

Installation and Operation

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Qualified Persons

⚠ WARNING

The equipment covered by this publication must be installed, operated, and maintained by qualified persons who are knowledgeable in the installation, operation, and maintenance of substation and overhead electric power distribution equipment along with the associated hazards. A qualified person is one who is trained and competent in:

- The skills and techniques necessary to distinguish exposed live parts from non-live 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 the special precautionary techniques, personal protective equipment, insulating 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 S&C Instruction Handbook before installing or operating your S&C Series 2000 Circuit-Switcher, Model 2030. Familiarize yourself with the Safety Information and Safety Precautions on pages 4 through 8.

Retain this
Instruction Sheet

This instruction sheet is a permanent part of your S&C Series 2000 Circuit-Switcher, Model 2030. These instructions should be stored in the Series 2000 Switch Operator using the instruction manual holder. The latest version is available online in PDF format at sandc.com/Support/Product-Literature.asp.

Proper Application

⚠ WARNING

The equipment in this publication must be selected for a specific application. The application must be within the ratings furnished for the equipment. The ratings for this circuit-switcher are listed on the nameplate on the front of the switch operator. Additional application information can be found in Specification Bulletin 716-31.

Usual Operating
Conditions

Series 2000 Circuit-Switchers will perform as intended at temperatures within the range of –40°C to +40°C (–35°C to +40°C for 161-kV and 230-kV models), at altitudes of up to 5000 feet, and at wind loadings of up to 90 miles (145 km) per hour. Further, Series 2000 Circuit-Switchers, when installed with the recommended S&C anchor bolts and with flexible-conductor connections at all six terminal pads, are capable of withstanding seismic loading of 0.2g ground acceleration in any direction and performing as intended during such loading and afterward. For applications at temperatures not within the specified range, at higher altitudes, at higher wind loadings, or where higher seismic-withstand capabilities are required, refer to the nearest S&C Sales Office.

Special Warranty Provisions

The standard warranty contained in the seller's standard conditions of sale, as set forth in Price Sheet 150, applies to S&C Series 2000 Circuit-Switchers and associated options, except that the first paragraph of said warranty is replaced by the following:

(1) General: The seller warrants to the purchaser for a period of five years from the date of shipment that the equipment delivered will be of the kind and quality specified in the contract description and will be free of defects of workmanship and material. Should any failure to conform to this warranty appear under proper and normal use within five years after the date of shipment, the seller agrees, upon prompt notification thereof and confirmation that the equipment has been stored, installed, operated, inspected, and maintained in accordance with recommendations of the seller and standard industry practice, to correct the nonconformity either by repairing any damaged or defective parts of the equipment, or (at seller's option) by shipment of necessary replacement parts.

Replacement parts provided by the seller under the warranty for the original equipment will be covered by the original-equipment warranty for its duration. Replacement parts purchased separately will be covered by the warranty contained in the seller's standard conditions of sale, as set forth in Price Sheet 150.

Warranty Qualifications

Warranty of Series 2000 Circuit-Switchers is contingent upon both of the following:

- Installation and adjustment of Series 2000 Circuit-Switchers in accordance with S&C's applicable instruction sheets
- Conformance with the inspection recommendations defined in S&C Instruction Sheet 716-590

Understanding
Safety-Alert
Messages

Several types of safety-alert messages may appear throughout this instruction sheet and on labels and tags attached to the S&C Series 2000 Circuit-Switcher, Model 2030. Familiarize yourself with these types of messages and the importance of these various 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 you do not understand any portion of this instruction sheet and need assistance, contact your nearest S&C Sales Office or S&C Authorized Distributor. Their telephone numbers are listed on S&C’s website www.sandc.com, or call S&C Headquarters at (773) 338-1000; in Canada, call S&C Electric Canada Ltd. At (416) 249-9171.

NOTICE

Thoroughly and carefully read this instruction sheet before installing your S&C Series 2000 Circuit-Switcher Model 2030.

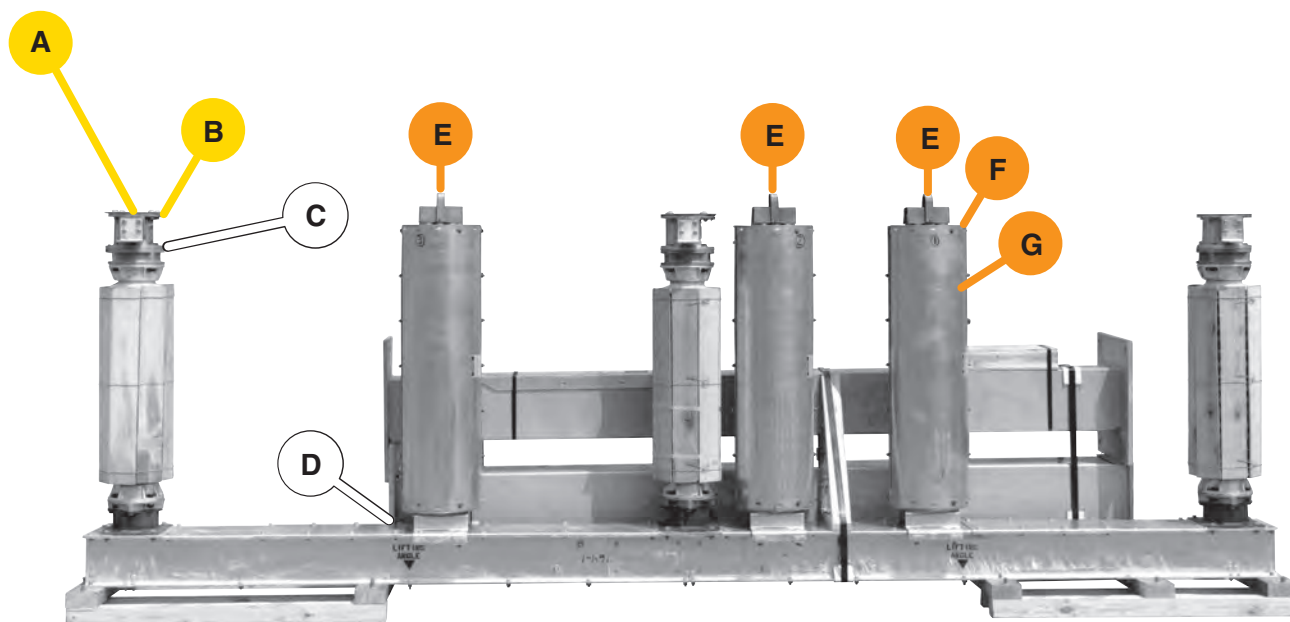


Replacement
Instructions
and Labels

If you need additional copies of this instruction sheet, contact your nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

It is important that any missing, damaged, or faded labels on the equipment be replaced immediately. Replacement labels are available by contacting your 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 Information

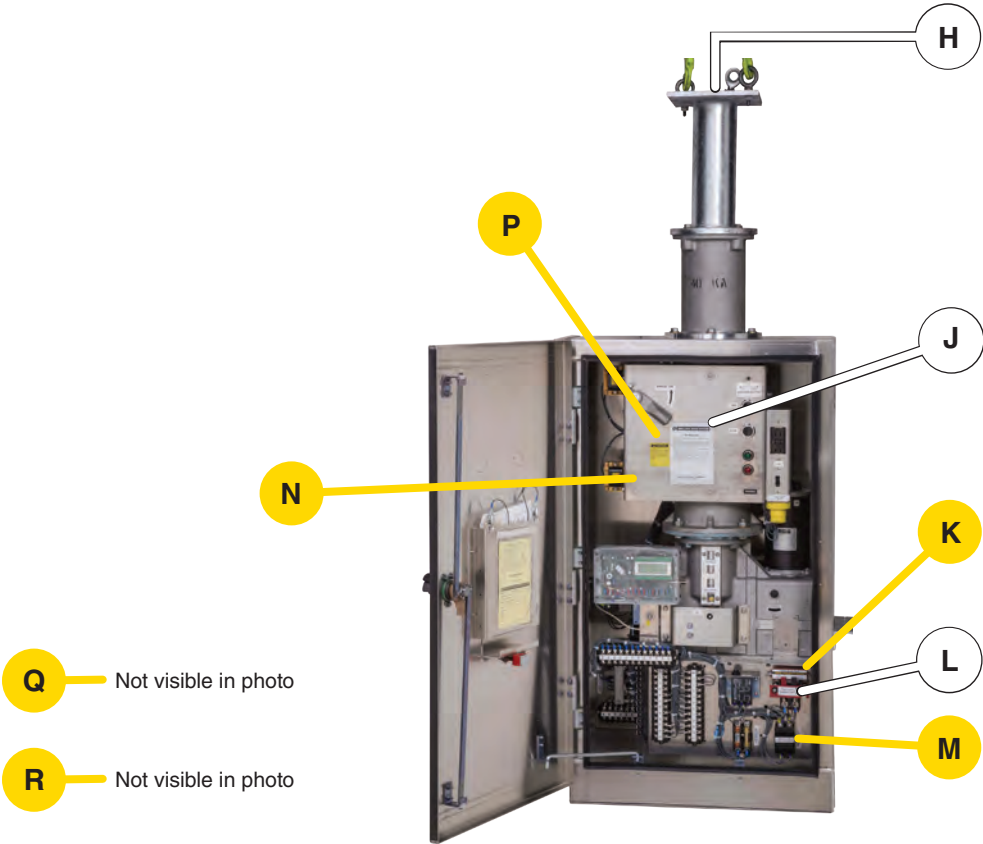
Location	Safety Alert Message	Description	Part Number
A	⚠ CAUTION	Transition box contains a stop bracket and spacer...	G-5807■
B	⚠ CAUTION	Remove the interrupter operating-rod holding bracket and spacer...	G-5951■
C	INFORMATION	Connecting-Pin Installation	G-5685●
D	INFORMATION	Coupling Preparation	G-5684■
E	⚠ WARNING	Do not lift switch with this bracket...	G-5713▲
F	⚠ WARNING	Do not remove steel over wrapper until installation is complete...	G-5699▲
G	⚠ WARNING	Do not remove...	G-5993▲

■ This label contains important instructions and should be promptly replaced if illegible or missing.

● This is a tag that is to be removed and discarded after the switch is installed and adjusted.

▲ This label is affixed to the shipping package and will be removed and discarded after the switch is installed and adjusted.

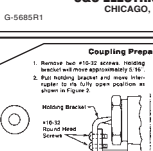
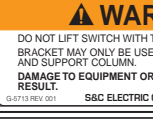



Location of Safety Labels






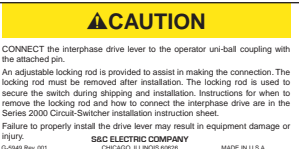
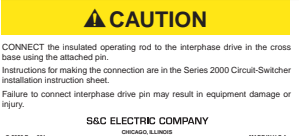



Reorder Information for Safety Information

Location	Safety Alert Message	Description		Part Number
H	INFORMATION	Attaching Operator Connecting Link		G-5792■
J	INFORMATION	Instruction – Operation, Gas Pressure Indicator, and Manual Handle		G-5672●
K		Control Voltage	48Vdc	G-5948-1
	⚠ CAUTION		125Vdc	G-5948-2
			115 V 60 Hz	G-5948-3
L	INFORMATION	Coupling Preparation		G-5939■
M	⚠ CAUTION	Do not apply control voltage or insert motor-and-closing circuit fuseholder.		G-5959▲
N	⚠ CAUTION	Do not apply control voltage to this device...		G-5946▲
P	⚠ CAUTION	Do not attempt to close Circuit-Switcher using manual trip lever...		G-6222
Q	⚠ CAUTION	Connect the interphase drive lever...		G-5949■
R	⚠ CAUTION	Connect the insulated operating rod...		G-5950■

■ This label contains important instructions and should be promptly replaced if illegible or missing.
● This is a tag that is to be removed and discarded after the switch is installed and adjusted.
▲ This label is affixed to the shipping package and will be removed and discarded after the switch is installed and adjusted.

A	<div data-bbox="328 317 630 346" style="background-color: yellow; text-align: center; padding: 5px;"> ⚠ CAUTION </div> <p>Transition box contains a stop bracket and spacer which must be removed during installation, in the manner described in the S&C instruction sheet furnished with this Circuit-Switcher. Failure to do so can result in damage to the Circuit-Switcher when operated.</p> <div data-bbox="328 346 630 480" style="text-align: center; font-size: small;"> S&C ELECTRIC COMPANY CHICAGO, ILLINOIS 60602 MADE IN U.S.A. </div>	G-5807■
B	<div data-bbox="328 510 630 539" style="background-color: yellow; text-align: center; padding: 5px;"> ⚠ CAUTION </div> <p>REMOVE the interrupter operating-rod holding bracket, stop bracket and spacer during installation.</p> <p>These packing parts are used to secure the switch during shipping and installation. Instructions for when to remove the packing are in the Series 2000 Circuit-Switcher installation instruction sheet.</p> <p>Failure to remove the packing may result in equipment damage or injury.</p> <div data-bbox="328 539 630 674" style="text-align: center; font-size: small;"> S&C ELECTRIC COMPANY CHICAGO, ILLINOIS 60602 MADE IN U.S.A. </div>	G-5951■
C	<div data-bbox="328 703 630 882" style="text-align: center;"> Connecting-Pin Installation  <p>Pin Retaining Clip</p> <p>Link</p> <p>Stop Bracket</p> <p>5/16" Screw</p> <p>Spacer</p> <p>Link, connecting pin, and pin retaining clip must be positioned as shown.</p> <p>IMPORTANT: After connecting link to coupling, remove 5/16" screw, stop bracket, and spacer before operating Circuit-Switcher.</p> <div data-bbox="328 882 630 896" style="text-align: center; font-size: small;"> S&C ELECTRIC COMPANY CHICAGO, ILLINOIS 60602 MADE IN U.S.A. </div> </div>	G-5685●
D	<div data-bbox="328 911 630 1089" style="text-align: center;"> Coupling Preparation Instructions <ol style="list-style-type: none"> Remove Rod, #10-32 screws, coupling bracket with spacer approximately 1/4" to 1/2" and 5/16" screw. Put coupling bracket and spacer in position as shown in Figure 1. Remove connecting pin and spacer for later use. Insert coupling bracket. <div data-bbox="334 926 485 1045"> <p>Figure 1 Stripping position</p>  </div> <div data-bbox="492 926 625 1045"> <p>Figure 2 Fully open position</p>  </div> <div data-bbox="328 1089 630 1104" style="text-align: center; font-size: small;"> S&C ELECTRIC COMPANY CHICAGO, ILLINOIS 60602 MADE IN U.S.A. </div> </div>	G-5684■
E	<div data-bbox="328 1119 630 1148" style="background-color: orange; text-align: center; padding: 5px;"> ⚠ WARNING </div> <p>DO NOT LIFT SWITCH WITH THIS BRACKET. BRACKET MAY ONLY BE USED TO LIFT INTERRUPTER AND SUPPORT COLUMN.</p> <p>DAMAGE TO EQUIPMENT OR PERSONAL INJURY MAY RESULT.</p> <div data-bbox="328 1148 630 1297" style="text-align: center; font-size: small;"> S&C ELECTRIC COMPANY CHICAGO, ILLINOIS 60602 MADE IN U.S.A. </div>	G-5713▲
F	<div data-bbox="328 1327 630 1358" style="background-color: orange; text-align: center; padding: 5px;"> ⚠ WARNING </div> <p>DO NOT remove steel outer wrapper until installation is complete.</p> <p>Interrupter contains gas under pressure.</p> <p>Injury or damage to equipment may result.</p> <div data-bbox="328 1358 630 1505" style="text-align: center; font-size: small;"> S&C ELECTRIC COMPANY CHICAGO, ILLINOIS 60602 MADE IN U.S.A. </div>	G-5699▲
G	<div data-bbox="328 1535 630 1566" style="background-color: orange; text-align: center; padding: 5px;"> ⚠ WARNING </div> <p>DO NOT remove steel outer wrapper until installation is complete.</p> <p>Interrupter contains gas under pressure.</p> <p>Injury or damage to equipment may result.</p> <div data-bbox="328 1566 630 1713" style="text-align: center; font-size: small;"> S&C ELECTRIC COMPANY CHICAGO, ILLINOIS 60602 MADE IN U.S.A. </div>	G-5993▲
H	<div data-bbox="328 1745 630 1921" style="text-align: center;"> Instructions for Attaching Operator Connecting Link to Interrupter Drive Lever <ol style="list-style-type: none"> Turn the "1/4" -20 locking nut on the adjustable locking rod, as required, so that it is loose on the interrupter drive lever. Then adjust the nut so that the adjustable locking rod and locking nut are in the position shown in the diagram. Remove the "1/4" -20 locking nut and adjust the adjustable locking rod and locking nut so that the adjustable locking rod and locking nut are in the position shown in the diagram. <div data-bbox="334 1759 485 1906">  </div> <div data-bbox="492 1759 625 1906">  </div> <div data-bbox="328 1921 630 1938" style="text-align: center; font-size: small;"> S&C ELECTRIC COMPANY CHICAGO, ILLINOIS 60602 MADE IN U.S.A. </div> </div>	G-5792

J		G-5672●
K	<div>CONTROL VOLTAGE: 48V DC</div> <div>CAUTION: Polarity Must Be Maintained</div> <div> <div>+</div> <div>POSITIVE</div> </div> <div> <div>-</div> <div>NEGATIVE</div> </div> <div>-1</div> <div>CONTROL VOLTAGE: 125V DC</div> <div>CAUTION: Polarity Must Be Maintained</div> <div> <div>+</div> <div>POSITIVE</div> </div> <div> <div>-</div> <div>NEGATIVE</div> </div> <div>-2</div> <div>CONTROL VOLTAGE: 115V 60 HZ</div> <div>-3</div>	G-5948-1 G-5948-2 G-5948-3
L	<div>INSTRUCTION FOR FUSE SLUGS For Series 2000 Operators</div> <p>When the Circuit-Switcher is ready to be placed in service, the motor-and-closing circuit fuses can—at the user's option—be replaced with the enclosed slugs. This practice is recommended for increased reliability because low-voltage fuses can be damaged by the repeated inrush current experienced during normal Circuit-Switcher opening and closing operations and can thus sneak out, leaving the Circuit-Switcher inoperative.</p> <p>Before replacing these fuses with slugs, make certain that the control-source battery is adequately protected to prevent discharge, using fuses or circuit breakers located at the battery bus.</p> <div>  S&C ELECTRIC COMPANY <small>CHICAGO, ILLINOIS</small> </div> <div> <small>G-5939 REV. 01</small> <small>CHICAGO, ILLINOIS</small> <small>MADE IN U.S.A.</small> </div>	G-5939■
M		G-5959▲
N	<div>  </div>	G-5946▲
P	<div>  </div>	G-6222
Q	<div>  </div>	G-5949■
R	<div>  </div>	G-5950■

⚠ DANGER	
	<p>Series 2000 Circuit-Switchers operate at high voltage. Failure to observe these precautions will result in serious personal injury or death.</p> <p>Some of these precautions may differ from company operating procedures and rules. Where a discrepancy exists, users should follow their company's operating procedures and rules.</p>
<div><div><div>1. QUALIFIED PERSONS. Access to substation switching equipment must be restricted only to qualified persons. See "Qualified Persons" on page 2.</div><div>2. SAFETY PROCEDURES. Always follow safe operating procedures and rules.</div><div>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.</div><div>4. SAFETY LABELS AND TAGS. Do not remove or obscure any of the "DANGER," "WARNING," "CAUTION," or "NOTICE," labels and tags. Remove tags ONLY if instructed to do so.</div></div><div><div>5. ENERGIZED COMPONENTS. Always consider all parts live until de-energized, tested, and grounded.</div><div>6. CIRCUIT-SWITCHER POSITION. Always confirm the Open/Close position of circuit-switcher by visually observing the position of the switch position indicator located on the high-speed base. Switches may be energized from either side.</div><div>7. MAINTAINING PROPER CLEARANCE. Always maintain proper clearance from energized components.</div><div>8. OPERATION. Circuit making and breaking is involved in the normal operation of this interrupter switch. To operate, follow the operating procedure as outlined in this Instruction Sheet starting on page 27.</div></div></div>	

Inspection

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

If there is visible loss and/or damage:

1. Notify the delivering carrier immediately.
2. Ask for a carrier inspection.
3. Note the condition of the 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 catalog drawing can be found in a water-resistant envelope attached to the wrapper around one of the insulating support columns. Study this drawing carefully and check the bill of material to verify all parts are at hand. The Model 2030 Series 2000 Circuit-Switcher shipment should include the following items, as shown in Figures 1, 2a and 2b on pages 10 and 11.

CAUTION

Do not intermingle components from different installations. Series 2000 Circuit-Switchers are completely factory assembled and thoroughly tested. To speed installation and maintain proper adjustment of the circuit-switcher and its operator, it is imperative that components belonging to a specific circuit-switcher installation not be mixed with components belonging to a different installation. For this reason, each Series 2000 Circuit-Switcher is serially numbered. This serial number appears on the circuit-switcher base, the mounting pedestals, and the operator.

Mixing parts from different circuit-switchers will result in significant damage to the switch operator and misoperation of the circuit-switcher.

S&C maintains an historical record—by serial number—of every circuit-switcher it produces. This record lists information pertinent to each installation, such as application, date of shipment, and any service performed by S&C factory service specialists. This record is an invaluable reference for future maintenance, modifications or replacements.

The shipment contains:

- Three interrupters, mounted to the high-speed base for shipping along with their associated insulating support columns
- A single high-speed base, enclosing the high-speed power train.
- The appropriate number of mounting pedestals (A single pedestal is used for Circuit-Switchers rated 69 kV (with 48-inch phase spacing); a set of two pedestals is used for Circuit-Switchers rated 69 kV (with 84-inch phase spacing), 115 kV and 138 kV; a set of three pedestals is used for Circuit-Switchers rated 161 kV and 230 kV
- A Series 2000 Circuit-Switcher Operator
- A container of miscellaneous operating-mechanism components and hardware—all individually identified
- Any optional features specified, such as a grounding switch

DANGER

DO NOT disassemble or modify the interrupters. The interrupters are pressurized at 75 PSIG. Serious injury can result.

Storage

NOTICE

Connect control power to the switch operator when storing it outdoors. The Series 2000 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 may be necessary if the ground is uneven. If storing outdoors, connect control power to the space heater inside the Series 2000 Switch Operator per the wiring diagram furnished. Inspect the circuit-switcher regularly when storing for prolonged periods.

NOTICE

Please complete and mail the circuit-switcher registration card (enclosed in a vinyl envelope located inside the operator) after the circuit-switcher has been installed. The information requested on this card is vital to ensure prompt notification in the event field modifications are needed.

Installation

Before Starting

⚠ CAUTION

Do not remove the containers from the interrupters or the plastic bubble-wrap from the insulating support columns until the installation is complete.

NOTICE

Bolted and Pinned Connections: A typical bolted connection for field assembly requires one flat washer under the cap screw and one under the nut. When self-locking hex nuts are specified, it is essential that the threads of the associated cap screws be lubricated with a general purpose grease to facilitate tightening. All pins used in the field assembly should also be lubricated to facilitate insertion.

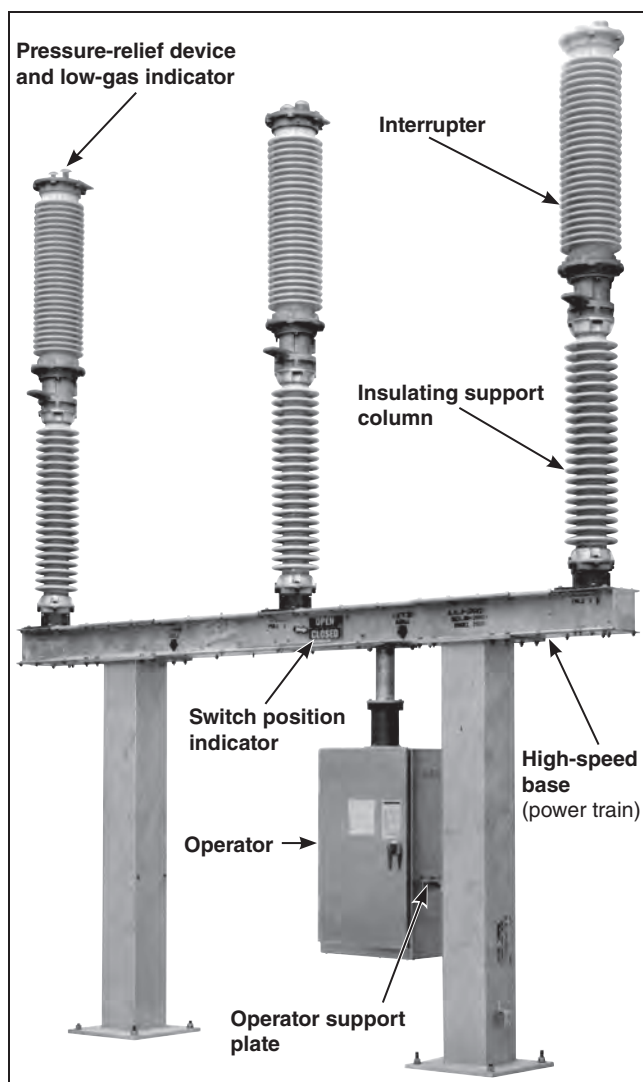


Figure 1. Model 2030 Circuit-Switcher rated 138 kV.

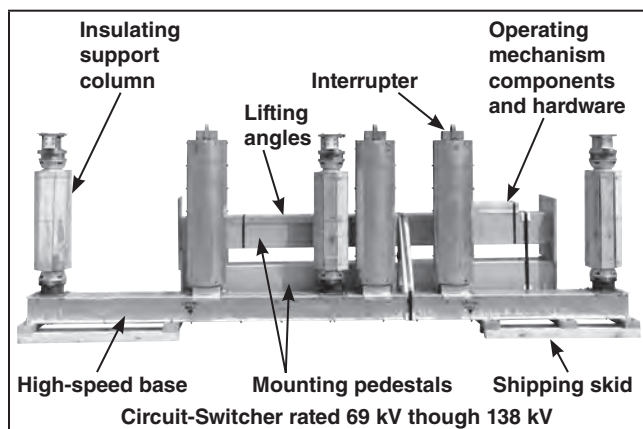


Figure 2a. Typical shipment of Model 2030 Series 2000 Circuit-Switcher. Operator is shipped on a separate skid. (69-138 kV)

STEP 1. For circuit-switchers rated 69 kV through 138 kV: Cut the steel straps that bind the mounting pedestals to the high-speed base and the straps that bind the container of operating mechanism components and hardware and the straps that bind the pole-units using a steel strapping cutter. See Figure 2a on page 10.

For circuit-switchers rated 161 kV and 230 kV: Cut the steel straps binding the container of miscellaneous operating-mechanism components and hardware. See Figure 2b.

CAUTION

The foundations and anchor bolts for S&C mounting pedestals must be designed to meet the loading limits specified in S&C Data Bulletin 716-61.

Failure to meet these loading limits can result in personal injury and equipment damage.

Installing the Mounting Pedestals and High-Speed Base

STEP 2. Install each pedestal as follows:

- (a) Install the lower set of anchor bolt nuts and flat washers onto the pre-installed anchor bolts. Level all anchor bolts to the same height, leaving space below and above the bolt for leveling. See Figure 3.
- (b) Install the temporary eyebolts into the holes provided at the top of the mounting pedestal. Attach the lifting slings to the eyebolts. See Figure 4.
- (c) Lift the pedestal over the anchor bolts. Before lowering, make sure the grounding pad is positioned properly for the installation. Refer to the accompanying catalog drawing for details. See Figure 4.
- (d) Lower the pedestal onto the anchor bolt nuts and flat washers. Loosely secure a flat washer and nut to each anchor bolt. See Figure 3. Remove lifting slings and eyebolts.
- (e) 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 3.

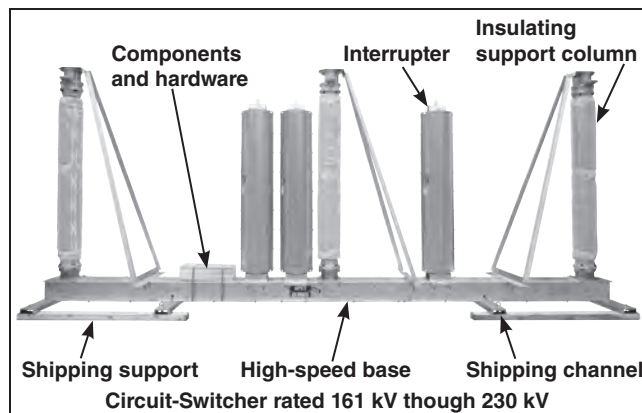


Figure 2b. Typical shipment of Model 2030 Series 2000 Circuit-Switcher. Operator is shipped on a separate skid. (161-230 kV)

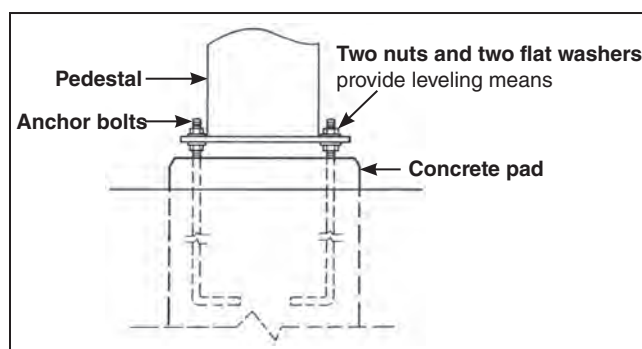


Figure 3. Pedestal anchor-bolt mounting detail.

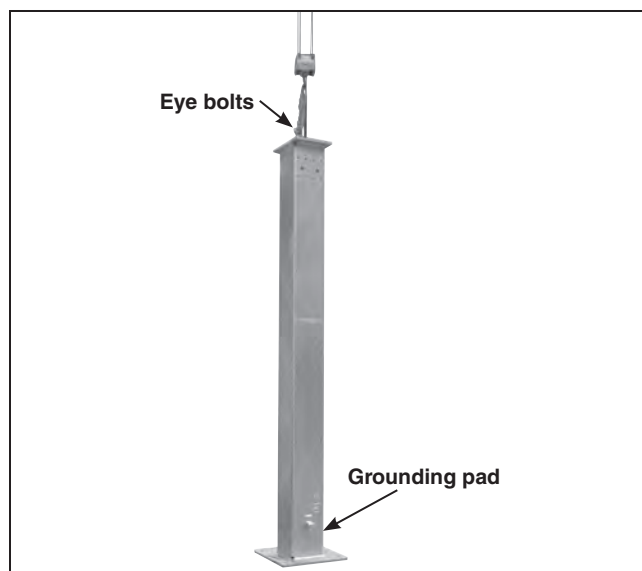


Figure 4. Lift the pedestal into position.

Installation

STEP 3. *For circuit-switchers rated 69 kV through 138 kV:* Attach the lifting angles to the circuit-switcher base using $\frac{1}{2}$ -13 x $1\frac{1}{4}$ hex-head galvanized steel cap screws, flat washers, and nuts furnished. See Figure 5. Securely tighten the cap screws, and then attach four suitable lifting slings to the lifting angles. Unbolt the base from the shipping skids and lift the base—with interrupters and insulating support columns attached—on top of the mounting pedestals as shown on the catalog drawing. Avoid sudden starts and stops. Verify that the SWITCH-POSITION indicator on the base is visible on the desired side. (This is also the side on which the operator door will open.) See Figure 5.

For Circuit-Switchers rated 161 kV and 230 kV: Attach four suitable lifting slings to the eyebolts connected to the two inboard shipping channels. See Figure 6. Unbolt all four shipping channels from the shipping supports. Also unbolt and discard the two outboard shipping channels from the circuit-switcher base, as shown in Figure 6, but retain the associated $\frac{1}{2}$ -13 x $1\frac{1}{4}$ galvanized steel cap screws, flat washers, and nuts. Do not unbolt the two inboard shipping channels from the circuit-switcher base. Now, lift the base—with interrupters and insulating support columns attached (including the support angles and support braces for the insulating support columns)—on top of the mounting pedestals, as shown on the catalog drawing. Avoid sudden starts and stops. Verify that the SWITCH-POSITION indicator on the base is visible on the desired side. (This is also the side on which the operator door will open.) See Figure 6.

Remove and discard the three sets of support angles and their associated hardware. Also remove and discard the three support braces and their associated hardware. Leave the shipping covers on top of the insulating support column transition boxes.

⚠ CAUTION

The operator directly drives the interrupters open and closed through a high-speed power train leading from the top of the operator, through a horizontal interphase linkage enclosed in a steel-sheathed box-type base, to reciprocating-action insulated operating rods that pass through the center of the insulating support columns. Permanently lubricated bearings are used throughout the power train. The high-speed base has been fully pre-assembled and adjusted at the factory. **DO NOT disassemble the high-speed base or high-speed power train.** Damage to the high-speed base and personal injury may result.

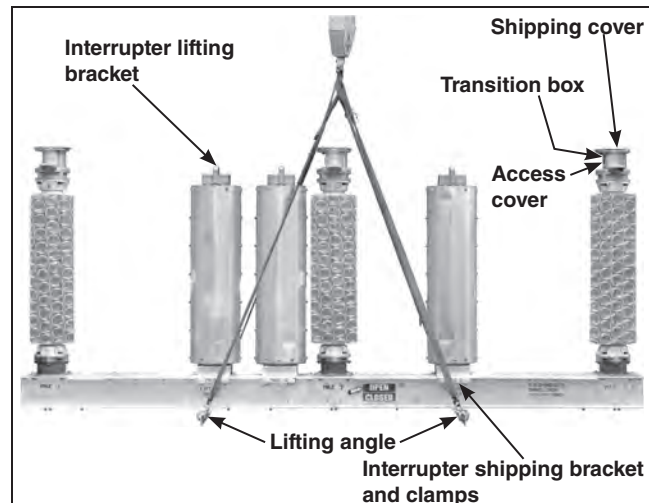


Figure 5. Hoist the high-speed base using a crane, 69-kV through 138-kV circuit-switchers.

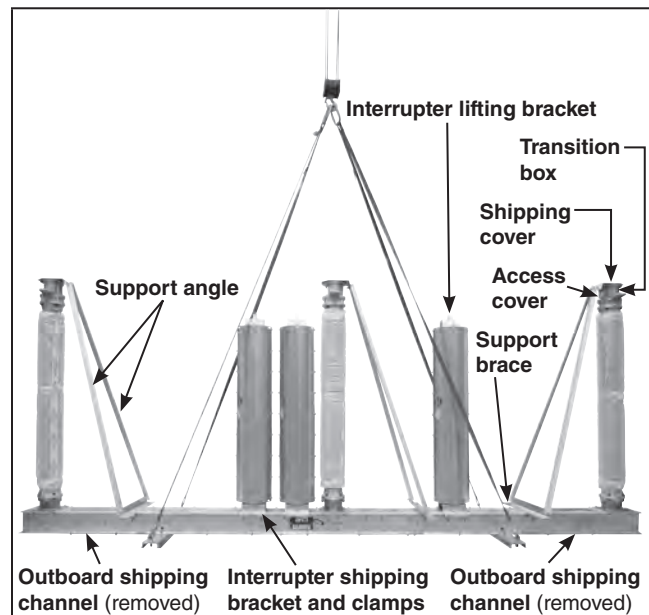


Figure 6. Hoist the high-speed base using a crane, 161-kV and 230-kV circuit-switchers.

STEP 4. Loosely bolt the high-speed base to the mounting pedestals using the $\frac{5}{8}$ -11 \times 2 $\frac{1}{4}$ hex-head galvanized steel cap screws, flat washers, and self-locking hex nuts furnished. Lubricate the bolts to facilitate tightening, and then, using a level, verify that the high-speed base is horizontal, both length-wise and sideways. Adjust the lower set of anchor bolt nuts at the pedestals to achieve level.

STEP 5. Securely bolt the high-speed base to the mounting pedestals. If necessary, install shims between the high-speed base and the pedestals to compensate for any gaps greater than $\frac{1}{8}$ -inch between the mating surfaces. See Figure 7.

Tighten the bolts on the high-speed base to 75 ft./lbs.

STEP 6. Check the lower set of anchor-bolt nuts at each mounting pedestal to verify that all nuts are in contact with the bottom of the pedestal. Hand-tighten the anchor-bolt nuts as necessary, and then securely tighten the upper set of anchor-bolt nuts at each mounting pedestal. See Figure 3 on page 11.

STEP 7. *For circuit-switchers rated 69 kV through 138 kV:* Remove and discard the lifting angles, but retain the associated $\frac{1}{2}$ -13 \times 1 $\frac{1}{4}$ galvanized steel cap screws, flat washers, and nuts. See Figure 5 on page 12.

For circuit-switchers rated 161 kV and 230 kV: Remove and discard the inboard shipping channels, but retain the associated $\frac{1}{2}$ -13 \times 1 $\frac{1}{4}$ galvanized steel cap screws, flat washers, and nuts. See Figure 6 on page 12.

Remove the remaining hardware used to attach the bottom plates adjacent to the operator support tube mounting plate. See Figure 8. Put the bottom plates and hardware aside on a clean surface. Also remove the $\frac{3}{4}$ -inch stainless-steel pin and cotter pin from the interphase drive lever enclosed in the high-speed base. See Figure 9. Retain these pins for re-use in Step 17 on page 19.

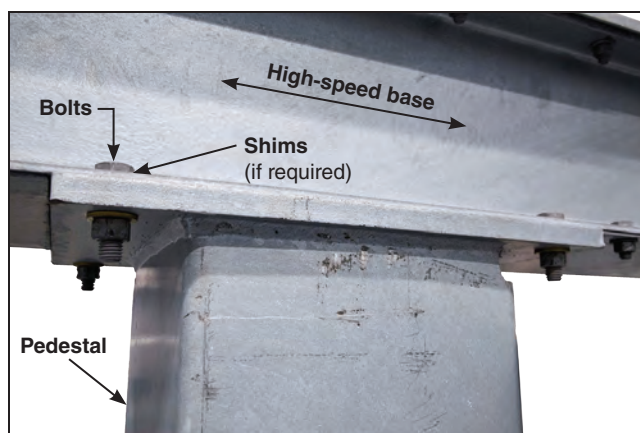


Figure 7. Shim the high-speed base for gaps of more than $\frac{1}{8}$ -inch (3.18 mm).

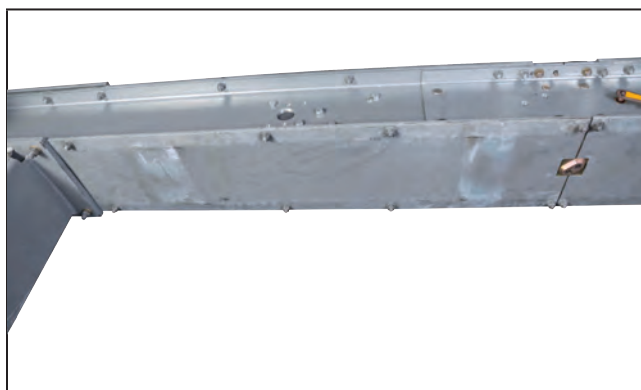


Figure 8. Remove bottom plates from high-speed base.

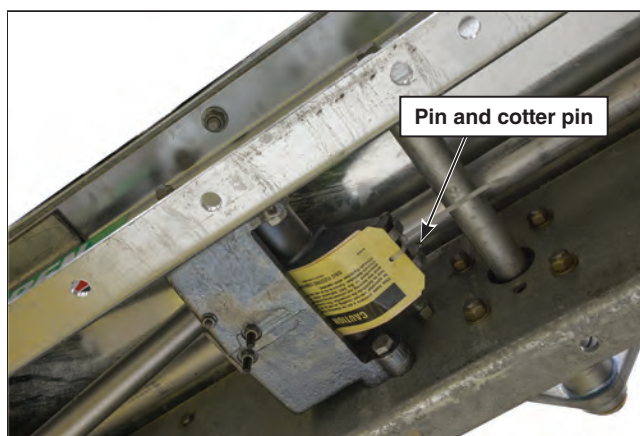


Figure 9. Remove the $\frac{3}{4}$ -inch stainless-steel pin and cotter pin from the interphase-drive lever inside the high-speed base.

Installation

STEP 8. Note the direction of the lower terminal pad on each insulating support column. See the catalog drawing. See Figure 10. If the alternate terminal-pad position is desired, remove the $\frac{1}{2}$ -13 \times 1 $\frac{1}{2}$ hex-head stainless steel cap screws and flat washers used to attach the transition box to the insulating support column. Turn the transition box 180 degrees, then replace and securely tighten the $\frac{1}{2}$ -13 \times 1 $\frac{1}{2}$ cap screws.

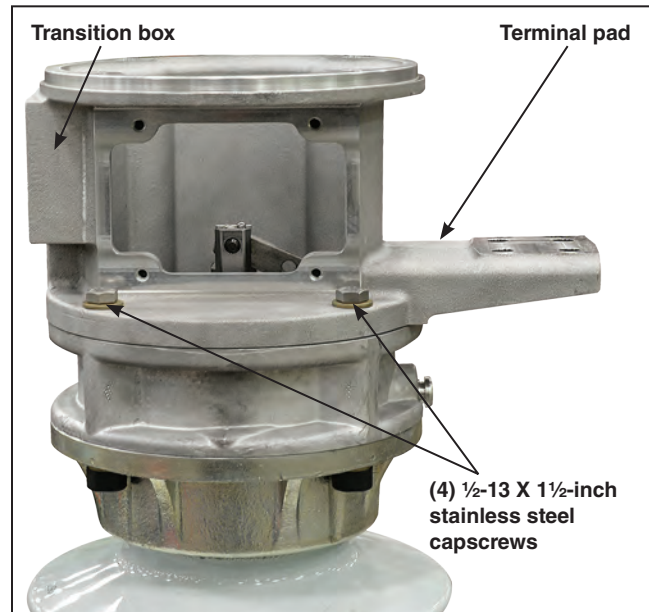


Figure 10. Terminal pad orientation can be rotated 180 degrees.

Installing the Interrupters

NOTICE

Interrupters are numbered "Pole 1," "Pole 2," and "Pole 3." Make sure to install the interrupter to its corresponding insulating support column. Please note that the pole numbers do not have to correspond with your system's phase designations.

STEP 9. Attach a lifting sling to the lifting bracket on one of the interrupters. See Figure 11. Remove and discard the clamps and associated $\frac{1}{2}$ -inch galvanized steel hardware that fasten the interrupter shipping bracket to the high-speed base. See Figure 12 on page 15. Carefully lift the interrupter somewhat higher than the top of the transition box of its associated insulating support column. Remove the four $\frac{1}{2}$ -13 stainless steel hex nuts and Belleville washers used to attach the interrupter shipping bracket to the threaded studs on the interrupter. Discard the shipping bracket, but retain the Belleville washers and nuts for re-use in Step 11(e).

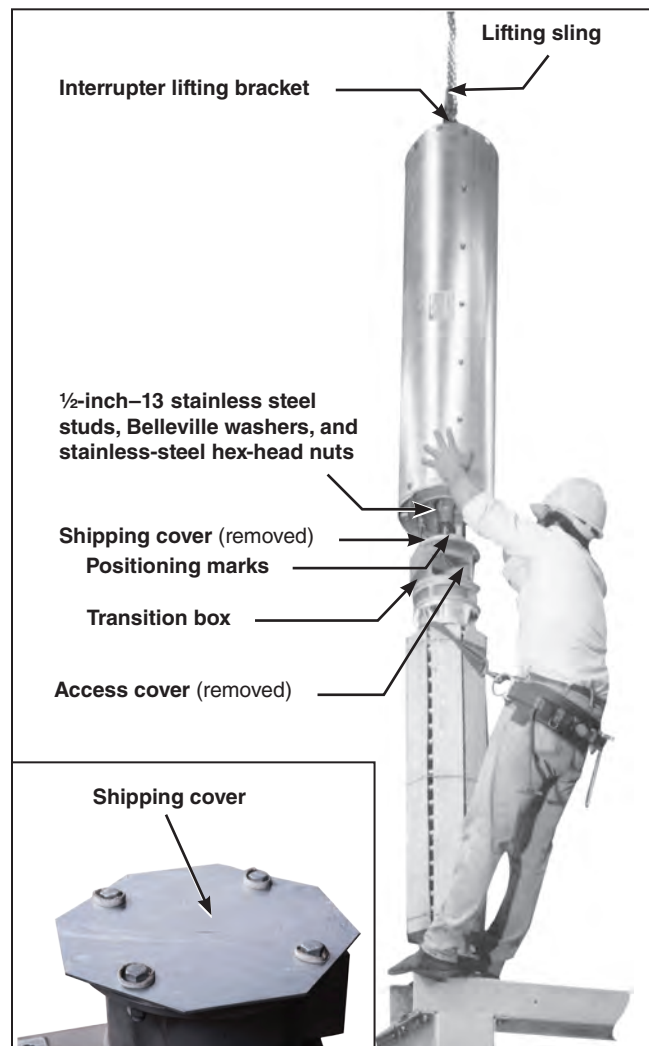


Figure 11. Lift the interrupter over the insulating support column.

STEP 10. Prepare the interrupter for attachment to its insulating support column as follows:

- (a) Remove and discard the two #10-32 screws that connect the operating-rod holding bracket (marked with a black/yellow striped label) for shipment. See Figure 13.

CAUTION

Keep hands clear of the operating rod when removing the shipping bracket. The insulated operating rod is under pressure. Removal of the bracket may result in the operating rod quickly moving down approximately 3/8-inch. Injury to the hands may result.

- (b) Pull the holding bracket to move the operating rod to its fully **Open** position. See Figure 13.
- (c) Remove the connecting pin used to attach the holding bracket to the coupling. Retain the connecting pin for re-use in Step 11(f). See Figure 13. Discard the holding brackets.

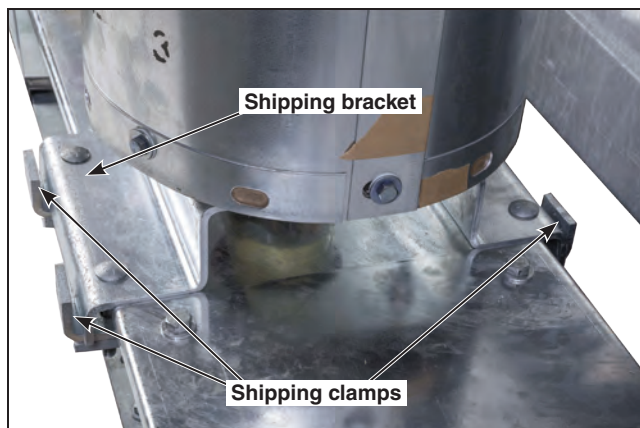


Figure 12. Attach a lifting sling to one of the interrupters. Remove the hardware securing the shipping clamps to the base. Lift the interrupter off of the base. Remove the hardware securing the clamp to the interrupter. Retain the hardware. Discard the shipping bracket.

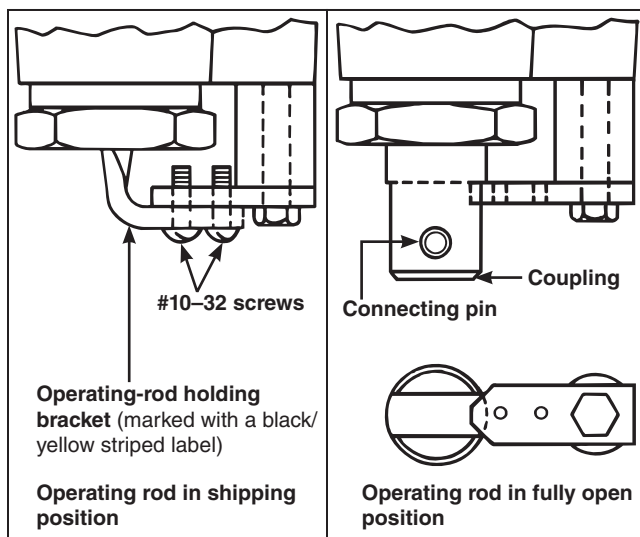


Figure 13. Prepare the interrupter for attachment to the insulating support column.

Installation

STEP 11. Attach the interrupter to its insulating support column as follows:

- Remove and discard the shipping cover on top of the transition box. See Figure 11 on page 14, inset.
- Thoroughly wire-brush the top of the transition box and mating surface on the interrupter, and immediately apply a liberal coating of Burndy Penetrox® A (available from Burndy Corporation) or equivalent aluminum-connector compound to the brushed surfaces.
- Remove the four $\frac{5}{16}$ -18 \times $\frac{3}{4}$ hex-head stainless-steel cap screws used to attach the access cover to the side of the transition box. Remove the cover and place it and the hardware on a clean surface. See Figure 11 on page 14. Also remove the cloth bag containing the hardware that will be used for connecting the interrupter coupling to the operating rod link in Step 11(f).
- Make certain the positioning mark stamped on the bottom of the interrupter is aligned with the position mark stamped on the top of the transition box. See Figure 14.
- Lower the interrupter onto the transition box. One of the $\frac{1}{2}$ -13 stainless steel studs on the interrupter is longer than the other three to aid in aligning the interrupter with the transition box. Reattach a $\frac{1}{2}$ -inch Belleville washer and a $\frac{1}{2}$ -12 stainless steel hex nut, retained from Step 9, to each of the four studs. Lubricate the nuts to facilitate tightening. Tighten each nut securely.
- For circuit-switchers rated 69 kV through 138 kV:* Insert the connecting pin retained from Step 10(c) into the coupling and operating rod link. See Figure 15. It will be necessary to loosen the $\frac{5}{16}$ -18 \times $2\frac{1}{4}$ hex-head stainless steel screw indicated in Figure 15 and withdraw it approximately $\frac{1}{8}$ -inch so the connecting pin can be inserted. Do not remove the screw at this time. Insert the pin retaining clip as indicated in Figure 15. Make sure that the clip is positioned as shown.

For circuit-switchers rated 161 kV through 230 kV: Insert the connecting pin retained from Step 10(c) into the coupling and operating rod link. See Figure 16. It will be necessary to loosen the $\frac{5}{16}$ -18 \times $2\frac{1}{4}$ hex-head stainless steel screw indicated in Figure 16 and withdraw it approximately $\frac{1}{8}$ -inch, so the connecting pin can be inserted. Do not remove the screw at this time. Use a flat-head screwdriver blade in the slot at the end of the connecting pin to align with the cross-hole in the operating rod link. Now, insert the pin retaining clip as indicated in Figure 16. Make sure the clip is positioned as shown.

- Remove and discard the $\frac{5}{16}$ -18 \times $2\frac{1}{4}$ hex head stainless steel screw, stop bracket (marked with a black/yellow striped label), and spacer (marked with a black/yellow striped label) illustrated in Figures 15 and 16.

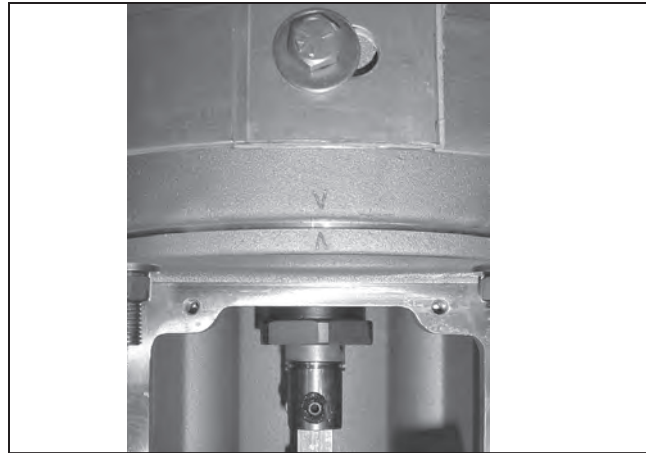


Figure 14. Align the positioning mark on the interrupter with the mark on the transition box.

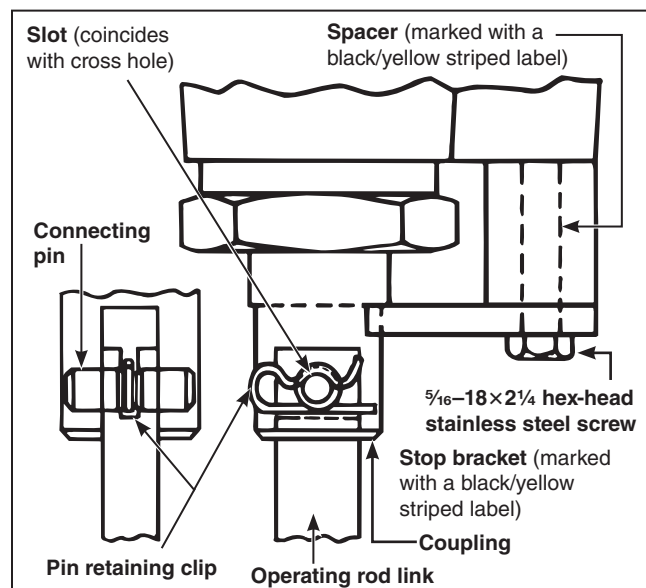


Figure 15. Connect the interrupter to the operating rod link. (69 through 138 kV)

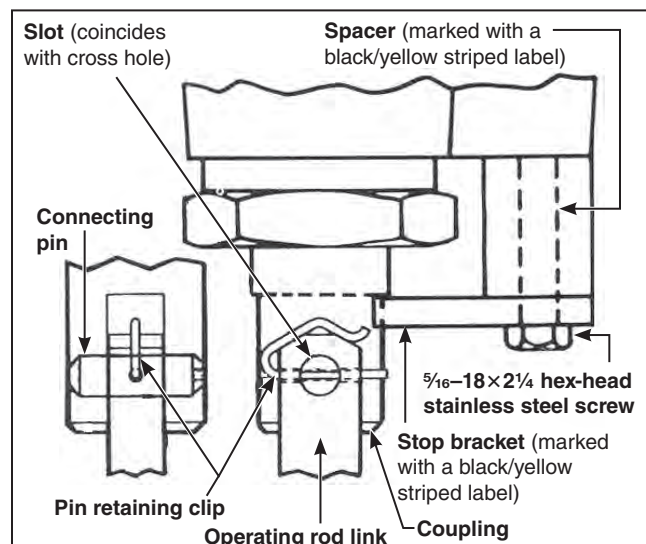


Figure 16. Connect the interrupter to the operating rod link. (161 kV and 230 kV)

STEP 12. Attach the upper terminal pad as follows:

- (a) Remove the interrupter lifting bracket and associated ½-inch stainless steel hardware from on top of the interrupter. See Figure 17. Discard the lifting bracket but retain the hardware.

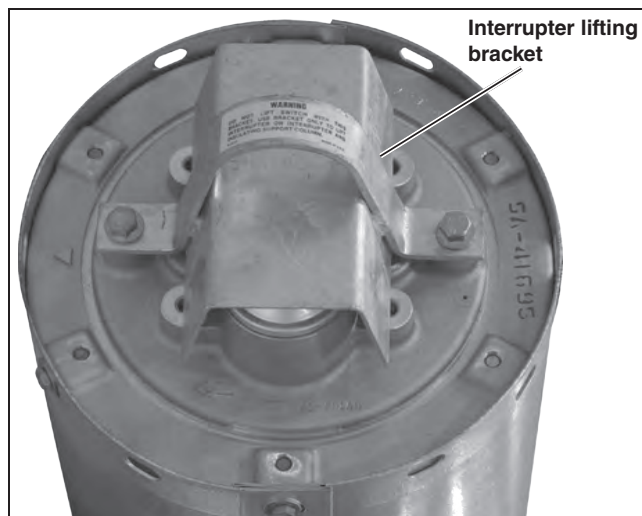


Figure 17. Remove the interrupter lifting bracket.

- (b) Thoroughly wire-brush the indicator end-casting where the upper terminal pad is to be attached as well as the mating surface on the upper terminal pad, and immediately apply a liberal coating of Penetrox A or other suitable aluminum-connector compound. See Figure 18.

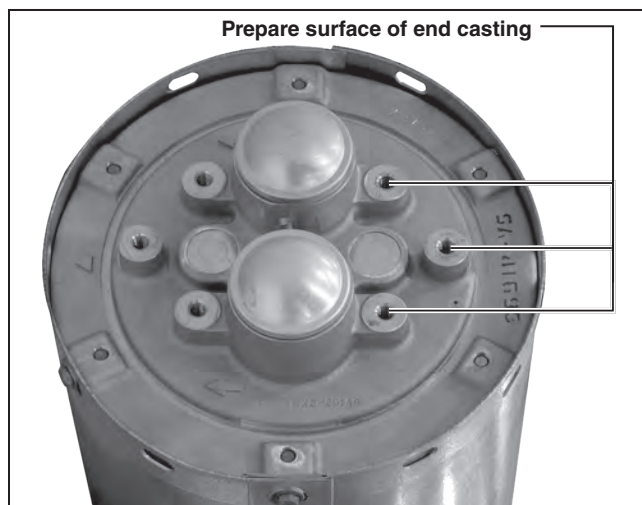


Figure 18. Wire-brush the surface of the end casting and prepare with aluminum connector compound.

- (c) Attach the upper terminal pad using three ½-13 × 1¼ hex-head stainless steel cap screws and Belleville washers. See Figure 19.

NOTICE

The terminal pad may be positioned in either of two ways, 180 degrees apart. See the catalog drawing for details.

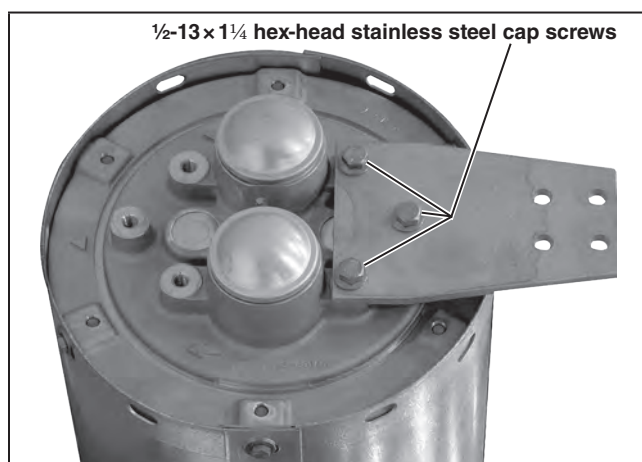


Figure 19. Attach the terminal pad

Repeat Steps 9 through 12 for the other two interrupters.

Installing the Operator

⚠ CAUTION

Do not attempt to set the operator upright by slinging to the skid. The skid is not designed to carry the weight of the switch operator. Damage to the operator and minor personal injury may result.

STEP 13. Wrap a lifting sling around the stored-energy housing of the operator, as shown in Figure 20. Carefully raise the operator to the upright position so it rests on its skid, as shown in Figure 20.

⚠ CAUTION

Do not remove the lifting sling around the stored-energy housing. The operator is top-heavy and must be adequately supported until it is attached to the circuit-switcher. Damage to the operator and minor personal injury may result.

STEP 14. Remove the skid and bracing that runs the length of the operator, stored energy housing, and operator support tube. See Figure 20. Also remove the protective cover atop the operator support tube as well as the protective covers on the operator enclosure louvers. See Figure 20 and Figure 21 on page 19.

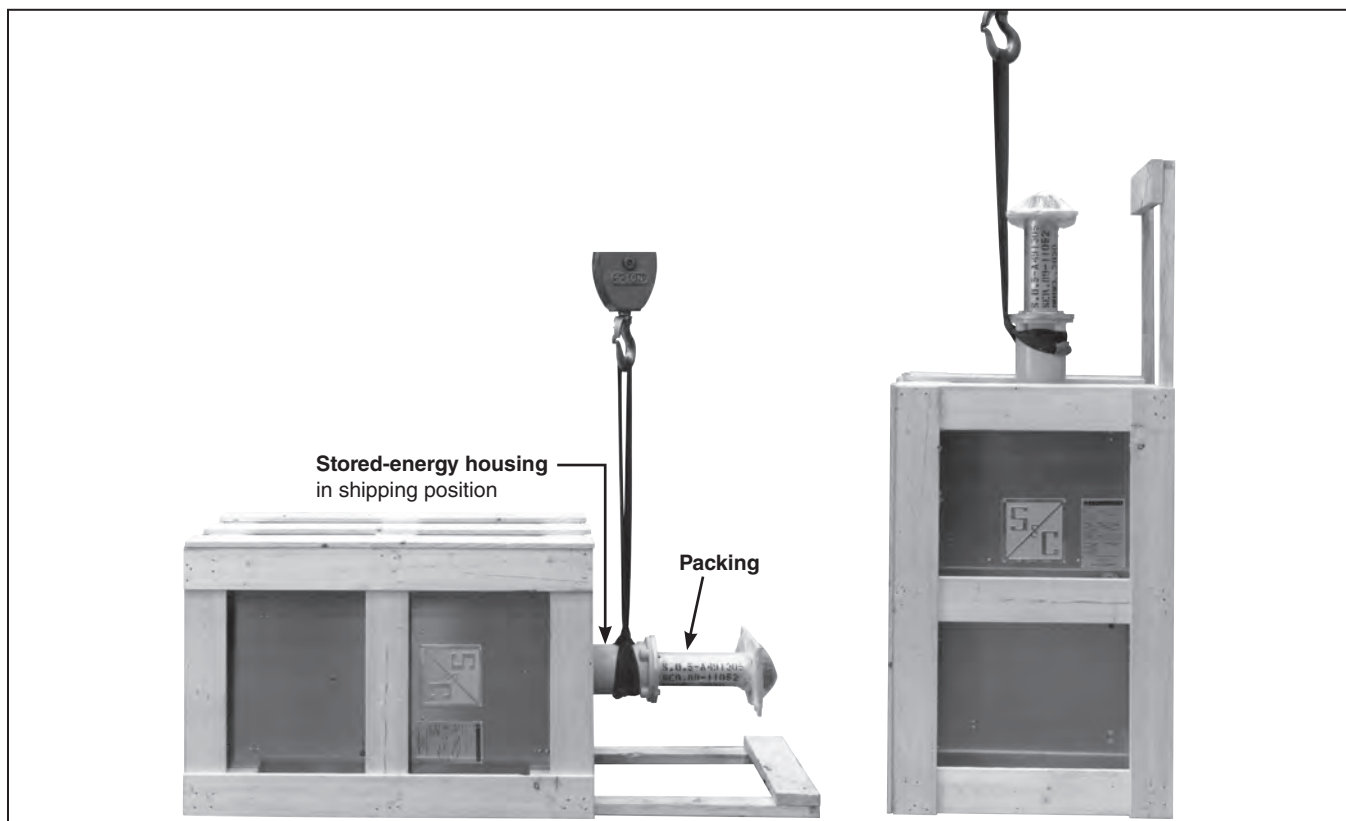


Figure 20. A typical shipment of Series 2000 Operator. Wrap lifting slings around the stored-energy housing to raise the operator to the upright position.

STEP 15. Reposition the lifting sling around the front of the stored-energy housing and wrap another lifting sling around the back of the stored-energy housing, as shown in Figure 21. Face the operator door the same direction as the Switch Position indicator on the high-speed base. Hoist the operator into place.

CAUTION

Be careful not to damage the uni-ball coupling on the operator-connecting link during hoisting and attachment of the operator. The uni-ball coupling cannot be replaced in the field. Damage will necessitate returning the operator for replacement.

Attach the operator support tube mounting plate to the underside of the high-speed base using four $\frac{1}{2}$ -13 x $1\frac{3}{4}$ hex-head galvanized steel cap screws, flat washers, and self-locking hex nuts. Lubricate the screws to facilitate tightening. Tighten all four screws securely.

STEP 16. Attach the operator support angle to the appropriate mounting pedestal using two $\frac{5}{8}$ -11 x 14 hex-head galvanized steel cap screws, four flat washers, and two self-locking hex nuts. Refer to the catalog drawing for exact placement. See Figure 21. Attach the operator support plate to the angle on the operator and the angle on the mounting pedestal using four $\frac{1}{2}$ -13 x $1\frac{1}{2}$ hex-head galvanized steel cap screws, flat washers, and self-locking nuts furnished. Lubricate the bolts to facilitate tightening. Securely tighten the screws. On circuit-switchers with two or three mounting pedestals, insert the hole plugs furnished into all unused holes in the pedestals.

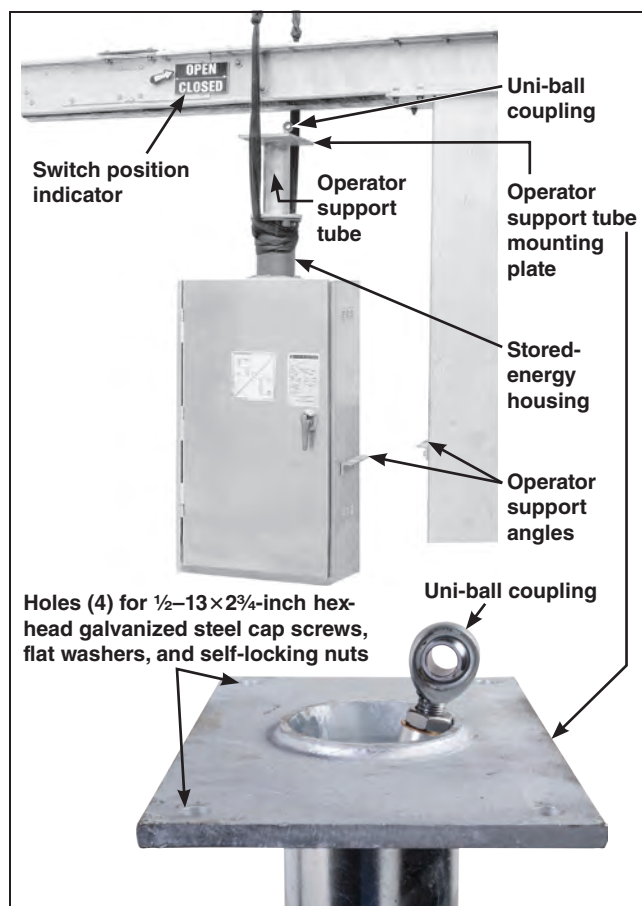


Figure 21. Hoist operator into position below the high-speed base using a lifting crane.

Connecting the Operator to the High-Speed Power Train

STEP 17. Attach the uni-ball coupling on the operator connecting link to the interphase drive lever in the high-speed base using the $\frac{3}{4}$ -inch stainless steel pin and cotter pin retained from Step 7. See Figure 22. An adjustable locking rod (marked with a black/yellow striped label) is furnished, factory connected to the interphase drive lever; turn the associated $\frac{1}{4}$ -20 locknuts as required to raise or lower the interphase drive lever to facilitate insertion of the stainless steel pin.

STEP 18. After the pin is installed, remove the lower $\frac{1}{4}$ -20 locknut that retains the adjustable locking rod, and then remove and discard the adjustable locking rod and locknuts. See Figure 22.

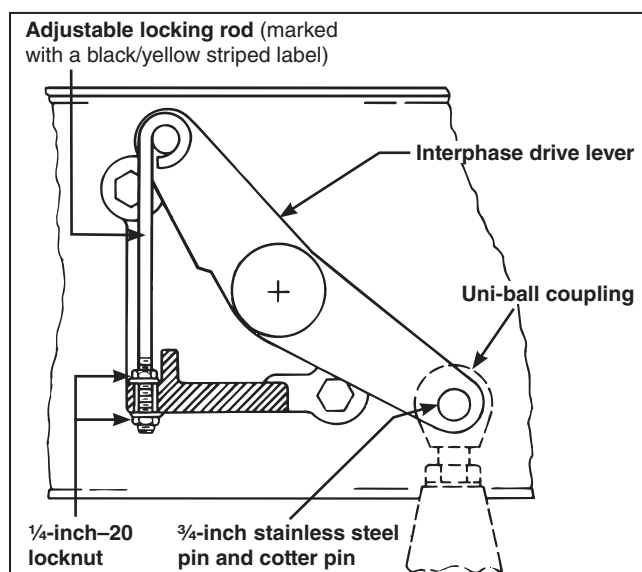


Figure 22. Attach the uni-ball coupling on the operator-connecting link to the interphase-drive lever inside the high-speed base.

Connecting Conductors

STEP 19.

DANGER

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

Attach the high-voltage conductors to their respective circuit-switcher terminal pads using flexible-conductor connections. Observe the terminal-pad loading limits specified on the catalog drawing. Use the following procedure for attachment:

- (a) Thoroughly wire-brush the current-transfer surfaces of each connector and immediately apply a liberal coating of Penetrox® A (available from Burndy Corporation) or other suitable aluminum connector compound to the brushed surfaces.
- (b) Wire-brush each circuit-switcher terminal pad and apply a coating of Penetrox A, and then bolt the connectors to the terminal pads.
- (c) Prepare the conductors using established procedures and clamp them in their respective connectors.

Remove the Interrupter Containers

STEP 20. Remove the container from each interrupter as follows:

- (a) Remove and discard the $\frac{3}{8}$ -16 zinc-plated serrated hex nuts that run the length of the container.
- (b) Remove and discard the two $\frac{3}{8}$ -16 \times 1 and two $\frac{3}{8}$ -16 \times $\frac{7}{8}$ zinc-plated hex-head cap screws and flat washers that attach the two container-halves to the coupling end casting of the interrupter.
- (c) Remove and discard the two $\frac{3}{8}$ -16 \times 1 and one $\frac{3}{8}$ -16 \times $\frac{7}{8}$ zinc-plated hex-head cap screws and flat washers that attach one of the container halves to the indicator end casting of the interrupter. Do not remove the remaining $\frac{3}{8}$ -16 \times $\frac{7}{8}$ cap screw—it's needed to temporarily retain the other container-half.
- (d) Pry the container halves apart with a screwdriver. One of the container-halves can now be removed and discarded—slotted holes are provided so a rope or lifting sling can be attached and the container safely lowered to the ground.
- (e) Remove and discard the remaining $\frac{3}{8}$ -16 \times $\frac{7}{8}$ hex-head cap screw and flat washer that attach the other container half. Then discard this container half.
- (f) Finally, remove and discard the foam-core inner liner wrapped around the interrupter.

STEP 21. Remove and discard the wrappers from each insulating support column.

Setting up the Operator and Checkout

STEP 22.

CAUTION

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

Do not apply control voltage to the operator at this time.

Perform the following set-up procedure on the operator. See Figures 23 through 25 on pages 22, 23, and 24.

- (a) To avoid accidentally energizing the operator after the external connections have been completed, open the control power Knife switch, and then swing the Knife switch retainer arm out of the way by putting pressure on the red insulated retainer and the black nylon retainer nut. The Knife switch retainer arm will “pop up” and can then be swung out of the way. See Figure 25 on page 24.
- (b) Mark the conduit-entrance location for the control-circuit wiring on the conduit-entrance plate at the bottom of the operator enclosure. Then remove the plate and cut out the necessary opening. Apply the sealing compound furnished, replace the plate, and make up the entrance fittings. Verify the entrance fittings are properly sealed to prevent water ingress.

NOTICE

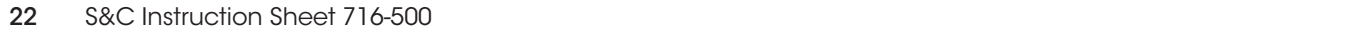
Make sure the polarity of the control circuit is correct on dc-control-voltage models. Energizing the switch operator with polarity reversed will cause damage to the operator control circuit and will require repair or replacement of the operator.

- (c) Connect the external control-circuit wiring (including the space heater source leads) to the terminal blocks at the bottom of the enclosure, in accordance with the wiring diagram furnished. Observe correct polarity on dc-control-voltage models.

NOTICE

Trip-circuit conductors and motor-and-closing circuit conductors must be adequately sized for the ampacities indicated on the wiring diagram.

DO NOT apply control voltage to the operator at this time.



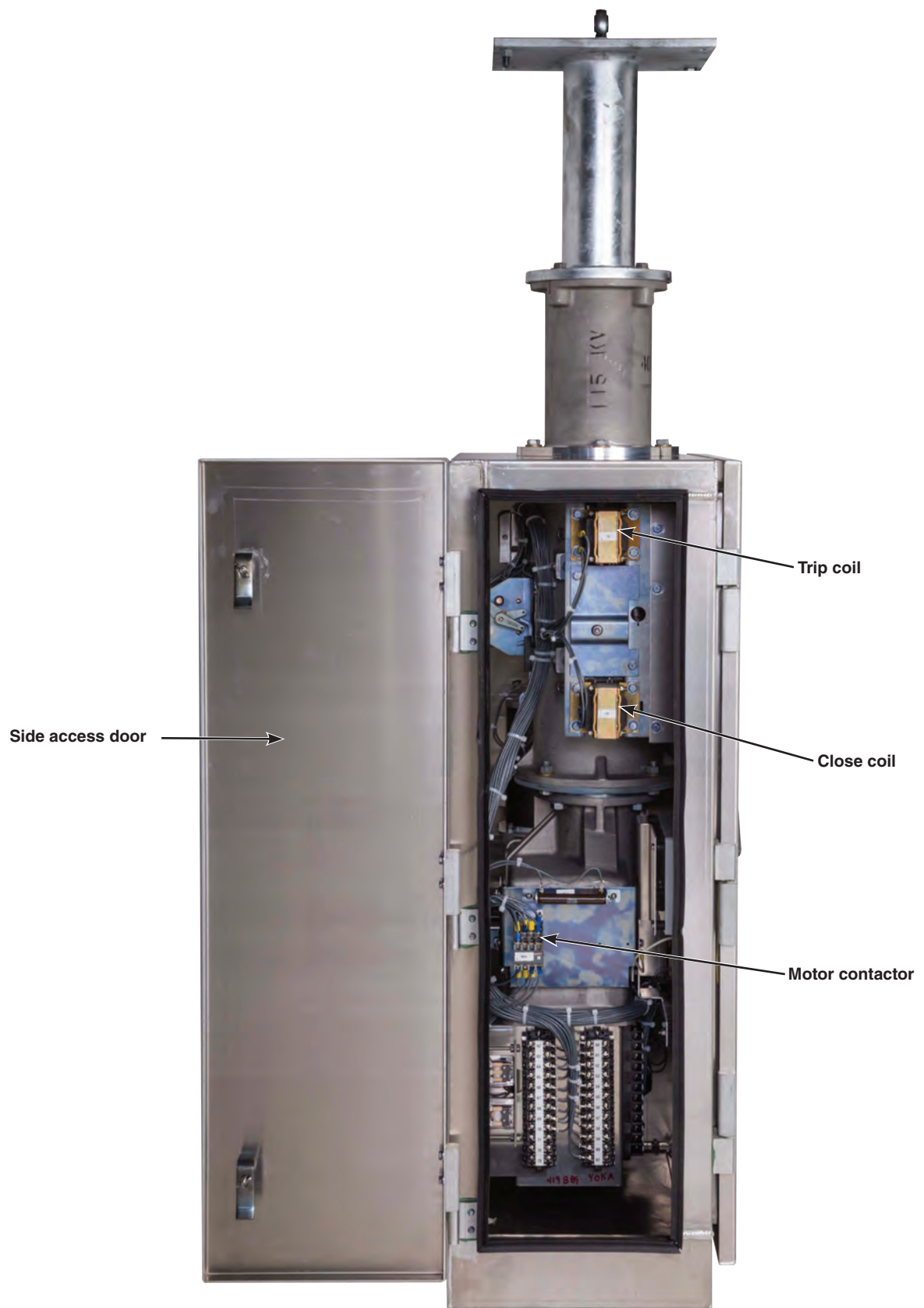


Figure 24. Side-access panel of switch operator.



Figure 25. The knife switch retainer and knife switch.

STEP 23. Perform the final checkout as detailed below:

NOTICE

Check the following. Failure to do so can result in damage to the circuit-switcher when operated.

- (a) At each transition box, make sure:
 - The operating rod holding bracket, stop bracket, and spacer have been removed from the interrupter (see Figure 26)
 - The interrupter coupling has been connected to its insulated operating rod link (see Figures 15 and 16 on page 16)
 - The connections are made according to Instruction Sheet 716-530 when the optional remote gas-density monitor is present (catalog number suffix “-R”)
- (b) At each interrupter make sure:
 - Both interrupter container halves and all associated packing and hardware have been removed
- (c) In the high-speed base:
 - Each insulated operating rod is connected to the interphase drive (see Figure 27)
 - The interphase drive lever has been connected to the operator uni-ball coupling (see Figure 28)
 - The adjustable locking rod attached to the interphase drive lever has been removed (see Figures 28 and 26)

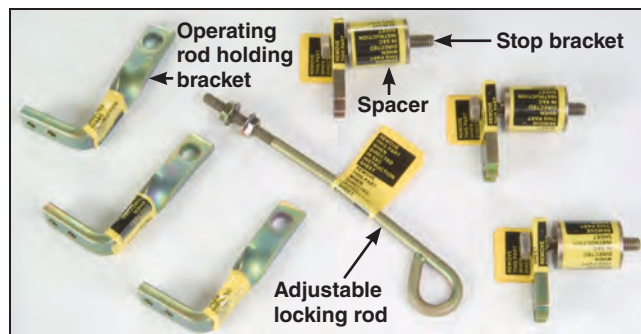


Figure 26. Check the transition box and high-speed base for these shipping parts.

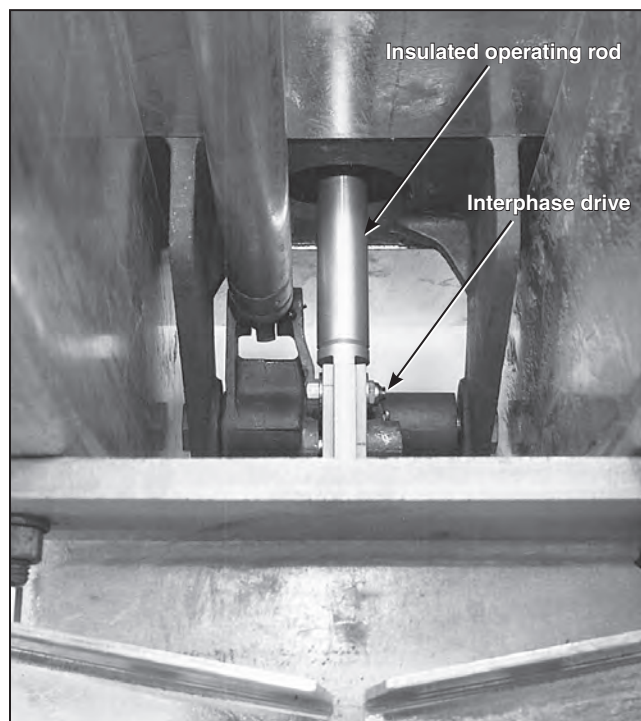


Figure 27. Check that each insulated operating rod has been connected to the interphase drive.

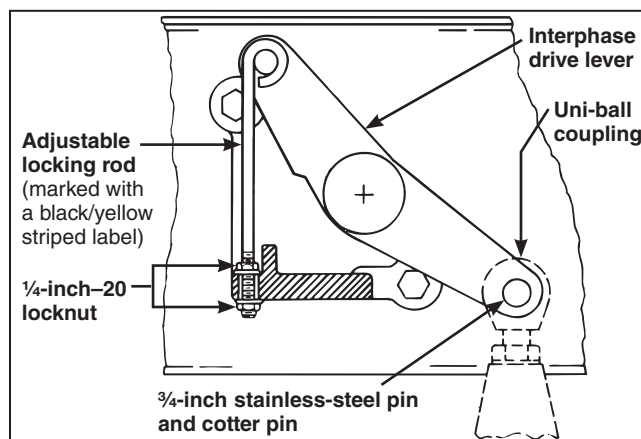


Figure 28. Check that the interphase drive lever has been connected to the uni-ball coupling. Also, check that the adjustable locking rod has been removed.

Installation

- (d) In the switch operator make sure:
- Correct polarity has been observed on dc-control-voltage models (see Figure 29)
 - To check the motor contactor and surge suppressor to ensure all electrical connections are secure, and that the surge suppressor is fully-seated in its mount (see Figure 30)
 - Any optional “ice-cube” style relays (used for catalog option “-P” and “-T2”) are fully seated in their mounts (see Figure 31)
- (e) Make sure all other pinned connections have been made and all bolted connections have been securely tightened.

STEP 24. Replace the access cover on the side of each transition box and securely tighten the associated $\frac{5}{16}$ -18 \times $\frac{3}{4}$ hex-head stainless steel cap screws.

STEP 25. Replace the bottom plates, which were removed in Step 7 on page 13, to the underside of the high-speed base and securely tighten the associated $\frac{1}{2}$ -13 \times $1\frac{1}{4}$ or $\frac{1}{2}$ -13 \times $1\frac{3}{4}$ galvanized steel cap screws, flat washers, and nuts. See Figure 8 on page 13.

For circuit-switchers rated 161 kV and 230 kV: Attach the six 13-inch \times $3\frac{3}{4}$ -inch adjustment plates to the underside of the high-speed base. These plates are used to cover small gaps between the bottom plates, the operator support tube mounting plate, and the mounting pedestal.

STEP 26. Insert the motor and closing circuit fuseholder, and then close the control-source disconnect knife switch. See Figure 29.

STEP 27. Press the CLOSE pushbutton or send a **Close** signal to the switch operator. See Figure 23 on page 22. The closing latch will release, discharging the closing spring. This action closes the interrupters. The switch-position indicator on the high-speed base will move to the **Closed** position. Further, if the position-indicating lamp option has been specified, the red lamp will light.

STEP 28. When the circuit-switcher is ready to be placed in service, the motor and closing circuit fuses can—at the user's option—be replaced with the slugs furnished. This practice is recommended for increased reliability because low-voltage fuses can be damaged by the repeated inrush current experienced during normal circuit-switcher opening operations and can “sneak out,” leaving the circuit-switcher inoperable.

NOTICE

Before replacing these fuses with slugs, make certain that the control-source battery is adequately protected to prevent discharge using fuses or circuit breakers located at the battery bus.

STEP 29. Please complete and mail the circuit-switcher registration card. The information requested on this card is vital to ensure prompt notification in the event field modifications are needed.

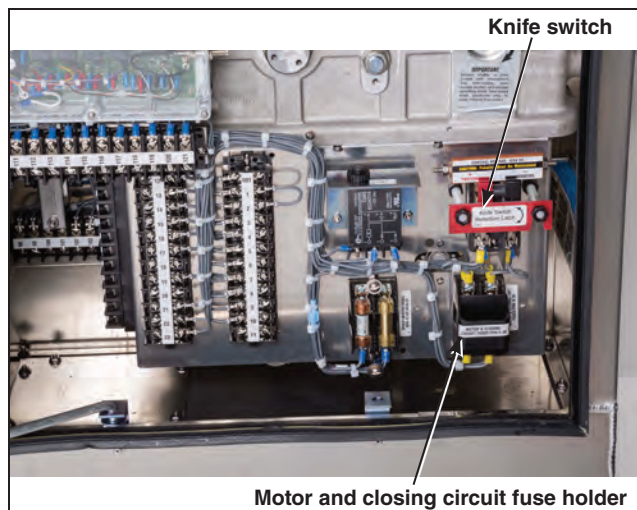


Figure 29. Motor and closing circuit fuse holders. Control source knife switch.

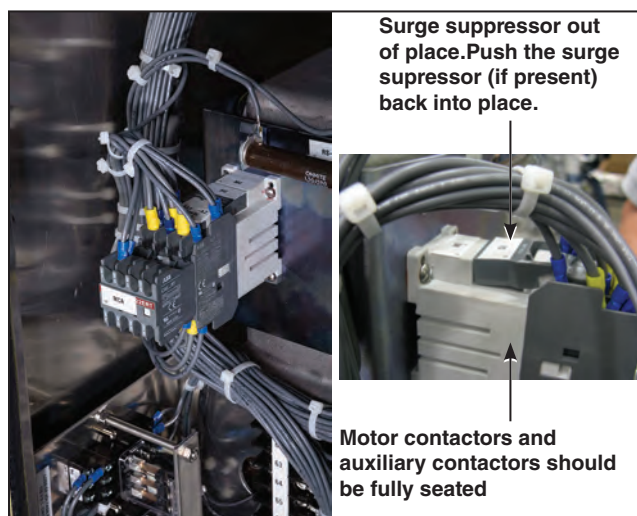


Figure 30. Check the motor contactor and the surge suppressor behind the operator side panel.

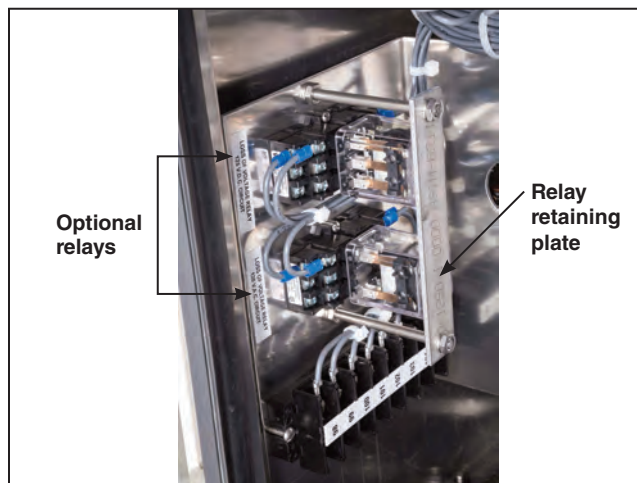


Figure 31. Check that all optional “ice-cube” style relays are fully seated and that the retaining plate is in place.

Understanding Trip-Free Operation

The stored-energy mechanism has an instantaneous trip-free capability. If the Series 2000 Circuit-Switcher is closed into a fault sensed by the user-furnished relaying, the mechanism will immediately trip. To accomplish trip-free operation, the stored-energy mechanism uses two spring assemblies: one for closing and one for opening. Both springs are charged by the operator motor before the circuit-switcher can be closed.

Recharging time after a trip operation is approximately 10 seconds for Model 2030 Circuit-Switchers rated 69 kV through 138 kV and 16 seconds for circuit-switchers rated 161 kV and 230 kV.

Electrical Operation

To open the circuit-switcher, press the TRIP pushbutton or send a remote trip signal to the switch operator. See Figure 23 on page 22.

The opening latch in the stored-energy mechanism will release, discharging the opening spring. This action trips the interrupters and forces the opening and closing pistons in the mechanism downward, which can be seen in the **Discharged** indicator window inside the operator. See Figure 32. The switch position indicator on the high-speed base will move to the **Open** position. See Figure 33 on page 28. Further, if the position-indicating lamp option (catalog number suffix “-M”) has been specified, the green lamp will light.

The motor-driven cam in the stored-energy mechanism will immediately start rising, thereby charging both the opening and closing springs; when the opening spring latches, the indicator will again be visible at the **Charged** window.

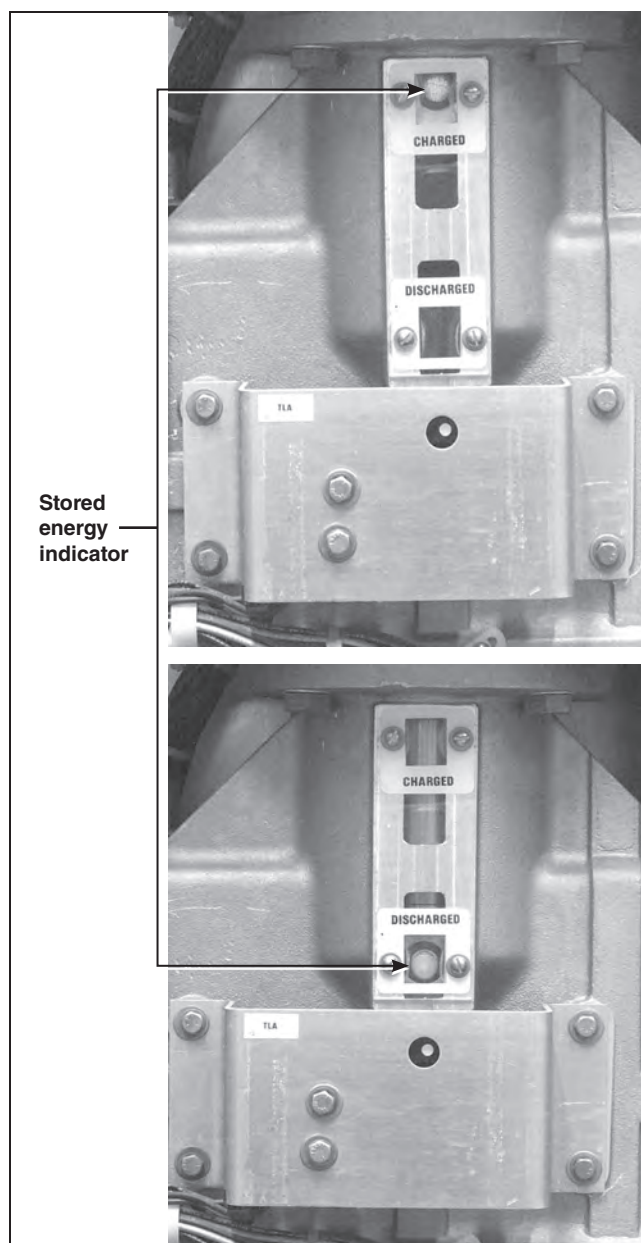


Figure 32. A close up of the stored-energy mechanism indicator CHARGED AND DISCHARGED.

Operation

To **close** the Circuit-Switcher, press the CLOSE pushbutton or send a remote close signal to the switch operator. See Figure 23 on page 22.

The motor-driven cam in the stored-energy mechanism will immediately start retracting. The closing latch will release, discharging the closing spring. This action closes the interrupters. The switch position indicator on the high-speed base will move to the **Closed** position. See Figure 33. If the position-indicating lamp option has been specified, the red lamp will light.

The Circuit-Switcher may also be electrically operated via remotely located control switches. No instructions are included for remote control because control schemes vary with the installation and specific application of the switch.

Manual Operation

To trip the interrupters, push the manual TRIP lever counterclockwise as indicated by the TRIP lever label. See Figure 23 on page 22. The opening latch in the stored-energy mechanism will release, discharging the opening spring. This action trips the interrupters and forces the opening and closing pistons in the mechanism downward, as shown by movement of the indicator to the **Discharged** window. (See Figure 32 on page 27.) The switch-position indicator on the high-speed base will move to the **Open** position. (See Figure 33.) If the position-indicating lamp option has been specified—and operator control voltage is available—the green lamp will light.

If operator control voltage is available, the motor-driven cam in the stored-energy mechanism will immediately start rising, charging both the opening and closing springs. When the opening spring latches, the indicator will again be visible at the **Charged** window.

If operator control voltage is not available, the interrupters will open. The motor-driven cam in the stored-energy mechanism will charge the opening and closing springs when control power is restored to the operator.

Manual closing of the circuit-switcher cannot be performed.

Understanding the Gas-Pressure Indicator and Safety Relief Device

Series 2000 Circuit-Switchers have sealed interrupters containing gas under pressure. Loss of gas pressure may result in improper interrupting action. Low gas pressure is signaled by a red target in the **Gas-Pressure** indicator at the upper terminal end of the interrupter.

Figure 34 illustrates a **Gas-Pressure** indicator with acceptable gas pressure.

Figure 35 illustrates a **Gas-Pressure** indicator with a red target, signaling a loss in gas-pressure.

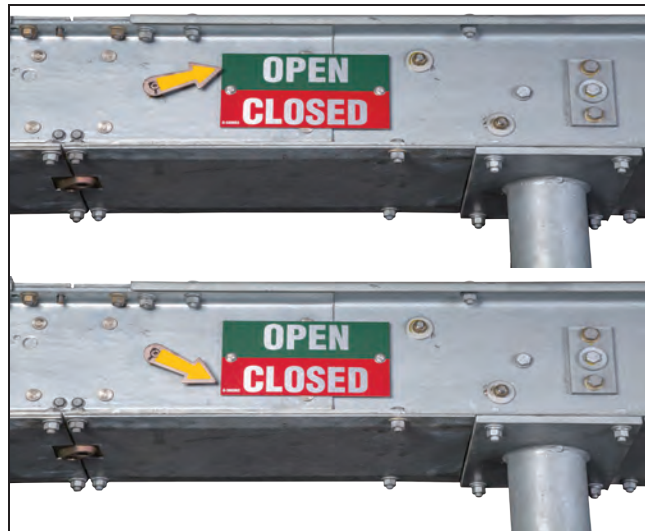


Figure 33. A switch-position indicator in the OPEN position. The switch-position indicator in the CLOSED position.

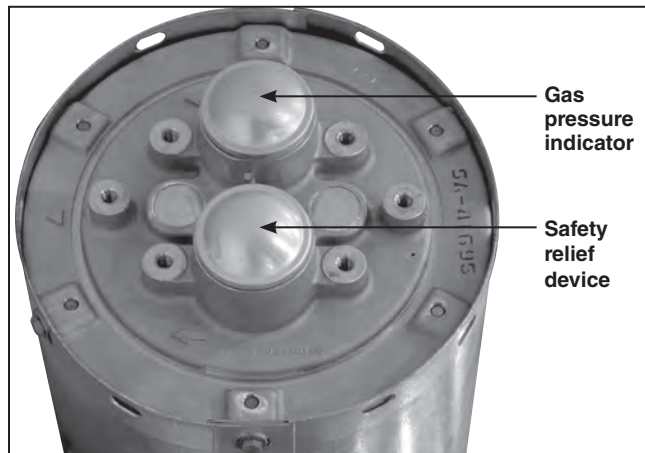


Figure 34. A normal gas-pressure indicator and relief device.

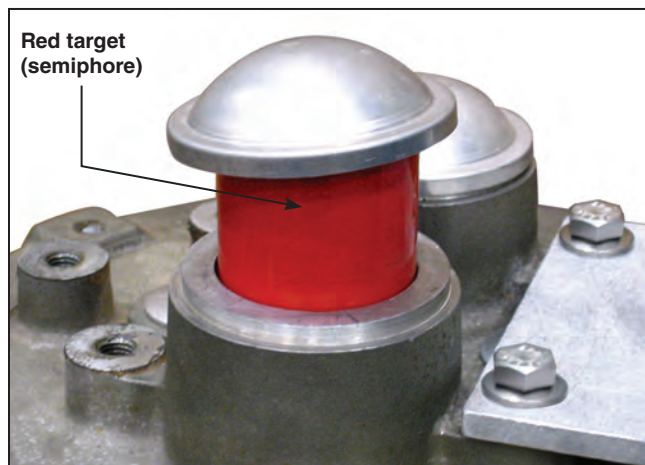


Figure 35. A visible “red target” gas-pressure indicator.

Understanding the Optional Remote Gas-Density Monitor

The remote gas-density monitor provides local and remote indication of the gas-density in each interrupter in terms of percent full. The system can be wired to provide remote indication of the gas density of each interrupter via three analog 0 to 1.0 mA dc outputs. The LCD screen provides indication of gas density and alarms for each interrupter. The remote gas-density monitor transmits updated measurements approximately once per hour.

The remote gas-density monitor has three available alarm contacts. The system provides both local and remote indication of alarms.

Level 1 alarm indicates that an interrupter is leaking. The circuit-switcher can still be operated, but the leaking interrupter should be replaced promptly.

Level 2 alarm indicates that an interrupter has lost enough SF₆ gas that it can no longer clear faults properly.

The **System Trouble** alarm indicates a problem with the monitoring system. A **System Trouble** alarm will activate when the receiver fails to receive a signal for over 24 hours. The **System Trouble** alarm will also activate when there are approximately three months or less of battery life remaining. At first, a **Low-Battery** alarm will appear locally. After the battery has completely discharged, an Error message will appear in place of the percent-gas-density information, and the **System Trouble** alarm will signal remotely.

For complete instructions on installing, operating, and troubleshooting the optional remote gas-density monitor, refer to S&C Instruction Sheet 716-530.

Inspection Recommendations

To ensure Series 2000 Circuit-Switcher's continued proper performance, it should be inspected in accordance with S&C recommended schedule and procedures contained in S&C Instruction Sheet 716-590.

