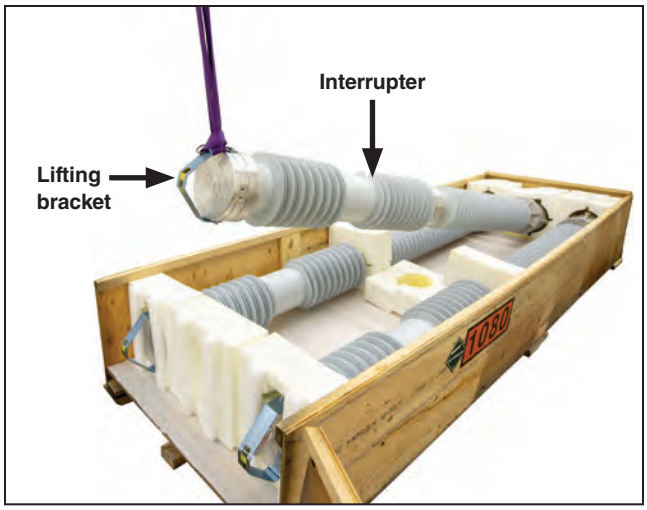


Figure 7. Lift the interrupter only by the lifting bracket.

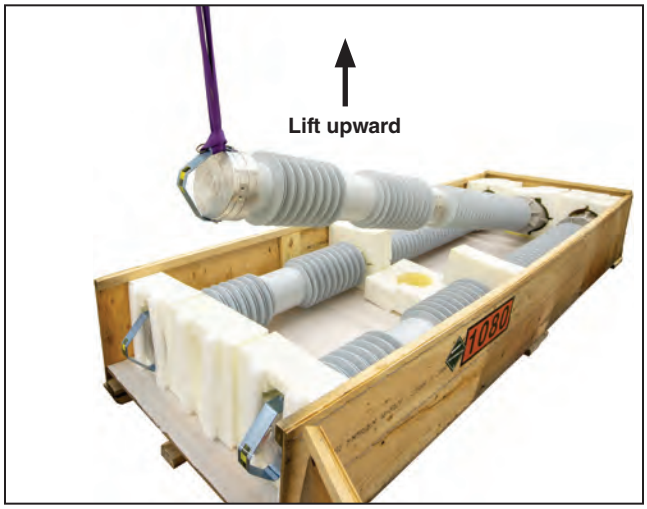


Figure 8. Lift the interrupter carefully upward.

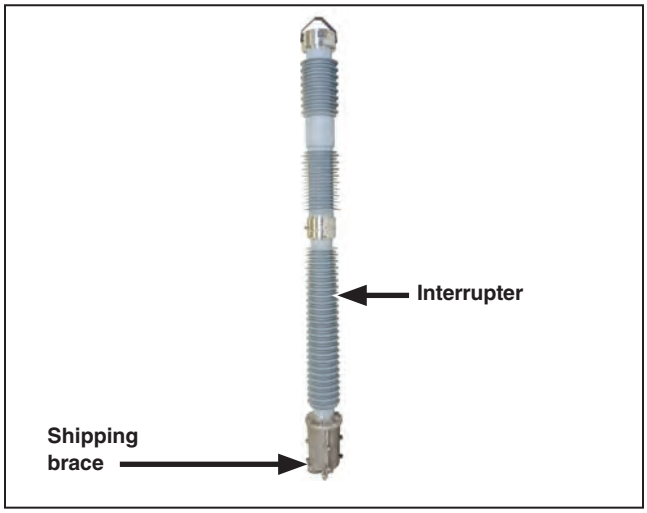


Figure 9. Do not remove the shipping brace at this time.

STEP 2. With the interrupter lifted off the ground, make sure the gas-pressure gauge on the underside of the interrupter is in the OK to Operate zone. See Figure 10 and Figure 11.

NOTICE

If the gauge is not in the OK to Operate zone, stop the installation and notify S&C Electric Company.

STEP 3. Remove the shipping brace from the interrupter base. See Figure 12.

NOTICE

DO NOT rest the interrupter on its base after the shipping brace has been removed. **Damage to the operating shaft can occur.**

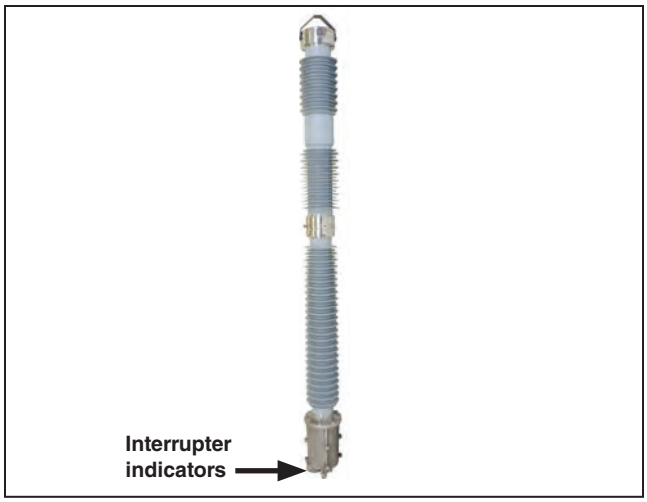


Figure 10. With the interrupter lifted off the ground, check the gas-pressure gauge.

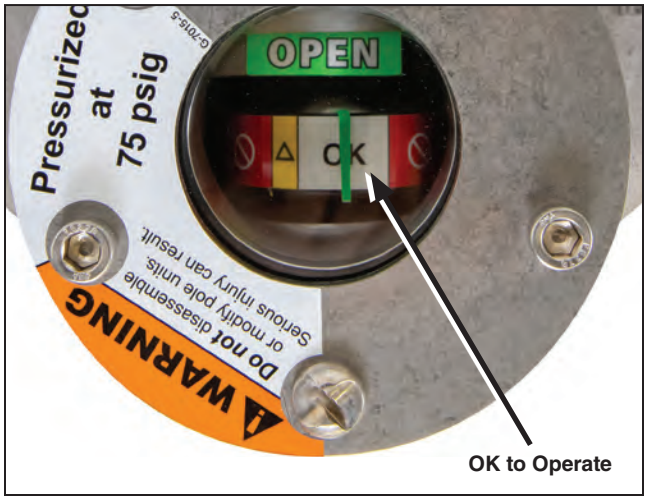


Figure 11. Make sure the gas-pressure gauge on each interrupter is in the OK to Operate zone.

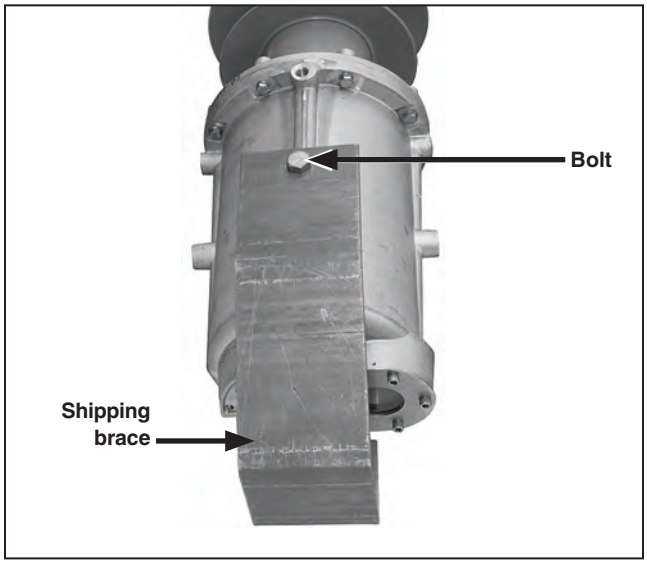


Figure 12. Unbolt the shipping brace.

STEP 4. Position the interrupter so its base is near the interrupter mounting brackets. See Figure 13. If necessary, rotate the interrupter so the electrical junction box is positioned according to the reference drawing.

STEP 5. To attach the interrupter to the mounting bracket:

(a) Align the interrupter mounting bosses with the holes in the mounting brackets, and secure the interrupter using four ⅝–11×2-inch stainless steel studs furnished. Both the upper and lower mounting bosses must be used on each side.

(b) Screw the studs until they bottom, approximately 8 to 9 turns, and tighten.

(c) Attach a hex nut to each stud and tighten. Use a flat washer on each stud. Do not remove the lifting sling from the interrupter at this time. See Figure 14.

⚠ WARNING

Make sure the interrupter is supported on three sides. **Failure to properly support the interrupter can result in damage to the Mark VI Circuit-Switcher and personal injury.**

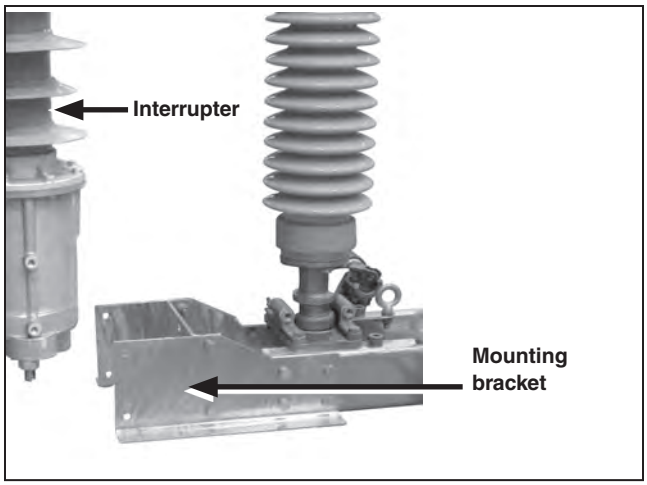


Figure 13. Position the interrupter near the interrupter mounting brackets (115 kV shown; 69 kV similar).

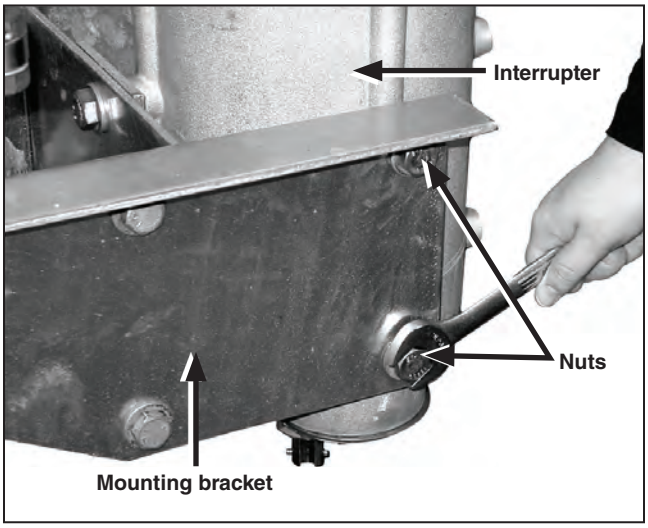


Figure 14. Attach the interrupter to the mounting bracket.

STEP 6. To install the motor brackets:

(a) Insert one of the two motor brackets between the support bracket and the interrupter mounting bosses. Position the motor bracket as shown in Figure 15. Align the holes in the motor bracket with the holes in the mounting bracket and mounting bosses, and secure the motor bracket using two ⅝–11×2-inch stainless steel studs furnished. Both the upper and lower mounting bosses must be used.

(b) Screw the studs until they bottom, approximately 8 to 9 turns, and hand-tighten.

(c) Attach a hex nut to each stud and tighten. Use a flat washer on each stud. See Figure 16.

(d) Place the second motor bracket flush against the mounting bosses on the opposite side of the interrupter base. Position the bracket as shown in Figure 16 and attach it using two ⅝–11×2-inch stainless steel studs furnished. Both the upper and lower mounting bosses must be used.

(e) Screw the studs until they bottom, approximately 8 to 9 turns, and hand-tighten.

(f) Attach a hex nut to each stud and tighten. Use a flat washer on each stud. Do not remove the lifting sling from the interrupter at this time. See Figure 17.

STEP 7. Tighten all nuts to a torque of 70 to 80 ft.-lbs.

⚠ WARNING

Never exceed the recommended torque limit. **The interrupter base is pressurized to 75 ft-lbs. Damage to the interrupter and personal injury can occur.**

STEP 8. Remove the lifting sling from the interrupter.

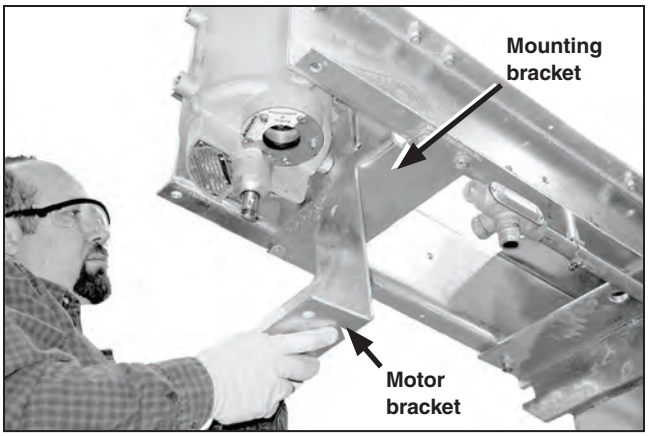


Figure 15. Insert the motor bracket between the interrupter and the support bracket.

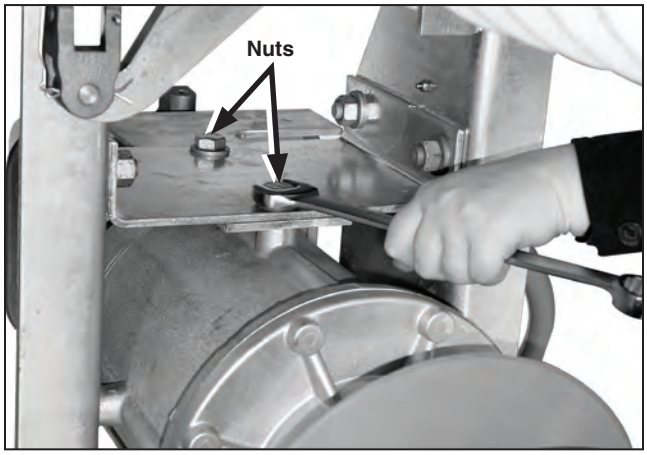


Figure 16. Tighten the nuts.

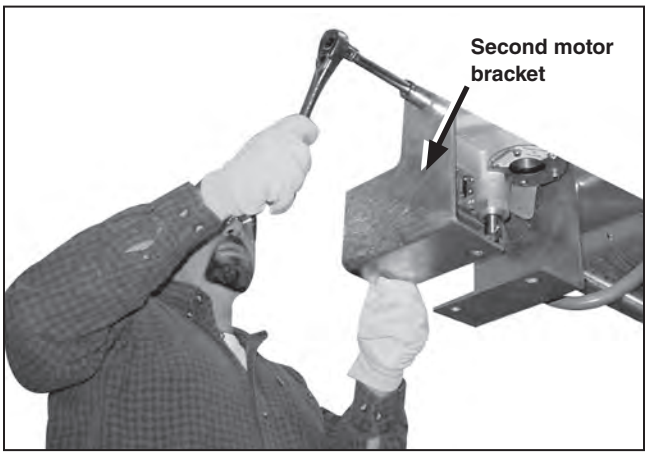


Figure 17. Place the second motor bracket against the opposite side of the interrupter and bolt in place.

STEP 9. Prepare the electrical connections to the interrupter as follows:

NOTICE

Do not wire-brush the buswork. The buswork pieces are plated and do not require abrasive cleaning as a part of their preparation. Wipe any dirt or grease from the surface and apply a thick coating of Penetrox A or other appropriate conductor preparation compound. Wire brushing can damage the plating and cause corrosion.

(a) Thoroughly clean the interrupter bus with a soft cloth. Wire-brush the interrupter casting.

(b) Immediately apply a liberal coating of Burndy Penetrox® A or other suitable aluminum connector compound to the clean surfaces.

(c) Apply Penetrox A to the threads of two ½–13×1-inch hex-head stainless steel cap screws furnished.

(d) Attach the interrupter bus to the set of tapped holes on the interrupter using the two cap screws and lock washers, provided. See Figure 18. Tighten the screws to a torque of 40 to 50 ft.-lbs.

STEP 10. Prepare the electrical connection to the disconnect bus as follows:

(a) Thoroughly clean the disconnect bus with a soft cloth. Wire-brush the disconnect casting.

(b) Immediately apply a liberal coating of Penetrox A or other suitable aluminum connector compound to the clean surfaces.

(c) Apply Penetrox A to the threads of the four ½–13×1¼-inch hex-head stainless steel cap screws furnished.

(d) Attach the disconnect bus to the disconnect casting using the four stainless steel cap screws and Belleville washers provided. See Figure 19. Tighten the screws to a torque of 40 to 50 ft.-lbs. The disconnect bus will overlap the interrupter bus.

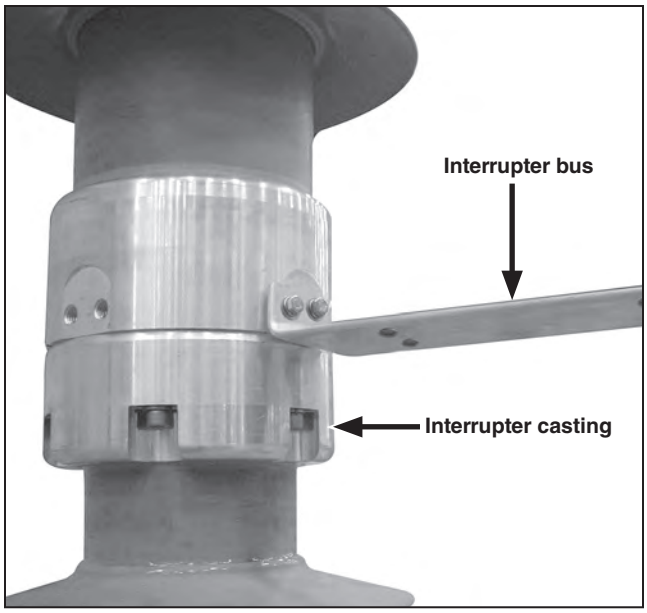


Figure 18. Attach the interrupter bus to the tapped holes on the interrupter casting.

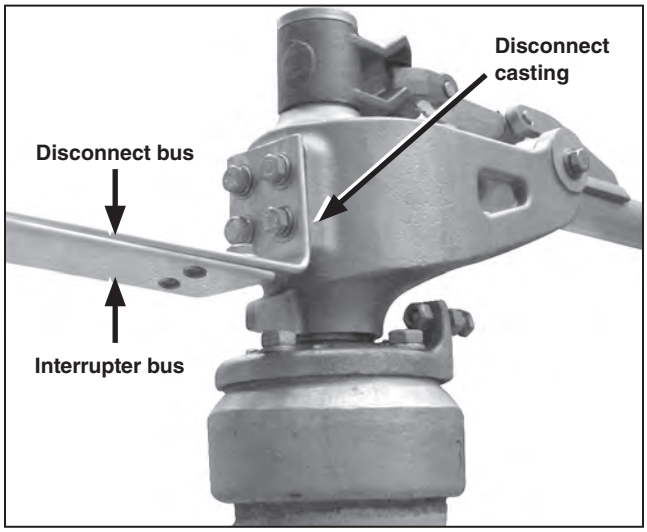


Figure 19. Attach the disconnect bus to the tapped holes in the disconnect casting.

STEP 11. Attach the interrupter bus to the disconnect bus using the four ½–13×1½-inch hex-head stainless steel cap screws, flatwashers, Belleville washers, and nuts furnished. See Figure 20.

Avoid excess tension or torque between the interrupter bus and the disconnect bus. If the holes do not line up properly, loosen the hardware securing the interrupter to the disconnect base, and shift the interrupter until the holes are aligned. Retighten the interrupter to a torque of 70 to 80 ft.-lbs.

⚠ WARNING

Never exceed the recommended torque limit. **The interrupter base is pressurized and damage to the interrupter and personal injury can occur.**

Checking the Operation of the Disconnect

Check the operation of the blade using the following procedure. Repeat Step 1 through Step 4 for each pole-unit:

STEP 1. Bolt the TEMPORARY MANUAL OPERATING handle to the disconnect drive-shaft crank. See Figure 21.

STEP 2. Firmly crank the disconnect to its fully **Open** position. The disconnect blade should open to an angle of 90° to 96° from horizontal. See Figure 22.

If the blade does not open 90° to 96°: shim underneath the disconnect base as required to make up for any irregularities or distortion in the mounting surface and/or readjust the pedestals to level the disconnect bases.

Make sure the pole-unit base is level and the interrupter is vertically aligned with the disconnect pole-unit insulators.

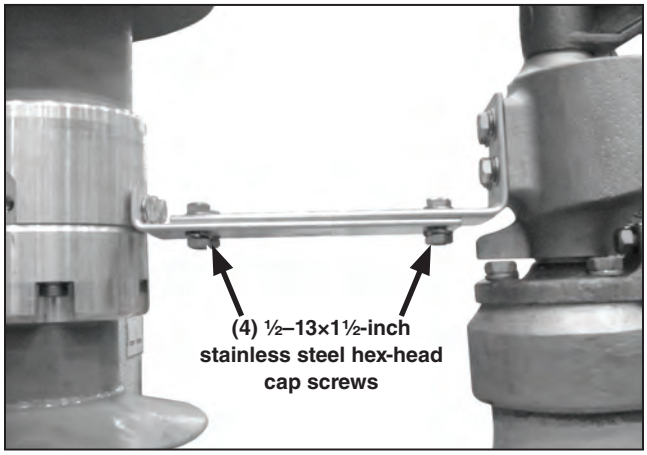


Figure 20. Attach the interrupter bus to the disconnect bus.

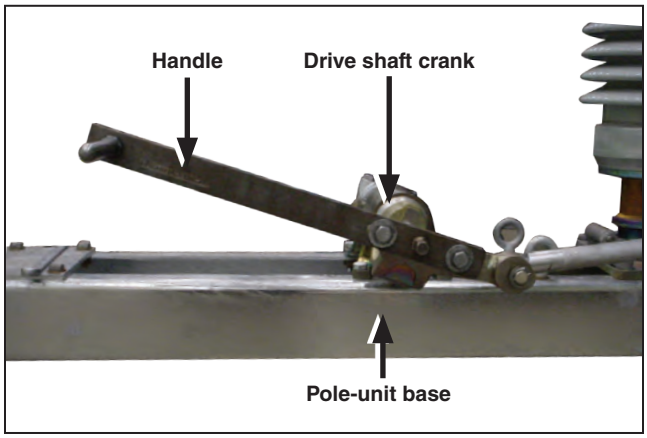


Figure 21. Attach the TEMPORARY MANUAL OPERATING handle to the drive-shaft crank.

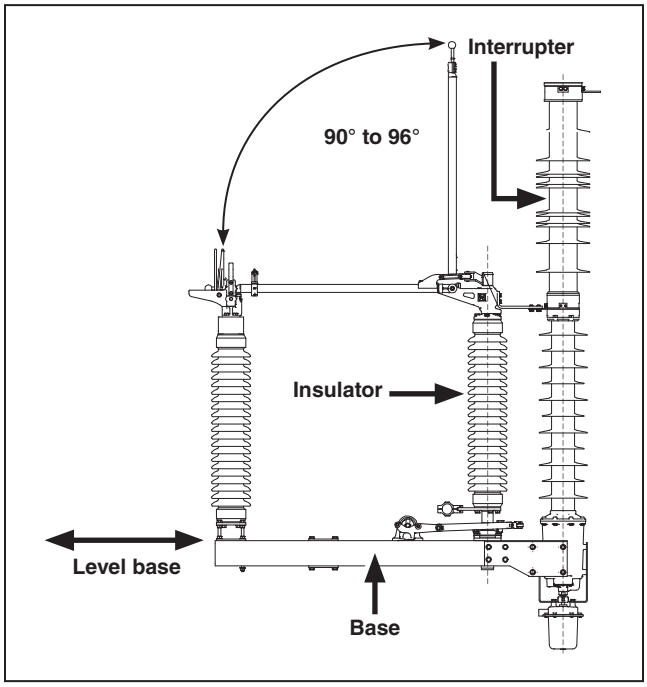


Figure 22. Check the angle of the disconnect.

STEP 3. Check for proper alignment of the blade with the jaw-contact assembly. As the blade is closed, the fault-closing tongue contact should engage each of the fault-closing jaw contacts with equal pressure, and the current-carrying tongue contact should enter the current-carrying jaw contacts with equal clearance on each side.

The silver-surfaced area of the current-carrying tongue contacts should center laterally with the silver-surfaced current-carrying jaw contacts, and the blade should rotate with slight pressure against the blade bumper stop and come to rest either on the stop or slightly above it. See Figure 23.

NOTICE

If the blade angle is not attained or the contacts are not properly aligned after leveling the disconnect base, stop the installation and contact S&C Electric Company.

STEP 4. Close the disconnect and remove the TEMPORARY MANUAL OPERATING handle.

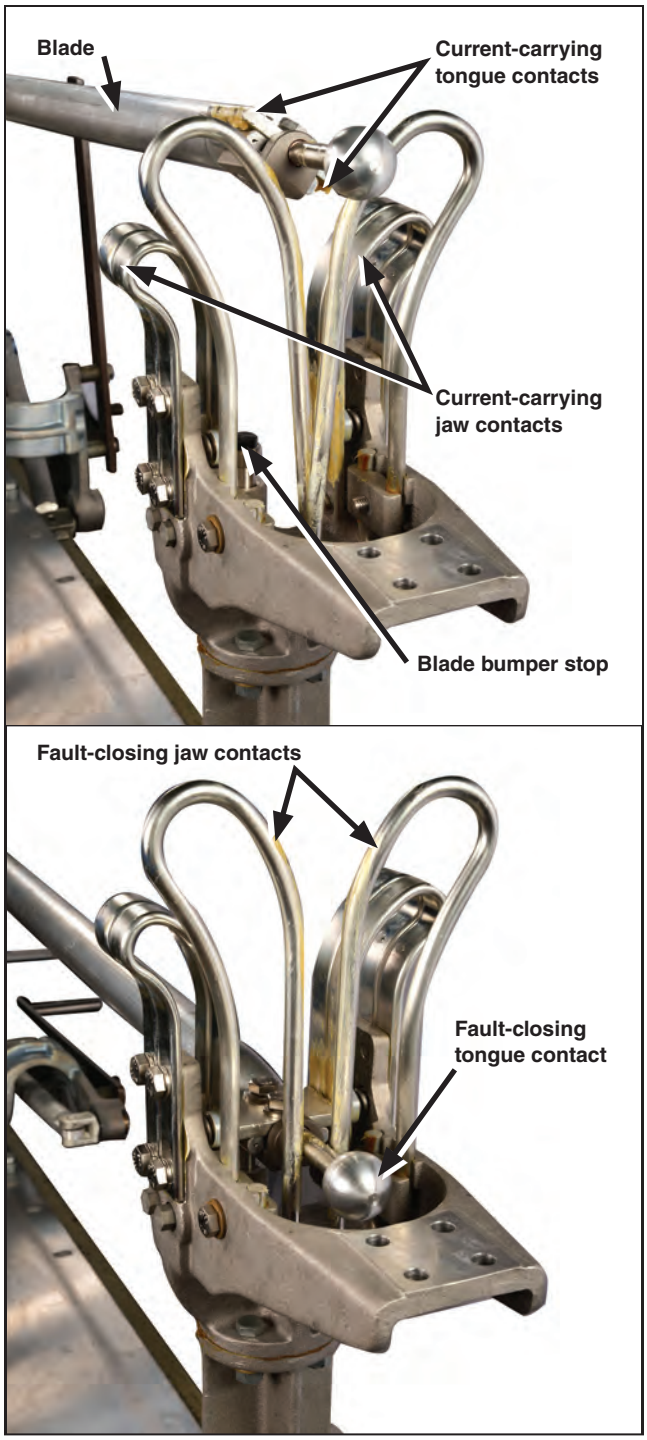


Figure 23. Check penetration of the blade into the jaw contact during closing.

Installing the Drive Train

The drive train is comprised of several sections of interphase shaft connecting the three interrupters to each other, a section of vertical operating shaft directly driven by the Mark VI CS-1A Switch Operator, and a gearbox connecting the vertical operating shaft to the interphase shaft. See Figure 24.

On 69-kV switches with a 51-inch phase spacing, the gearbox and interphase operating shaft come pre-installed. Remove any packing and ties from the interphase operating shaft and gearbox.

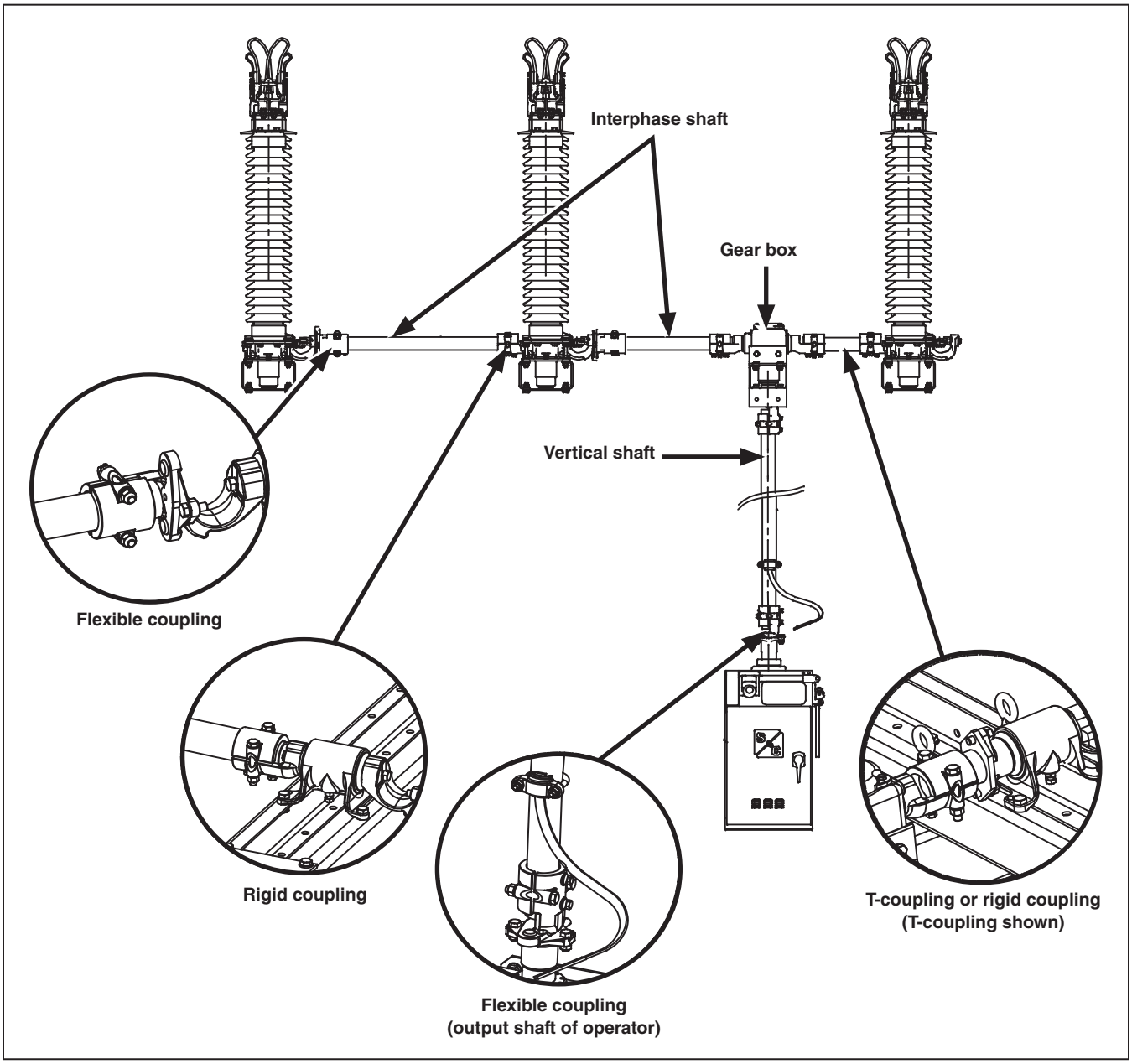


Figure 24. Drive train with coupling detail views.

Installing the Mark VI CS-1A Switch Operator and Vertical Shaft

NOTICE

If more than one switch operator is available at the installation site, be sure to select the one for this particular installation.

Complete the following steps to install the Mark VI CS-1A Switch Operator and Vertical Shaft: See Figure 25, Figure 26, and Figure 27.

STEP 1. Install the operator mounting brackets:

(a) Place a bracket against the pedestal at the appropriate mounting height indicated on the reference drawing, level it, and mark the position with a pen or pencil. Do the same with the second bracket on the opposite side.

(b) Align the brackets with the marks and bolt them to the pedestal with the two ⅝-inch galvanized steel threaded rods, washers, and nuts provided. Mount the longer extended mounting bracket toward the front of the pedestal (jaw side of disconnect pole-units). Tighten the nuts on the threaded rod.

(c) In the same manner, secure the lower bracket assembly in the position shown on the reference drawing. Hand-tighten the bolts in the lower bracket assembly.

STEP 2. Unbolt the Mark VI CS-1A operator from its shipping skid.

STEP 3. Attach lifting slings around the output shaft of the Mark VI CS-1A operator. Lift the operator into place. Avoid sudden stops and starts.

STEP 4. Align the upper flange on the rear of the operator with the upper operator mounting bracket. Fasten the operator to the mounting bracket using the two ⅝–11×2-inch galvanized steel hex-head cap screws, nuts, and flatwashers provided. Do not remove the lifting slings at this time.

Figure 25. Attach lifting sling to output shaft.

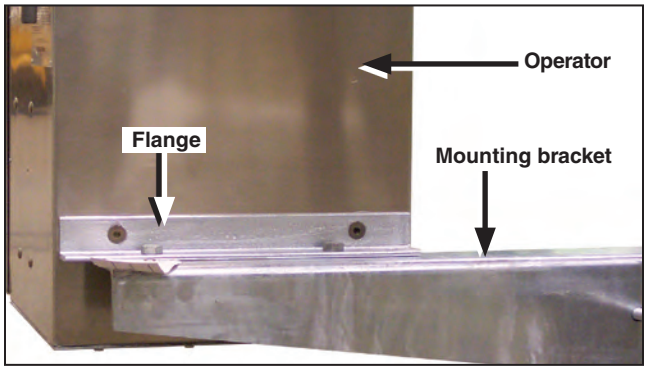


Figure 26. Attach the Mark VI CS-1A Switch Operator to the operator mounting brackets.

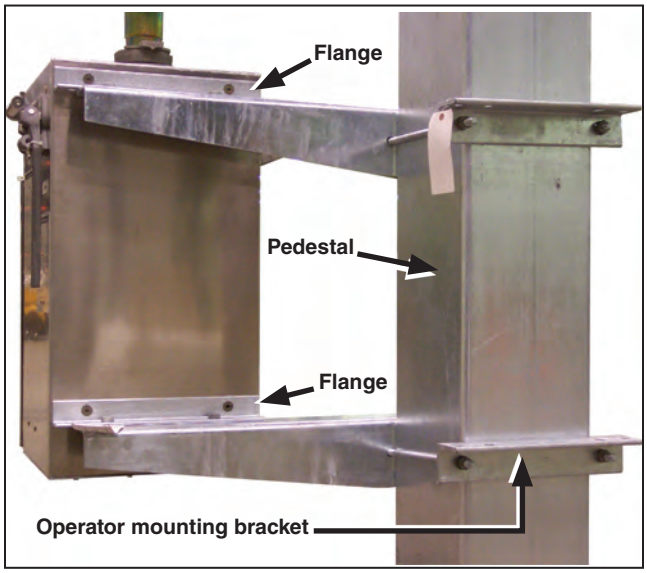


Figure 27. Install the operator mounting brackets.

STEP 5. The flexible couplings are pre-installed on the gearbox and Mark VI CS-1A operator. If required, attach the flexible coupling to the output shaft of the switch operator and to the input shaft of the gearbox using the following procedure:

(a) Thread the flexible coupling attachment bolts through the flexible coupling plate and through the coupling flange.

(b) Tighten the bolts to draw the flexible plate flush against the flange; this will deform the threads in the flexible plate, resulting in a binding, nonslip connection.

(c) Install and tighten the self-locking nuts. Do not use lockwashers with the flexible coupling attachment bolts. See Figure 28.

If universal couplings are specified on the catalog drawing instead of flexible couplings, use the same installation procedure.

STEP 6. Loosely fit the vertical shaft between the two coupling assemblies. The vertical shaft should extend slightly past the flange end of the clamp. See Figure 29. If the shaft is too long for the installation, cut it to the appropriate length with a pipe cutter.

STEP 7. Secure the vertical shaft to the gearbox flexible coupling using the following procedure:

NOTICE

Make sure the cutting tips of the piercing set screws do not protrude through the body of the flexible coupling on the switch operator output shaft and the flexible coupling attached to the shaft extending from the gearbox.

(a) With the vertical shaft inserted into the coupling from the gearbox, tighten the clamp bolts equally so the clamp pulls down evenly on the coupling.

(b) Tighten the piercing set screws, piercing the shaft, and continue turning until a firm resistance is felt. Make sure the cutting tips of the piercing set screws do not protrude through the clamp. See Figure 30.

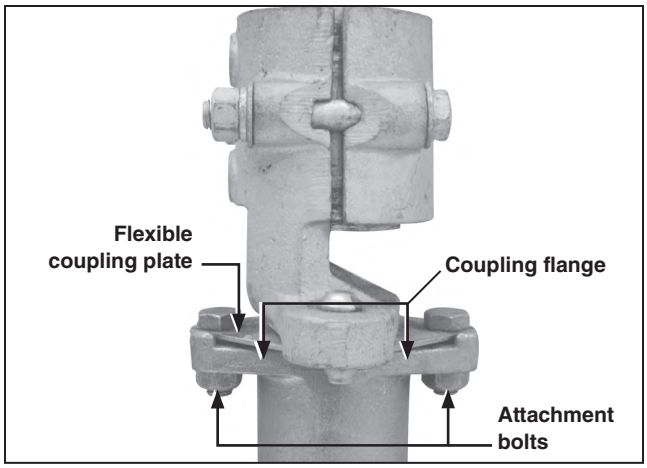


Figure 28. Attach the plate to the coupling flange.

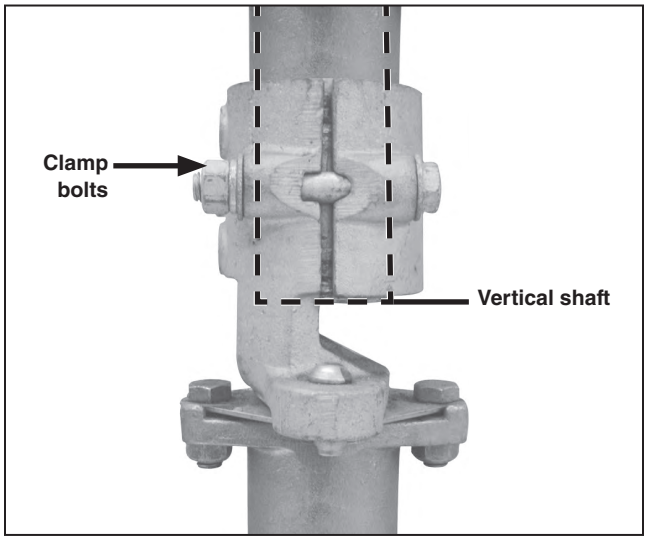


Figure 29. Insert the vertical shaft section between the couplings.

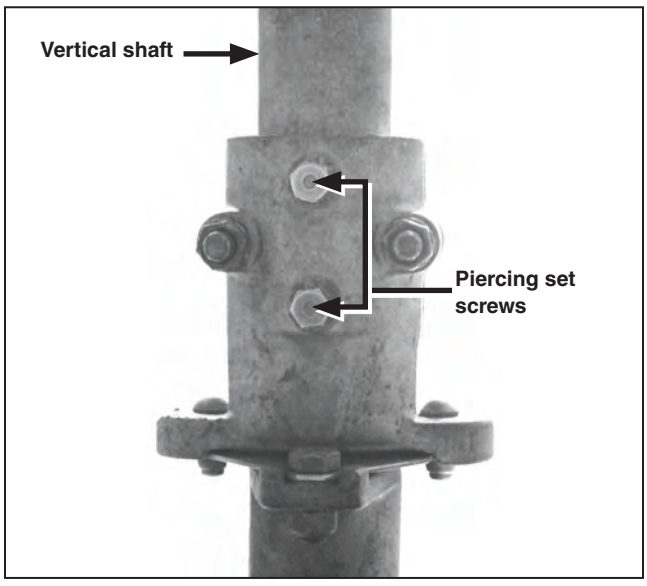


Figure 30. Tighten the piercing set screws.

STEP 8. Fasten the free end of the grounding strap to the vertical shaft a few inches above the flexible coupling attached to the switch operator using the grounding connector provided. Then, fasten the other end of the grounding strap to a suitable earth ground. See Figure 31.

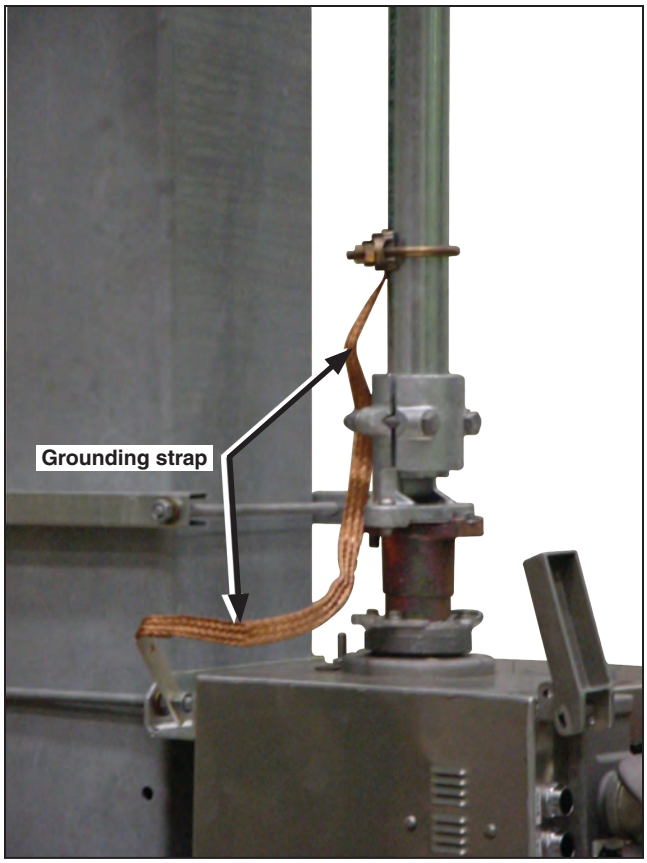


Figure 31. Attach the grounding strap.

Installing the Interrupter Charging Motor

NOTICE

The charging motors are factory-wired to use 48-Vdc, 125-Vdc, or 115-Vac control voltage. Motor control voltage cannot be changed in the field. **Make sure the motors are the correct voltage for the installation.**

Complete the following steps to install the interrupter charging motor. Repeat Step 1 through Step 3 on page 22 for each interrupter.

STEP 1. Manually rotate the operating shaft counterclockwise until it stops. See Figure 32.

STEP 2. Locate the four mounting bosses on the top of the motor. See Figure 33. Align the mounting bosses with the holes in the motor brackets. Rotate the headhook, if necessary.

If the holes do not align: Loosen the studs supporting the motor brackets and shift them until proper alignment is achieved.

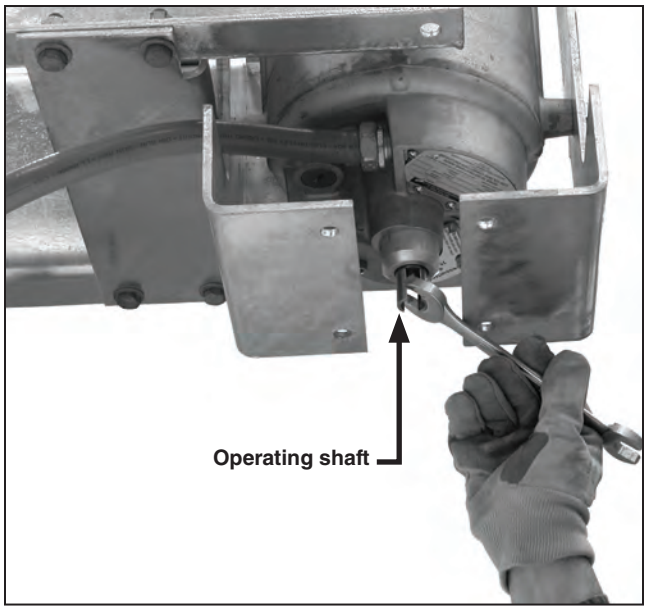


Figure 32. Rotate the operating shaft.

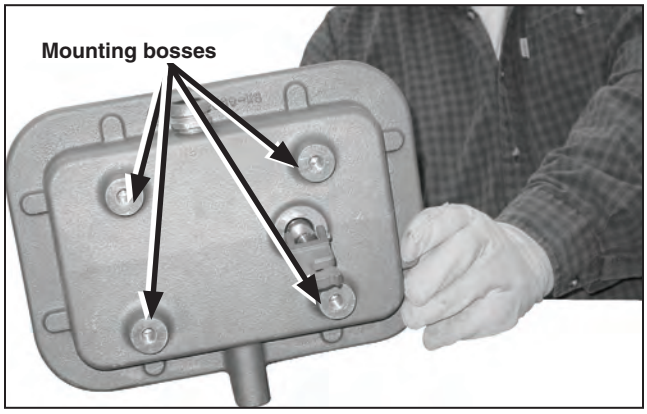


Figure 33. Locate mounting bosses.

STEP 3. Engage the headhook of the charging motor with the operating shaft. See Figure 34. Using the four ½–13×1 ¼-inch hex-head stainless steel cap screws and flat washers furnished, fasten the motor to the brackets. Tighten the screws to between 50 and 60 ft.-lbs. See Figure 35.

Retighten any stud nuts loosened in Step 1 to between 70 and 80 ft.-lbs.

⚠ WARNING

Never exceed the recommended torque limit. **The interrupter base is pressurized and damage to the interrupter can occur.**

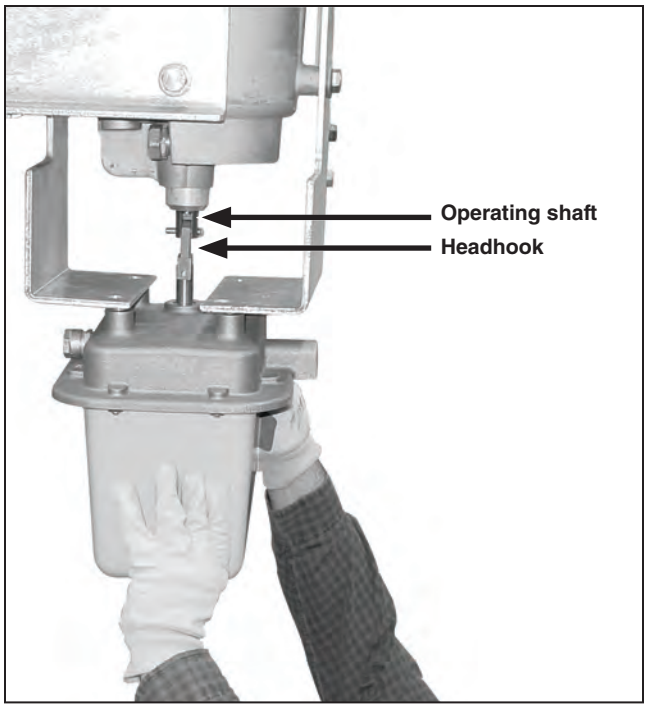


Figure 34. Attach the motor to the operating shaft.

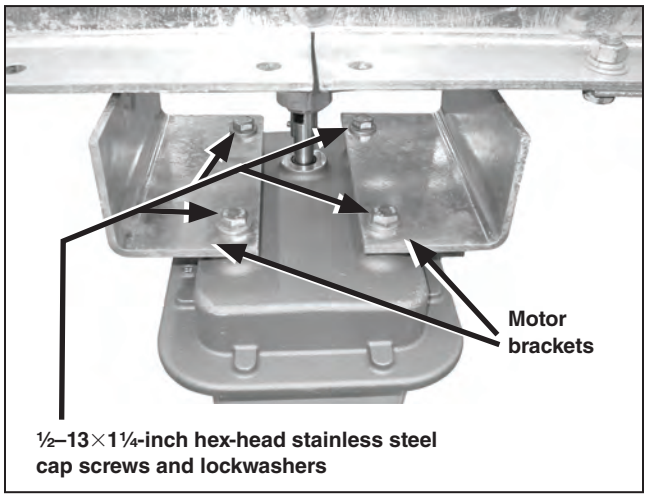


Figure 35. Secure the motor to the motor brackets.

Installing the Conduit Assembly

NOTICE

Keep conduit and conduit hangers clear of the drive train. Do not attach the conduit assembly to the interphase shaft or the vertical operating shaft, and do not attach conduit to any moving parts of the circuit-switcher. Damage to the circuit-switcher can occur.

Complete the following steps to install the conduit assembly:

STEP 1. Install the conduit assembly support brackets:

(a) Insert the conduit clip(s) into the channel in the conduit support bracket.

(b) Place the bracket against the pedestal at the appropriate mounting height indicated on the reference drawing, level it, and mark the position with a pen or pencil. Do the same with the second bracket on the opposite side.

(c) Align the brackets with the marks, and bolt them to the pedestal with the two ⅝-inch threaded rods, square nuts, hex nuts, and washers provided. See Figure 36.

STEP 2. Install the remaining conduit hangers to the holes in the cross base, as shown on the reference drawing.

STEP 3. Set the conduit assembly in the conduit hangers, and fasten it in place. The conduit should be attached to the cross base in accordance with the reference drawing, with the conduit directed down the pedestal to which the operator is attached. Position the conduit ends near the electrical junction boxes and charging motors of the interrupters.

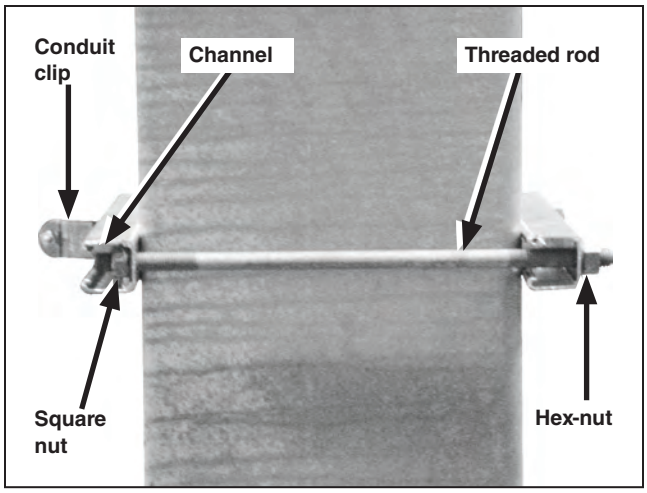


Figure 36. Install the conduit hangers.

Wiring the Interrupter Connections

Complete the following steps to wire the interrupter connections:

STEP 1. Remove the three removable screws at each interrupter electrical junction box cover. Retain the screws. Loosen the fourth retaining screw. Then, swing out the cover to access the wiring inside the electrical junction box. See Figure 37 and Figure 38.

⚠ WARNING

Do not remove the window bolts. The interrupter is pressurized to 75 PSIG. **Serious injury could occur.**

STEP 2. Following the wiring diagram furnished, connect the conduit wiring to the wiring inside the electrical junction box. Use the butt splices supplied with the junction-box wiring. The butt splices accommodate 18 to 22 AWG wire.

NOTICE

To ensure proper crimping of the butt splices, use the Panduit controlled-cycle hand tool (CT-1550) or a similar tool for attaching 18- to 20-gauge insulated ring lugs.

Rotate the cover of each electrical junction box, and replace the retained screws. Securely tighten all screws. See Figure 39.

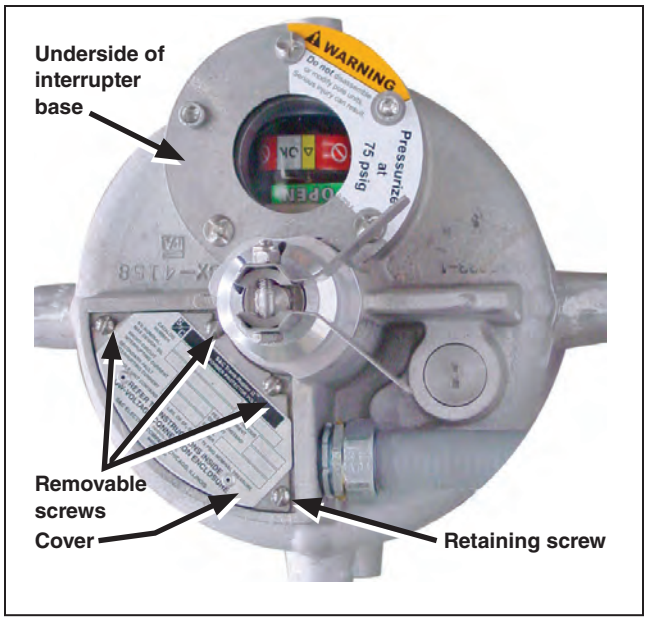


Figure 37. Remove the three removable screws at each interrupter electrical junction box cover. Loosen the fourth retaining screw.

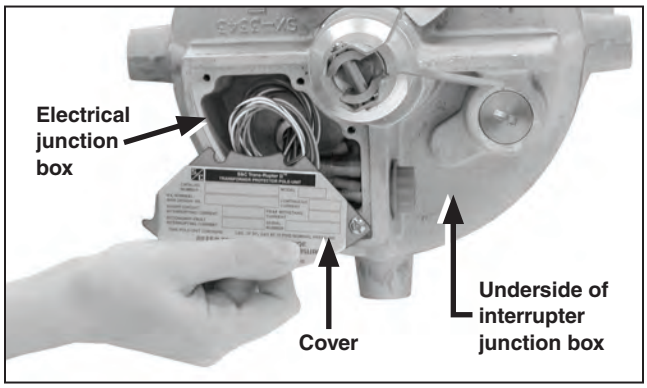


Figure 38. Swing out the cover to access the wiring inside the electrical junction box.

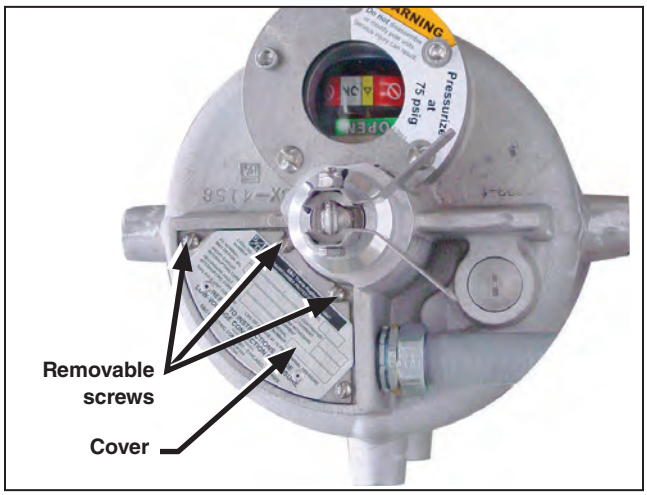


Figure 39. Securely tighten the screws of the electrical junction box covers.

If the quick-connect option ("-C2") is specified: Plug-style connections will replace the butt-splice connection.

The male plug is keyed to the female socket. See Figure 40. Push the plug into the socket and turn the black ring until the red line around the outside of the socket is obscured. See Figure 41 and Figure 42.

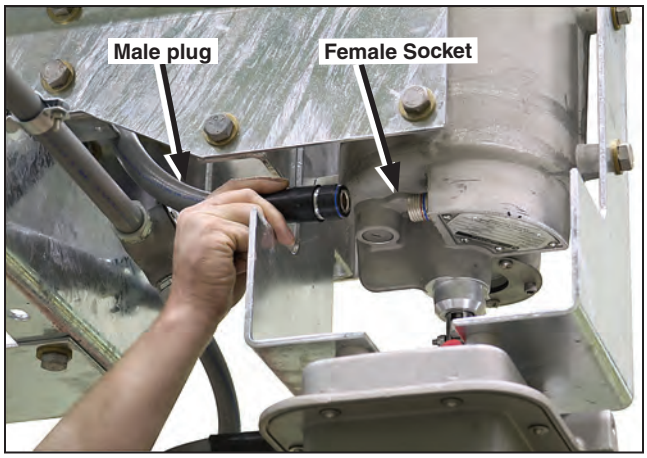


Figure 40. The optional quick-connect control cable. The male plug is keyed into female socket.

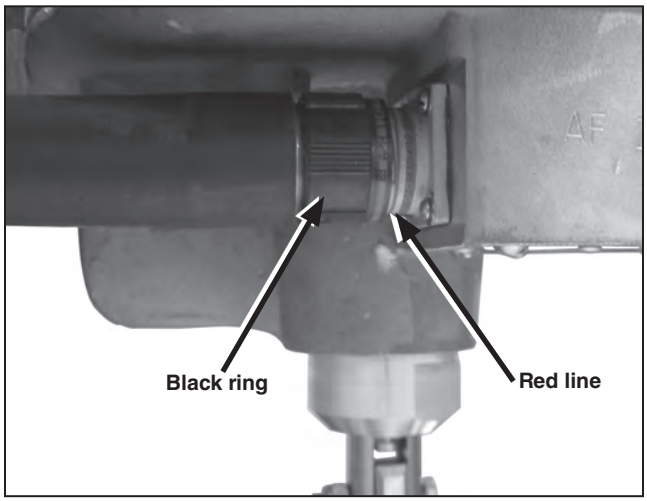


Figure 41. Turn ring until red line is obscured.

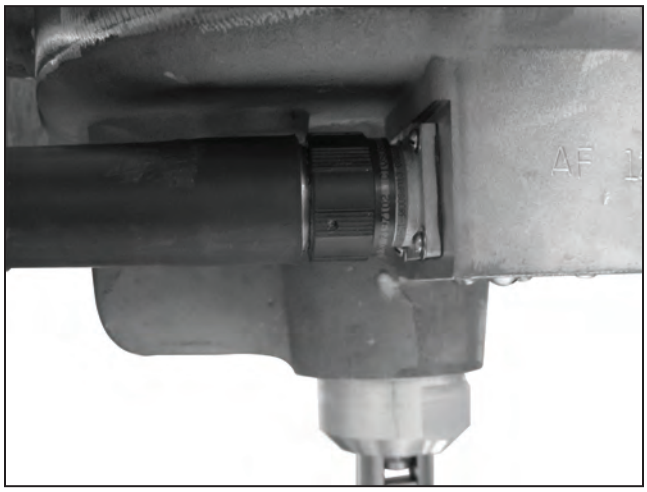


Figure 42. The quick connector fully tightened.

Wiring the Charging Motors

Complete the following steps to wire the charging motor connections:

STEP 1. Remove and retain the eight 10–32×1⅝-inch round-head stainless steel machine screws securing the motor cover to the motor housing. Remove the motor cover, and set the cover and screws aside in a protected area. See Figure 43.

STEP 2. Connect the conduit to the ½–14-inch NPT tap on the side of the motor housing, and pull the wires through and into the motor housing. Use watertight fittings to make all connections. See Figure 44.

STEP 3. Following the supplied wiring diagram, make the necessary wiring connections to the terminal block in the motor operator. See Figure 44. Do not remove the jumper between Terminals 8 and 9. Train the motor wiring towards the center of the housing so the motor wiring does not come in contact with the motor cover. Bend the terminal lugs if necessary.

NOTICE

If control power is lost while the Mark VI Circuit-Switcher interrupter charging motors are closing and charging the pole-units, the jumper between Terminals 8 and 9 will force the motor operators to "reset" to the beginning of their charge cycle when control power is restored.

STEP 4. Replace the motor cover and secure it using the 10–32×⅝-inch round-head machine screws retained in Step 1.

Continue with the section titled "Wiring and Adjusting the Switch Operator".

NOTICE

DO NOT connect the wiring from the Mark VI CS-1A Switch Operator at this time. Keep the wiring from the motors and interrupters clear of any moving parts inside the operator.

Figure 43. Remove the motor cover.

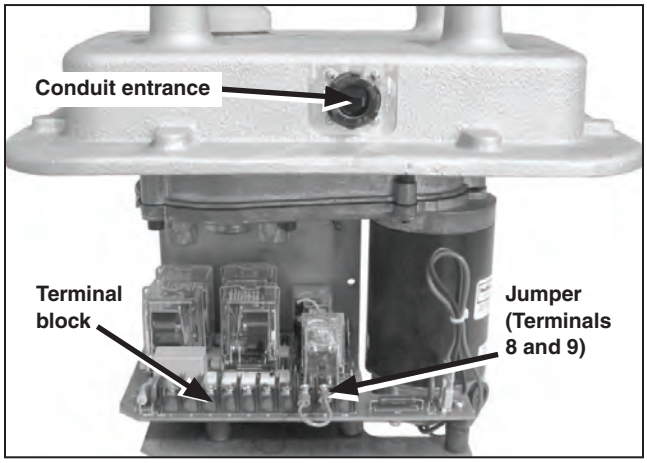


Figure 44. Bring conduit through entrance into motor housing. Do not remove the jumper.

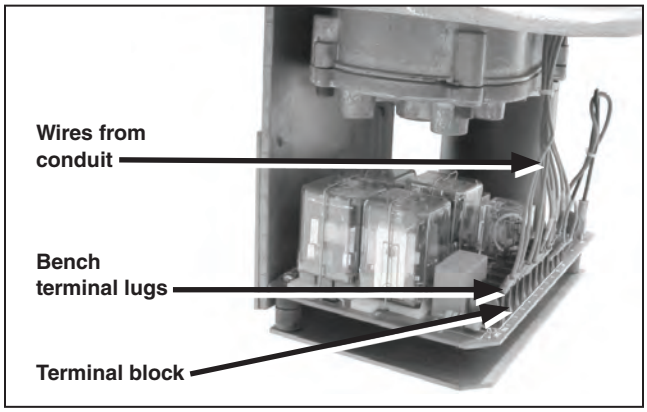


Figure 45. Connect wiring to terminals per the wiring diagram. Train the wires away from the edge of the motor housing to allow clearance between the wires and the motor cover. Bend the terminal wire lugs if necessary.

Before Starting

Make sure the Mark VI CS-1A Switch Operator is securely attached to the S&C Mounting Pedestal, and the vertical shaft is attached to the coupling on the output shaft of the switch operator. The piercing set screws on the coupling on the output shaft of the switch operator should not be tightened at this time.

The factory-installed temporary jumpers should be in place between the interrupter contacts. See Figure 46.

NOTICE

Do not remove the temporary jumpers until directed to do so in the following instructions. **Do not** wire the interrupters and charging motors to the Mark VI CS-1A Switch Operator until directed to do so in the following instructions.

Two tagged temporary jumpers have been installed inside the switch operator between the interrupter "a" contacts and the "b" contacts. These jumpers bypass the interrupter, allowing for adjustment and checkout of the operator before the interrupters and charging motors are wired into the circuit. (The charging motors take two minutes to close and reset the interrupters between operations.)

Connecting Control Power and User-Furnished Control Circuits

Complete the following steps to connect control power and the user-furnished control circuits:

STEP 1. Mark the conduit entrance location for the control-circuit and control-power wiring on the conduit entrance plate. See Figure 47. Remove the conduit entrance plate and cut out the required openings.

STEP 2. Replace the conduit entrance plate and make the entrance fittings. Apply the provided sealing compound when replacing the conduit entrance plate. Verify the fittings are properly sealed to prevent water ingress.

NOTICE

To avoid accidental energizing of the operator after the external connections have been completed, remove the two-pole pull-out fuseholders for the motor and space heater. See Figure 47. **Reinsert the fuseholders only when indicated in the following steps**.

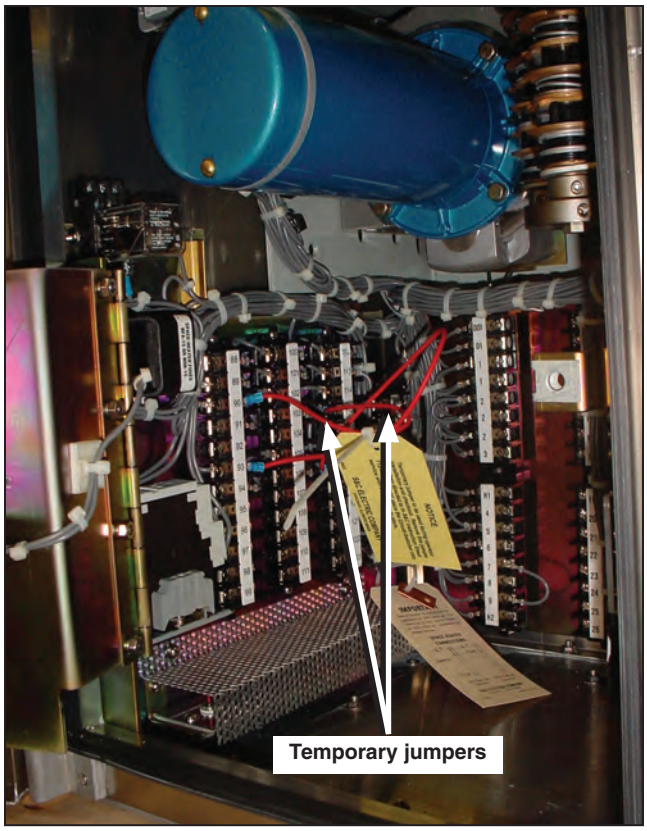


Figure 46. The location of the temporary jumpers.

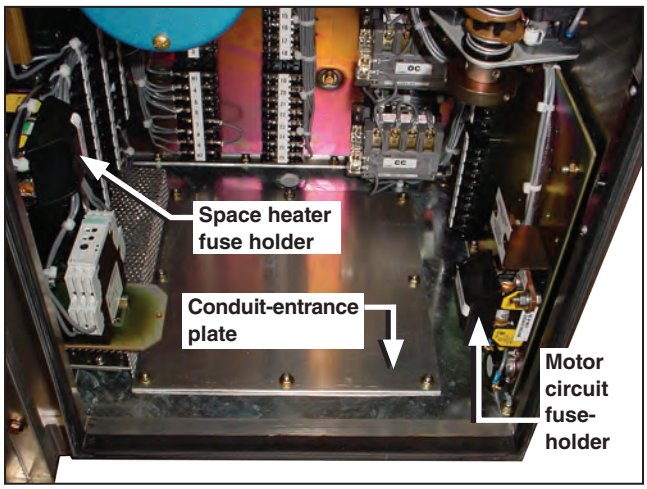


Figure 47. The location of the conduit entrance plate.

STEP 3. Remove the labels and blocking tape from the motor contactors. See Figure 48.

NOTICE

Do not connect the wiring from the interrupters or interrupter charging motors at this time. Complete the installation and testing of the control circuit wiring before wiring the interrupters and charging motors. The charging motors take approximately two minutes to close and charge the interrupters.

STEP 4. Connect the external control-circuit wiring (including space-heater source leads) to the terminal blocks of the switch operator in accordance with the wiring diagram furnished. See Figure 49.

NOTICE

Unauthorized changes should not be made in the wiring of this switch operator. Should a control-circuit revision appear desirable, it should be made only on the authority of a revised wiring diagram approved by both the user and S&C Electric Company.

NOTICE

Observe recommended minimum wire-size requirements for the control-circuit wiring, as shown in Information Bulletin 712-60 and on the switch operator schematic wiring diagram furnished. Wiring must be complete, and adequate control voltage must be available at the switch operator before checkout.

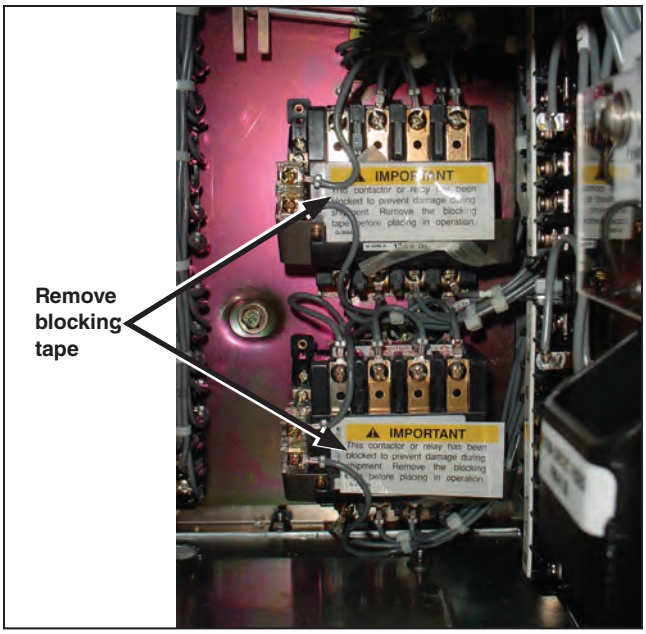


Figure 48. Remove the blocking tape from the motor contactors.

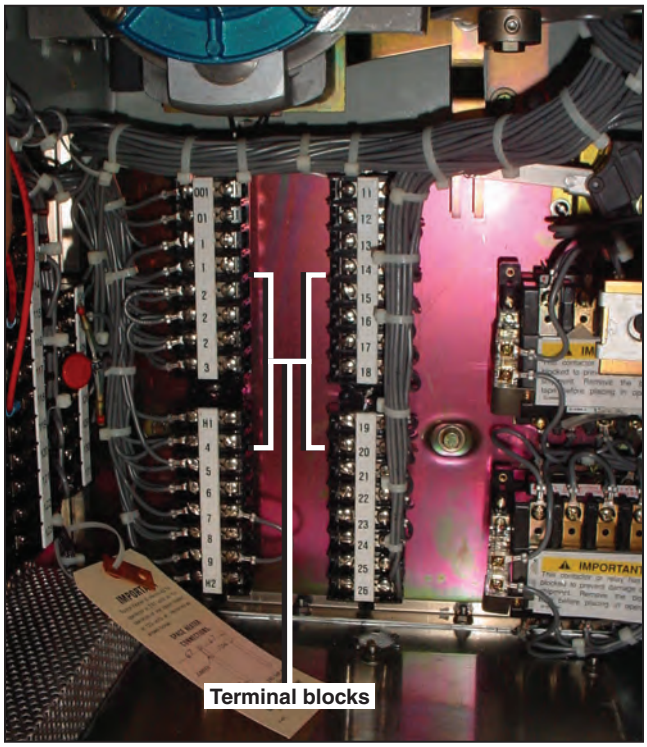


Figure 49. Connect external control-circuit wiring.

Using the Manual Operating Handle

Before proceeding further, become familiar with the operation of the MANUAL OPERATING handle.

Note: The MANUAL OPERATING handle should only be used during installation, checkout and inspection of the circuit-switcher.

⚠ WARNING

Do not operate the Mark VI Circuit-Switcher with the MANUAL OPERATING handle while the switch is energized. The MANUAL OPERATING handle should only be used during installation and checkout of the switch. Manual operation of an energized Mark VI Circuit-Switcher could, in the event of a fault or loss of control power to the operator, cause serious injury or death as well as damage to the circuit-switcher.

To operate:

STEP 1. Pull the latch knob on the hub of the MANUAL OPERATING handle and pivot the handle forward slightly from its **Storage** position.

STEP 2. Release the latch knob while continuing to pivot the handle forward to lock it into the **Cranking** position. See Figure 50. (As the handle is pivoted forward, the motor brake is mechanically released, both leads of the control source are automatically disconnected, and both the "opening" and "closing" motor contactors are mechanically blocked in the **Open** position.)

STEP 3. Crank the handle clockwise or counterclockwise respectively to move the operator between the **Open** and **Closed** position.

To return the MANUAL OPERATING handle to its storage position:

STEP 1. Pull the latch knob and pivot the handle approximately 90 degrees. The handle will disengage from the switch operator and can be rotated freely in either direction.

STEP 2. Complete handle storage by pivoting the operating handle backward approximately 90° until it latches in the **Storage** position.

NOTICE

The MANUAL OPERATING handle can be disengaged from the switch operator mechanism at any handle position and padlocked in its **Storage** position.

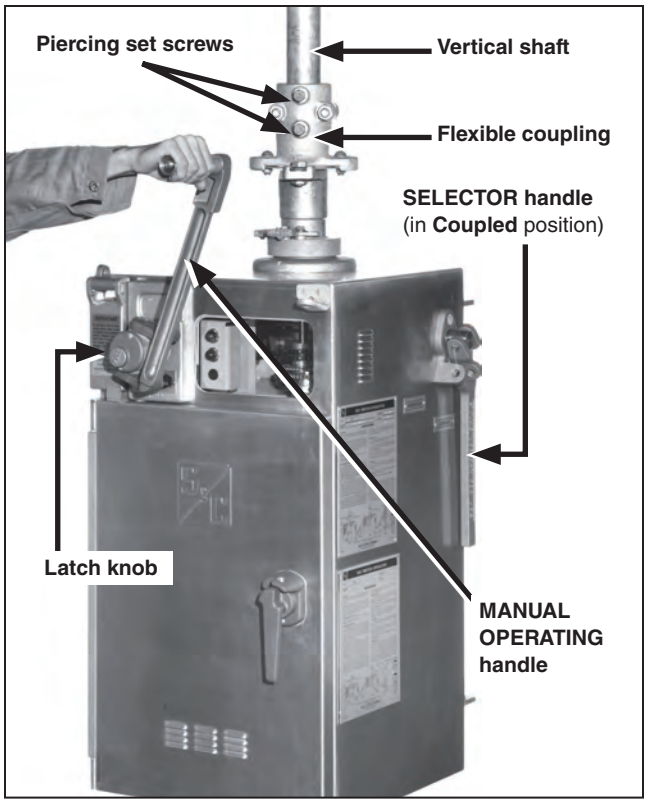


Figure 50. Manual operation.

Using the Selector Handle (Coupling and Decoupling)

The SELECTOR handle is used to couple and decouple the motor from the operating shaft. Decoupling the motor allows the user to install and configure control schemes and inspect the motor operation without opening and closing the disconnect.

The integral external SELECTOR handle used to operate the built-in internal decoupling mechanism is located on the right-hand side of the switch operator enclosure. See Figure 51.

To decouple:

STEP 1. Swing the SELECTOR handle upright and slowly rotate it clockwise 50 degrees to the **Decoupled** position. See Figure 51.

STEP 2. Lower the SELECTOR handle to engage the locking tab.

Note: The switch operator can be operated either manually or electrically without operating the disconnect. Moreover, in the **Decoupled** position, the switch operator output shaft is prevented from moving by a mechanical locking device located within the switch operator enclosure. During the intermediate segment of the SELECTOR handle travel including the position at which actual disengagement (or engagement) of the internal decoupling mechanism occurs, the motor-circuit source leads are momentarily disconnected, and both the opening and closing motor contactors are mechanically blocked in the **Open** position.

STEP 3. Look through the observation window and verify the internal decoupling mechanism is in the **Decoupled** position. See Figure 52.

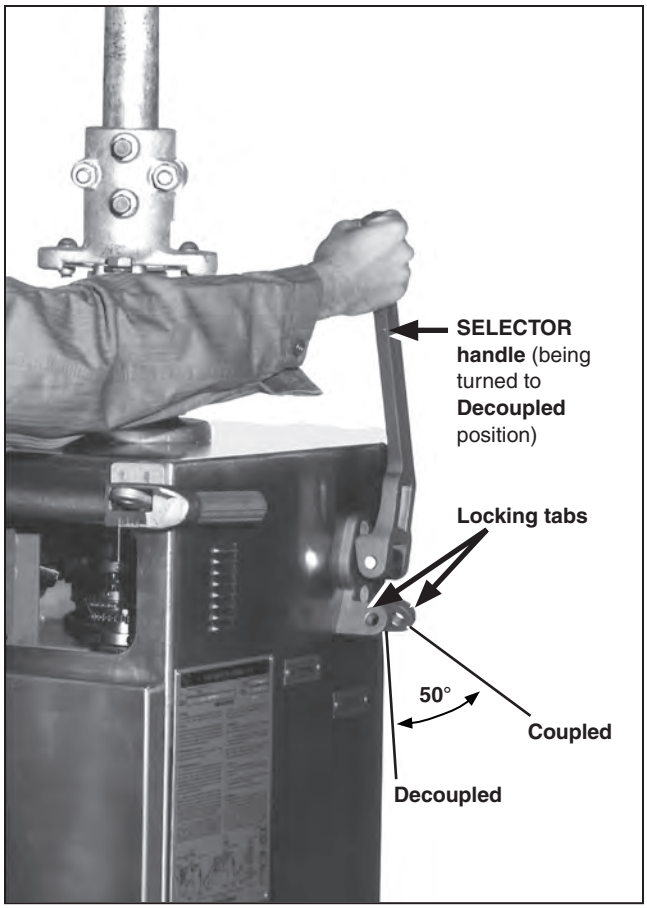


Figure 51. SELECTOR handle operation.

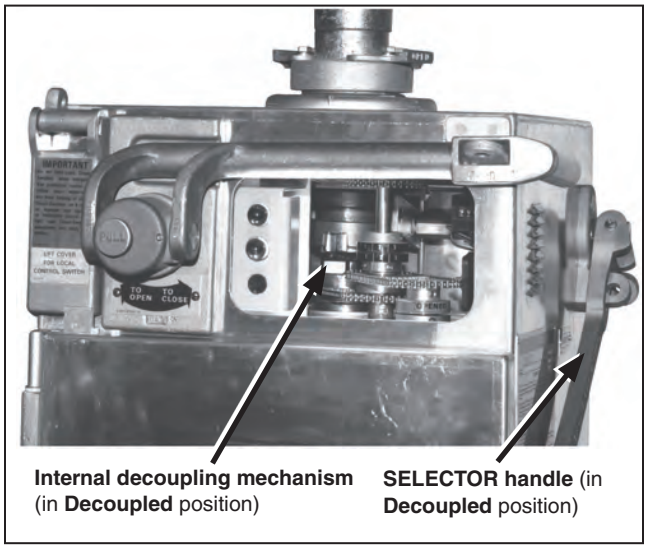


Figure 52. Verify switch is decoupled.

To Couple:

STEP 1. Manually operate the MANUAL OPERATING handle to bring the disconnect to the same position (**Open** or **Closed**) as the Mark VI CS-1A Switch Operator. The switch operator position indicator, seen through the observation window, will show when the approximate **Open** or **Closed** position has been attained. (The position indicator for the disconnect, located on the output-shaft collar of the switch operator, will be aligned later.)

STEP 2. Turn the MANUAL OPERATING handle slowly until the position-indexing drums are numerically aligned. See Figure 53.

STEP 3. Swing the SELECTOR handle upright and rotate it counterclockwise to the **Coupled** position. See Figure 53.

STEP 4. Lower the handle to engage the locking tab.

NOTICE

The SELECTOR handle can be padlocked in either the **Open** or **Closed** position.

Adjusting the Switch Operator

NOTICE

To avoid accidentally energizing the operator, remove the two-pole pull-out fuseholders for the motor and space heater and do not reinsert them until so directed.

To adjust the switch operator, complete the following steps:

STEP 1. Manually operate the disconnect to bring it to the same position (fully **Open** or fully **Closed**) as the Mark VI CS-1A Switch Operator.

STEP 2. Tighten the flexible coupling clamp bolts on the output shaft of the operator equally so the clamp pulls down evenly. Then, tighten the associated piercing set screws, piercing the shaft, and continue turning until a firm resistance is felt. See Figure 54.

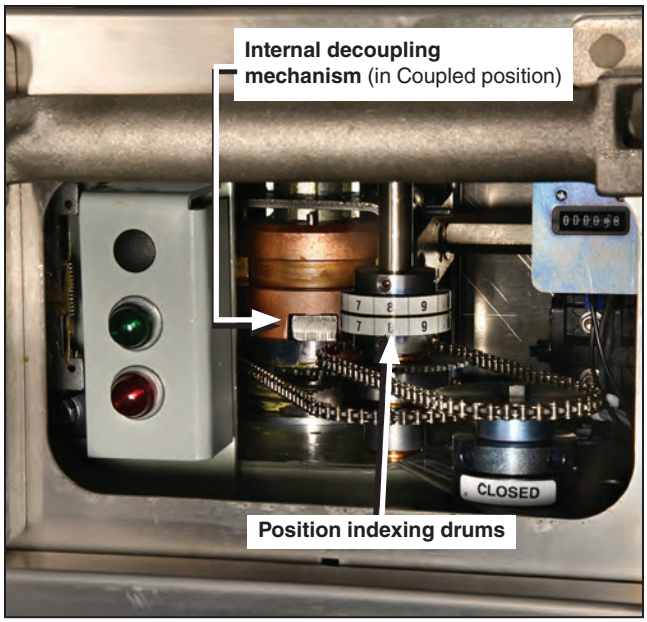


Figure 53. Verify switch is coupled.

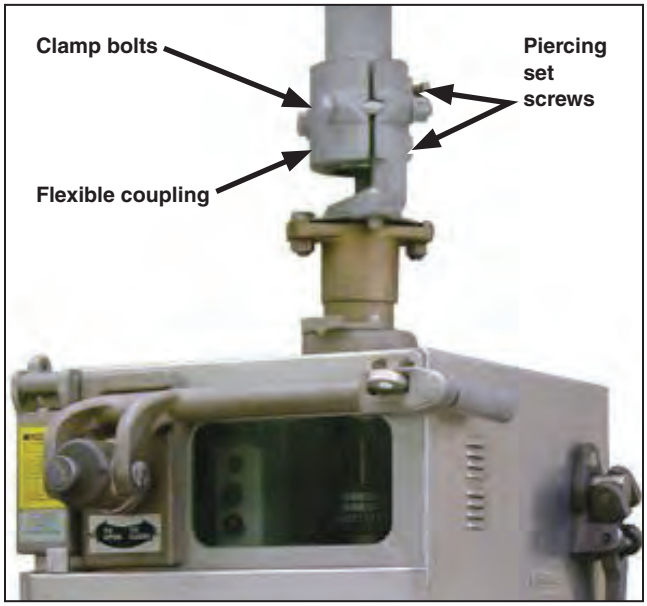


Figure 54. Tighten flexible coupling on operator output shaft.

STEP 3. With the SELECTOR handle in the **Coupled** position, crank the disconnect to the fully **Open** position and then accurately align the disconnect position indicators on the output-shaft collar of the switch operator with the alignment arrow below. See Figure 55.

STEP 4. Make sure the drive-shaft crank of each pole-unit is in an **Overtoggle** position and against its open or closed stop at the fully **Open** or fully **Closed** position of the switch operator.

⚠ CAUTION

Avoid forcing the power train beyond the fully **Open** or fully **Closed** stop positions. **Forced cranking against these stops can build up sufficient spring energy in the vertical and interphase shafts to cause the MANUAL OPERATING handle to spin backwards should the grasp on the handle be accidentally released, causing minor injury.**

STEP 5. Verify the directions of rotation are correct as follows:

NOTICE

The cranking direction to close the disconnect is indicated by an arrow plate located near the hub of the MANUAL OPERATING handle and is set at the factory. Do not attempt to adjust the motor direction or cranking direction without first consulting S&C Electric Company.

(a) With the SELECTOR handle in the **Coupled** position, manually crank the disconnect to the fully **Open** position and then to the fully **Closed** position. Temporarily mark on the top of the switch operator enclosure the direction in which the output shaft rotates to close the disconnect. See Figure 55.

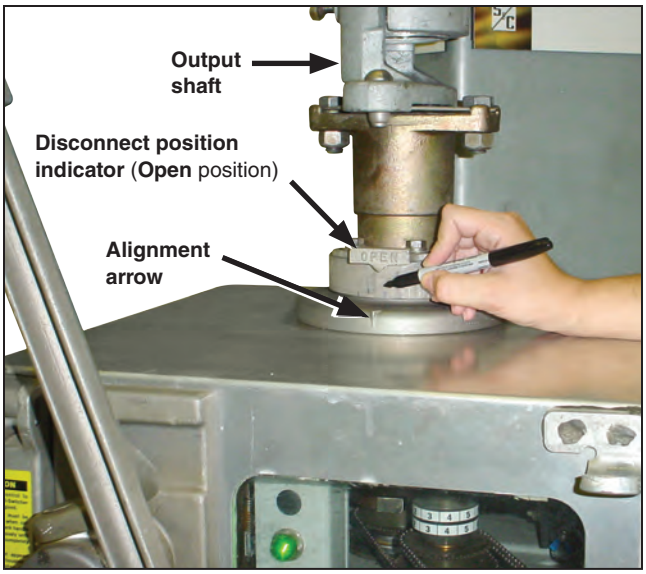


Figure 55. Adjust position indicator. Mark direction of rotation on operator.

(b) If the cranking direction required to close the circuit-switcher is opposite to that indicated by the arrow plate, remove the arrow-plate mounting screws and remount the arrow plate, exposing the other side. See Figure 56.

(c) With the MANUAL OPERATING handle in its **Storage** position and the SELECTOR handle in the **Decoupled** position, reinsert the motor-circuit fuseholder. Open the pushbutton protective cover●, and operate the switch operator by means of the externally mounted OPEN and CLOSE pushbuttons, if provided, or in their absence, by momentarily jumpering Terminals 1 and 8 to open and 1 and 9 to close.

NOTICE

Terminal designations can differ in special wiring diagrams. In such cases, refer to the specific wiring diagram for the correct terminal designations.

Note: the direction in which the travel-limit discs rotate when the switch operator closes should agree with the temporary direction mark on the top of the enclosure and with the direction displayed in the cutaway section on the outer ring of the travel-limit discs. See Figure 57 and Figure 58.

STEP 6. Verify the direction of rotation of the travel-limit discs is always the same as the direction of rotation of the output shaft:

(a) ***If the direction of rotation of the travel-limit discs noted in*** Step 5 on page 32 ***is opposite to the temporary direction mark, a reversal of the motor direction will be necessary:*** Remove the motor-circuit fuseholder to avoid accidentally energizing the control circuit. Interchange the "-S1" and "-S2" motor leads connected to Terminals 4 and 5. Reversal for the motor direction reverses only the direction of the rotation of the output shaft and travel-limit discs. The identity of the opening-stroke and closing-stroke travel-limit discs (which will be adjusted later) is unaffected.

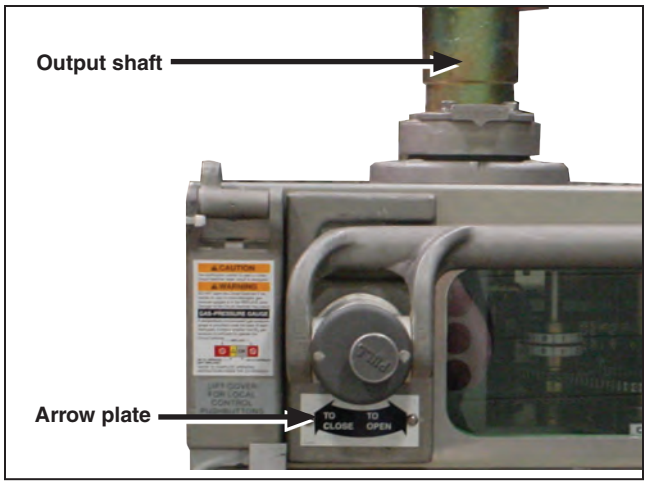


Figure 56. Verify the direction of the output shaft rotation matches the direction indicated by the arrow plate.

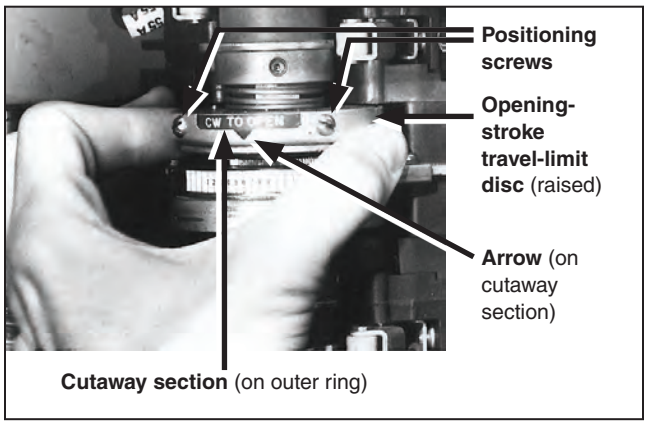


Figure 57. Make sure the cutaway section indicates the correct direction of rotation (Opening-stroke disc).

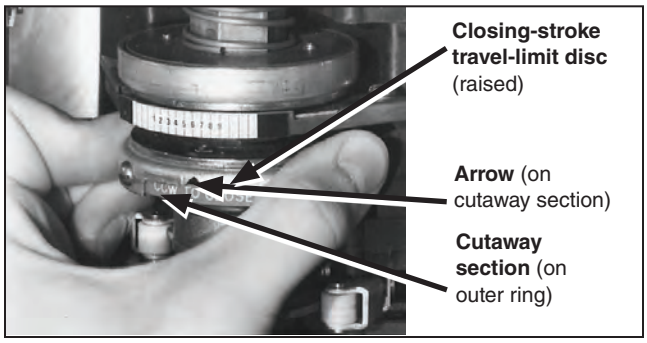


Figure 58. Make sure the cutaway section indicates the correct direction of rotation (Closing-stroke disc).

● For a switch operator with optional REMOTE-CONTROL BLOCKING switch (Suffix "-Y"), opening the pushbutton protective cover prevents remote operation of the switch operator.

If the direction of rotation of the travel-limit discs noted in Step 5 on page 32 ***is opposite to the direction displayed in the cutaway section on the outer ring of the closing-stroke travel-limit disc***: Remove the positioning screws on the outer ring of the closing-stroke travel-limit disc. See Figure 58 on page 33. Rotate the outer ring until the desired direction is displayed in the cutaway section. Replace the positioning screws.

(b) Reinsert the motor-circuit fuseholder and electrically operate the switch operator to the **Open** position.

(c) ***If the direction of output-shaft rotation to open the disconnect is opposite to that displayed in the cutaway section on the outer ring of the opening-stroke travel-limit disc, change the direction displayed***: Remove the positioning screws on the outer ring of the opening-stroke travel-limit disc. See Figure 58 on page 33. Rotate the outer ring until the desired direction is displayed in the cutaway section. Replace the positioning screws. See Figure 57 on page 33.

STEP 7. The travel-limit switch governing the extent of output-shaft rotation in the opening and closing directions includes six contacts operated by cam-actuated rollers. Positioning the cams to properly engage the rollers is facilitated by the travel-limit discs (upper one is the opening-stroke travel-limit disc; lower one is the closing-stroke travel-limit disc).

Adjust the opening-stroke travel-limit as follows:

(a) Remove the motor-circuit fuseholder.

(b) Place the SELECTOR handle in the **Coupled** position and manually crank the disconnect to the **Open** position. See "Using the Selector Handle (Coupling and Decoupling)" on page 30 for instructions on coupling and decoupling the operator.

(c) Before rotating the limit disc, from Table 1, select the indicator-plate number from the "Opening-Stroke Adjustment—Clockwise to Open" column if the disc and output shaft rotates clockwise to open the disconnect or from the "Opening-Stroke Adjustment—Counterclockwise to Open" column if the disc and output shaft rotates counterclockwise to open the disconnect.

(d) Grasp the handwheel and turn it to the extent possible in a direction *opposite* to the direction the output shaft rotates to open the disconnect. See Figure 59.

(e) With the handwheel held in the position indicated above, raise the opening-stroke travel-limit disc approximately 3⁄16- inch (5 mm) and rotate the disc until the arrow on its outer ring is in line with the number on the indicator plate as specified in Table 1. Lower the disc, make sure it is engaged, and release the handwheel.

Table 1. Adjustment of Travel-Limit Discs

Indicator Plate Number			
Opening-Stroke Adjustment		Closing-Stroke Adjustment	
Clockwise to Open	Counterclockwise to Open	Clockwise to Close	Counterclockwise to Close
5	5	5	5

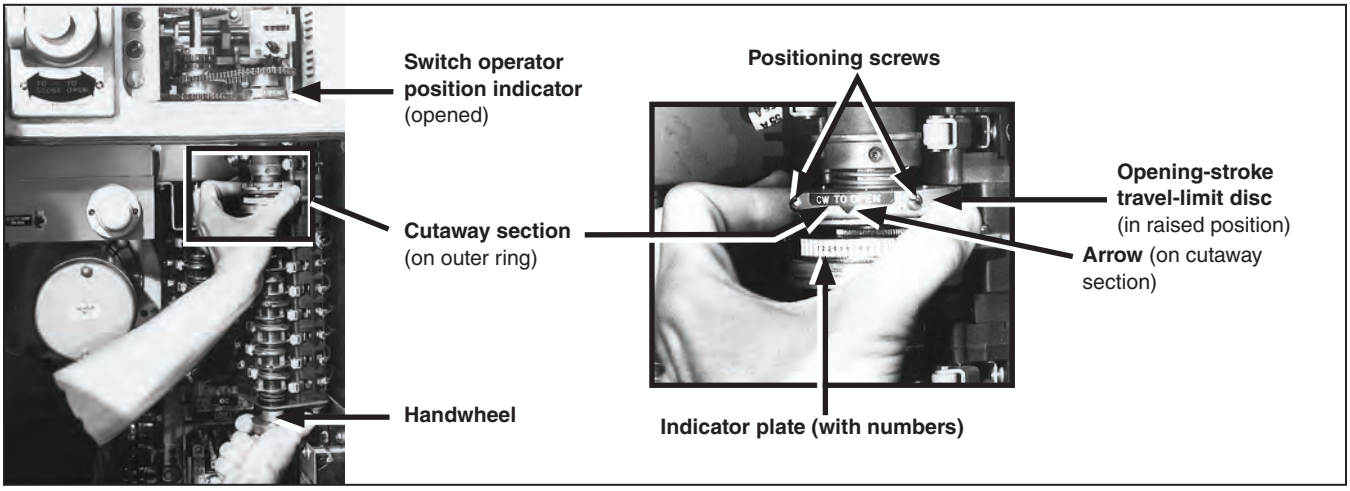


Figure 59. Adjustment of opening-stroke travel-limit disc.

STEP 8. Adjust the closing-stroke travel-limit disc (and the associated cams) as follows:

(a) Manually crank the disconnect to the fully **Closed** position.

(b) Grasp the handwheel and turn it to the extent possible in a direction *opposite* to the direction the output shaft rotates to close the disconnect. See Figure 60.

(c) With the handwheel held in the position indicated above, lower the closing-stroke travel-limit disc approximately 3⁄16-inch (5 mm) and rotate the disc until the arrow on the outer ring is in line with the number 5 on the indicator plate. Raise the disc, make sure it is engaged, and release the handwheel.

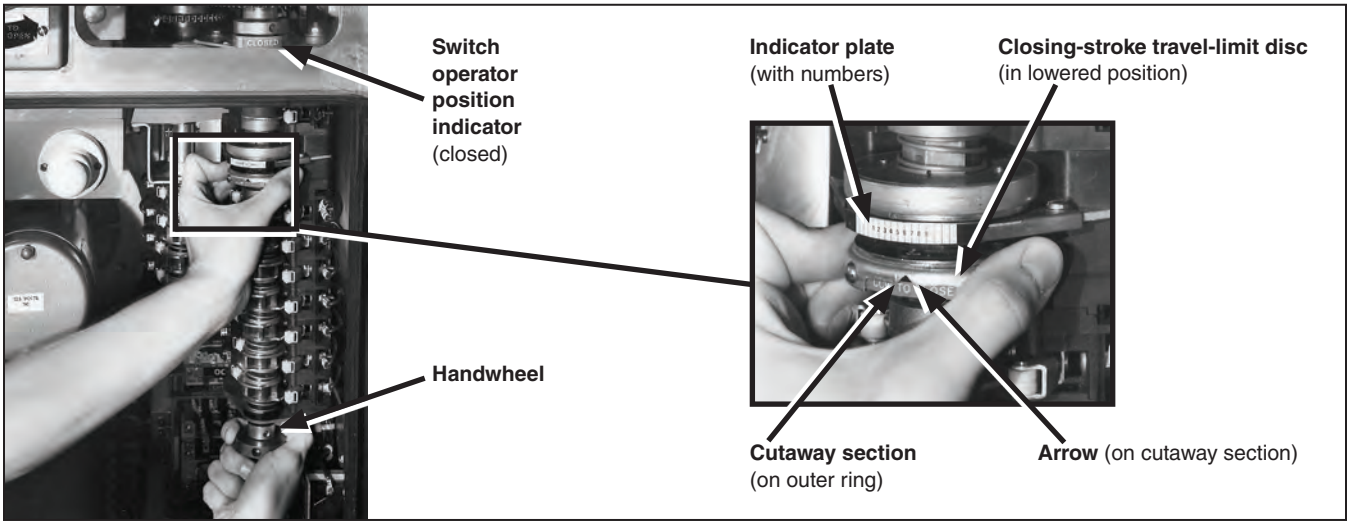


Figure 60. Adjustment of closing-stroke travel-limit disc.

STEP 9. After adjusting the travel-limit discs, check the following:

(a) Place the SELECTOR handle in the **Decoupled** position.

(b) Return the MANUAL OPERATING handle to its **Storage** position.

(c) Reinsert the motor-circuit fuseholder.

(d) Operate the switch operator electrically to **Open** and **Close** the disconnect.

(e) Verify the rotation direction of the travel-limit discs for opening and closing corresponds with the direction of rotation of the output shaft and these directions agree with the direction displayed in the cutaway section on the outer ring of the travel-limit discs. See Figure 61.

NOTICE

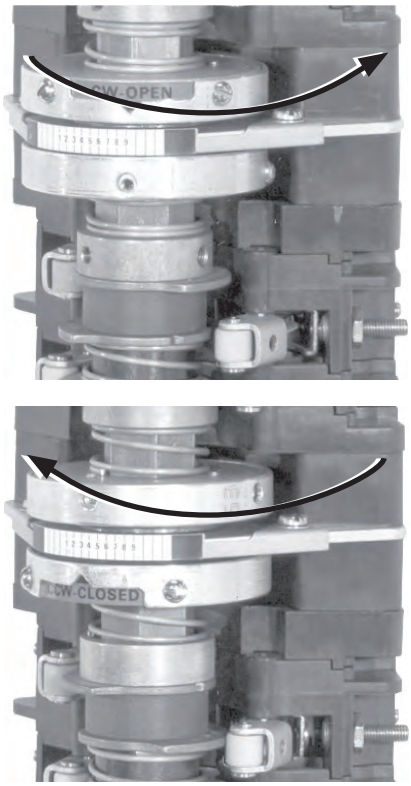
When the switch operator is operated in the **Decoupled** position, the travel-limit discs do not stop at the indicator-plate positions for which they were set in Step 7 and Step 8. This can be disregarded.

STEP 10. There should always be a certain amount of "unwind" or relaxation of the output shaft (in both the **Open** and **Closed** positions) indicating the disconnect has been driven to a **Positive-toggle** position against its Open (or Closed) stops.

Place the SELECTOR handle in the **Coupled** position. Operate the Mark VI CS-1A Switch Operator electrically to open the circuit-switcher and determine the amount of overtravel in the opening direction by releasing the motor brake and noting how far the output shaft "unwinds."

Release the motor brake by unlatching the MANUAL OPERATING handle and pivoting it rapidly, with a snap motion, toward its **Cranking** position. Then return the MANUAL OPERATING handle to its **Storage** position.

Use when the output shaft direction and the travel-limit disc rotation are clockwise to open.



Opening-stroke travel-limit disc (with the circuit-switcher and switch operator in fully **Open** position—raise and turn counterclockwise to increase travel of switch operator)

Closing-stroke travel-limit disc (with the circuit-switcher and switch operator in fully **Closed** position—lower and turn clockwise to increase travel of switch operator)

Figure 61. Adjustment of travel-limit discs for desired "unwind" of output shaft (Clockwise to Open).

If adjustment is needed:

(a) Remove the motor-circuit fuseholder.

(b) Increase the amount of "unwind" by decreasing the opening-stroke travel-limit disc (to increase travel) one indicator-plate number at a time. See Figure 61 and Figure 62.

Note: the direction of disc rotation is always the same as that of the output shaft. The output shaft should never have sufficient "unwind" when the switch operator is decoupled to cause rotation of the travel-limit discs.

(c) If rotation of the travel-limit disc is evident, advance the opening-stroke travel-limit disc (to decrease travel) an amount necessary only to eliminate the "unwind" rotation of the travel-limit discs.

NOTICE

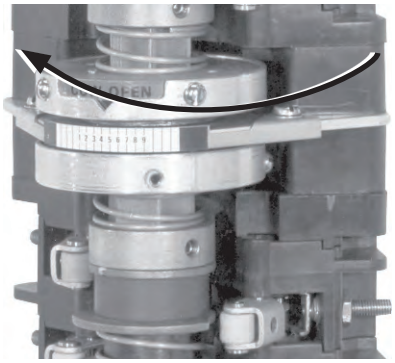
Before checking the "unwind" after a closing stroke, remove the motor-circuit fuseholder before releasing the motor brake. Excessive "unwind" at this point could cause rotation of the travel-limit switch sufficient to pick up a "bb" contact, which, in turn, would cause the switch operator to open (if energized).

(d) With the MANUAL OPERATING handle in its **Storage** position, reinsert the motor-circuit fuseholder, and operate the switch operator electrically to close the circuit-switcher.

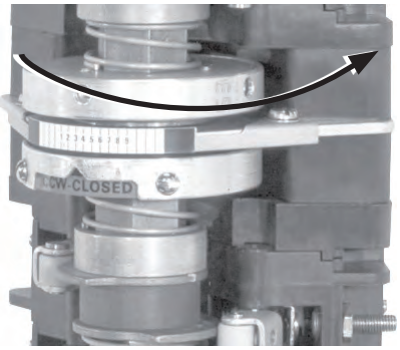
(e) Repeat the procedure to adjust the closing-stroke travel-limit disc one indicator-plate number at a time to obtain the correct amount of overtravel in the closing direction.

STEP 11. Check the operation of the disconnect by operating the switch operator several times to observe the action. Operation should appear smooth, with the circuit-switcher drive-shaft cranks coming to rest firmly against their stops, in an **Overtoggle** position, in both opening and closing directions.

Use when the output shaft direction and the travel-limit disc rotation are counterclockwise to open.



Opening-stroke travel-limit disc (with circuit-switcher and switch operator in fully **Open** position— raise and turn clockwise to increase travel of switch operator)



Closing-stroke travel-limit disc (with circuit-switcher and switch operator in fully **Closed** position— lower and turn counterclockwise to increase travel of switch operator)

Figure 62. Adjustment of travel-limit discs for desired "unwind" of output shaft (Counterclockwise to Open).

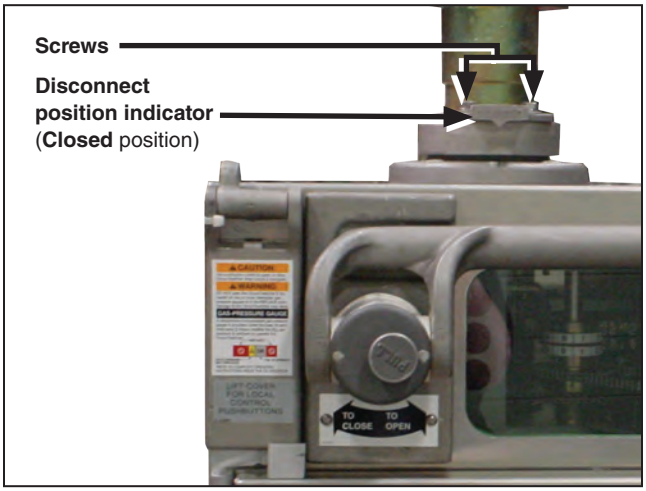


Figure 63. Align position indicator arrow.

If necessary, realign the circuit-switcher position indicators on the switch operator output-shaft collar with the alignment arrow. See Figure 63.

With the switch operator in the fully **Open** position and then in the fully **Closed** position, check the corresponding switch operator position indicator. In each position, the corresponding position indicator should be readily visible from the front of the enclosure.

If adjustment of either position indicator is necessary: Remove the motor-circuit fuseholder, loosen the two set screws (see Figure 63 on page 38) and rotate the indicator to the desired position. Retighten set screws.

STEP 12. The auxiliary switch, which is permanently coupled to the motor, includes eight contacts, Terminals 11 through 26. (If the optional position-indicating lamps are included, six contacts are available: Terminals 13 through 18 and Terminals 21 through 26.)

These contacts permit external circuits to be established to monitor switching operations. A cam-actuated roller operates each contact. The cams are individually adjustable in 4.5-degree increments and can be positioned so roller engagement occurs at the desired point in the operating cycle.

The "standard" configuration for the auxiliary switch consists of four "a1" contacts, Terminals 11 through 18, and four "b1" contacts, Terminals 19 through 26. Thus, with the switch operator in the **Open** position, the "a1" contacts are open and the "b1" contacts are closed. With the switch operator in the **Closed** position, the "a1" contacts are closed and the "b1" contacts are open. A contact is closed if its roller is disengaged from a cam and open if its roller is engaged by a cam. See Figure 64 and Figure 65.

Any auxiliary-switch contact being used must be checked for proper operation after the switch operator travel-limit discs have been adjusted. Check the auxiliary-switch contacts for both **the Open** and **Closed** positions of the switch operator.

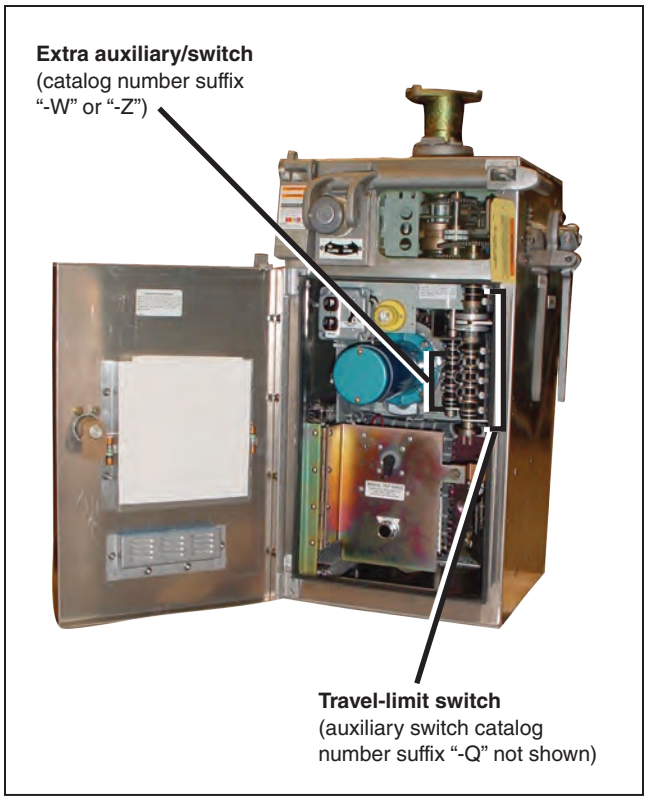


Figure 64. An open front view of switch operator "standard" contact configurations.

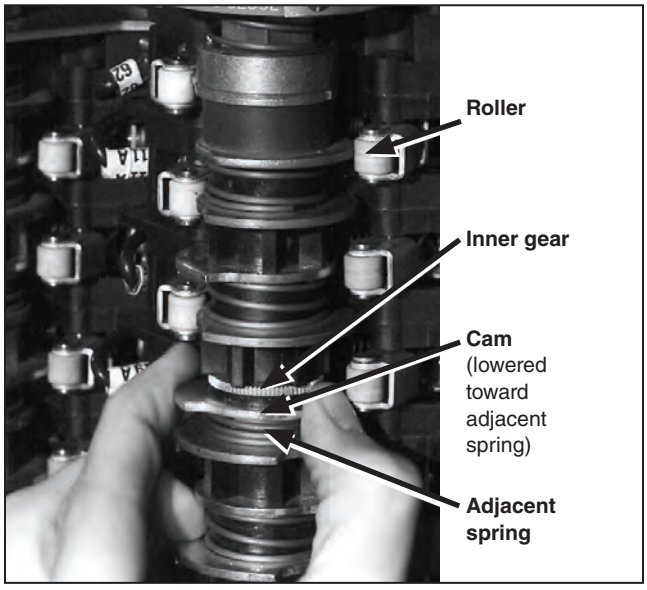


Figure 65. Adjustment of cams on auxiliary switch.

To adjust the auxiliary-switch contacts, refer to Figure 65 and Figure 66 on page 40 and proceed as follows:

(a) With the SELECTOR handle in the **Coupled** position, operate the switch operator to the fully **Closed** position.

(b) Remove the motor-circuit fuseholder.

(c) Determine which "a1" contacts are not in the **Closed** position. A contact is closed if its roller is disengaged from a cam and is open if its roller is engaged by a cam.

(d) For the "a1" contacts not in the **Closed** position, raise (or lower) the corresponding cam toward its adjacent spring until the cam is separated from the teeth of the inner gear. Rotate the cam so when lowered (or raised) it will be disengaged from the roller. Lower (or raise) the cam, making sure the teeth mesh with the inner gear and the cam is disengaged from the roller.

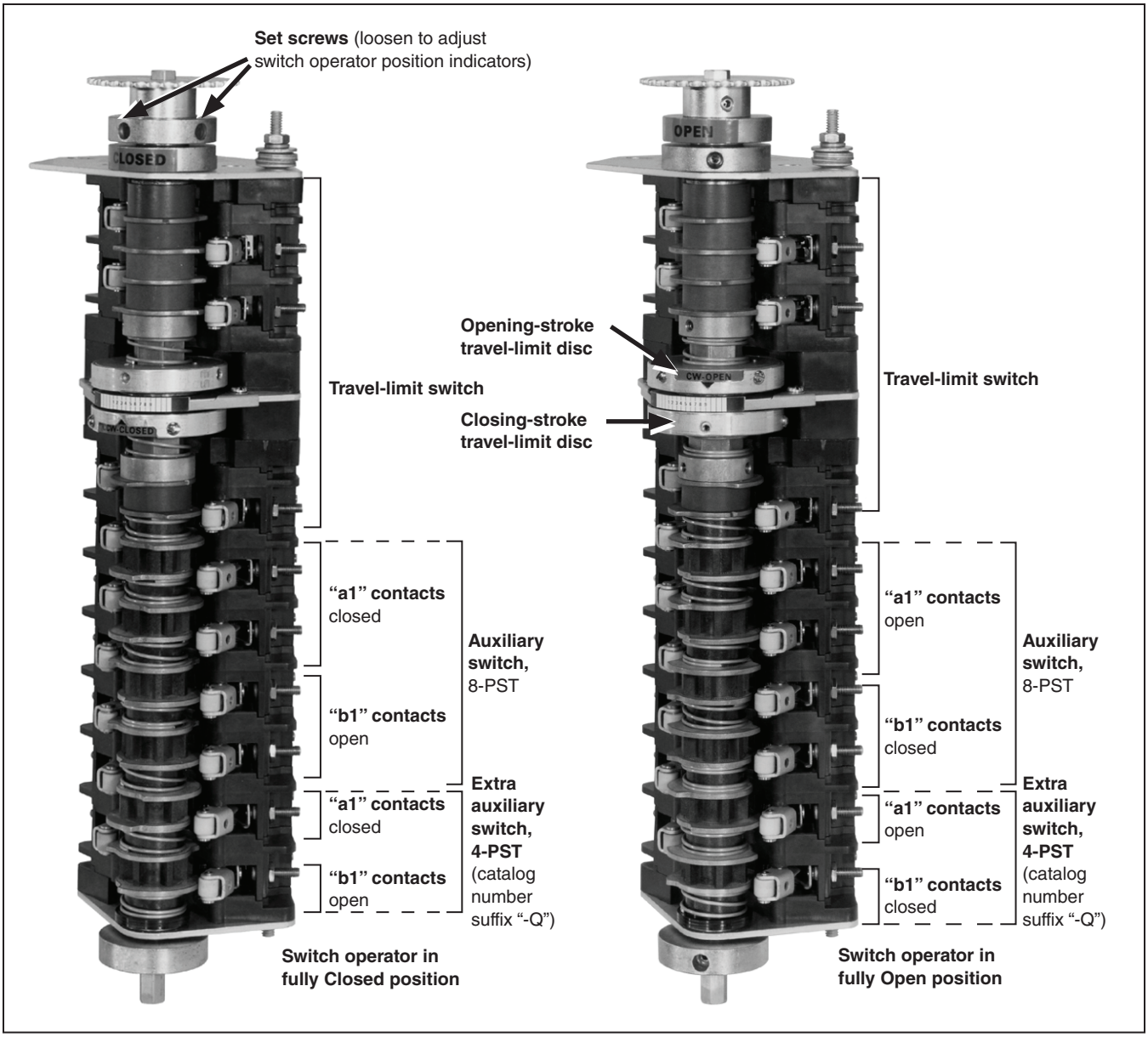


Figure 66. Travel-limit and auxiliary switches.

(e) Reinsert the motor-circuit fuseholder.

(f) Operate the switch operator to the fully **Open** position. Remove the motor-circuit fuseholder and, if necessary, adjust the cams as described in (d) until all "b1" contacts are in the **Closed** position.

(g) Reinsert the motor-circuit fuseholder and operate the disconnect. Both sets of contacts should now be correctly positioned for both the **Open** and **Closed** positions of the disconnect. Sufficient adjustment is available to provide correct positioning of both sets of contacts.

Because each cam can be individually adjusted in 4.5-degree increments, any "a1" contact can be changed to a "b1" contact, or vice versa. Because of the many positions to which the cams can be adjusted, various rollers can be engaged or disengaged to open or close their contacts either simultaneously, sequentially, randomly, or in various combinations.

Adjustment of the auxiliary switch for other than the "standard" contact configuration is left to the user. The motor-circuit fuseholder should be removed when adjusting these contacts.

(Switch operators furnished with the suffix "-Q" option are equipped with an extra auxiliary switch, Terminals 27 through 34, having four contacts—two "a1" and two "b1"—which can be adjusted as previously described. See Figure 66 on page 40.

STEP 13. Switch operators furnished with either the suffix "-W" or "-Z" are equipped with an extra auxiliary switch coupled to the disconnect. The suffix "-W" auxiliary switch consists of 8 contacts, Terminals 35 through 50. The suffix "-Z" auxiliary switch consists of 12 contacts, Terminals 35 through 50, plus Terminals 80 through 87. These contacts permit external circuits to be established to monitor disconnect operation. A cam-actuated roller operates each contact, and the cams are individually adjustable in 4.5-degree increments.

The "standard" configuration for the suffix "-W" extra auxiliary switch consists of 4 "a2" contacts, Terminals 35 through 42, and 4 "b2" contacts, Terminals 43 through 50. The "standard" configuration for the suffix "-Z" extra auxiliary switch consists of 6 "a2" contacts, Terminals 35 through 42 and Terminals 80 through 83, and 6 "b2" contacts, Terminals 43 through 50 and Terminals 84 through 87.

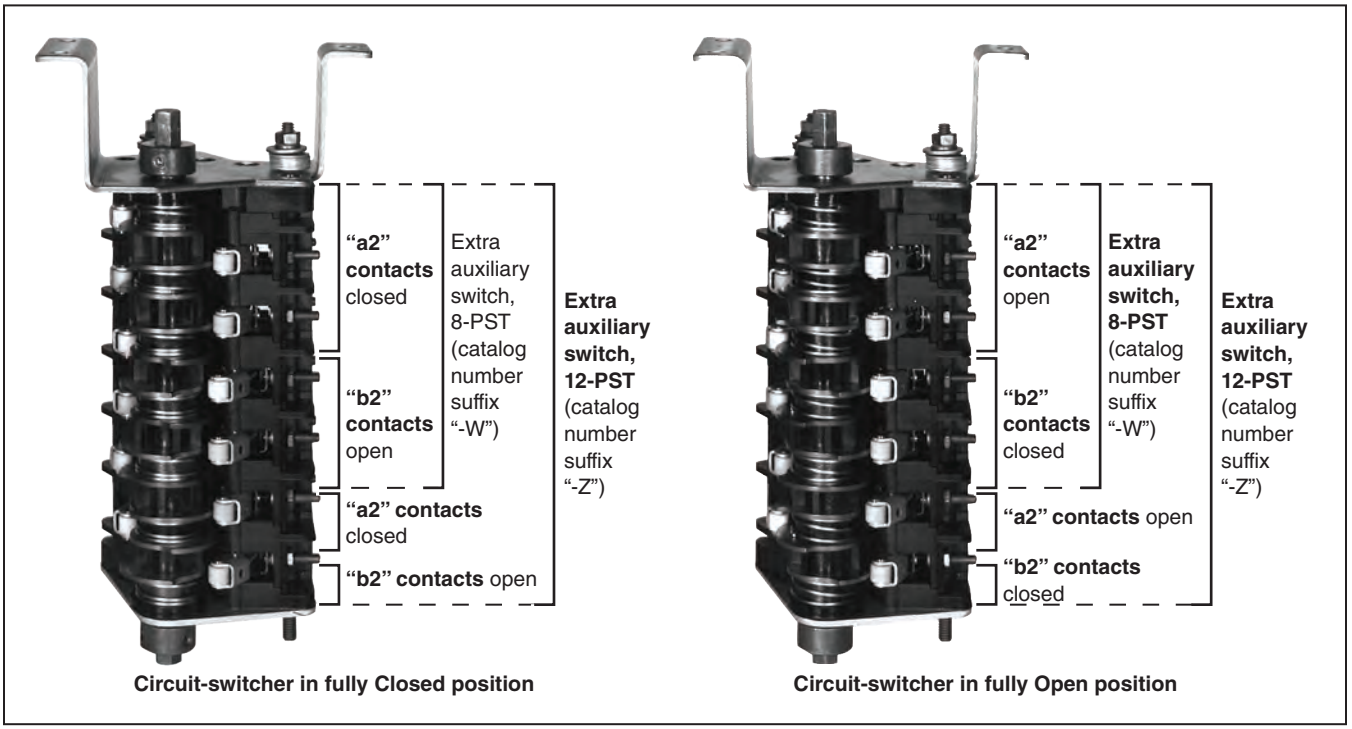


Figure 67. Extra auxiliary switches.

With the disconnect in the fully **Closed** position, the "a2" contacts should be closed and the "b2" contacts should be open. With the disconnect in the fully **Open** position, the "a2" contacts should be open and the "b2" contacts should be closed. See Figure 67.

Any suffix "-W" or "-Z" auxiliary switch contact being used must be checked for proper operation after satisfactory electrical operation of the disconnect has been achieved. Check the auxiliary-switch contact engagement for both the **Open** and **Closed** positions of the disconnect. Adjustment of the suffix "-W" or "-Z" extra auxiliary switch is identical to the procedure for the auxiliary switch and the suffix "-Q" extra auxiliary switch. If adjustment of the suffix "-W" or "-Z" auxiliary switch is needed, refer to Step 12 and Figure 65 on page 39 and Figure 67.

STEP 14. Make sure all protective-relay, control-circuit, and control-power wiring is complete. Wire the interrupters and charging motors to the Mark VI CS-1A Switch Operator using the following procedure:

(a) Disconnect power to the switch operator by removing the fuseholder inside the operator enclosure.

(b) With control power disconnected, remove the temporary jumpers between the interrupter contacts. Discard the jumpers. See Figure 68.

(c) Following the wiring diagram furnished, make up the electrical connections from the charging motors and interrupters to the appropriate terminal blocks inside the switch operator. Do not apply control power at this time.

Control power will be applied during "Startup" on page 45.

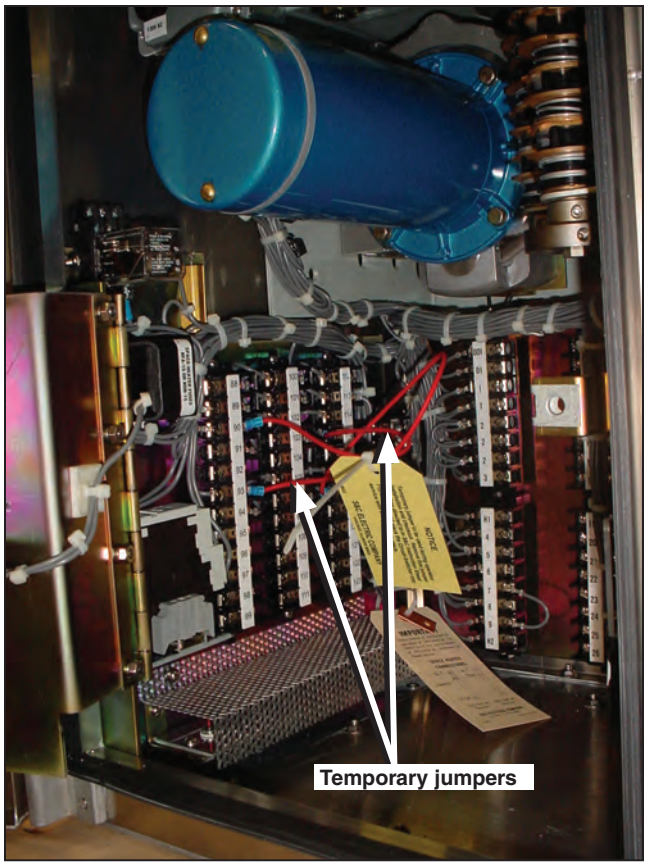


Figure 68. Remove temporary jumpers and wire the interrupters to the apropriate terminals in the operator.

Installing the Terminal Pad

NOTICE

DO NOT exceed the terminal pad loading limits outlined in S&C Information Bulletin 712-60. **Failure to do so can result in damage to the Mark VI Circuit-Switcher**.

Repeat Step 1 through Step 2 for each pole-unit.

STEP 1. Remove the lifting bracket from the interrupter. Make sure all packing material has been removed from the top of the interrupter. See Figure 69.

NOTICE

The lifting brackets must be removed before energizing the Mark VI Circuit-Switcher. **Failure to do so can result in damage to the interrupters.**

STEP 2. Prepare the interrupter terminal pad attachment as follows:

(a) Thoroughly clean the terminal pad using a soft cloth.

(b) Thoroughly wire-brush the appropriate set of holes on the interrupter casting.

(c) Immediately apply a liberal coating of Burndy Penetrox A or other suitable aluminum connector compound to the clean surfaces.

(d) Apply Penetrox A to the threads of two ½–13×1-inch hex-head stainless steel cap screws furnished.

(e) Attach the terminal pad to the appropriate set of tapped holes on the interrupter. Tighten the screws to a torque of 40 to 50 ft.-lbs. See Figure 70.

NOTICE

Do not use a wire brush to clean the upper terminal pad. Abrasive cleaning may damage the terminal pad plating and cause corrosion.

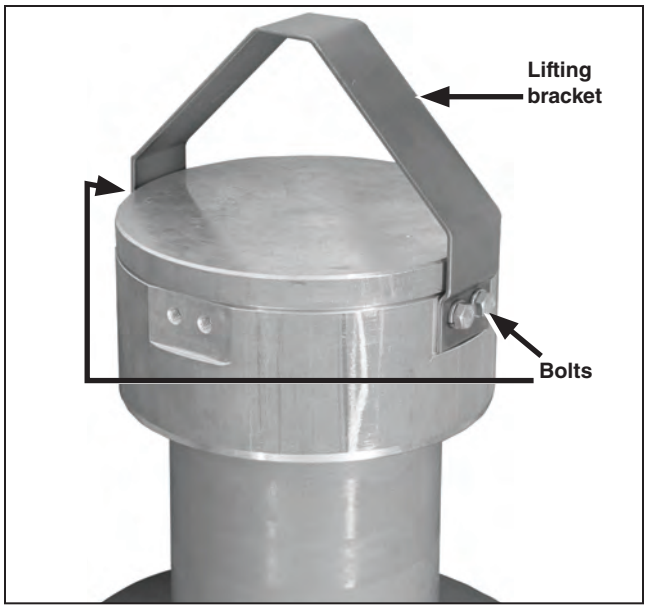


Figure 69. Remove the lifting bracket.

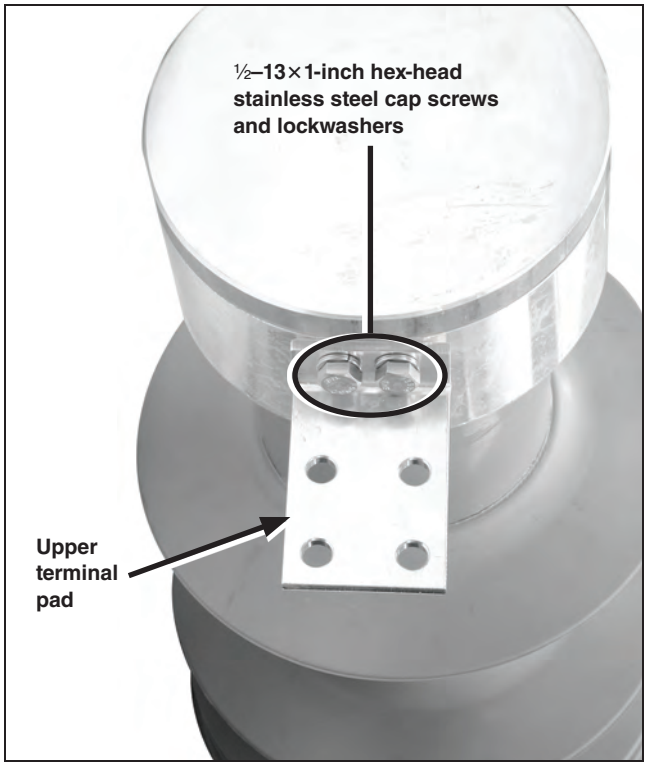


Figure 70. Bolt the upper terminal pad to the interrupter.

STEP 3. Prepare the jaw-end terminal pad as follows:

(a) Thoroughly wire-brush the jaw-end terminal pad casting.

(b) Immediately apply a liberal coating of Penetrox A or other suitable aluminum connector compound to the clean surface. See Figure 71.

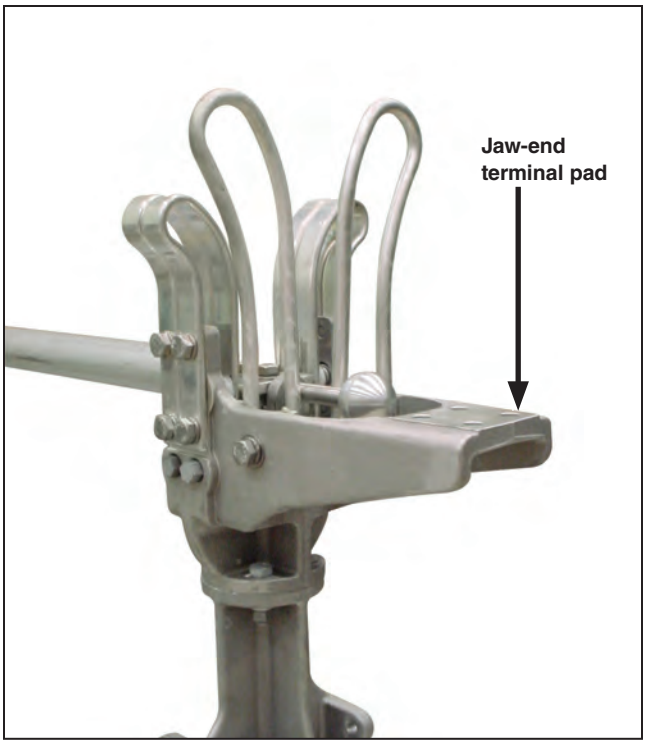


Figure 71. Prepare the jaw-end terminal pad.

Connecting Conductors

⚠ DANGER

Conductors must be de-energized and grounded in accordance with standard system operating practice. **Failure to do so will result in serious injury or death**.

STEP 1. Attach the conductors to their respective terminal pads using flexible-conductor connections. Attach and form the conductors to minimize terminal-pad loadings. Do not exceed the terminal-pad loadings specified in Information Bulletin 712-60.

STEP 2. After attaching conductors, recheck the alignment of the blade as described in Step 3 on page 16.

Startup

⚠ DANGER

Conductors must be de-energized and grounded in accordance with standard system operating practice during checkout. **Failure to do so will result in serious injury or death.**

STEP 1. Verify the disconnect is in the **Coupled** position by looking at the internal decoupling mechanism inside the Mark VI CS-1A Switch Operator. See Figure 72. If the switch operator is in the **Decoupled** position, manually operate the switch operator to bring it into the same position as the disconnect (**Open** or **Closed**). See Figure 73. For instructions on coupling the switch operator, refer to "Using the Selector Handle (Coupling and Decoupling)" on page 30.

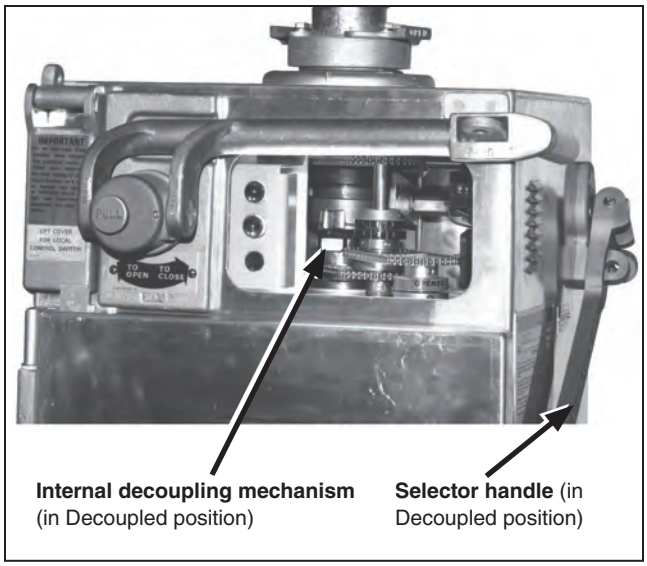


Figure 72. View of a decoupled switch operator through the observation window.

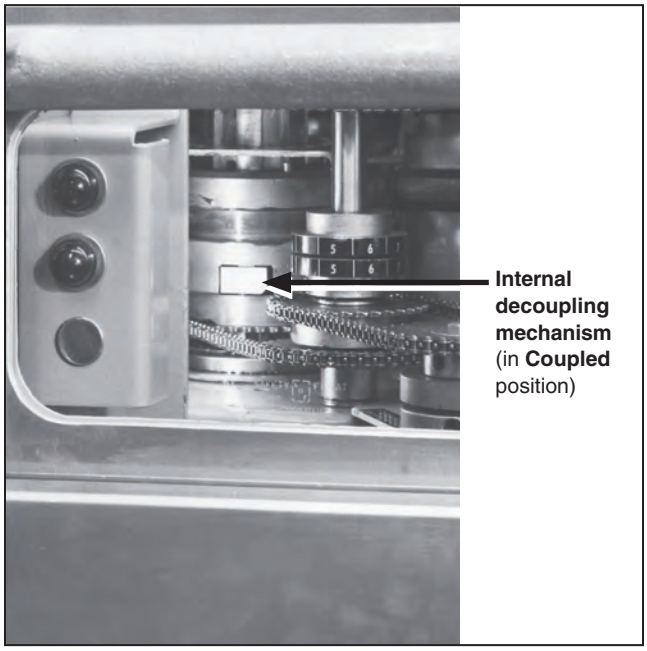


Figure 73. View of the coupled switch operator through the observation window.

STEP 2. Crank the MANUAL OPERATING handle on the Mark VI CS-1A Switch Operator until the disconnect is in the fully **Open** position. See Figure 74. Visually inspect the blade to confirm it is open. For instructions on using the MANUAL OPERATING handle refer to "Using the Manual Operating Handle" on page 29.

STEP 3. Verify the interrupters are in the **Open** position and the gas pressure gauge on the underside of the interrupter is in the Ok To Operate zone. See Figure 75 on page 47.

NOTICE

The gas-pressure gauge needle should be in the OK To Operate zone. If the gauge is not in this position, stop the installation and notify the S&C Electric Company.

Figure 74. A switch with disconnect in open position.

STEP 4. Reconnect control power to the operator by replacing the fuseholder in the Mark VI CS-1A Switch Operator. The charging motors should begin closing and charging the interrupters.

NOTICE

The interrupter charging motors have a **Return-to-Home** feature. If control power is disconnected during an interrupter charging operation, when power is restored, the circuit will prompt the motors to return to **Home** position:

***If control power is disconnected prior to the interrupters being latched and closed*,** the motor will return to the start of the charging cycle (**Home** position) and the interrupter indicators will show **Open** before the charging cycle automatically begins again.

If control power was disconnected after the interrupters were latched and closed, the motor will return to the **Home** position and the interrupter indicators will show **Closed.**

⚠ DANGER

Conductors must be de-energized and grounded in accordance with standard system operating practice during checkout. **Failure to do so will result in serious injury or death**.

STEP 5. If the interrupter charging motors do not immediately begin charging, remove the fuseholder, recheck the wiring connections per the furnished wiring diagram, and reapply power to the operator. If the motors still do not start, stop the installation and notify S&C Electric Company.

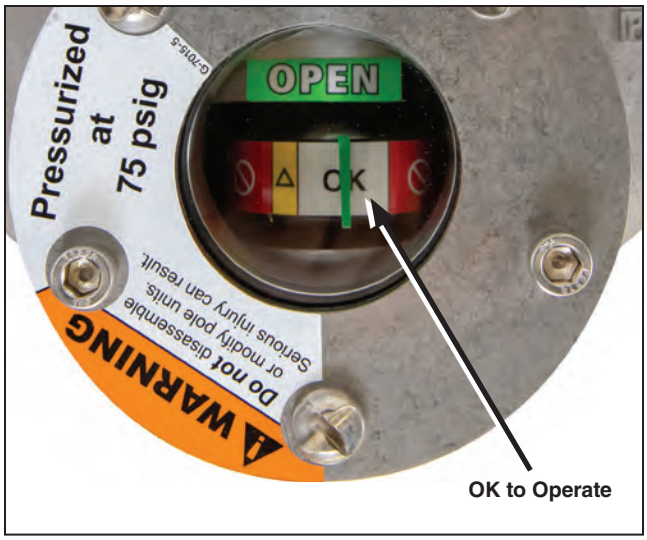


Figure 75. Interrupter gas-pressure gauge in the OK to Operate zone.

Checkout

The following instructions assume the switch operator output shaft has been connected to the disconnect drive train, the electrical connections to the control source have been completed, and the switch operator has been correctly adjusted. See Figure 76.

Using this instruction sheet, the furnished reference drawing, and S&C Instruction Sheet 712-501 as a guide, visually inspect the entire installation. Verify the following:

Mounting Pedestals (if applicable)

- Make sure both the upper and lower sets of anchor bolt nuts are in contact with the pedestal base.
- Make sure the fasteners for the pedestal brackets, adapter brackets, support arms, and support angles are securely tightened.
- Make sure all packaging materials, lifting brackets, and eyebolts have been removed.

Pole-Units

- Make sure the fasteners for the interrupter mounting bracket, support brackets, and motor brackets are securely tightened.
- Make sure all packaging materials, lifting brackets, and eyebolts have been removed.
- Make sure the conduit is securely fastened to the structure or mounting pedestals and all conduit fasteners furnished have been used.
- Check for damage to the porcelain insulators and interrupters. Clean dirt and grease from the insulation.
- Make sure the manual hand crank is not attached to a disconnect. If it is, remove it.
- Check for torque in the bus connection between the interrupters and disconnect. Loosen and reposition interrupter base if necessary.

Figure 76. A completed switch with pre-insertion inductors.

Drive Train

- Make sure all drive train couplings are secure and none of the piercing set screws is loose or protruding through the coupling clamp.
- Make sure the grounding strap attached to the base of the vertical operating shaft is properly grounded.
- Make sure the gearbox is level, and all fasteners are secure.

Mark VI CS-1A Switch Operator

- Make sure all electrical connections are landed on the appropriate terminal blocks, per the furnished wiring diagram.
- Make sure all terminal block screws are secure.
- Make sure the temporary jumper has been removed and discarded.
- Make sure all control-power and wiring conduit entrances are sealed with a watertight sealant.

The switch can now be operated according to the instructions in S&C Instruction Sheet 712-501.

Understanding the Interrupter Indicators

The interrupter indicators are located underneath the interrupter base. The indicators are not accurate while the interrupters are being closed and charged.

If the interrupter is in the **Open and Discharged** position, the indicator reads "OPEN". See Figure 77.

If the interrupter is in the **Closed and Charged** position, the indicator reads "CLOSED". See Figure 78.

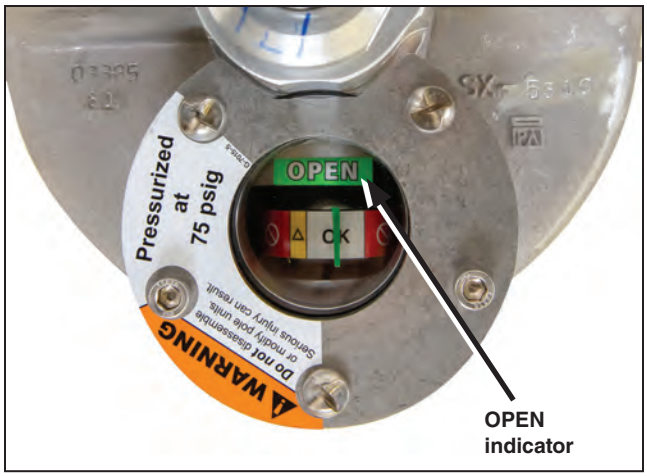


Figure 77. The interrupter is in the Open and DIscharged position. The indicator reads "OPEN."

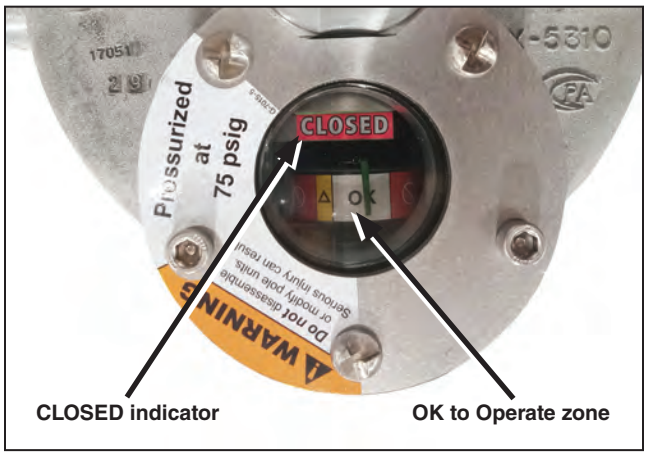


Figure 78. The interrupter is in the Closed and Charged position. The indicator reads "CLOSED."

Understanding the Gas-Pressure Gauge

A temperature-compensated gas-pressure gauge is located underneath the interrupter base. It shows whether SF_6 gas density is sufficient for a **Trip** operation. The gas-pressure gauge shows three zones:

OK to Operate

This is the White zone. If the gauge needle is in this zone, the interrupter is at normal gas density and can be opened and closed. See Figure 79.

OK to Operate (but Replace)

This is the Yellow zone. If the gauge needle is in this zone, the interrupter can be opened and closed with full ratings. However, the interrupter has lost gas and should be replaced as soon as possible. See Figure 80.

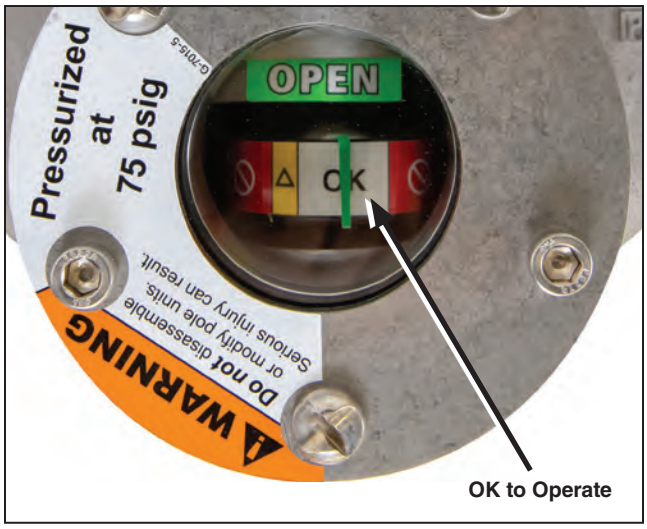


Figure 79. The gauge needle in white OK to Operate zone.

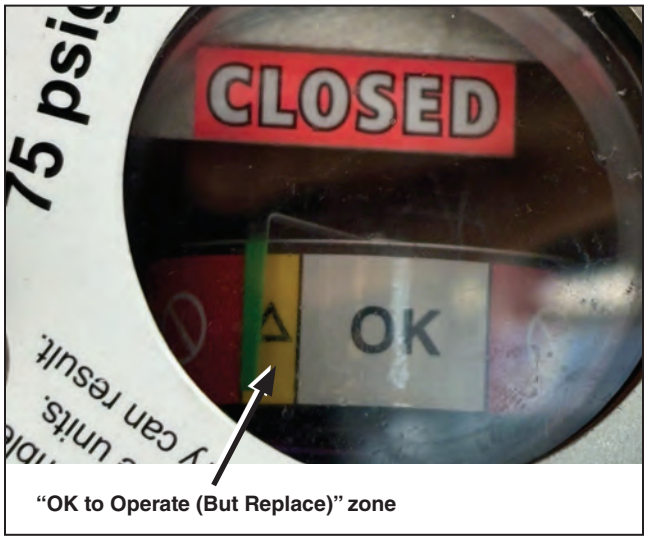


Figure 80. The gauge needle in yellow OK to Operate (but Replace) zone.

Replace

There are two Red zones. If the indicator needle is in the Red zone shown in Figure 81, the gas density in the interrupter has dropped below the minimum functional level and the interrupter will not maintain full interrupting or dielectric ratings. The interrupter should be removed from service and replaced promptly. Do not operate the Mark VI Circuit-Switcher.

If the indicator needle is in the Red zone shown in Figure 82, the local gas density gauge is damaged and cannot be relied on to provide an accurate indication of gas density. The interrupter should be removed from service and replaced promptly. Contact the local S&C Electric Company Sales Office. Do not operate the Mark VI Circuit-Switcher.

NOTICE

At temperatures below –31°F (–35°C), the indicator needle will be in the red zone due to the cold temperature. The normal operating temperature for the Mark VI Circuit-Switcher is +104°F to –31°F (+40°C to –35°C); below this temperature the gas density does not allow the full interrupting or dielectric capability of the switch. **At these temperatures, the gas-pressure gauge does not accurately indicate whether an interrupter is losing SF_6 gas.**

Figure 81. The gauge needle in red Replace zone.

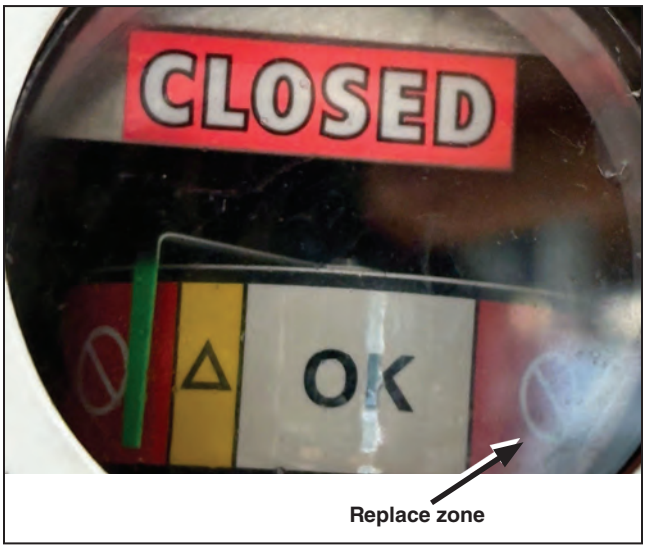


Figure 82. The other red Replace zone.

Understanding the Optional Remote Gas-Density Indicator

If furnished, the remote gas-density indicator provides contacts for each pole-unit allowing remote monitoring of two low-gas-pressure alarms:

Level 1 Alarm

When a **Level 1** alarm is issued, the interrupter can be opened and closed as usual. However, the interrupter has lost gas and should be replaced as soon as possible.

The remote-gas-density **Level 1** alarm contact opens at 95% of normal density, or 70 psig at 68°F (20°C). Contacts are normally closed at normal operating gas pressure.

Level 2 Alarm

When a **Level 2** alarm is issued, the gas density in the pole-unit has dropped below the minimum functional level. The interrupter will not maintain full interrupting or dielectric ratings. The interrupter should be removed from service and replaced promptly. Do not operate this Mark VI Circuit-Switcher.

The remote gas-density **Level 2** alarm contact opens at 88% of normal density, or 65 psig at 68°F (20°C). Contacts are normally closed at normal operating gas pressure.

NOTICE

At temperatures below –31°F (–35°C), a **Level 2** alarm can be issued because of the cold temperature. The gas density is below the minimum functional level, so the interrupter will not have full interrupting or dielectric ratings. **At these temperatures, a Level 2 Alarm does not accurately indicate whether a pole-unit is losing SF_6 gas.**