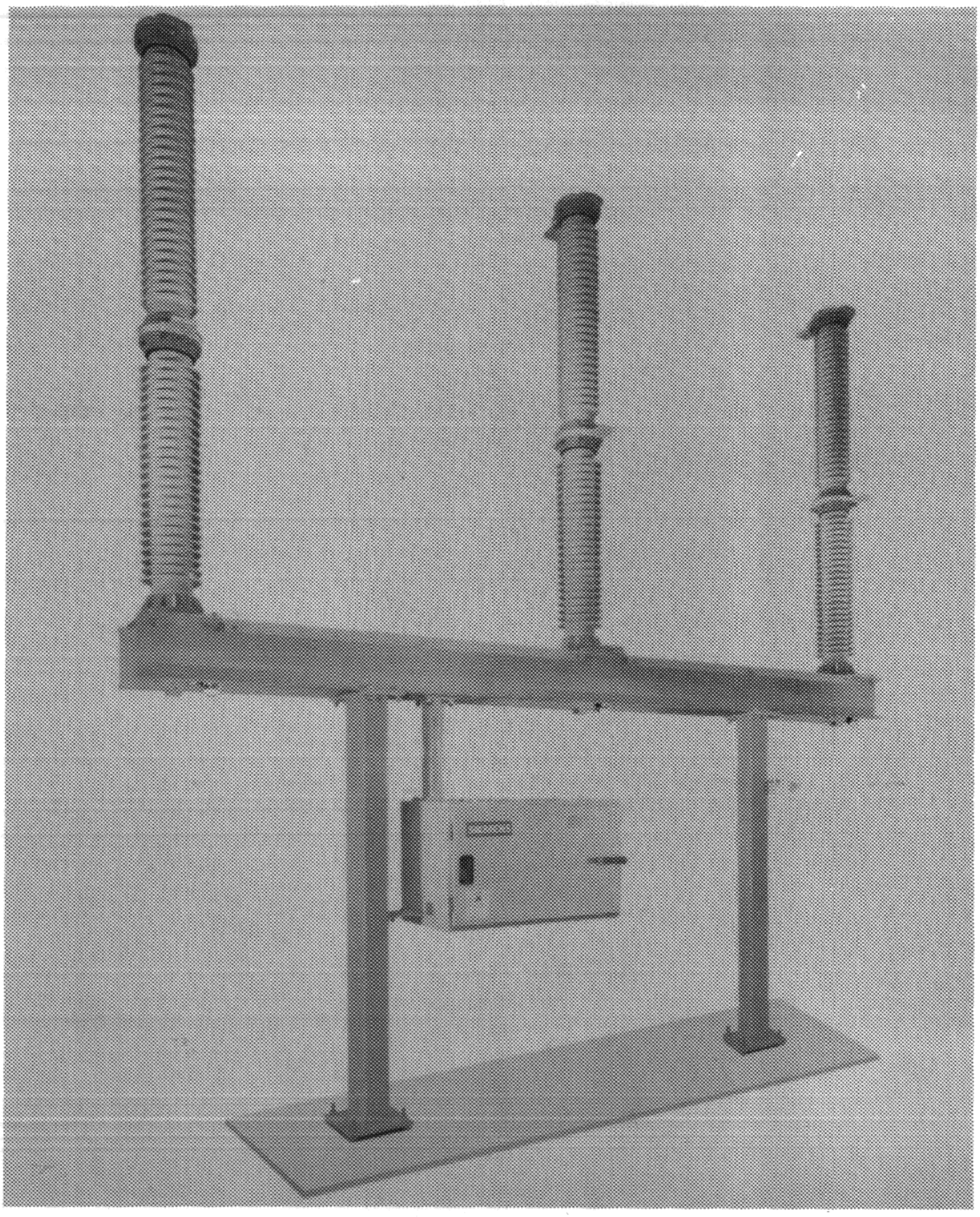
SIEMENS

Instructions

Installation
Adjustment
Maintenance



Type CPV - 72kV to 242kV Circuit Switcher

PB 3948-02

Introduction

About This Book

The instructions included in this book are necessary for safe installation, maintenance and operation and to aid you in obtaining longer and more economical service from your Siemens circuit switchers. For proper installation and operation, which will result in better service and lower maintenance costs, this information should be distributed to your operators and engineers.

By carefully following these instructions, difficulties should be avoided. However, these instructions are not intended to cover all details or variations that may be encountered during the installation, operation and maintenance of this equipment.

Should additional information be desired, including replacement instruction books, contact your Siemens representative.

The successful field performance of these Circuit Switchers depends as much on proper installation and maintenance as it does on good design and careful manufacture. Refer to these sections before performing any installation or maintenance operations.

Distinctive signal words (DANGER, WARNING, CAUTION) are used in this instruction book to indicate degrees of hazard that may be encountered by the user. For the purpose of this manual and product labels these signal words are defined below.

DANGER — Indicates an imminently hazardous situation which, if not avoided, **will** result in death or serious injury.

WARNING — Indicates a potentially hazardous situation which, if not avoided, **could** result in death or serious injury.

CAUTION — Indicates a potentially hazardous situation which, if not avoided, **may** result in minor or moderate injury.

⚠ DANGER

Hazardous voltage and mechanisms. Death or serious injury due to electrical shock, burns and entanglement in moving parts, or property damage will result if safety instructions are not followed.

To prevent:

Do not service or touch until you have de-energized high voltage, grounded all terminals and turned off control voltage.

Only qualified personnel should work on or around this equipment after becoming thoroughly familiar with all warnings, safety notices, instructions and maintenance procedures contained herein. The successful and safe operation of this equipment is dependent upon proper handling, installation, operation and maintenance.

Qualified Person

For the purpose of this manual, a qualified person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he or she has the following qualifications:

a) Is trained and authorized to energize, de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.

b) Is trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc. in accordance with established safety practices.

c) Is trained in rendering first aid.

Introduction

Installation and Maintenance Alerts

No attempt should be made to operate the circuit switcher until all shipping braces and blocks are removed, the switcher is fully assembled and inspected, and is filled with SF_6 gas. A manual operating device is available for slow opening and closing the switcher for installation and maintenance purposes. This device must only be used on a de-energized switcher with control power disconnected.

Read this instruction book, and be thoroughly familiar with the installation and maintenance procedures, and the hazards associated with these activities. Follow the step-by-step procedures in the "Installation' and "Maintenance and Adjustment" sections. Check that the work is correct and complete before operating the switcher.

A wiring schematic and connection diagram is supplied with the circuit switcher. These drawings (not the "typical" arrangement shown in this book) should be used when checking the operation of the operator and control circuits.

⚠ DANGER

Hazardous voltage and mechanisms. Death or serious injury from electrical shock, burns and entanglement in rapidly moving parts will result.

To prevent:

Do not service or touch until you have de-energized high voltage, grounded all terminals and turned off control voltage.

Never trip or close the circuit switcher while working on it, since the parts move rapidly and can cause injury.

Discharge the switcher's energy storage springs before performing maintenance or inspection.

The switcher and its mechanism must be disconnected from all electrical power before performing maintenance or inspection.

Never manually operate the switcher while it is energized or control power is connected.

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Important

The information contained herein is general in nature and not intended for specific application purposes. It does not relieve the user of responsibility to use sound practices in application, installation, operation, and maintenance of the equipment purchased. Siemens reserves the right to make changes in the specifications shown herein or to make improvements at any time without notice or obligations. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material, or both, the latter shall take precedence.

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Summary

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens sales office.

The contents of this instruction manual should not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens. Any statements contained herein do not create new warranties or modify the existing warranty.

Receiving, Handling, Storing

Receiving

Siemens Type CPV Circuit Switchers are packaged for shipment by either of two methods. Where shipping restrictions between the factory and the delivery site permit, a fully assembled three-pole unit is provided. Otherwise, the pole units are separated from the base assembly for a knocked-down shipment.

Three-pole units are packaged for shipment as shown in Figure 1. Boxes for the special installation tools and assembly hardware are strapped to the three-pole assembly base. In addition to this assembly, the shipment consists of a crated operator/control cabinet and two support columns.

The switcher serial number is shown on the nameplate affixed to the operator/control cabinet door. The same number is written on the hardware box. The support columns have the serial number stencilled on the uprights.

A packing list and circuit switcher assembly drawing are provided in weather resistant envelopes in the hardware box. The purchaser should use the included packing list and drawing to check for missing parts. List all damage or missing parts on the bill of lading. File claim with the delivering carrier and notify the local Siemens representative. Failure to do so may affect damage or missing parts claim at a later date.

Shipping channels are bolted to the circuit switcher base to resist tipping of the assembly and to provide a means for lifting the unit. Steel angles connected between the individual pole units brace the pole unit columns for shipping, and also prevent overturning of the assembly when lifted according to the recommended lifting procedure. The angle bracing should not be removed until final assembly of the switch, after the three-pole unit is bolted to the support columns. Wooden braces and blocks should be left in place during storage, and removed just prior to installation of the switcher.

Knocked-down shipments consist of a base assembly with wooden boxes containing hardware and special installation tools strapped to it (see Figure 2), three individual pole units and two support columns.

The switcher serial number is shown on the nameplate affixed to the operator/control cabinet door. The hardware box on the base assembly is marked with the same number. The support columns have the serial number stencilled on the uprights.

A packing list and circuit switcher assembly drawing are provided in weather resistant envelopes in the hardware box. The purchaser should use the included packing list and drawing to check for missing parts. List all damage or missing parts on the bill of lading. File claim with the delivering carrier and notify the local Siemens representative. Failure to do so may affect damage or missing parts claim at a later date.

Handling

The pole units are shipped partially filled with SF_6. In order to minimize the hazard of handling pressurized porcelains, the fill pressure is limited to about 5 psig. Even so, care should be taken when handling the pole units to avoid conditions which could cause porcelain rupture.

WARNING

Pressurized pole unit housings and heavy equipment.
Death, serious injury, or damage to the equipment during handling could result.

To prevent:

Do not strike, shock, or strain the porcelain housings or in any way cause the porcelains to rupture.

Do not move the pole units if the SF_6 pressure is above 10 psig.

The assembled three-pole unit is shipped with channels bolted to the base, and steel angles bolted between the pole units. Holes in the shipping channels are provided for lifting the assembly. Four chains or cables long enough to clear the top of the center pole unit must be used for lifting. See Figure 3 for an illustration of the correct lifting method.

The assembly has a high center of mass, and there is danger of overturning. Should tipping start during a lift, the shipping angles prevent overturning by contact with the lifting chains. The maximum weight of a three pole assembly is 3600 pounds.

Receiving, Handling, Storing

> **WARNING**
>
> Heavy equipment with high center of mass. Death, serious injury, or damage to the equipment could result.
>
> To prevent:
>
> When lifting a three-pole assembly, lift only with four chains or cables long enough to reach above the center pole unit. Lift from the holes provided in the shipping channels, and be sure the inter-pole shipping angles are in place.
>
> Do not strike, shock, or strain the porcelain housings or in any way cause the porcelains to rupture.
>
> Do not use nylon slings because of their uncontrolled stretch.

The three-pole assembly should be placed only on level, firm surfaces (for example, concrete or crushed rock), or on heavy timbers to distribute the weight of the unit so that the soil will support the weight without excessive imbedding. Otherwise, the unit could eventually tip over.

For circuit switchers which are shipped knocked-down, the base and the pole units are separate. The base can be lifted from the shipping channel holes using chains or slings of a convenient length. It is recommended that the lifting chains be long enough so that the lift angle is at least 45 degrees. Weight of the base assembly is approximately 800 pounds.

Knocked-down pole units are individually crated and can be lifted by slings or chains around the crates. The maximum weight of a crated pole unit is 800 pounds.

Operator/control cabinets are equipped with a lifting eye at the top of the cabinet. The crated assembly weighs approximately 700 pounds.

Support columns can be lifted with slings wrapped around the column. The columns weigh from 350 to 500 pounds, depending on size.

Storing

All parts should be left in the crates until time to install the circuit switcher. For outdoor storage, it is advisable to protect moisture absorbing materials (such as wood and cardboard) from water. Three-pole assemblies should also be secured against the possibility of high winds tipping the unit.

The operator/control cabinet space heater circuit (Figure 4) should be energized if stored outdoors and as soon as possible after installation to prevent condensation. External temporary wiring has been provided for convenience in making this connection. Discard the temporary leads upon installation of the circuit switcher. A plug is provided to close the temporary lead hole in the cabinet when the lead is removed.

Description

Circuit Switcher

The Siemens Type CPV Circuit Switcher can switch and protect transformers, lines, cables, shunt capacitor banks, and shunt reactors.

Figure 5 shows the major components of a CPV circuit switcher. These components and their operation and maintenance are covered in the following sections of this instruction book.

Pole Unit

A cross-sectional view of a CPV pole unit is shown in Figure 6. The interrupter is contained in the upper porcelain shell. The lower porcelain shell provides line-to-ground insulation, and houses an insulated rod which is connected to the interrupter moving contact. The lower end of the rod runs in a guide which is integral with the crank housing, and is linked to the pole unit operating crank.

The porcelain shells, crank housing, end cover, terminal plates and associated o-ring seals form a pressure vessel which is filled with SF_6 gas.

SF_6 Characteristics

The medium for arc interruption and dielectric strength is sulfur hexafluoride (SF_6) gas. In its pure state, SF_6 is inert, non-flammable, non-toxic and odorless. Exposure to arcing results in some breakdown of the SF_6 which produces small amounts of gaseous by-products and powders. Such decomposition is very slight and has a negligible effect on dielectric strength and arc interruption ability. Molecular sieve filters in the interrupter compartment remove most of these decomposition products.

Precautions to be followed in handling the gas are covered in detail under the heading "Opening the Pole Units" on page 39.

Gas Monitoring

Normally, each pole unit is equipped with a manifold which incorporates a fill valve and a pressure gauge. This manifold is located at the lower end of the pole unit, connected to the cover assembly by a union coupling. The coupling allows the pressure gauge to be rotated by the user to provide the most satisfactory view from the ground.

The pressure gauge has a color coded face for ease of reading from a distance. If the gauge is within the orange segment, the unit should not be operated under fault conditions and should be removed from service. A sticker showing a picture of the gauge and an operating pressure range versus ambient temperature is located on the door of the control cabinet.

As an option, the Siemens circuit switcher can be equipped with a temperature compensated pressure switch to automatically monitor the status of the SF_6 gas in the pole units. This switch is located inside the control cabinet, and is connected to the pole units by stainless steel tubing. It has two sets of contacts. One set of contacts prevents operation if gas pressure falls (due to leakage) to a level at which current interruption is not assured. The other set provides an alarm indication when the gas pressure approaches within 5 psi of the lockout value. The temperature compensating feature of the switch avoids alarms and lockouts due to normal pressure variations associated with circuit switcher temperature changes.

Rupture Disk

Each pole unit is equipped with a rupture disk which protects the porcelains and cast housings from bursting should an accidental over-pressure condition occur. The rupture disk will operate at a pressure of 119 to 131 psig, and quickly relieve the over-pressure condition.

Base Assembly

The base assembly provides mechanical support for the pole units and the operator/control assembly, and houses the opening spring and the operating rods which connect the bell crank to the pole units. A cross-sectional view of the base assembly is shown in Figure 7.

The connecting rods have right-hand threads on one end and left-hand threads on the other. This allows easy adjustment of the rod lengths to match pole unit spacing.

Description

Operator/Control

The Type SE-4A operator and necessary control and monitoring equipment are housed in a common cabinet (Figure 8). Large doors located on either side of the cabinet are made of aluminum and are easily lifted from their hinges for unobstructed access to the cabinet interior.

The operator occupies one side of the cabinet, and the electrical controls the other side.

Operator

The SE-4A operating mechanism stores energy for use in closing the circuit switcher. This energy is stored by compressing a powerful spring. An electrical motor with an integral gear reduction set (called a gearmotor) is used to compress the operator spring. The purpose of storing the motor-supplied energy in the spring is to allow a rapid closing operation of the circuit switcher. It takes about 5 seconds for the gearmotor to compress the spring, but the spring can discharge and close the switcher in less than 0.1 seconds.

With the circuit switcher open, a close operation is initiated by energizing the gearmotor. The closing spring becomes fully compressed, and then discharges, closing the switcher and charging the opening spring. The gearmotor is automatically de-energized.

The switcher is maintained in the closed position by a latch system in the operator. A trip operation is initiated by energizing a solenoid which releases the trip latch and allows the switcher to open.

An exploded view of the operator is shown in Figure 9. Reference to this figure will aid in following the description of the unit.

Frame. The mechanism is built up around a frame which provides the physical structure for the operator. It serves as the housing for shaft bearings, provides mounting surfaces for the closing spring, gearmotor and solenoid, and includes the mounting pads for fastening the mechanism to the circuit switcher.

Closing Spring and Housing. The closing spring is enclosed in a cylindrical housing bolted to one side of the frame. Slots in the spring housing serve as a track for rollers attached to the spring carrier. When the spring is compressed, the track and rollers assure that the spring stays concentric with the housing and does not buckle under load.

Gearmotor. The motor is a universal type, which means that it can be operated by either alternating current or direct current sources, providing the ancillary control circuits are compatible. The motor output speed is stepped down by an integral gearbox which provides a 36 to 1 reduction ratio. The gearmotor normally charges the closing spring in less than 5 seconds.

Eccentric Drive. The output shaft of the gearmotor is directly coupled to an eccentric shaft (Figure 9, item [22]) which runs in needle bearings housed in the mechanism frame. The eccentric end of the shaft connects to a drive rod assembly [10]. The left rod end is equipped with a needle bearing and connects to the rod by means of left hand threads. The opposite end of the rod has right hand threads, so the effective rod length is adjustable. The right rod end has a pinned connection to a pawl [24] and to two arms [9] which are fastened to, but free to rotate about, the main shaft. This rod end also houses a compression spring [78] which acts on the pawl to urge it against the ratchet wheel [8].

Main Shaft Assembly. A splined shaft [5] extends through the frame. On the front side of the frame, a toothed ratchet wheel [8] is splined to the shaft. Inside the frame is a cam [7], and on the back side of the frame is a crank [4], both of which are splined to the shaft. Sleeves, also splined to the shaft, are located between the ratchet wheel and the cam, the cam and the crank, and outside the ratchet wheel. These sleeves form the inner races of the needle bearings which support the shaft. They also serve as a rotary joint between the shaft and the pawl arms [9], and provide appropriate spacing between the components of the assembly.

The crank [4] is positioned on the shaft by a set screw which locates in a recess machined in the shaft. A splined collar [11] provides lateral support for the pawl arms, and a plate [12] is screwed into the end of the shaft to retain the components on the shaft. The plate is screwed to the collar, and both screws through the plate are secured by bending a tab over the screw flats.

Description

A rod extends from the pin connection of crank [4] to the closing spring carrier [21]. In operation, the ratchet wheel is driven by the gearmotor through the eccentric drive system and causes the crank to rotate from its bottom dead center position to top dead center. In the process, the spring compression changes from its minimum to its maximum value. As the crank passes through top dead center, the closing spring force causes the shaft assembly to rotate free of the eccentric drive.

Output Lever. The output lever [14] is positioned between the side plates of the frame. It pivots about pin [33] which is supported at either end by need bearings housed in the frame.

The upper end of the lever is pinned to a linkage which opens and closes the circuit switcher. At the lower end of the lever is a cam follower roller. During a close operation, the cam follower is driven by the cam [7] causing the lever to rotate in a clockwise direction and thereby close the switcher.

The second roller of the lever is the trip latch roll. During a close operation, the latch roll passes under the trip latch, and the latch prevents reverse rotation of the lever which would reopen the switcher.

The lever has two protrusions which are case hardened and are designed to strike the shock absorber [23] and the overtravel stop bolt.

Trip latches. The trip latches [31] and [27] are held in their unlatched position by a cam [14-13] attached to the output lever until the trip latch roll passes under the latch. At this position, the return springs [80] and [107] move the latches to their latched position, and the lever is held until the latches are released..

The face of the trip latch [31] which contacts the latch roll is machined to an arc which is not concentric with the center of rotation of the latch. The force of the latch roll against the latch tends to rotate the latch counterclockwise, which is in the direction to release the latch roll. A release latch [27] blocks this rotation. To release the trip latch and cause the switcher to open, the release latch must be rotated counterclockwise.

Rotation of the release latch can be accomplished manually or from a remote location by energizing a solenoid. When the edge of the slot in the release latch clears the edge of the close latch, the close latch is free to rotate into the slot and away from the latch roll. This frees the latch roll, and the output lever rotates to open the switcher.

Controls

A typical control scheme is shown in Figure 10.

Auxiliary Switches. The auxiliary switches are located in the electrical control section of the cabinet. These switches are mechanically linked to the output lever of the operator. They serve as circuit interlocking devices to prevent initiating a close operation when the switcher is already closed, or energizing the trip solenoid when the circuit switcher is open. Spare auxiliary switch contacts are wired to terminal blocks.

Open and Close Pushbuttons. Local manual control pushbuttons are provided for opening (green) and closing (red) the circuit switcher. Associated with each button is an indicator light of the same color which lights to indicate switcher status.

Open/Closed Indicator. A mechanical open/closed indicator driven by the auxiliary switch operating linkage is provided. This indicator is located to be visible in the window of the cabinet door.

Operation Counter. A mechanical operation counter actuated by the auxiliary switch linkage is standard. The operation counter is visible through the cabinet door window.

SF_6 Density Switch. An optional SF_6 density switch can be provided. This is a temperature compensated pressure switch. It provides an extra degree of security in the application of the circuit switcher by automatically preventing operation if the SF_6 gas pressure is below the safe limit. The switch is positioned on the control panel in the cabinet with a temperature-sensing bulb located within the switcher base assembly. The density switch is illustrated in Figure 11.

SF_6 Pressure Gauge. If equipped with the optional automatic gas system monitor, a gas pressure gauge and a gas fill valve are provided. The gas pressure gauge is visible through the window in the cabinet door.

Heater. A heater provided in the cabinet is intended to be energized continuously, to maintain a temperature differential between the compartment and the outside air. This prevents undesirable moisture condensation within the housing.

Operation

Interrupter

The interrupter is a single-gap SF_6 "puffer" type, which provides full rated dielectric strength in the open position. Operation of the interrupter is illustrated in Figure 12.

During an opening operation, a moving contact slides over a fixed contact. A cylinder attached to the moving contact acts against a fixed piston to compress the SF_6 gas contained in the cylinder (Figure 12a). At contact part, an arc results between the fixed and moving contacts, and the compressed SF_6 gas begins to flow through a nozzle to cool the arc (Figure 12b). At a current zero, the arc is momentarily extinguished. The SF_6 gas stream cools the contact gap area and prevents arc reignition (Figure 12c). The interrupter moving contact continues to move to the full open position, and full dielectric strength is established (Figure 12d).

Operator

An exploded view of the SE-4A operating mechanism is shown in Figure 9. In the following sections of text, numbers contained in brackets refer to the item numbers of this figure.

Closing

The gearmotor drives an eccentric shaft [22]. When the shaft rotates, it causes a connecting rod [10] to oscillate. The upper end of the rod is pinned to a pawl [24] and to a pair of arms [9] which are free to rotate about the main shaft [5]. The upper end of rod [10] is constrained by the arms [9] to move in an arc concentric with the main shaft. Located between the arms [9], and splined to the main shaft is a toothed ratchet wheel [8].

The offset of the eccentric shaft [22] is such that one revolution of the shaft causes the drive pawl [24] to travel through an arc slightly greater than the arc occupied by one tooth of the ratchet wheel. The drive pawl engages a tooth of the ratchet wheel at the extreme upward position of the eccentric shaft, and on the downward stroke advances the wheel far enough so that the holding pawl [17] engages the next tooth on the wheel. The holding pawl prevents backward rotation of the wheel on the next upward stroke of the drive pawl. This action is repeated, with the ratchet wheel advancing one tooth for each revolution of the eccentric shaft.

Splined to the opposite end of the main shaft is a crank [4] which has a rotary joint with a rod assembly [18],[19],[20]. The opposite end of the rod assembly connects to a spring carrier [21]. Rotation of the ratchet wheel causes the crank to rotate from bottom center position, and in doing so raises the spring carrier and compresses the spring [77]. Compression of the spring continues in this fashion until the crank passes top dead center of its rotation. At that point, the force of the spring causes the crank to rotate ahead of the driving pawl.

The shaft and attached components are forced by the closing spring to rotate in a counterclockwise direction. A cam [7] is splined to the shaft between the ratchet wheel and the crank. The cam contacts the follower roll [14-5a] of the lever [14] and drives it in a clockwise direction. The upper end of the lever is attached to a rod which connects to the switcher linkage and the opening spring. A cam [14-13] attached to the lever holds the trip latch in the released position until the latch roll [14-5b] reaches the latch. When the latch roll clears the latch face, the trip latch rotates under the influence of the return spring [80] to block reverse rotation of the lever. The trip latch is constructed so that the force of the latch roll tends to unlatch the roll. The release latch [27] blocks the trip latch and holds the switcher in the closed position.

Opening

A trip command energizes the trip solenoid which strikes the lever rod [29] and rotates the trip release latch to allow the trip latch to rotate and free the latch roll and lever. The opening spring forces the lever to rotate counterclockwise and opens the circuit switcher. At the end of the opening stroke, the lever strikes a shock absorber [23] which dissipates the remaining kinetic energy of the system and brings the lever to a controlled stop.

Installation

Factory Assembly

Type CPV Circuit Switchers are fully assembled, adjusted, and thoroughly tested in the factory. Minimum disassembly has been done to accommodate shipping clearance restrictions. Wherever practical, a fully assembled three-pole unit is shipped. Otherwise, the pole units are removed from the base for a "knocked-down" shipment.

General

For either method of shipment, assembly requires bolting together only a few major components. Normally, no adjustments should be required.

Bolts, nuts and washers required for the assembly are included with the shipment. The packing list itemizes the parts and is keyed to an assembly drawing included in the hardware box. Special tools required for assembly are also included.

Installation of the circuit switcher requires a foundation prepared in advance with studs embedded according to the switcher foundation plan. Studs and mounting hardware are not normally included with the circuit switcher shipment.

Galvanized hardware is supplied. All 1/2-inch hardware should be tightened to 50 lb-ft torque, 5/8-inch hardware to 90 lb-ft, and 3/4-inch hardware to 160 lb-ft.

Special tools required for the circuit switcher installation are included with every order. These are:

1. Adapter and service hose for SF_6 filling.
2. Manual operating device.
3. Gauge pin for checking pole unit open position.
4. Timer transducer mounting adapter.

Circuit Switchers Supplied as Three-Pole Assemblies

1. Screw nuts onto each tie-down stud. Position each support column over the four tie-down studs, resting on the nuts. (Note that one column has extra angles welded to it at a height of about 4 to 6 feet above the base plate. This column is to be oriented with the angle between the two columns, and located on the pole 1 side of the switcher. Refer to the field assembly drawing.) Adjust the nuts to plumb the columns, and to level the two columns within 0.25 inches. Place a flat washer and nut on each stud, and tighten to 220 lb-ft.

2. Remove wooden braces and shipping protection from the three-pole assembly. Do not remove the steel inter-pole angle braces.

3. Remove the weather cover from the top of the base between poles 1 and 2. Withdraw the hairpin cotter from the pin in the pullrod fitting as indicated on the field assembly drawing, and remove the pin and washers. Discard the hairpin cotter, but retain the pin and washers.

4. Refer to the section "Handling" for the proper method of lifting the three-pole assembly. Lift the assembly into place on the support columns, and bolt it to the columns with the hardware provided.

WARNING

Heavy equipment with high center of mass. Death, serious injury, or damage to the equipment could result.

To prevent:

When lifting a three-pole assembly, lift only with four chains or cables long enough to reach above the center pole unit. Lift from the holes provided in the shipping channels, and be sure the inter-pole shipping angles are in place.

Do not strike, shock, or strain the porcelain housings or in any way cause the porcelains to rupture.

Do not use nylon slings because of their uncontrolled stretch.

5. Uncrate the operator/control assembly and remove all external packing material. Lift the assembly by the lifting eye in the top of the cabinet, and position the unit under the three-pole assembly with the cabinet pipe extension directly below the mounting channel (see Figure 5 and Figure 13).

6. Pass a single cable between the base assembly main channels, and connect to the operator/control lifting eye. Lift the assembly and position the bellcrank box to mate with the locating pin in the mounting channel, with the bellcrank located in the slot of the horizontal pullrod end fitting (refer to Figure 13). Insert the mounting hardware provided to bolt the bellcrank box to the mounting channel, but do not tighten.

7. While still supporting the operator/ control assembly weight, loosely bolt the connecting plate between the support column and the cabinet. Hold cabinet level, tighten all mounting hardware, and remove the lifting cable.

8. Connect the bellcrank to the pullrod fitting with the pin retained from step 3, positioning a washer on either side of the pullrod fitting. Insert the cotter pin from the hardware kit, and bend the tines of the pin.

9. Install the manual operating device on the operator (see Figure 14), and partially close the operator to the point where the opening spring load is removed from the spring blocking tool (Figure 15). Remove the tool and save it for possible future use. Release the load on the manual operating device, and remove it from the operator.

10. If the circuit switcher is equipped with an SF_6 density monitor (optional equipment) connect the tube fittings at each pole unit and at the bellcrank box. (These fittings contain check valves which permit disassembly and assembly without significant loss of gas.)

11. Replace the weather cover on the base assembly.

12. Remove one terminal pad of each pole unit from its shipping position at the top of the interrupter. Using the same hardware, reinstall the pad at the bottom of the interrupter. Note that the terminal pad can be installed on either side of the circuit switcher.

Circuit Switchers Shipped Knocked-Down

1. Screw nuts onto each tie-down stud. Position each support column over the four tie-down studs, resting on the nuts. (Note that one column has an extra angle welded to it at a height of about 4 feet above the base plate. This column is to be oriented with the angle between the two columns, and located on the pole 1 side of the switcher. Refer to the field assembly drawing.) Adjust the nuts to plumb the columns, and to level the two columns within 0.25 inches. Place a flat washer and nut on each stud, and tighten to 220 lb-ft.

2. Remove the weather covers from the top of the base assembly. Remove wooden shipping braces and blocks. Withdraw the hairpin cotter from the pin in each pullrod fitting (at each pole location, and at the bellcrank position) and remove the pin and washers. Discard the hairpin cotters, but retain the pins and washers.

3. Lift the base assembly to the top of the columns, and bolt it in place using the hardware supplied. Note that the end of the base opposite the opening spring goes toward the column with the extra angle.

4. Uncrate the pole units. The center pole unit (pole 2) should be installed first. Lift the pole unit by means of nylon slings choke hitched around the top of the interrupter porcelain just below the top flange (see Figure 16). Two slings of equal length should be used to obtain a level lift.

5. Orient the pole unit with the operating lever side toward the base assembly pullrods. Lower the center pole into position while holding the pullrod away from the pole unit operating levers. When the pole unit is positioned correctly, bolt it to the base channels using the hardware provided. Lift the pullrod and place it between the pole unit operating levers.

6. Install the end pole units by raising them to the top of the base channel, then moving them into position from outside the end of the base, with the pullrod between the operating levers.

7. Connect the pole units to the base assembly pullrods with the pins and washers saved from step 2. One washer should be placed on either side of the pullrod fitting. Secure the pins with cotter pins contained in the hardware kit, and bend the tines of the cotter pins.

8. Uncrate the operator/control assembly and remove all external packing material. Open the cabinet and remove the band between the operator lever and the shock absorber. Lift the assembly by the lifting eye in the top of the cabinet, and position the unit under the three-pole assembly with the cabinet pipe extension directly below the mounting channel (see Figure 13).

9. Pass a single cable between the base assembly main channels, and connect to the operator/control lifting eye. Lift the assembly and position the bellcrank box to mate with the locating pin in the mounting channel, with the bellcrank located in the slot of the horizontal pullrod end fitting. Insert the mounting hardware provided to bolt the bellcrank box to the mounting channel, but do not tighten.

10. While still supporting the operator/ control assembly weight, loosely bolt the connecting plate between the support column and the cabinet. Hold cabinet level, tighten all mounting hardware, and remove the lifting cable.

11. Connect the bellcrank to the pullrod fitting with the pin retained from step 2, positioning a washer on either side of the pullrod fitting. Insert a cotter pin from the hardware kit, and bend the tines of the pin.

12. Install the manual operating device on the operator (see Figure 14), and partially close the operator to the point where the opening spring load is removed from the spring blocking tool (Figure 15). Remove the tool and save it for possible future use. Release the load on the manual operating device, and remove it from the operator.

13. If the circuit switcher is equipped with an SF_6 density monitor (optional equipment) connect the tube fittings at each pole unit and at the bellcrank box. (These fittings contain check valves which permit disassembly and assembly without significant loss of gas.)

14. Replace the weather covers on the base assembly.

15. Remove one terminal pad of each pole unit from its shipping position at the top of the interrupter. Using the same hardware, reinstall the pad at the bottom of the interrupter. Note that the terminal pad can be installed on either side of the circuit switcher.

Grounding Connections

NEMA standard ground pads are provided on each support column, and on the operator/control cabinet. A connection should be made from these pads to the station grounding network. The grounding conductor should be capable of carrying the maximum short circuit current for the duration of the fault. All joints must be clean, bright and free from burrs or surface roughness.

WARNING

Poor grounds could result in death or serious injury due to electrical shock.

To prevent:

The circuit switcher must be connected to a permanent, low resistance ground.

Line Connections

Line connections should have sufficient flexibility and support to limit the load on the switcher terminal pads. Permissible line loadings are: 300 pounds in line with the terminals, 150 pounds perpendicular to the terminals horizontally, and 250 pounds vertical.

Conductor and connector must have adequate current carrying capacity to prevent heat transfer into the switcher. All joints must be clean, bright and free from burrs or surface irregularities, and must be assembled using "joint compound".

The contact faces of the terminal plates, terminal pads and connecting parts should be rubbed vigorously with a stainless steel brush, which should be used for copper or aluminum only, until bright metal shows and, in the case of aluminum, until they become slightly roughened. Wipe the faces with a rag and apply a coating of corrosion resistant, conductive compound such as Alcoa No. 2 Electrical Joint Compound on both surfaces.

The terminal pads are made of aluminum. If copper connecting parts are used, insert copper/aluminum adapter plates. Firmly tighten the connecting bolts.

Installation

CAUTION

Improper operation of switcher may cause equipment damage.

To prevent:

Do not operate the switcher until it has been filled with SF_6 to at least the minimum operating pressure.

Filling the De-Energized Switcher with SF_6 Gas

Pole units are shipped partially filled with SF_6 gas at a pressure of about 5 psig. This avoids the need for evacuation prior to filling the switcher, and the low gas pressure reduces the hazard of handling pressurized porcelains. Before the switcher can be safely operated, it must be filled with SF_6 gas to within its normal operating range.

If the circuit switcher is equipped with an optional SF_6 density monitor, all three pole units are filled through a single port located in the operator/control cabinet. Otherwise, each pole unit is filled through a manifold connected to the bottom cover of the crank housing.

Before filling the circuit switcher, check the pressure gauge(s) to confirm that pressure has not been lost due to damage or leakage. If pressure is reduced to 0 psig, it will be necessary to find and repair the cause of the leakage, and then evacuate the pole unit(s) to 2mm of mercury before filling with SF_6.

The proper fill pressure is dependent on the prevailing temperature of the switcher. A graph showing this relationship is shown in Figure 17. Switcher temperature cannot be measured directly. The ambient temperature is usually used for this purpose. If the switcher is exposed to direct sunlight, the prevailing temperature of the switcher can be substantially higher than the ambient temperature. It is best to fill the switcher with SF_6 on a cloudy day or early in the morning before being exposed to direct sunlight. Since this is not always practical, the switcher gas pressure should be monitored until such conditions exist, then adjust the fill pressure as necessary.

Equipment to fill the circuit switcher is included as part of the installation tools kit. Assemble the equipment as shown in Figure 18. If an SF_6 source with a pressure regulator is available, omit the bottle adapter and relief valve from the assembly, and connect the hose to the pressure regulator.

WARNING

Over pressurization could result in death, serious injury, or burst disk fragmentation.

To prevent:

Closely monitor the fill pressure during the filling process to avoid over pressurizing the pole units.

To fill the circuit switcher with SF_6:

1. Remove the cap from the SF_6 cylinder fitting and attach the SF_6 pressure regulator or adapter.
2. Attach and tighten hose to regulator or adapter.
3. Loosely attach female disconnect to the end of the hose.
4. Purge air from the hose by slightly opening the SF_6 cylinder valve to allow SF_6 gas to exhaust at the loose fitting.
5. Shut the cylinder valve and tighten the quick disconnect to the hose.
6. Remove the cap from the pole unit fill valve (or switcher fill valve if the unit is equipped with a density monitor) and attach the hose-end quick disconnect.
7. Open the SF_6 cylinder valve slowly and fill to the proper pressure as determined from Figure 17.
8. After proper pressure is reached, shut the cylinder valve and disconnect the hose from the fill valve fitting. Replace the cap on the fill valve.

The moisture content of the SF_6 should be no higher than 300 ppmv. If the pole units have maintained the positive shipping pressure, it will not be necessary to check for moisture after filling from an SF_6 bottle. If there is reason to suspect high moisture levels, do not use the rubber filling hose for sampling the gas. Use stainless steel tubing for this purpose.

Installation

Adjustment

Circuit switchers which are shipped knocked-down may require adjustment of the pullrods in the base assembly. This is because the pole units may be located slightly off of the location occupied during factory test. Circuit switchers shipped as a three-pole assembly will retain their factory adjustments and need not be checked.

Check the adjustment as follows:

1. Place the circuit switcher in the open position.

2. Use the gauge pin included with the installation tool kit to check the open position of each pole unit. See Figure 19.

3. If adjustment is necessary, start with pole 1 (the end pole nearest the operator), then pole 2 and finally pole 3. The position of pole 1 is affected only by the length of the pullrod between the bellcrank and pole 1. The position of pole 2 is affected only by the length of the pullrod between the bellcrank and pole 2. The position of pole 3 is affected by the position of pole 2 and the length of the pullrod between pole 2 and pole 3.

4. Loosen the locknuts adjacent to the fittings at each end of the indicated pullrod. Each pullrod has a right hand thread at one end and a left hand thread at the other. Turn the pullrod to change its effective length. Only a few degrees of rotation should be needed to correct the adjustment. Check the new position with the gage pin.

5. When all adjustments are satisfactory, tighten the locknuts against the pullrod fittings. The fittings should be held by a wrench while the nuts are being tightened.

Baseline Data

An effective maintenance program begins during installation of the circuit switcher. It is strongly recommended that a permanent record of each circuit switcher be established at the time of installation and maintained throughout the life of the equipment. Included in this log should be the complete records of all installation, inspection, maintenance and lubrication work performed.

It is particularly important to establish baseline data at the time of installation. The change of an operating parameter is normally more significant than the absolute value of the parameter.

Adherence to the procedures identified in the "Installation Checklist" which follows, and verification that the items checked are within the allowable tolerances, will assure a proper installation. This information can then be used as a base reference for future maintenance.

CAUTION

Improper operation of switcher may cause equipment damage.

To prevent:

Do not operate the switcher until all tests and inspections are done.

Circuit switcher timing can be checked with a travel analyzer (for example, Doble TR-3000) or slidewire/ oscillograph combination. The transducer can be mounted on the mechanism as indicated in Figure 20. The transducer adapter shown is included as part of the installation tool kit.

If the contact part time exceeds 4.5 cycles (75 ms), the difficulty may be due to an excessive voltage drop in the DC control cable to the switcher.

Contact velocity during open and close operations is set at the factory and need not be set or adjusted during installation. If, however, the contact velocity is measured and found to be out of limits, be sure the test equipment is working properly. If possible, recheck the results with another test set. If the switcher is still out of specification, consult the factory.

Contact resistance should be measured terminal to terminal with a ductor, or equivalent 100 amp DC source. Record the contact resistance of each pole to provide a permanent baseline reference to which future measurements can be compared.

Establishing a baseline value is particularly important for contact resistance measurements. Small variations in the chemical makeup of alloys used in the interrupter are inevitable, and these can cause noticeable differences in the pole unit resistance. In diagnosing impending problems, the change in contact resistance with time is far more significant than the absolute value of resistance.

Installation

Checklist

Installation Date _____

1. Nameplate Data _____

   1.1 Switcher Type _____ Rating: _____ kV _____ amp

   Serial-S.O. _____ Instruction Book PB-3948

   1.2 Mechanism Type SE-4A Instruction Book PB-3948

   Control Diagram _____ Control Voltage _____

   Motor and Heater Voltage _____

2. General Condition of Switcher when Received _____

NOTE: The following checks are to be made after the switcher has been installed on its permanent foundation.

3. Switcher bolted to its permanent foundation and shipping braces removed. _____

4. Grounding connections installed. (left) _____

   (right) _____

5. Control wiring installed. _____

6. Switcher filled with SF_6 (see Figure 17). _____ psig

   Ambient Temperature _____ °F

7. Final check of switcher for loose hardware. _____

8. Timing tests (At normal operating voltage).

   8.1 Trip command until contacts part (3.0 to 4.5 cycles, 50 to 75 ms). _____ milliseconds

   8.2 Close command until contacts touch (6 seconds maximum). _____ seconds

9. Contact resistance terminal to terminal measured with ductor or equivalent 100 amp DC source. (Maximum for new contacts: 242 kV, 115 micro-ohms; 169 and 145 kV, 105 micro-ohms; 121 kV, 95 micro-ohms.)

   (Pole 1)_____ micro-ohms

   (Pole 2)_____ micro-ohms

   (Pole 3)_____ micro-ohms

10. Operation counter reading as left

11. SF_6 gas pressure as left _____ psig Ambient temperature _____ °F

12. Check all labels and nameplates attached to the switcher to be sure that they are securely fastened in place and are readable.

Inspection

Inspection

The intent of this section is to identify the parameters which can be used to establish and carry out a proper program to assure reliability of the equipment.

Of primary importance in carrying out an effective program is that the individuals involved understand the equipment, how it is to function, and the potential problems should out-of-specification conditions exist.

It is desirable to maintain a permanent record of each circuit switcher. Included in this log should be the complete records of all installation, inspection, maintenance, and lubrication work performed. Installation, Periodic, 3 Year Inspection, 6 Year Inspection and Major Inspection Checklists should be included as well as information relative to the number of faults and associated current magnitudes the switcher has been required to interrupt.

Record keeping of this type will permit accurate evaluation of the conditions of the switcher at all times and assure reliable service if the suggested procedures are followed. In addition, it will permit the comparison of present-day values of such items as contact resistance and contact timing to previously obtained data.

Many of the tests which are made are diagnostic type tests which will provide information relative to potential problems. This is to say that when one analyzes the test results and compares the results with previous test data, it can be determined whether a change is normal or whether it is one which requires attention.

An effective maintenance program begins during the installation of the equipment. A copy of an Installation Checklist follows the INSTALLATION section of this book. Adherence to the procedures identified on the Installation Checklist and verification that the items checked are within the allowable tolerances will assure a proper installation. This information is then to be used as a base reference for future maintenance. The checklists do not provide an in depth description of the checks and tests to be made. This information is contained in the text of this instruction book. Switchers installed in areas of severe environmental conditions may require more frequent inspection. It is recommended that frequent visual inspections be made by operators while touring the switchyard in order to observe any obvious abnormal conditions.

General

Thorough, periodic inspection is important to satisfactory operation. Inspection and maintenance frequency depends on installation site, weather and atmosphere conditions, experience of operating personnel and special operation requirements. Because of this, a well-planned and effective maintenance program depends largely on experience and practice.

⚠ DANGER

Hazardous voltage and mechanisms. Death or serious injury from electrical shock, burns, and entanglement in rapidly moving parts will result.

To prevent:

1. Do not service or touch until you have de-energized high voltage, grounded all terminals and turned off control voltage.
2. Never trip or close the switcher while working on it, since the parts move rapidly and can cause injury.
3. Discharge the switcher's mechanical systems before performing maintenance or inspection.
4. Switcher and its mechanism must be disconnected from all electrical power before performing maintenance or inspection. Grounding leads should be properly attached and framework grounded.
5. Never slow operate the switcher while it is energized or control power is connected.
6. Remove the maintenance closing device before operating the switcher.
7. Only qualified personnel should work on or around this equipment after becoming thoroughly familiar with all warnings, safety notices, instructions and maintenance procedures contained herein. The successful and safe operation of this equipment is dependent upon proper handling, installation, operation and maintenance.

Inspection

WARNING

Failure to properly maintain the equipment could result in death, serious injury, product failure, and prevent successful functioning of connected apparatus.

To prevent:

The instructions contained here should be carefully reviewed, understood and followed. The following maintenance procedures should be performed regularly.

STEP 1
Be sure that the circuit switcher and its mechanism is disconnected from all electric power, both high voltage and control voltage, before it is inspected or repaired.

STEP 2
After the circuit switcher has been disconnected from power lines, attach the grounding leads properly before touching any of the circuit switcher parts.

STEP 3
Keep the mechanism clean and follow instructions for lubrication.

STEP 4
Be sure the circuit switcher is well grounded.

STEP 5
See that bolts, nuts, washers, cotter pins and all terminal connections are in place and tight.

STEP 6
At all inspections operate the circuit switcher by hand to see that the mechanism works smoothly and correctly before operating it with power.

This checklist does not represent an exhaustive survey of maintenance steps necessary to ensure safe operation of the equipment. Particular applications may require further procedures. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens sales office.

WARNING

The use of unauthorized parts in the repair of the equipment could result in dangerous conditions which could cause death, serious injury, or equipment damage.

To prevent:

Follow all safety instructions contained herein.

Periodic Inspection Procedure

Periodic Inspections should be made at monthly and semi-annual intervals to assure continued satisfactory performance of the switcher. At the end of this section is a Periodic Inspection Checklist.

3-Year And 6-Year Inspection Procedure

An inspection should be made every 3 years and used as an additional guideline in determining the necessity of maintenance. This inspection includes checks which may be made externally. At the end of this section is a copy of a 3-Year and a 6-Year Inspection Checklist which identifies those items which can be checked without removing the gas from the switcher. By making the checks identified on the list, it can be verified whether or not the switcher is satisfactory for continued service without performing a Major Inspection.

Major Inspection

Major inspection is that which requires removal of the gas from the switcher to determine the condition of the interrupters, contacts, and other internal components. A Major Inspection should be performed when:

1. The accumulated interruptions equal 20-20kA faults.
2. After completing a year of daily capacitor switching duty.

This schedule should be modified based on the information obtained from the 3-Year and 6-Year Inspections, and on accumulated experience of switcher characteristics and duty.

Periodic Inspection Checklist

Station _____ Bus or Line _____

Date of Inspection _____

1. Nameplate Data

   1.1 Switcher Type _____ Amp. _____

   Serial-S.O. _____ I.B. PB-3948

   1.2 Mechanism Type SE-4A I.B. PB-3948

   Control Diagram _____ Control Voltage _____

   Motor and Heater Voltage _____

Monthly Checks

2. General Condition of Switcher: _____

3. Operation Counter Reading _____

4. SF_6 Gas Pressure

   SF_6 Pressure _____ psig

   Ambient Temperature _____ °F

6 Month Checks

(In Addition to Monthly Checks)

5. Check all labels and nameplates attached to the switcher to be sure that they are securely fastened in place and are readable. _____

Annual Check

(In Addition to Monthly Checks and 6 Month Check)

6. Time to close the switcher (6 seconds maximum) _____

3-Year Inspection Checklist

Station _____ Bus or Line _____

Date of Inspection _____

1 Nameplate Data

1.1 Switcher Type _____ Amp. _____

Serial-S.O _____ I.B. PB-3948

1.2 Mechanism Type SE-4A I.B. PB-3948

Control Diagram _____ Control Voltage _____

Motor and Heater Voltage _____

WARNING

Hazardous voltage.
Death or serious injury due to electrical shock could result.

To prevent:

Prior to performing inspection of the switcher, trip the switcher and open adjacent switcher disconnect switches, solidly ground all terminals to remove residual electrical charge and open all A-C and D-C switches.

2. General Condition of Switcher: _____

3. Switcher Hold Down Bolts Tight _____

4. Grounding Connections Tight (Left) _____

(Right) _____

Inspection

CAUTION

Improper operation of switcher may result in equipment damage.

To prevent:

Do not operate the switcher until all tests and inspections are done.

5 Spring Mechanism

5.1 General Checks:

5.1.1 Condition of mechanism. Corrosion of hardware. Loose hardware. _____

5.1 2 Lubricate in accordance with "Lubrication" in MAINTENANCE AND ADJUSTMENT Section, page 33. _____

5.1.3 Connections on terminal blocks, switches, and relays; tight and no corrosion. _____

5.1.4 Heater(s) operating properly. _____

5.1.5 Wiring: deteriorated or damaged insulation. _____

5.2 Minimum operating voltage (See Mechanism nameplate for voltage range).

Trip _____ Vd-c

6. Switcher Checks

6.1 Check open position of pole units against the gauge position.

(Pole 1) _____

(Pole 2) _____

(Pole 3) _____

7. Contact resistance terminal-to-terminal measured with ductor or equivalent 100 amp d-c source. (150 micro-ohms maximum for used contacts.) If maximum micro-ohms values are greater than those listed a major inspection is required.

(Pole 1) _____ micro-ohms

(Pole 2) _____ micro-ohms

(Pole 3) _____ micro-ohms

8. SF_6 Pressure Switches (if provided)

Temperature Compensated Sw.

Alarm Switch #1 Closes _____ PSIG Alarm at _____ °F

Cutout Switch #2 Opens _____ PSIG Cutout at _____ °F

Switch Differential is 2 to 8 PSIG.

9. Operation Counter Reading as Left _____

10. SF_6 Gas Pressure as Left

SF_6 Pressure _____ psig

Ambient Temperature _____ °F

6-Year Inspection Checklist

Station _____ Bus or Line _____

Date of Inspection _____

1. Nameplate Data

1.1 Switcher Type _____ Amp. _____

Serial-S.O. _____ I.B. PB-3948

1.2 Mechanism Type SE-4A I.B. PB-3948

Control Diagram _____ Control Voltage _____

Motor Voltage _____ Heater Voltage _____

WARNING

Hazardous voltage.
Death or serious injury due to electrical shock could result.

To prevent:

Prior to performing inspection of the switcher, trip the switcher and open adjacent switcher disconnect switches, solidly ground all terminals to remove residual electrical charge and open all A-C and D-C switches.

2. General Condition of Switcher: _____

3. Switcher Hold Down Bolts Tight _____

4. Grounding Connections Tight (Left) _____

(Right) _____

Inspection

CAUTION

Improper operation of switcher may result in equipment damage.

To prevent:

Do not operate the switcher until all tests and inspections are done.

5. Spring Mechanism

   5.1 Wire Check:

      5.1.1 Inspect wiring for damaged or deteriorated insulation. _____

      5.1.2 Inspect wiring for possible grounds or short circuit. _____

      5.1.3 Connections on terminal blocks, switches, and relays; tight and no corrosion. _____

      5.1.4 Heaters; electrical continuity and terminals not shorted to ground. _____

   5.2 Lubricate in accordance with "Lubrication" in MAINTENANCE AND ADJUSTMENT section, page 33. _____

   5.3 Mechanism mounting bolts tight (160 ft.-lb.). _____ ft.-lb.

6. Switcher Checks

   6.1 Install manual operating device and check the mechanism linkage to make sure all connecting rods operate freely and without interference during a manual operation.

   Interrupter 1 _____

   Interrupter 2 _____

   Interrupter 3 _____

   Mechanism _____

   6.2 Check open position of pole units against the gauge position.

   (Pole 1) _____

   (Pole 2) _____

   (Pole 3) _____

   6.3 Check the length of the opening spring with the switcher in the open position. _____ in.

   6.4 Final check for loose hardware. Remove manual operating device. Reconnect the power line connections. (See "Line Connections" in INSTALLATION Section, page 11. _____

7. Mechanism Operational Checks.

8. Minimum operating voltage. (See mechanism nameplate for voltage range.) Trip _____ Vd-c

9. Timing Tests: (These tests are to be made at normal operating voltage and SF_6 fill pressure in the interrupters.

   9.1 Trip coil energized until contacts part. (3.0 to 4.5 cycles) _____ milliseconds

   9.2 Opening velocity measured (5.3-6.1 m/sec). (See Figure 21.) _____ m/sec

   9.3 Close command until contacts touch. (6 seconds max.) Close velocity 3.5-4.3 m/sec. (See Figure 22.) _____ seconds

10. Contact resistance terminal to terminal measured with ductor or equivalent 100 amp d-c source (150 micro-ohms max. for used contacts. If maximum micro-ohm values are greater than those listed a major inspection is required.)
    (Pole 1) _____ micro-ohms
    (Pole 2) _____ micro-ohms
    (Pole 3) _____ micro-ohms

11. SF_6 Pressure Switches (if provided)

    Temperature Compensated Sw.

    Alarm Switch #1 Closes _____ PSIG Alarm at _____ °F

    Cutout Switch #2 Opens_____ PSIG Cutout at _____ °F

    Switch Differential is 2 to 8 psig

12. Operation Counter Reading as Left _____

13. SF_6 Gas Pressure as Left
    SF_6 Pressure _____ psig
    Ambient Temperature _____ °F

Major Inspection Checklist

Station _____ Bus or Line _____

Date of Major Inspection _____

Installation Date _____

1. Nameplate Data

1.1 Switcher Type _____ Amp. _____

Serial-S.O. _____ I.B. PB-3948

1.2 Mechanism Type SE-4A I.B. PB-3948

Control Diagram _____ Control Voltage _____

Motor and Heater Voltage _____

WARNING

Hazardous voltage.
Death or serious injury due to electrical shock could result.

To prevent:

Prior to performing inspection of the switcher, trip the switcher and open adjacent switcher disconnect switches, solidly ground all terminals to remove residual electrical charge and open all A-C and D-C switches.

2. General Condition of Switcher: _____

3. Switcher Hold Down Bolts Tight _____

4. Grounding Connections Tight (Left) _____

(Right) _____

Inspection

CAUTION

Improper operation of switcher may result in equipment damage.

To prevent:

Do not operate the switcher until all tests and inspections are done.

5. Spring Mechanism

   5.1 Wire Check:

      5.1.1 Inspect wiring for damaged or deteriorated insulation. _____

      5.1.2 Inspect wiring for possible grounds or short circuit. _____

      5.1.3 Connections on terminal blocks, switches, and relays; tight and no corrosion. _____

      5.1.4 Heaters; electrical continuity and terminals not shorted to ground. _____

   5.2 Mechanism mounting bolts tight (160 ft.-lb.). _____ ft.-lb.

6. Internal Inspection:

   6.1 Remove SF_6 gas from pole units as per page 39, "Opening the Pole Units."

WARNING

Hazardous arc products.
Death or serious injury could result.

To prevent:

Refer to PART REPLACEMENT Section for precautions to be observed when handling arced SF_6 gas.

   6.2 See PART REPLACEMENT Section beginning with "Opening the Pole Units".

7. Mechanism Operational Checks.

8. Minimum operating voltage. (See mechanism nameplate for voltage range). Close _____ Vd-c

9. Timing Tests: (These tests are to be made at normal operating voltage and SF_6 fill pressure in the interrupters.)

   9.1 Trip coil energized until contacts part. (3.0 to 4.5 cycles) _____ milliseconds

   9.2 Opening velocity measured 5.3-6.1 m/sec). (See Figure 21.) _____ m/sec

   9.3 Close coil energized until contacts touch (6 seconds max.). Close velocity 3.5 to 4.3 m/sec. (See Figure 22.) _____ milliseconds

10. Contact resistance terminal to terminal measured with ductor or equivalent 100 amp d-c source (150 micro-ohms maximum for used contacts.)

    (Pole 1) _____ micro-ohms

    (Pole 2) _____ micro-ohms

    (Pole 3) _____ micro-ohms

11. SF_6 Pressure Switches (if provided)

    Temperature-Compensated Sw.

    Alarm Switch #1 Close_____ PSIG Alarm at _____ °F

    Cutout Switch #2 Opens _____ PSIG Cutout at _____ °F

    Switch Differential is 2 to 8 psig

12. Operation Counter Reading as Left _____

13. SF_6 Gas Pressure as Left

    SF_6 Pressure _____ psig

    Ambient Temperature _____ °F

Maintenance and Adjustment

General

This instruction book section describes procedures to be followed when adjustments are necessary as determined by the installation, periodic, 3-year, 6-year, or major inspections. The step-by-step instructions given should be followed carefully to assure proper equipment operation.

Thorough periodic inspection is important to satisfactory operation. Required frequency of inspection and maintenance depends on installation site, weather and atmospheric conditions, experience of operating personnel and special operation requirements. Because of this, a well planned and effective maintenance program depends largely on experience and practice.

WARNING

Failure to properly maintain the equipment could result in death, serious injury, product failure, and prevent successful functioning of connected apparatus.

To prevent:

The instructions contained herein should be carefully reviewed, understood, and followed. The following maintenance procedures should be performed regularly:

STEP 1
Be sure that the circuit switcher and its mechanism are disconnected from all electric power, both high voltage and control voltage, before it is inspected or repaired.

STEP 2
After the circuit switcher has been disconnected from power lines, attach grounding leads properly before touching any of the circuit switcher parts.

STEP 3
Clean and lubricate the mechanism.

STEP 4
Be sure the circuit switcher is well grounded.

STEP 5
See that bolts, nuts, washers, cotter pins and all terminal connections are in place and tight.

STEP 6
Manually close and open the circuit switcher to see that the mechanism works smoothly and correctly before operating it with power.

STEP 7
Check the open position of each pole unit against the gauge position in the pole unit crank housing.

This checklist does not represent an exhaustive survey of maintenance steps necessary to ensure safe operation of the equipment. Particular applications may require further procedures. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens sales office.

WARNING

The use of unauthorized parts in the repair of the equipment could result in dangerous conditions which could cause death, serious injury, or equipment damage.

To prevent:

Follow all safety instructions contained herein.

Maintenance and Adjustment

DANGER

Hazardous voltage and mechanisms. Death or serious injury from electrical shock, burns and entanglement in rapidly moving parts will result.

To prevent:

1. Do not service or touch until you have de-energized high voltage, grounded all terminals and turned off control voltage.
2. Never trip or close the circuit switcher while working on it, since the parts move rapidly and can cause injury.
3. Discharge the switcher's energy storage springs before performing maintenance or inspection.
4. The switcher and its mechanism must be disconnected from all electrical power before performing maintenance or inspection.
5. Never manually operate the switcher while it is energized or control power is connected.
6. Remove the manual operator before operating the switcher.
7. Only qualified personnel should work on or around this equipment after becoming thoroughly familiar with all warnings, safety notices, instructions and maintenance procedures contained herein. The successful and safe operation of this equipment is dependent upon proper handling, installation, operation and maintenance.

Maintenance Tools, Materials and Equipment

The following tools, material, and equipment are recommended to perform maintenance, adjustment and lubrication on the breaker:

PI - Periodic Inspection
3I - 3 Year Inspection
6I - 6 Year Inspection
MI - Major Inspection

(PI) (3I) (6I) (MI) 1. Wrenches - Standard sizes of open end or box type and allen wrenches. 1/4", 3/8" and 1/2" drive ratchets, ratchet extensions and sockets. Also a metric set of sockets, 13mm through 24mm.

(PI) (3I) (6I) (MI) 2. Thermometer.

(PI) (3I) (6I) (MI) 3. Screwdrivers - 1/8", 1/4" and 3/8" blade.

(3I) (6I) (MI) 4. Twelve foot "A" frame stepladder.

(3I) (6I) (MI) 5. Ductor or equivalent 100 ampere DC source with a micro-ohmmeter.

(3I) (6I) (MI) 6. Feeler gauges and 6" and 12" measuring rules.

(3I) (6I) (MI) 7. 6" calipers capable of reading to .001 in.

(MI) 8. Leak-tec for leak testing.

(MI) 9. 1 1/2 ton crane with a working height of 30 feet and 2 rope slings (for removing the pole units).

(MI) 10. 0-50 ft.-lb. torque wrench - 3/8" drive, (Snap-on Model TE 50 FFU-A Recommended) and 0-250 ft.-lb. torque wrench.

(6I) (MI) 11. Timing equipment and mounting hardware. (See "Baseline Data" in INSTALLATION Section.)

(MI) 12. Corrosive resistant conductive joint compound and wire brush.

(6I) (MI) 13. Capacitance measuring device - Doble or equivalent high voltage type.

(MI) 14. Slip-joint pliers.

(MI) 15. Lineman's pliers with side cutters.

(MI) 16. Small vacuum pump (Welsh Duo-Seal Model 1400B (0.9CFM) or equivalent) with vacuum gauge measuring down to at least 1 mm of mercury.

(MI) 17. Hammer

(MI) 18. 1/16" diameter pin punch.

(MI) 19. Alcohol and clean, lint-free cloths.

(MI) 20. Dust mask and gloves.

(MI) 21. SF_6 gas (60 lbs.)

(MI) 22. Spanner wrenches.

(MI) 23. 1/4" drive socket with 6mm allen wrench attachment.

(MI) 24. Service hose and adapter for SF_6 filling. (1)

(MI) 25. Manual operating device. (1)

(MI) 26. Terminal o-rings. (3) (2)

(MI) 27. Crank housing o-rings. (3) (2)

(MI) 28. Gauge pins. (1)

(MI) 29. Loctite-medium strength 242. (2)(3)

(MI) 30. Manual charging tools. (2)

(MI) 31. Molykote G-N. (1)

(MI) 32. Shell 8420 Vaseline. (1)

(MI) 33. Beacon #325 grease. (2)

(MI) 34. Molecular sieve. (2)

(MI) 35. Silicon lubricant. (1)

(1) Available from Siemens as Installation Tool Kit, Part No. 72-165-226-801, and included with each order.

(2) Available from Siemens as Major Inspection Kit, Part No. 72-165-226-802.

(3) Shelf life 1 year.

Manual Operating Device

The switcher may be "slow opened" and "slow closed" for adjustment and alignment inspection using the manual operating device. Application of the manual operating device is shown in Figure 14.

To open a closed and latched switcher using the manual operating device, the trip latch must be disengaged. First take the load off the latch by pulling the mechanism slightly into the overtravel position. Then rotate the release latch and hold it in the released position while the mechanism is let out until the latch roll passes the trip latch.

⚠ DANGER

Hazardous voltage and mechanism.

Death or serious injury from electrical shock, burns or entanglement in rapidly moving parts will result.

To prevent:

1. Never slow operate the switcher while it is energized or control power is connected.
2. Remove the maintenance closing device before operating the switcher.
3. Keep hands free of mechanism while operator is in motion.

Maintenance and Adjustment

Spring Discharge

Normally, the opening and closing springs can be discharged by simply opening or closing the switcher with the electrical power disconnected from the gearmotor. This procedure will, however, leave the closing spring partially charged because the momentum of the rotating mass will cause the main shaft to rotate beyond its bottom center position. To fully discharge the closing spring, the manual charging tool (part of a maintenance tool and materials kit) can be used.

Insert the manual charging tool through the frame as shown in Figure 23 to engage the drive pin on the gearmotor auxiliary shaft. Use a ratchet wrench with the appropriate socket to drive the charging tool. If the drive pawl is not already separated from the ratchet wheel tooth, turn the tool in the direction which will retract the pawl from the tooth. Use a screwdriver to lift the drive pawl so it will clear the crest of the tooth as the charging tool is turned further. As soon as the drive pawl passes the crest of the tooth, remove the screwdriver. Continue to turn the tool until the drive pawl contacts the drive surface of the next tooth and picks up the spring load to free the holding pawl. Use a screwdriver to retract the holding pawl, and be sure both the holding pawl and the screwdriver are clear of the ratchet wheel tooth crests. Continue turning the charging tool in the same direction as previously until the eccentric shaft goes over center; when this happens, the charging tool and socket will spin free of the wrench ratchet as the ratchet wheel rotates through one tooth position.

Repeat the above process, tooth by tooth, until the spring crank reaches the bottom center position.

Operator Eccentric Drive

The length of the eccentric drive rod assembly (Figure 9, item [10]) is adjustable. The offset of the eccentric shaft causes the drive pawl to oscillate through an arc somewhat larger than the arc occupied by a ratchet wheel tooth. This allows for a gap between the drive pawl and the ratchet tooth when the drive pawl is at the top of its stroke; and between the holding pawl and its ratchet tooth when the drive pawl is at the bottom of its stroke. The length of the drive rod should be set to obtain approximately equal gaps (about .035 inches) at both locations.

To check the adjustment, discharge the closing spring and use the manual charging tool to turn the eccentric shaft through a full turn. Observe the gaps when the drive pawl is at its extreme positions.

To adjust the length of the drive rod assembly, first loosen the two locknuts at either end of the rod. The upper nut is right hand and the lower left hand. Turn the rod by means of the hex at its middle. (Normally, only a small fraction of a turn will be needed.) Check the adjustment, and repeat until a satisfactory result is obtained.

When retightening the locknuts, hold the adjacent part (rod end or clevis) with a wrench to prevent twisting of the assembly which would result in undesirable binding of the mechanism.

Operator Release Latch and Solenoid

To check the adjustment of the trip release latch, it is necessary to put the output lever in the switcher closed position. This can be done by using the manual operating device to close the switcher, pulling it into a slight overtravel position to remove the load from the trip latch, and holding in this position. Alternatively, the manual operating device can be used to partially close the switcher to allow insertion of the spring blocking tool (part of the installation tools), then the manual operating device can be removed, and the pin connecting the mechanism output lever to the vertical pullrod can be withdrawn to allow free movement of the lever.

To check the adjustment of the release latch, turn the latch to the release position, and pry the trip latch (against the return spring force) just into the notch in the release latch. Let the release latch return (by its spring) to rest against the face of the trip latch. In this position, the distance between the stop screw [101] and the release latch lever, measured parallel to the stop screw at the closest part of the lever, should be 0.120 to 0.150 inches.

To adjust the position of the stop screw, set the latches as described for the adjustment check. Turn the screw out to contact the release latch lever, then turn the screw in three and one-half turns. Tighten the locknut at the base of the stop screw.

To check the adjustment of the solenoid position, put the latches in the position described for the release latch

adjustment check. With the solenoid armature held against its pole face, and the actuating pin solid against the armature, there should be no more than 0.01 inches between the trip pin and the release latch lever.

Operator Trip Latch

The trip latch is made of hardened steel. The face of the latch which contacts the latch roll may be polished with fine emery cloth if it becomes dirty. Do not attempt to grind the surface or change the profile. Apply a thin film of Beacon #325 (Siemens W-962-030) grease to the latch to inhibit rust. This material was selected because it is free flowing at all anticipated temperatures, non-hardening and self-healing (does not completely wipe off in one operation). The latching surfaces should be examined at every inspection to verify their condition.

Operator Holding Pawl Stop

The holding pawl, Figure 9, item [17], prevents clockwise rotation of the ratchet wheel. For the pawl to reliably perform this function, its rotation away from the ratchet wheel must be limited. To check the clearance between the pawl and the ratchet wheel, use the manual charging tool to advance the ratchet wheel to a position at which the pawl contacts the crest of a ratchet wheel tooth. Pry the pawl away from the wheel until it contacts its stop pin (located inside the pawl return spring). Measure the gap between pawl and tooth with a feeler gauge. The gap should be .010 to .020 inches.

To adjust the holding pawl stop position, first loosen the set screw [82a]. This set screw bears against a nylon pin [83a] which protects the thread of the adjusting screw [112] from damage. Turn the adjusting screw to obtain the specified clearance gap, then retighten the set screw.

Operator Trouble Shooting

The following trouble shooting checklist is intended to provide typical actions to aid in isolating and correcting mechanism problems. This list is not to be considered as including all reasonable trouble shooting steps that might be required to resolve a particular problem.

A. IF THE GEARMOTOR FAILS TO RUN

1. Check to see that the correct control voltage is available.
2. Check motor circuit breaker.

B. IF THE GEARMOTOR RUNS BUT FAILS TO CLOSE THE SWITCHER

1. If the eccentric drive oscillates, but does not advance the ratchet wheel, check the adjustment of the drive rod length.
2. If the eccentric drive does not oscillate, check the connection between the motor and the eccentric shaft.

C. IF THE MECHANISM CLOSES THE SWITCHER BUT FAILS TO KEEP IT CLOSED

1. Check the minimum voltage of the cutoff relay and increase the supply voltage if it is too low.
2. Check the adjustment of the trip release latch stop screw.
3. Check the condition of the return springs on the trip latch and the trip release latch.
4. Check to ensure that the trip coil is not being inadvertently energized.

D. IF THE MECHANISM FAILS TO TRIP

1. Check the voltage at the trip coil terminals.
2. Check the terminals and contacts on the switcher auxiliary switch to be sure that they are making good contact.
3. Check whether the mechanism can be tripped manually by prying the release latch lever to the trip position with a screwdriver.

Switcher Linkage

All pullrods are equipped with right-hand threads on one end and left-hand threads on the other. This allows the effective length of each rod to be adjusted by simply turning the rod, once the lock nuts at each rod fitting are loosened.

The correct open position for each pole unit is determined by aligning the operating levers with a gauge hole in the pole housing crank housing. A gauge pin (72-165-225-001) is included in the installation tools kit. Insert the pin through the pole unit operating levers and, if the pole unit position is correct, the pin will pass into the gauge hole in the housing (see Figure 19).

The setting of the open position is not extremely critical, and will tend to change, particularly at pole three, with ambient temperature fluctuations. If the gauge pin misses the crank housing hole by less than 1/4 the pin diameter, adjustment is not necessary.

If adjustment is needed, loosen the jam nuts at the ends of the pullrod(s) between the pole unit to be adjusted and the bellcrank. Observe the "hand" of the nut, and turn it in the proper direction to loosen.

Note that the position of pole 1 is affected only by the length of the pullrod between the bellcrank and pole 1. The position of pole 2 is affected only by the length of the pullrod between the bellcrank and pole 2. The position of pole 3 is affected by the position of pole 2 and the length of the pullrod between pole 2 and pole 3. A pullrod rotation of a quarter turn or less should be all that is required to correct a maladjustment.

If all pole unit open positions appear to be off by the same amount, the pullrod between the operator and the bellcrank should be adjusted. The adjustment procedure is the same as for the inter-pole pullrods.

When the adjustment has been completed and the pole unit open positions checked, tighten the jam nuts against the pullrod fittings. Use a wrench to hold the adjacent fitting while tightening the nut to prevent undue loading of the linkage connecting pins.

There is no adjustment for the closed position of the pole units. The closed position is controlled by the operator, and is not adjustable.

Auxiliary Switch

Auxiliary switches for the DC control circuits are mounted on the control panel in the cabinet. Spare contacts are wired to terminal blocks.

These switches serve as interlocking devices, to prevent energizing the closing motor if the switcher is already closed, or to prevent the trip solenoids from being energized when the switcher is open.

The auxiliary switch is mechanically linked to the operator output lever. Every closing or opening motion of the operator results in a rotation of a shaft which turns the rotors of the switch assembly. Figure 24 shows a sixteen-switch unit.

Each rotor contact can be set to function as an "a" or "b" contact, according to functional requirements. Adjustment can also be made at intermediate steps of 15 degrees.

To adjust the making or breaking point of any switch, refer to Figure 24, use needle nose pliers, and proceed as follows:

Press the rotor contact sideways against the rotor contact spring to disengage the driving hub pins from the rotor contact. Move the rotor contact to the desired position and release the pressure against the spring to allow the locking pin to engage at the new position.

Lubrication

The following lubricants are to be used as indicated:

Molykote (Siemens part number 00-337-271-095) is used for all switcher linkage pins, including the connection to the mechanism output lever, and for the tip of the mechanism shock absorber.

Beacon #325 (Siemens part number W-962-030) is used for mechanism pins, needle bearings and brass washer spacers.

The mechanism should be re-lubricated at least once every three years. If the switcher operates frequently, or is installed in a dusty or corrosive atmosphere, more frequent lubrication is recommended.

Lubrication amount is not critical. Lubricated surfaces should be evenly coated. Bearings should be filled to capacity. Excessive lubrication will not affect operation of the switcher mechanism or linkage.

Part Replacement

Ordering Replacement Parts

When ordering replacement parts for a Siemens Circuit Switcher, it is very important to give complete information. This information should include:

1. Switcher serial number (on switcher and operator nameplates).
2. Type of operator (on operator nameplate).
3. Type of switcher.
4. Rated amperes of switcher.
5. Rated voltage of switcher.
6. Description of part. (Use instruction book description or reference number if possible.)
7. Operator instruction book number (on switcher nameplate).
8. Number of pieces required.

While the operator can be identified by the serial number alone, all additional information that is given will help ascertain that the parts furnished are correct for the operator in question. Without the serial number, Siemens cannot be sure of the correct identity of the required parts.

If any doubt exists as to the instruction book reference number or the description, a dimensional sketch of the desired part will help to identify it.

Siemens recommends that a supply of repair parts be kept on hand so that emergency repairs can be made without waiting for shipment of parts from the factory.

Before removing any part to be replaced, observe its function and adjustment. This usually saves adjustment time during installation of the replacement part.

⚠ DANGER

Hazardous voltage and mechanisms. Death or serious injuries from electrical shock, burns and entanglement in rapidly moving parts will result from misuse.

To prevent:

1. This equipment should be installed, operated and maintained only by qualified persons thoroughly familiar with the equipment, INSTRUCTION MANUALS and drawings.
2. Do not trip or close the switcher unless you are clear of all moving parts.
3. Disconnect the switcher and its mechanism from all electrical power before performing maintenance or inspection. Grounding leads should be properly attached and the framework grounded.
4. Discharge the switcher's energy storage springs before performing maintenance or inspection.

General

Following the replacement of any part, adjustments affected by the replacement should be checked as indicated in the section "Maintenance and Adjustment". Before placing the circuit switcher in service, use the manual operating device to close and open the switcher. Check that the mechanism works properly and smoothly.

Remove the manual operating device and energize the operator gearmotor to close the switcher. Trip the switcher by means of the trip solenoid. Perform several close and open operations, and if all goes well, return the switcher to service.

Part Replacement

Trip Solenoid

Disconnect the solenoid leads from the terminal block. Remove the two nuts which hold the solenoid and its bracket to the operator frame. Withdraw the solenoid assembly. Take care not to loose the washers (if any) which serve as shims between the solenoid bracket and the operator frame mounting plate, or the push pin which is not connected to the rest of the assembly.

Make note of the orientation of the solenoid in its bracket. Separate the solenoid from the bracket and fasten the new solenoid in its place. Orient the solenoid the same as the original, and be sure the brass pin guide is captive between the solenoid and the bracket. Tighten the retaining nuts, place the push pin in the pin guide and check that the pin moves smoothly and freely as the solenoid armature is moved through its range of motion. If necessary, loosen the retaining nuts and reposition the solenoid in the bracket.

Place the washer shims on the mounting screws. Install the assembly on the operator frame and tighten the mounting screws. Cut the solenoid leads to the proper length and crimp on ring tongue terminals. Connect the leads to the terminal block.

Gearmotor

Disconnect the motor leads from the terminal block. The motor is bolted to the back side of the operator frame by three 0.25-20 socket head cap screws. The output shaft of the gearmotor is square, and fits into a square hole in the center of the eccentric shaft. Remove the mounting bolts taking care not to let the motor fall when the last bolt is removed.

Installation of the new motor requires that its shaft be aligned with the square hole in the eccentric shaft. Hold the motor in its mounting position, oriented correctly and with the auxiliary shaft located in its opening in the frame. Insert the manual charging tool through the frame and engage the drive pin on the motor auxiliary shaft. Turn the auxiliary shaft until the motor output shaft aligns with and engages the eccentric shaft hole. Insert the mounting bolts and torque them to 46 lb.-in.

Cut the motor leads to the proper length, crimp on terminals, and connect them to the terminal block. The leads may be connected to either polarity in a DC circuit.

Eccentric Shaft

The eccentric shaft (Figure 9, item [22]) is retained by a sleeve [15] which surrounds the shaft inside the operator frame side plates. A set screw threaded in the sleeve locates in a hole in the shaft circumference. Brass washers are used at either end of the sleeve to adjust the position of the eccentric shaft in the frame.

To remove the shaft, use the manual charging tool to turn the shaft and sleeve to a position which makes the set screw accessible. Turn the set screw out until the shaft is free of the sleeve. Next, remove the cotter pin from the inside of the pawl pivot pin [35] at the end of the drive rod assembly. Make note of the location of spacers and washers on the pivot pin, and then withdraw it. Rotate the pawl arms [9] to clear the drive rod clevis [10-3]. The eccentric shaft can then be pulled out, but be sure to note the location of spacers at the ends of the shaft sleeve, and hold onto the sleeve and spacers as the shaft is withdrawn from them.

Remove the cotter pin from the end of the offset portion of the eccentric shaft. Note spacer location on the shaft, and then press the shaft out of the rod end [10-2] bearing.

Wipe the sleeve and all the spacers with a clean cloth. Apply a film of grease, Beacon #325, to the spacer surfaces and to the sleeve ends. Fill the needle bearings in the frame and the rod end with the same grease.

To install a replacement shaft, insert the shaft through the first bearing, then through the spacers and sleeve in the same order as they had been previously installed. Locate the set screw in the hole in the shaft, but before tightening the set screw check the extension of the shaft beyond the frame surface. The main body of the shaft should extend approximately one eighth of an inch beyond the surface. Relocate the shaft spacers if necessary, then apply Loctite primer (W-946-020) and Loctite #242 (W-946-023) to the set screw and tighten.

Press the rod end of the drive rod assembly onto the eccentric shaft extension with the spacers located as on the original shaft. Align the clevis [10-3] with the pawl arms [9] and insert the pivot pin [35] through the washers, spacers and pawl [24] arranged in their original order.

Check alignment of the clevis and pawl arms to be sure there is no binding. The pawl should be approximately centered on the ratchet wheel. If necessary to improve alignment, redistribute the spacers. Insert the cotter pins in the shaft extension and the pivot pin, and bend their end to secure them in position.

Part Replacement

Eccentric Drive Rod

Removal and replacement of the drive rod [10] is described in relation to the removal and replacement of the eccentric shaft. (Refer to the previous section.) If a new rod assembly or a new component is installed, the rod length must be adjusted. Refer to the section of this instruction book "MAINTENANCE AND ADJUSTMENT".

Pawl Arms

To remove the pawl arms [9], begin by removing the pawl pivot pin [35] as described under "ECCENTRIC SHAFT". Next, unscrew the capscrew holding the retainer plate [12] to the center of the main shaft [5]. The splined collar [11] and the retainer can then be pulled off the end of the main shaft. Remove the outside pawl arm and spacers, noting the number and position of the spacers. A short splined sleeve [98] adjacent to the ratchet wheel [8] serves as the pivot for the outside pawl arm. Slide this sleeve off the shaft and move the ratchet wheel to the end of the shaft. Scribe a line on the shaft end and the face of the ratchet to mark the correct assembly position, then slide the wheel off the shaft to expose the inside pawl arm. Remove this pawl arm and spacers, again making note of the spacer positions.

Wipe the spacers clean with a cloth and inspect for damage or excessive wear. If not deformed or deeply scratched, the spacers can be greased with Beacon #325 and reused.

Wipe clean the exposed end of the splined sleeve [97] and the surface of the frame contacted by the spacers. Also clean the short section of splined sleeve [98] and the faces of the ratchet wheel where they contact the spacers. Apply a film of Beacon #325 to these surfaces, and to the faces of the new pawl arms.

Replace the components on the main shaft in the reverse order of disassembly. Tighten the capscrew which holds the retainer to the shaft. Check that the pawl arms rotate freely about the shaft, and that the alignment between the ratchet wheel and the drive rod clevis is satisfactory. If there is binding of the arms, a spacer should be removed from a position where there are two or more spacers. If necessary to improve ratchet wheel alignment with the drive rod, the spacers can be redistributed. Always leave at least one spacer between adjacent components which move relative to each other.

Finally, torque the retaining capscrew to 46 lb-in, and bend the locking tab [13] over one flat of the capscrew head.

Main Shaft

Removal of the main shaft (Figure 9, item [5] requires that the closing spring [77] be disconnected from the crank [4]. Begin by fully discharging the closing spring as described in the section titled "MAINTENANCE AND ADJUSTMENT".

With the crank at bottom center position, the locknut [50] on the spring rod [19] can be reached and loosened through the opening at the bottom of the frame. The thread at the top of the rod is right-hand and at the bottom is left-hand. Turn the rod completely out of the rod end [18] connected to the crank, and then stop turning. The lower end of the rod will remain connected to its rod end [20] if turning is stopped at this point.

Remove the pawl arms [9] and ratchet wheel [8] as described in the previous section. The crank [4] is held on the main shaft by a socket head setscrew. Remove this setscrew and pull the crank from the shaft. Also remove the brass spacers positioned between the crank and the frame. Pull the end of the main shaft from the frame until it reaches the edge of the cam [7]. Hold the cam through the frame openings to keep it from falling. Pull the shaft through the cam. Withdraw the cam from the frame, then finish pulling the shaft out of the frame. Remove the sleeves [6] and [97] from the frame.

All components should be wiped clean before reuse. If the parts have dirt embedded in their recesses, they should be washed out with denatured alcohol or other approved solvent. Also wipe clean the back of the frame in the area which contacts the shaft spacer. The cleaned parts should be coated with Beacon #325 before assembly. The main bearings should also be filled with Beacon #325. A heavy film of the grease, applied to the back of the frame where the shaft spacer will be located, will be helpful in temporarily holding the spacer in place during assembly.

To reassemble, first locate the prick punch mark on the edge of the cam at approximately the point of transition between the large concave arc and the hub. Also observe that the crank end of the shaft has a shallow hole which is centered on a shaft spline tooth. This tooth must engage the cam tooth indicated by the prick punch mark.

Hold the cam between the frame side plates and align the cam and the shaft. Slide the shaft into the cam and through the frame. Put the longer splined sleeve on the front of the shaft and slide it into the bearing. From the back of the frame, put the sleeve on the shaft and push it into the bearing. Push the front sleeve against the cam to force the cam and rear sleeve back as far as they will go. This will extend the rear sleeve beyond the back surface of the frame and provide a shoulder to locate the spacers there. Place the spacers over the rear sleeve and press them firmly against the greased surface of the frame. Apply Loctite #242 (W-946-023) to the crank arm set screw and turn the set screw part way into the crank arm, but not so far as to protrude into the spline teeth. From the back of the frame, push the crank against the spacers and maintain a force to clamp the spacers in this position while the rest of the assembly proceeds. Make the back end of the main shaft flush with the crank arm, and tighten the set screw in the crank arm.

Assemble the pawl arms and ratchet wheel as described in the section titled "PAWL ARMS". When assembly is complete, check the position of the cam by rotating the shaft until the crank arm is in the bottom center position. In this position, the tip of the cam should be visible in the upper opening of the frame about 15 degrees from the vertical through the main shaft. (If the cam position is off by one tooth, this angle will be differ by 9 degrees in either direction.)

To reconnect the spring rod to the crank rod end, the crank must be positioned clockwise from bottom center. Otherwise, when the rod is turned into the rod end, rotation of the ratchet wheel will be prevented by the pawls, and spring compression will begin immediately. Use screwdrivers to hold both pawls [17] and [24] clear of the ratchet teeth, and rotate the main shaft clockwise until stopped by the cam contacting the output lever cam follower. Release the pawls.

Pull the rod end down to meet the rod, and thread the rod into the rod end. Continue turning the rod into the rod end, and the main shaft will gradually rotate until the crank reaches the bottom center position. At this point, the spring should still be unloaded. Check whether this is so by reaching through the frame and into the spring rod opening to determine whether the top of the spring can still be moved by hand. Turn the rod into the rod end until the spring just begins to be compressed and cannot be moved in this way. From this point, turn the rod one-half turn more. Tighten the lock nut [50] to maintain this setting.

Output Lever

Removal of the output lever [14] requires that the lever be disconnected from the switcher vertical linkage. Proceed as outlined under the topic "MAINTENANCE AND ADJUSTMENT/RELEASE LATCH AND SOLENOID". Next, remove one of the cotter pins from the lever pivot pin [33]. Hold the lever while withdrawing the pivot pin.

Wipe the pin and lever clean, and re-lubricate the pin with Beacon #325 and the lever cam [14-13] with Molykote before reuse. Also pack the bearings in the frame with Beacon #325 before reassembling the lever to the frame.

Use a grease gun to lubricate the cam follower [14-5a] and [14-5b] and latch roll with Beacon #325. Also apply a light film of the lubricant to the surfaces of the cam follower and latch roll.

Lubricate the spherical bearing [14-12] and the connecting pin with Molykote.

Reassemble the lever to the frame in the reverse order of disassembly.

Trip Latches

To remove the trip latch [31], it must first be uncoupled from the cam [14-13] which holds the trip latches in the unlatched position. This is accomplished as described in "MAINTENANCE AND ADJUSTMENT/RELEASE LATCH AND SOLENOID". Then proceed as follows:

Reach through the opening in the frame and pull out the two hairpin cotters which retain the release latch [27]. Lift the end of the release latch torsion spring [107] away from the frame, and slowly pull the latch outward. When the far end of the latch clears its bearing, reach in and remove the spacer washers from that end of the latch shaft. Hold the front spacers in place to prevent them from slipping into the latch notch, and extract the latch. Remove the spacers, making a note of the number of spacers at each end of the latch. The release latch is finished with a hard chromium plating. Do not use an abrasive to clean the latch, as this could damage the surface.

Remove the capscrew and washer which retain the main latch pivot pin [26]. Unhook the end of the latch return spring [80] from the latch. Reach through the frame opening and hold the latch and any spacers to prevent them from falling, then pull the pin out of the frame. Remove the latch and spacers, and wipe them clean with a cloth. Examine the end face of the latch for any damage or wear and replace the latch if necessary. The tip of the latch is hardened, and may be polished with a fine emery cloth to remove any dirt buildup. Do not attempt to re-grind the latch face or change its curvature.

Clean and re-grease the spacers with Beacon #325 before reusing them. Also apply a film of the lubricant to the curved face of the latch and to the leading edge of the release latch notch.

Install the latches by reversing the removal process. Be sure that the spacers are distributed as in the original assembly. Operate the latches manually to be sure they work freely. Adjust the latch stop screw as described in the section of this instruction book titled "MAINTENANCE AND ADJUSTMENT/RELEASE LATCH AND SOLENOID".

Closing Spring and Carrier

To remove the closing spring [77] and the spring carrier [21], begin by removing the access panel in the side of the cabinet, and fully discharge the spring as described in the section "MAINTENANCE AND ADJUSTMENT/ SPRING DISCHARGE".

With the crank at bottom center position, the locknut [50] on the spring rod [19] can be reached and loosened through the opening at the bottom of the frame. The thread at the top of the rod is right-hand and at the bottom is left-hand. Turn the rod in the direction to screw it out of the end fittings. Hold the spring carrier to prevent it from falling when the rod is screwed out of the rod end. Make note of the position of the spacers at the spring carrier axle relative to the spring housing.

Turn the spring rod to unscrew it from the crank rod end. Withdraw the spring carrier, spring and rod assembly. (The assembly weighs in excess of seventy pounds.) Lift the spring off of the carrier. Remove the cotter pin from one end of the carrier axle rod [34] and slide the roller [25] and spacers off the axle. Make a note of the number and location of the spacers. Pull the axle through the carrier to disconnect the rod end from the carrier.

Before reassembling, clean and re-grease the axle, rollers, spacers and rod end bearing with Beacon #325. Assemble the carrier, and the carrier, spring and rod assembly to the frame, in the reverse order of their removal.

Reconnect the spring to the mechanism as described at the end of the section "PART REPLACEMENT/MAIN SHAFT"

Mechanism Linkage

To replace any part of the mechanism linkage (Figure 16) except the opening spring and the spring rod, it is not necessary to remove or adjust the spring. Begin by opening the switcher. Connect the manual operating device as shown in Figure 14, and partially close the switcher until the spring blocking tool (72-165-159-001) can be inserted as shown in Figure 15. Release the load on the manual operating device, and the opening spring load will be removed from the linkage.

The bellcrank and any of the pullrods, except the spring rod, can be removed by pulling the pins at each end of the rod assembly. Alternatively, if only the rod is to be replaced, this can be done by loosening the jam nuts at each rod end fitting, then turning the rod out of the fittings. After replacing the rod or rod assembly, the switcher open position must be adjusted as described in the section "MAINTENANCE AND ADJUSTMENT/ SWITCHER LINKAGE."

If the opening spring or the spring rod is to be replaced, the spring must be discharged. Open the switcher and loosen the two lock screws in the spring adjustment nut (refer to the detail on Figure 25). Unscrew the nut all the way. Remove the pin between the spring rod and the pole 3 operating levers. Remove the nut, the bearing plate and the spring from the spring rod. The spring rod can be removed by pulling the pin at its other end. Reassemble by reversing the disassembly steps.

Set the length of the opening spring to 18.5 inches by screwing in the spring adjusting nut. Check the open position of pole 3 and adjust if necessary. Trip timing curves should be taken to verify that the contact opening speeds are within specification limits. Then tighten the locking screws in the adjusting nut.

Part Replacement

Opening the Pole Units

Place the switcher in the open position before removing SF_6 in preparation for opening the pole units. If the switcher is equipped with an SF_6 density monitor, the SF_6 can be removed through the fill valve in the operator/control cabinet. If not equipped with a density monitor, or if only one pole unit is to be serviced, the SF_6 can be removed through the quick disconnect fitting at the base of the pole unit.

WARNING

Hazardous SF_6 gas by-products from arcing could result in serious injury.

To prevent:

1. Do not breathe gas containing these toxic products, especially within a few minutes after the covers have been removed or until the decomposition products are safely diluted with fresh air.
2. The absence of any detectable odor or nasal irritation should indicate safe working conditions.
3. Molecular sieves are incorporated in all SF_6 circuit switchers. This filter material is used to remove the expected toxic gases produced from arcing.
4. Caution should be observed to prevent the inhalation of fine metallic fluoride dust.
5. A dust mask should be worn while doing this work, and it is also advisable to avoid skin irritation by wearing gloves and keeping other parts of the body covered.
6. It is recommended that workmen exposed to arc powders wash carefully to remove the metal salts from their skin.

Evacuate the gas from the pole unit and then break vacuum with atmospheric air. Once the inside pressure equilibrates with the surroundings, the pole unit covers can be removed.

Rupture Disk Replacement

Each pole unit end cover contains a rupture disk to protect the pole unit from accidental high pressures which could cause the pole unit to burst.

To replace the rupture disk, remove the end cover from the pole unit. Unscrew the three bolts and remove the clamp plate, the gaskets and any remaining pieces of the rupture disk. Insert the new rupture disk and gaskets, oriented as shown in Figure 26. Replace the clamp ring and torque the retaining bolts to 10 lb-ft. Replace the end cover using a new o-ring coated with Shell #8420 (W-962-118). Torque the end cover bolts to 15 lb-ft.

Stationary Contact

The stationary contact is fastened to the upper terminal plate of the interrupter. Disconnect the power lines from the terminal pad and remove the eight bolts which hold the terminal plate to the flange of the porcelain insulator. Pull the terminal plate and attached stationary contact straight up and out of the porcelain insulator. Remove and dispose of the pouches of molecular sieve attached to the contact assembly.

Some wear of the stationary contact body is to be expected. However, if the contact is deeply scored or eroded, it should be replaced.

Refer to Figure 27. Unscrew the four machine screws [15] and remove the corona shield [2] from the assembly, taking care to retain the spacers [14]. Use a spanner wrench to unscrew the contact retainer [5] from the contact support tube [3]. This will expose the socket head shoulder bolt [13]. Remove the shoulder bolt, and pull the contact [4] and contact sleeve out of the transfer contact [7]. Examine the contact sleeve for wear, and replace it if necessary. Otherwise, remove the contact from the sleeve and replace it with a new contact, being sure to keep the spring washer [9] in place as shown. Tighten the contact securely.

Press the contact and sleeve assembly into the transfer contact. Apply Loctite 271 to the threads of the shoulder bolt and tighten it in the contact sleeve. Position the lock ring [8] on the end of the contact support tube and screw the contact retainer into the tube and tighten to flatten the lock ring.

Use new machine screws [15] treated with Loctite Primer and Loctite 271, and reassemble the corona shield and spacers to the contact tube.

Just before replacing the contact assembly in the porcelain insulator, remove the protective foil wrap from two pouches of molecular sieve (part number 23-150-241-001) and fasten them to the contact tube with the pin, washers and cotter pins. Limit exposure duration of the molecular sieve pouches to the atmosphere as this will tend to reduce their long term effectiveness in the pole unit.

Lubricate a new o-ring with Shell #8420 (W-962-118), position it on the end face of the porcelain insulator, and lower the contact assembly straight down into the porcelain. Be sure that the o-ring is captured in the terminal plate o-ring groove. The two bolts marked "*" in Figure 27 should be screwed in first, because they have tight clearances and serve to locate the contact assembly. Then the remaining bolts should be installed and torqued to 40 lb-ft.

Pole Unit Removal

If pole unit inspection or part replacement more extensive than discussed in the previous sections is to be undertaken, the pole unit must be removed from the base. Place the switcher in the open position, and remove the SF_6 from the pole unit as described in the section "PART REPLACEMENT/OPENING THE POLE UNIT.'

Apply lifting slings in a choke hitch around the pole unit porcelain near the top of the unit (see Figure 16c). Prepare to lift the pole unit with a crane. Remove the pin connecting the pole unit operating levers to the base assembly pullrods as described in the section "PART REPLACEMENT/MECHANISM LINKAGE." Remove the four bolts which fasten the pole unit to the base assembly channels, and lift the pole unit free of the base.

Lower the pole unit, and lay it horizontally on timbers at the top and bottom flanges of the pole unit.

Shaft/Seal Assembly

Begin by removing the pole unit operating levers (Figure 28). Straighten the bent locking clip [31] and remove the capscrew [30]. Then pull the levers [25], spacers [26] [27] [28], and washers [29] from the shaft [3].

Unbolt the pole unit mounting adapter plate from underneath the top flange of the crank housing [2]. Remove the bottom cover from the pole unit to gain access to the pinned joint between the inside lever and the connected links. The pin is held by a spring safety clip (refer to Figure 29) at either end. Turn one clip so the outside tongue faces outward. Lift the tongue over the end of the pin and push the clip out of the pin groove. Then remove the pin to separate the lever and the links.

Separate the crank housing from the support insulator Remove retaining ring [5], thrust washer [6] and washer [7]. Reach inside the crank housing and hold the lever [4] while pulling out the shaft [3]. Remove the lever and spacer [11] from the crank housing.

Remove the bearing [9] and seals [12] one at a time. These items are pressed into the housing and an inside puller (for example, Snap-On Tools CG250HL) or similar device is needed for this task. Discard the bearing and seals, but save the spacers [13]

Pack the replacement bearings with Beacon #325 grease. Use an arbor to press the seals into the housing one at a time. Be sure to orient the seals as shown in the detail of Figure 28. Place a spacer [13] between each seal, and pack the spacer area with Beacon #325. Press a new bearing into the housing flush with the surface of the counterbore.

Insert the shaft into the opening and through the hole in the lever [4]. Position the spacer [11] and push the shaft into it. Rotate the shaft by hand to align the square part of the shaft with the square hole in the lever, and push the shaft all the way in. Assemble the washers [7] and [8], the thrust washer [6], and the retaining ring [5].

Bolt the crank housing to the support insulator. Pin the lever to the operating links, and secure with the spring safety clip (Figure 29). See that the lever [4] and attached links are in the interrupter open position (nearly flush with the end of the crank housing).

Assemble the operating levers and related items as indicated in Figure 28. Orient the levers on the square shaft in the open position as indicated by the gauge hole in the crank housing. Tighten capscrew [30] and bend one corner of the locking clip [31] over a flat of the capscrew.

Bolt the adapter plate to the support insulator flange. Lubricate a new o-ring with Shell #8420 (W-962-118). Clean the o-ring groove in the bottom of the crank housing and the mating face of the end cover. Place the o-ring in the housing groove and bolt the end cover in place.

Part Replacement

Moving Contact

Place the pole unit in a horizontal position on timbers at both flanges of the support (lower) insulator, with the interrupter overhanging. Block the support insulator to prevent rotation.

Position two lifting slings at each end of the interrupter porcelain, and support the weight of the interrupter from the crane. Remove the nuts on the bolts fastening the interrupter to the support insulator. Two bolts on opposite sides of the interrupter are captive, and serve to align the assembly. Separate the interrupter from the support insulator until the insulated operating rod clears the support insulator. Support the operating rod by hand as it comes free of the support insulator to prevent damage to the rod or attached parts.

Lay the interrupter down on timbers and block to prevent rotation. The operating rod is connected to the moving contact tube by means of a special union nut. A setscrew in the nut prevents the nut from loosening in operation. Remove the setscrew and use spanner wrenches to unscrew the nut from the rod.

With the interrupter separated from the support insulator, the lower terminal plate is held to the porcelain insulator flange by two bolts. Remove these bolts and withdraw the moving contact assembly, taking care to avoid striking the inside of the porcelain with the blast cylinder.

Remove the machine screws (Figure 30, item [9]) which hold the blast cylinder to the spider [4]. Lower the blast cylinder to the terminal plate. Using two spanner wrenches, unscrew the contact tube [5] from the contact fingers [3], then unscrew the contact fingers from the spider. If the nozzle requires replacement, an assembled nozzle and spider should be ordered from the factory.

Withdraw the contact tube through the terminal plate. Separate the contact tube from the vent rod [11]. Examine the contact tube surface for wear. If less than 50% of the silver plating remains in the area of the transfer contacts, the tube should be replaced.

Assemble a new set of contact fingers to the lock ring [7] and spider. Then assemble the contact tube and lock ring [8] to the contact fingers. Tighten the assembly to flatten the lock rings.

Examine the transfer contacts [12] for wear or damage. If replacement is necessary, find the end of each contact strip and lift it out of the retaining slot with a finger nail or small screw driver. With the replacement contact strip, form a loop just small enough to fit inside the transfer contact housing. Insert the loop to the contact slot, and allow the loop to spring into the slot.

Apply a thin film of Beacon #325 grease to the surface of the contact tube. Carefully insert the contact tube through the transfer contacts to avoid dislodging the contact strips. Push the moving contact assembly into the contact support tube until the end of the contact tube is visible in the openings in the support tube wall.

Apply Loctite 242 to the threads of the vent rod, and screw the vent rod into the contact tube. Tighten this connection with spanner wrenches at the contact end of the contact rod and at the end of the extension rod [13] under the special union nut [14].

Fasten the blast cylinder [6] to the spider with new machine screws [9]. Use Loctite 242 on the screw threads. Bolt the completed moving contact assembly to the interrupter porcelain insulator. Connect the insulated operating rod to the union nut [14] and tighten with spanner wrenches. Apply Loctite 242 to the threads of the union nut setscrew and tighten to prevent the nut from rotating. Support the end of the operating rod to prevent damage to the rod or connected parts.

Assembly of the interrupter to the support insulator requires that the links attached to the end of the operating rod be threaded through the rod guide at the top of the crank housing. This task can be simplified by passing a string or flexible wire from the crank housing through the support insulator and tying the string to the free end of the links.

Wipe the operating rod with denatured alcohol to remove any dirt or arc products. Guide the interrupter and operating rod into place and bolt the interrupter to the support insulator. Install the pin between the crank lever and the operating rod connecting links and secure with the spring safety clip (see Figure 29).

Clean the o-ring groove in the bottom of the crank housing and the mating face of the end cover. Place the o-ring in the housing groove and bolt the end cover in place. Replace the molecular sieve pouches in the interrupter as described in the section "PART REPLACEMENT/ STATIONARY CONTACT".

Illustrations

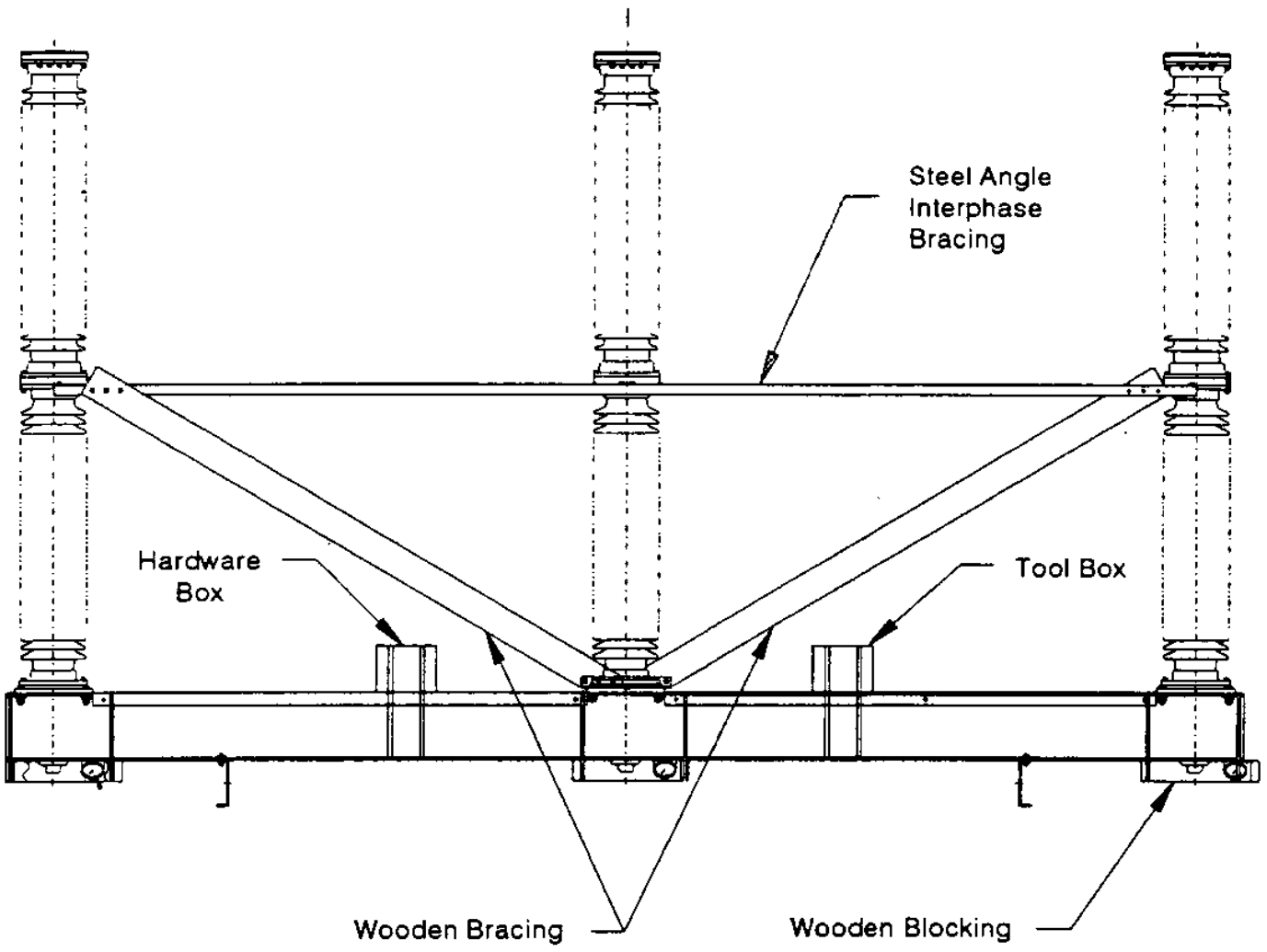


Figure 1 -- 3-Pole Shipping Assembly **72-265-100-413**

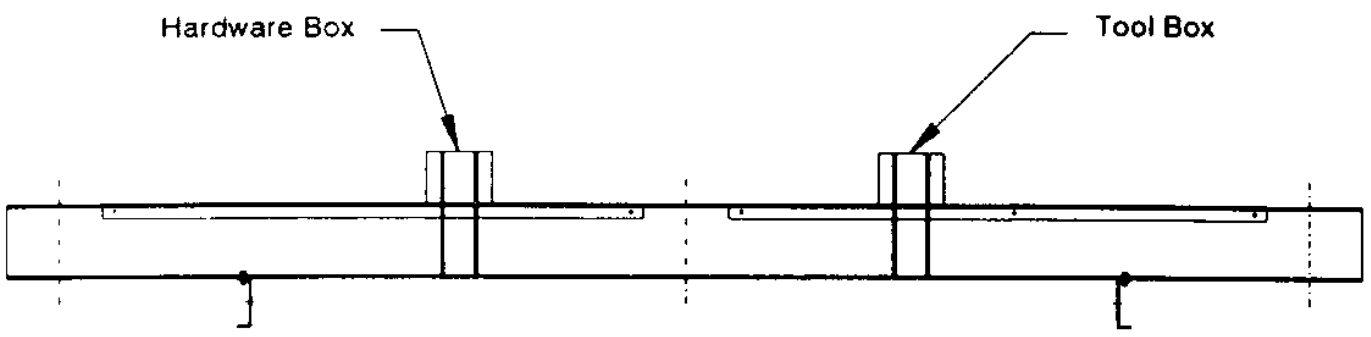


Figure 2 -- Knocked-Down Shipping Assembly **72-265-100-418**

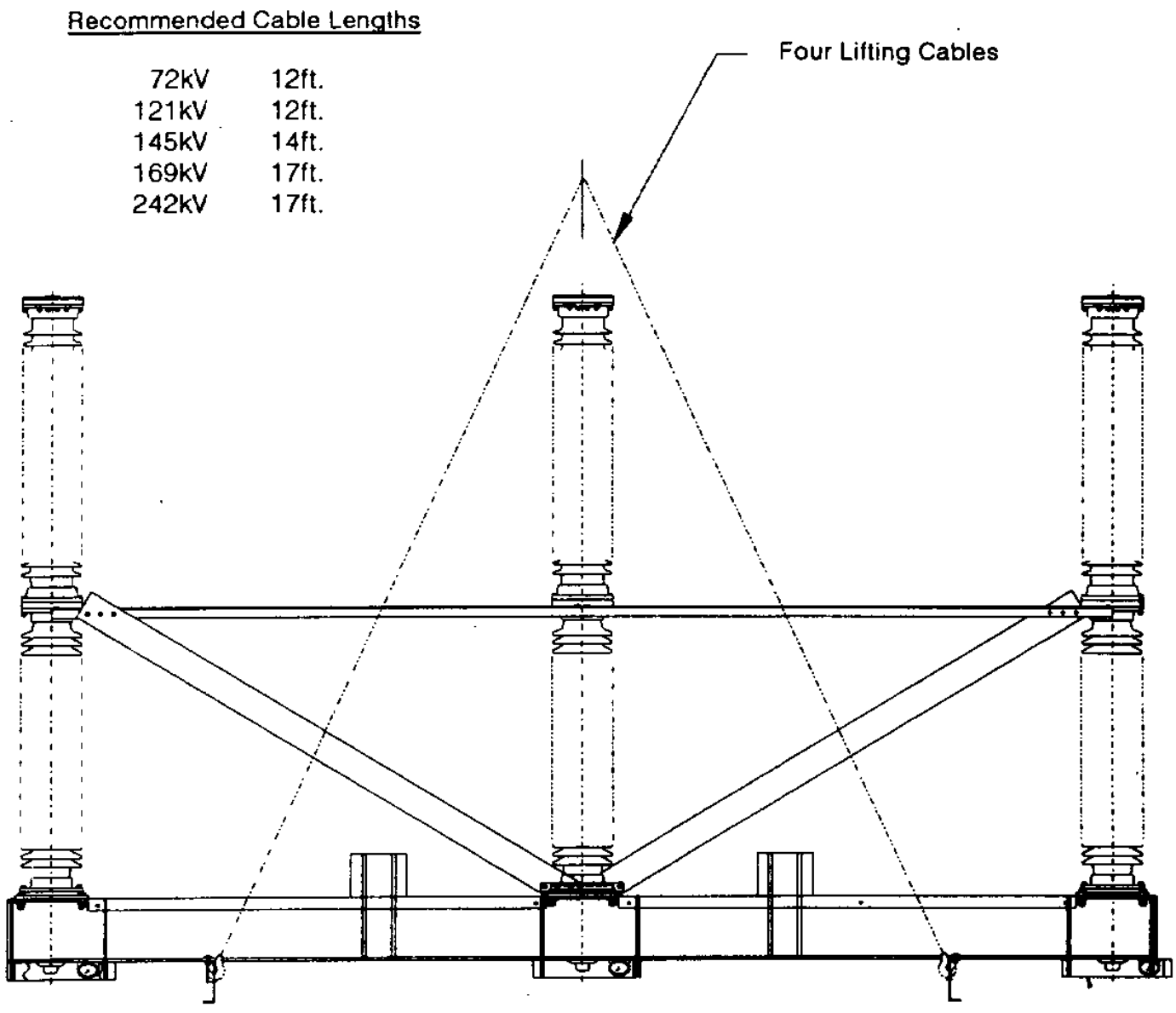


Figure 3 -- Lifting the 3-Pole Shipping Assembly **72-265-100-414**

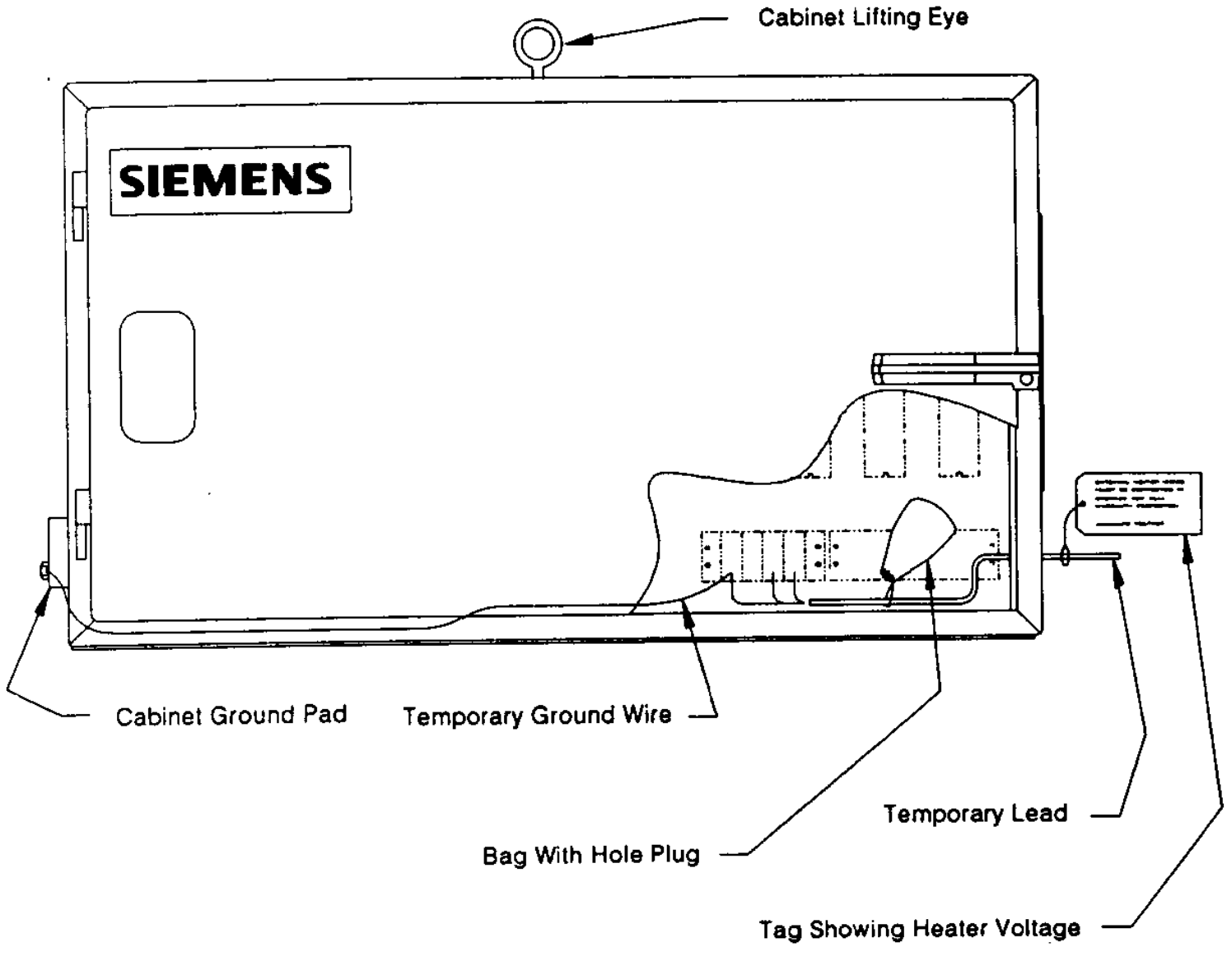


Figure 4 -- External Heater Application

72-265-100-417

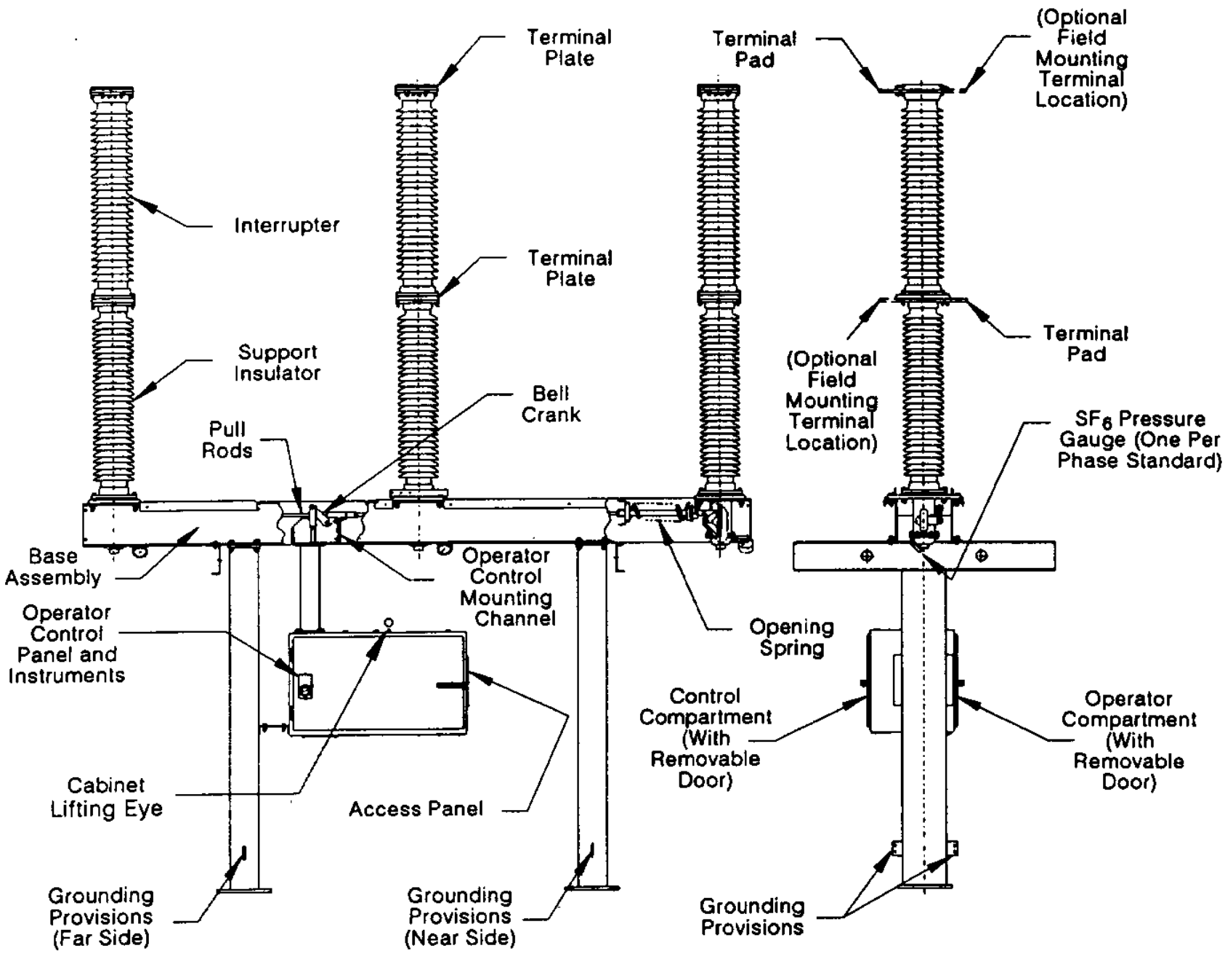


Figure 5 -- CPV Circuit Switcher

72-265-100-411

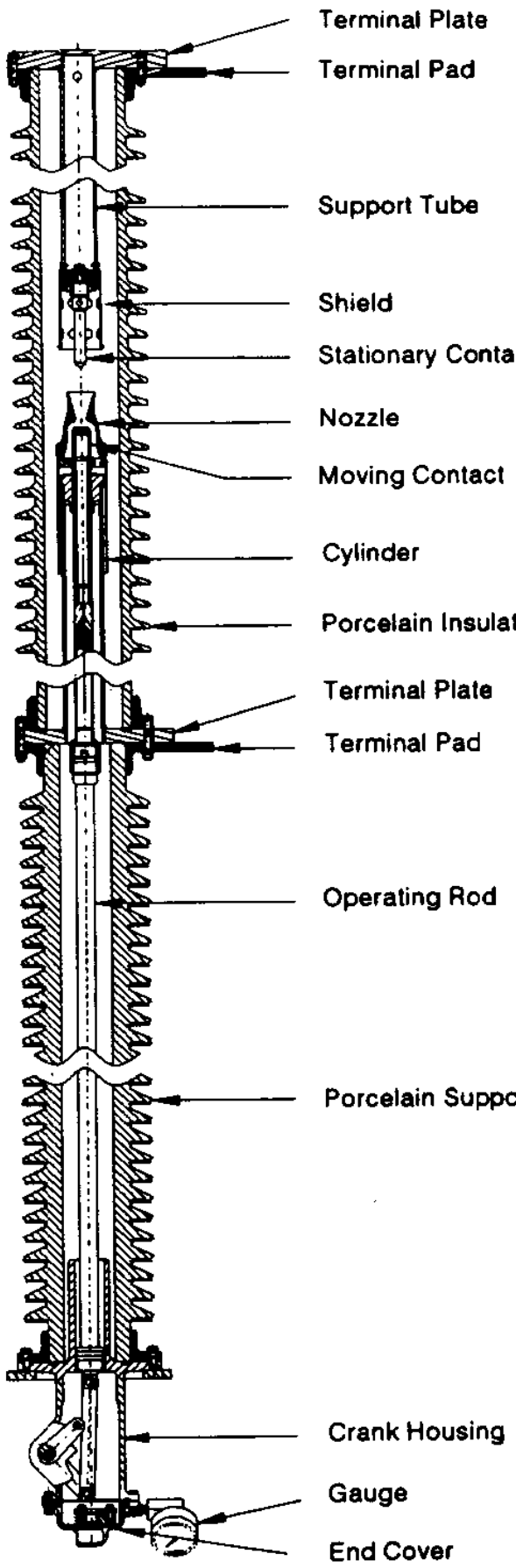


Figure 6 -- CPV Pole Unit

72-265-100-410

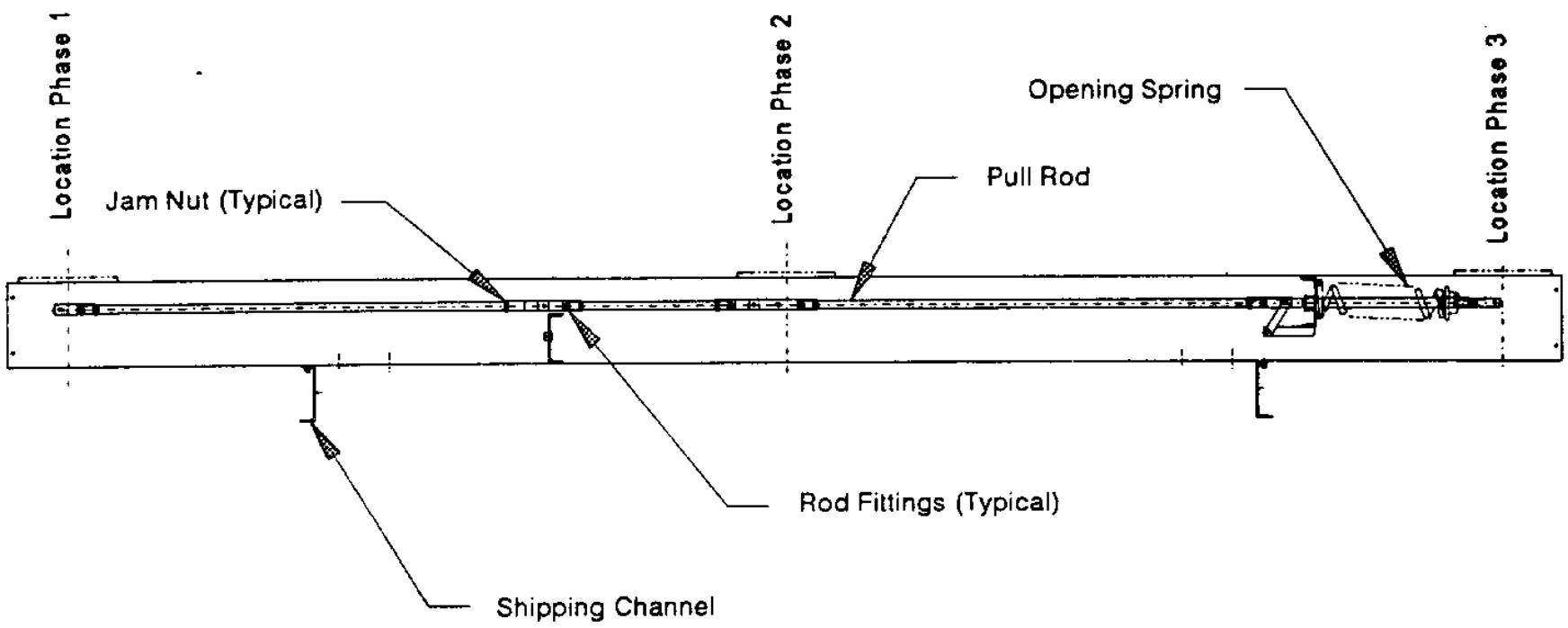


Figure 7 -- Base Assembly

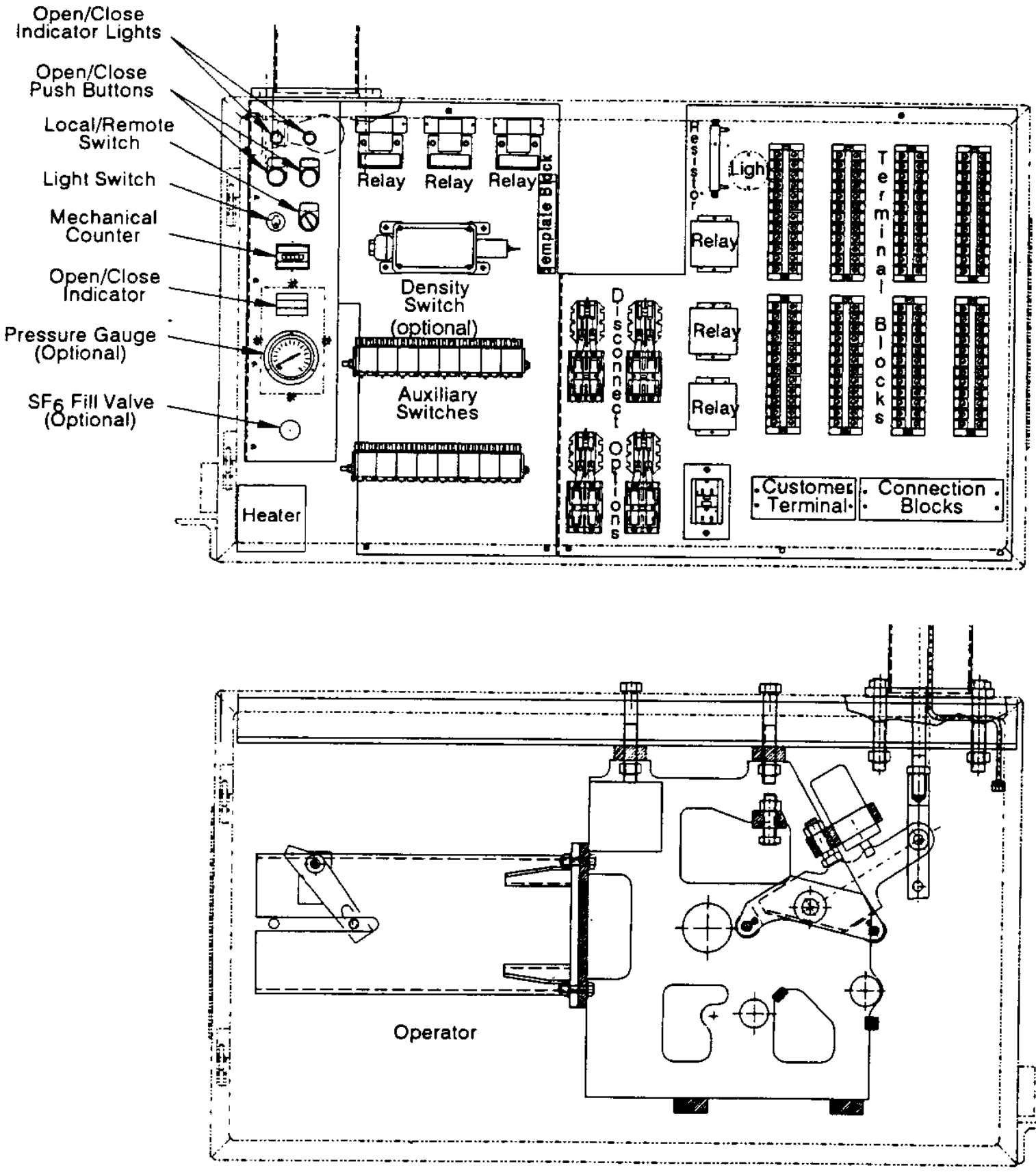


Figure 8 - Operator/Control Cabinet

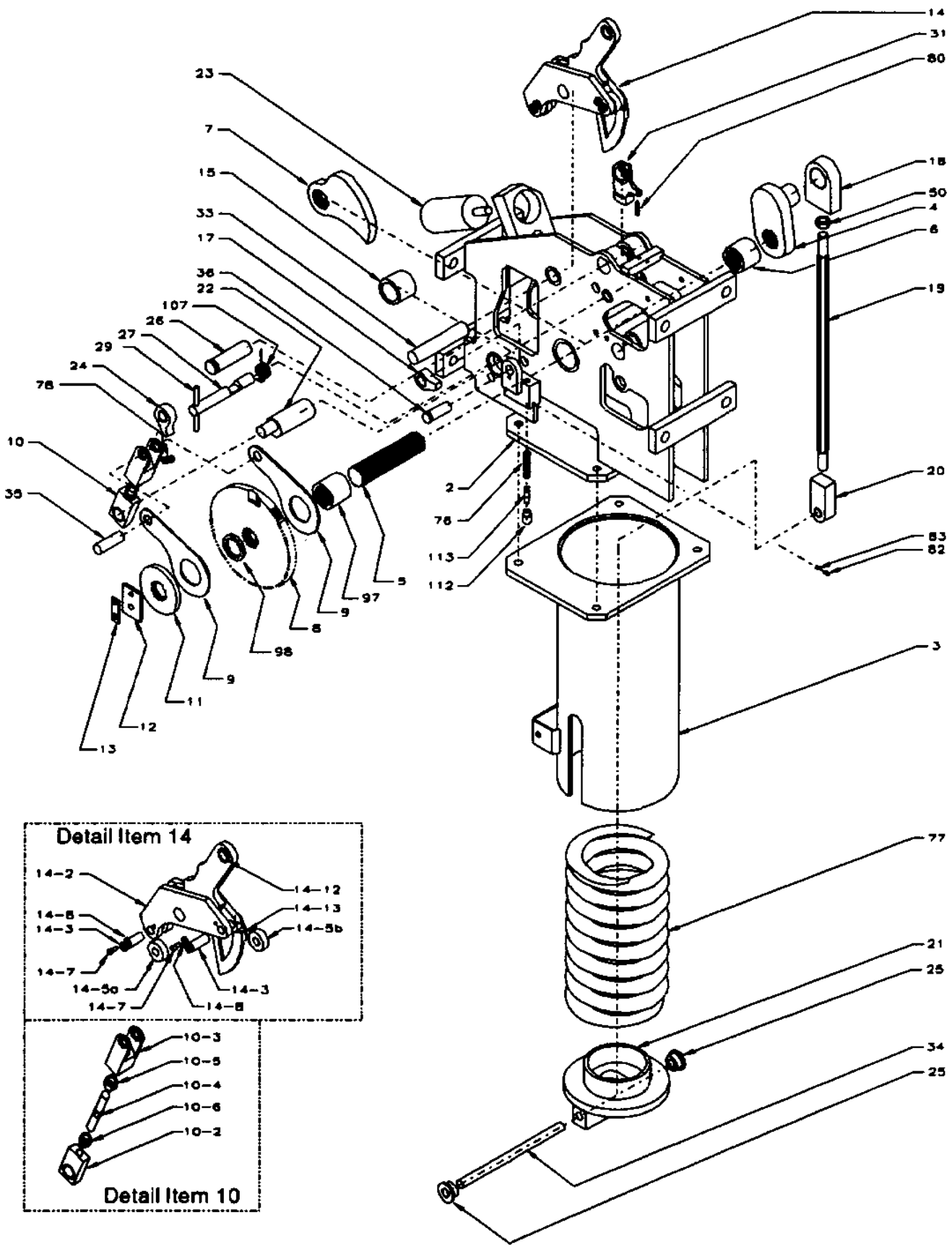
72-265-100-427

Illustrations

Item	Part No.	Description
2	72-480-378-004	Operator Frame
3	72-280-683-501	Spring Housing
4	72-280-672-002	Crank
5	72-181-335-001	Shaft
6	72-181-332-001	Sleeve
7	72-280-677-001	Cam
8	72-280-761-001	Ratchet Wheel
9	72-181-331-001	Pawl Arm
10	72-181-330-501	Rod Assembly
11	72-181-327-001	Collar
12	72-181-383-001	Plate
13	72-181-339-001	Strip
14	72-181-361-501	Lever Assembly
15	72-181-563-001	Sleeve
17	72-181-356-502	Pawl, Holding
18	72-181-321-502	Rod End
19	72-280-685-003	Rod
20	72-181-565-502	Rod End
21	72-280-684-501	Spring Support
22	72-280-687-001	Motor Shaft
23	1654B08H02	Shock Absorber
24	72-181-356-501	Pawl, Drive
25	72-181-358-501	Bushing
26	72-181-551-002	Pin
27	72-280-766-001	Release Latch
29	72-181-549-001	Pin
31	72-280-820-002	Latch (Trip)
33	7353D68H11	Pin
34	72-181-363-002	Pin
35	72-181-363-003	Pin
36	72-181-348-001	Pin
50	72-181-675-001	Nut, Special
76	W 391810	Spring
77	72-181-143-001	Spring
78	W 39180902	Spring
79	W 392156	Spring
82	512A416H01	Set Screw
83	9043A41H02	Pin
97	72-181-332-002	Sleeve
98	72-181-332-003	Sleeve
107	72-181-531-001	Spring, Tors
112	72-181-619-001	Set Screw Mod
113	72-181-620-001	Pin

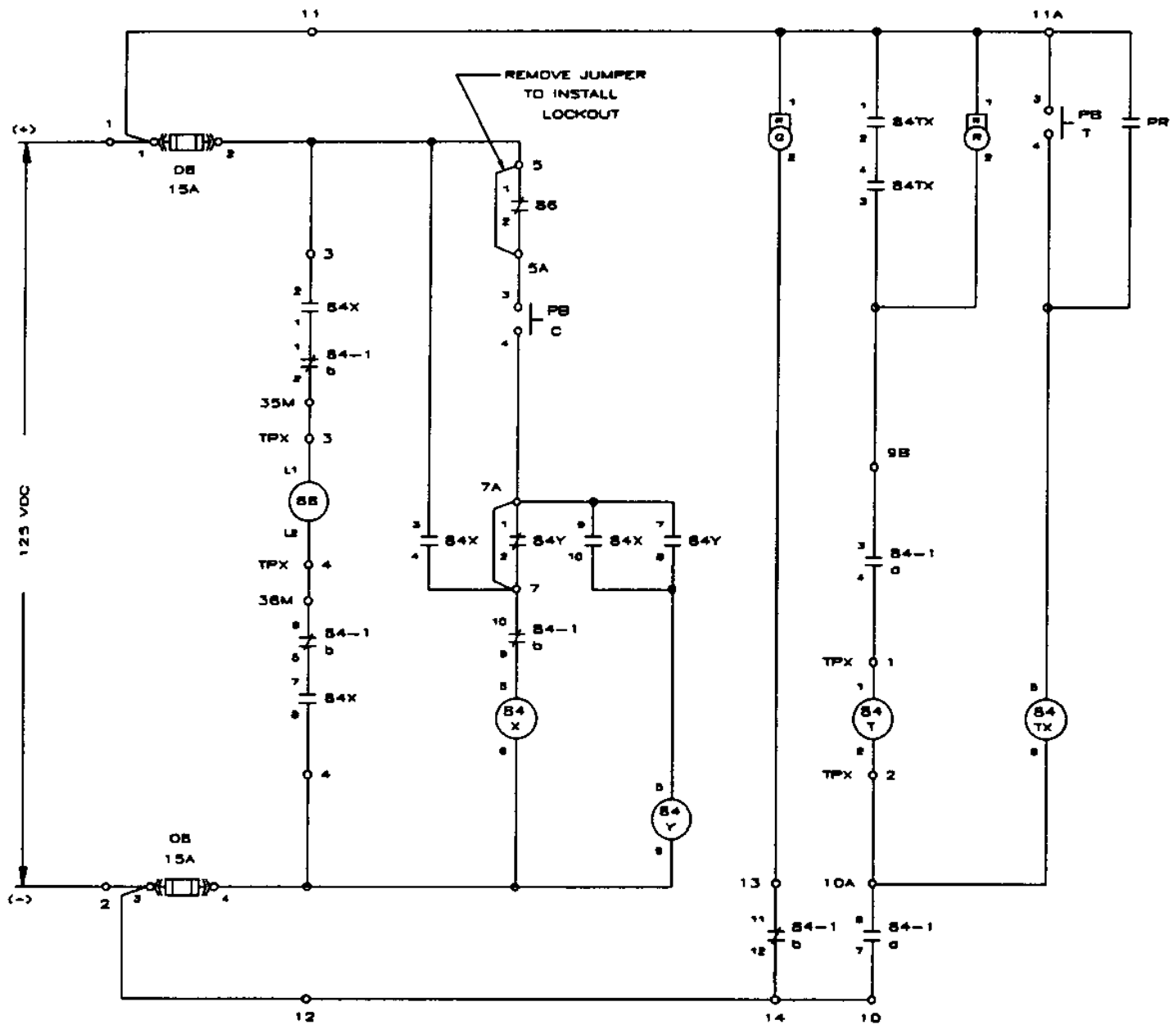
Figure 9 -- Operator SE-4A

Illustrations



LEGEND

08	DC Control Power Disconnect
08H	AC Control Power Disconnect
84a	Auxiliary Switch - Open When Circuit Switcher Open
84b	Auxiliary Switch - Closed When Circuit Switcher Open
84T	Circuit Switcher Trip Coil
84TX	Auxiliary Circuit Switcher Tripping Relay
84X	Auxiliary Circuit Switcher Closing Relay
84Y	Circuit Switcher Closing Cutoff Relay (Anti-Pump)
86	Lockout Relay (Remote)
88	Motor
EC	Electric Operations Counter
G	Green Indicator Light
PBC	Close-Control Switch (Pushbutton)
PBT	Trip-Control Switch (Pushbutton)
PR	Remote Protective Relays
R	Red Indicator Light
R1	Resistor



Notes: All Equipment Shown With:

Circuit Switcher Open
Control Voltage Off
SF_6 Pressure Low
Spring Discharged

Figure 10 -- Typical Elementary Diagram **72-265-100-416**

Illustrations

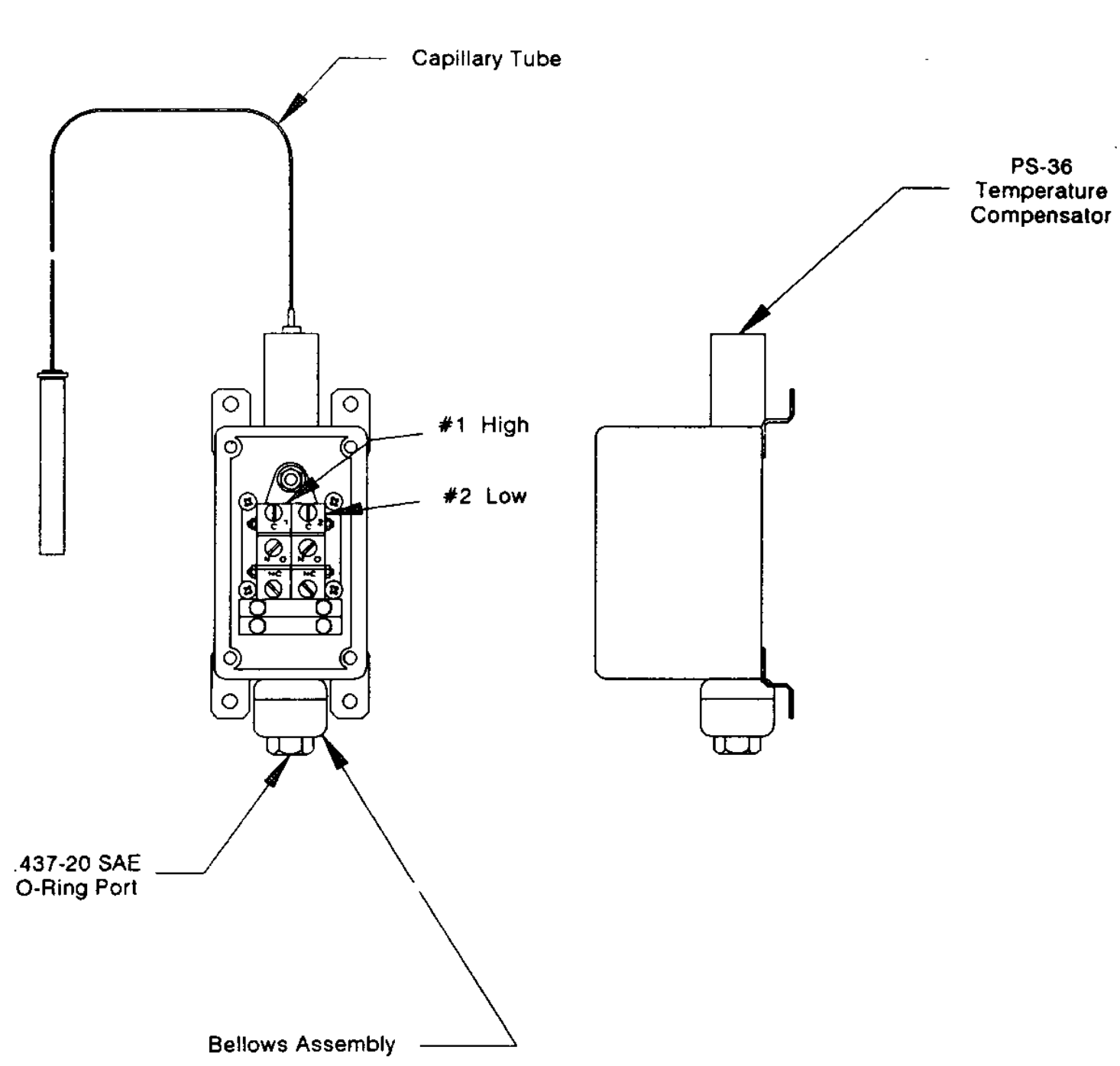


Figure 11 -- Density Switch (Optional Equipment)

72-265-100-426

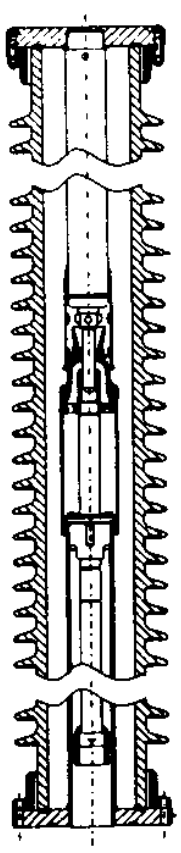
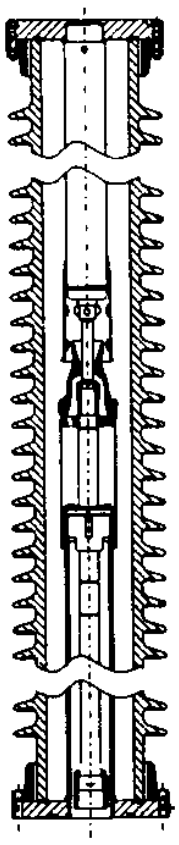
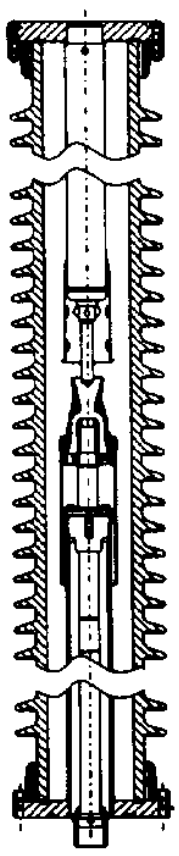
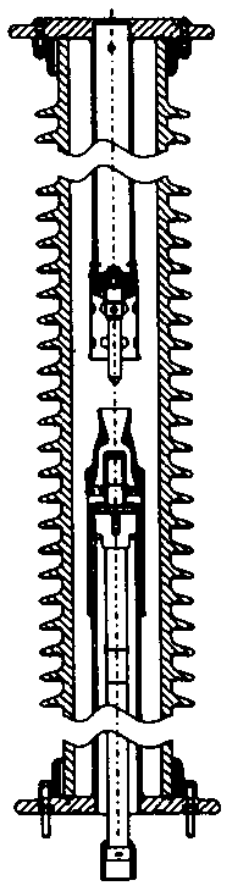
A	B	C	D
			
Interrupter trips with contacts in the closed position. Contacts remain in contact as movable contact travels over stationary contact and compresses the gas. Gas is ready to flow when contacts part.	Contact parts -- arcing begins -- gas flows to extinguish arc.	At current zero, gas prevents reignition.	Interruption complete, interrupter in full open position. Full BIL established.

Figure 12 -- Interrupter Operation

72-265-100-421

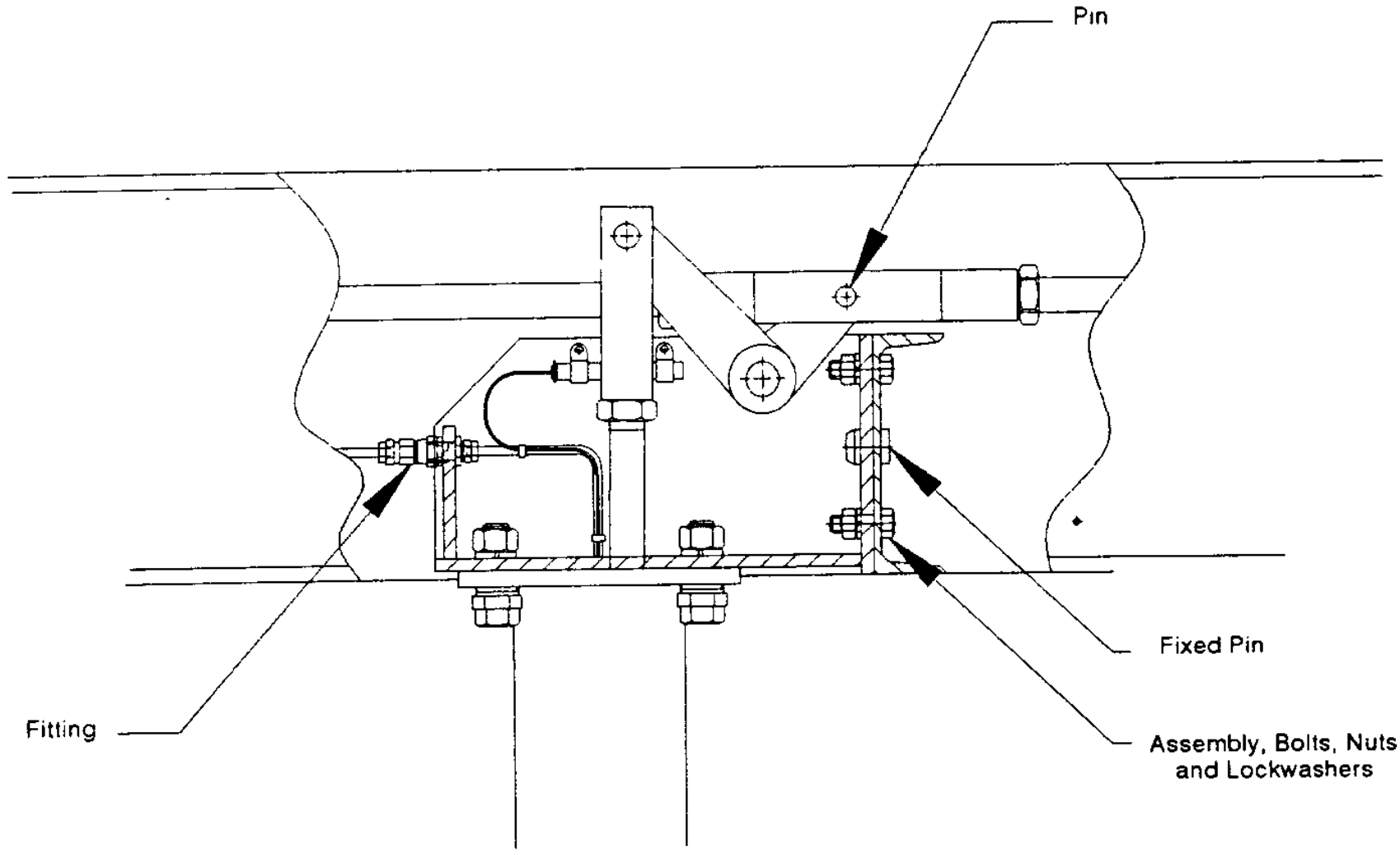


Figure 13 -- Bell Crank Housing Linkage

72--265-100-403

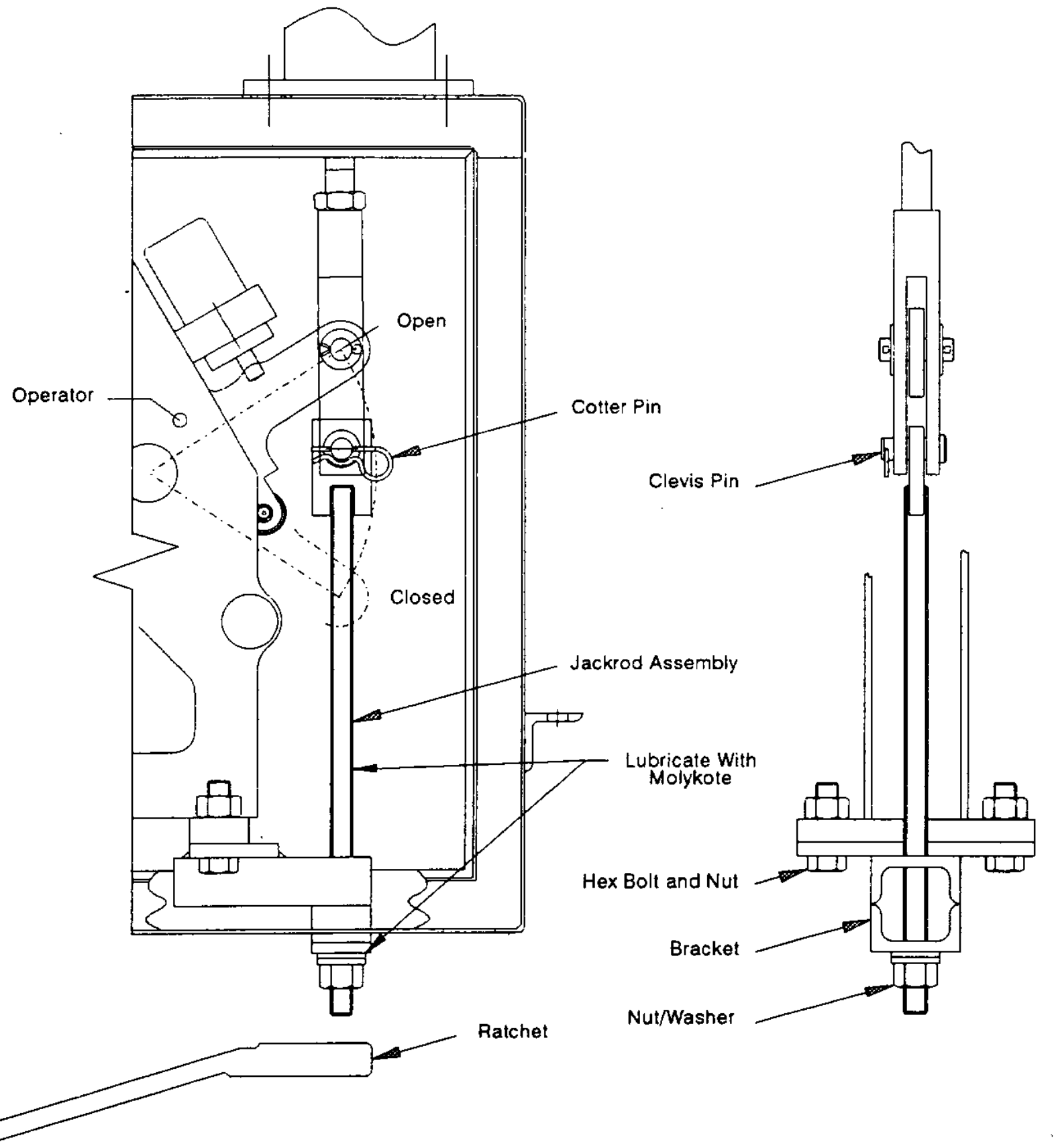


Figure 14 -- Manual Operating Device Application **72-265-100-423**

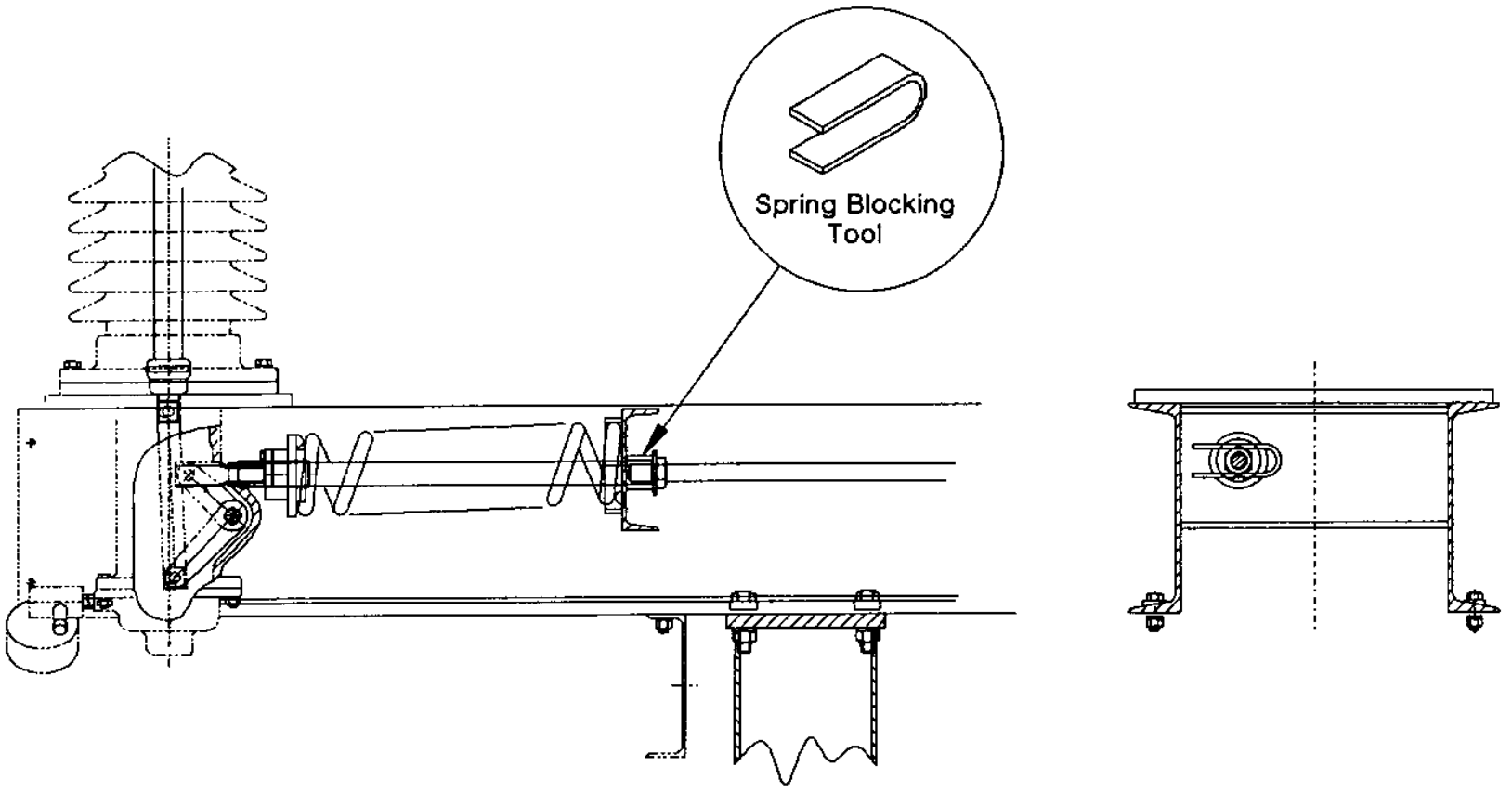


Figure 15 -- Spring Blocking Tool

72-265-100-404

Illustrations

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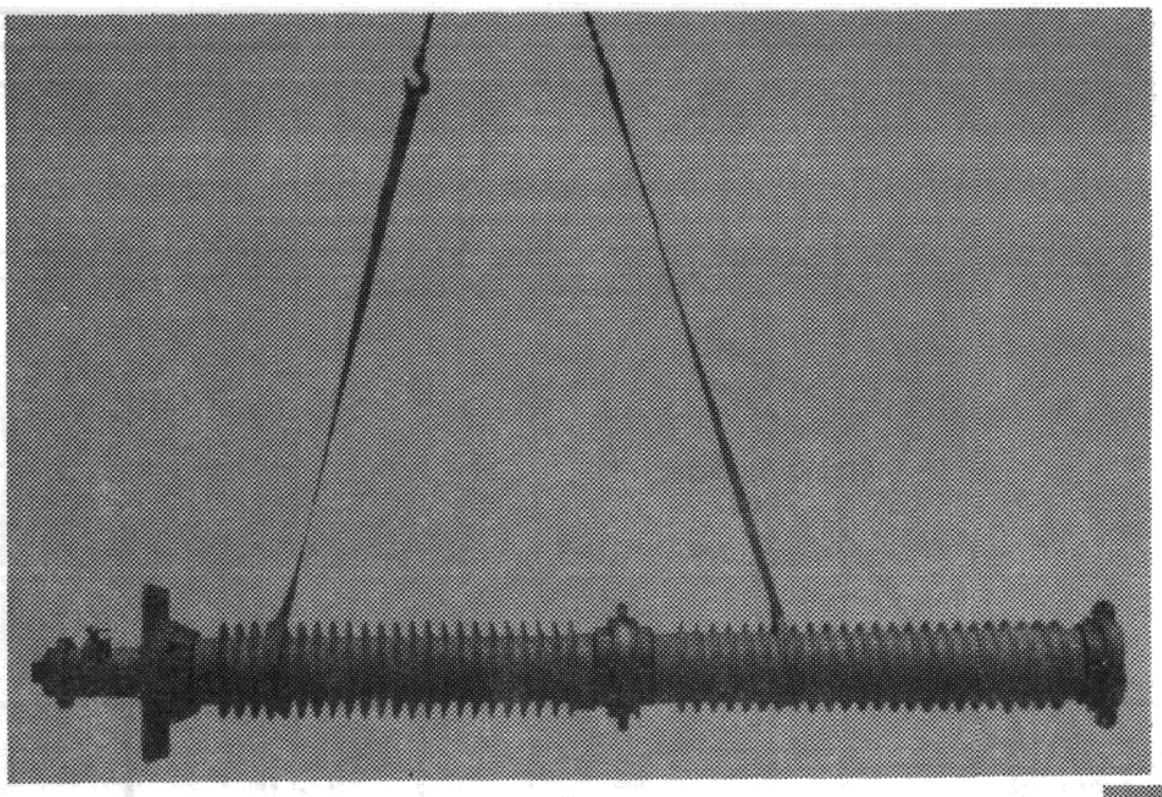
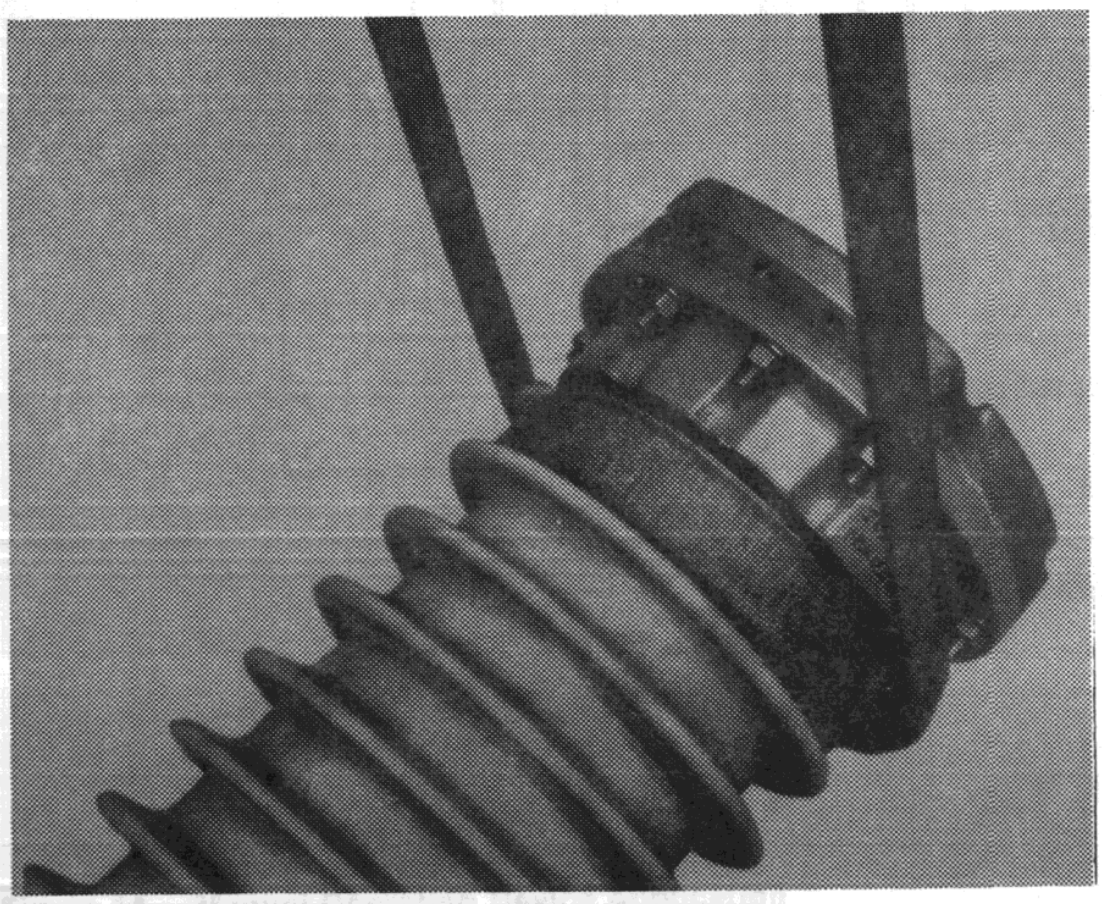
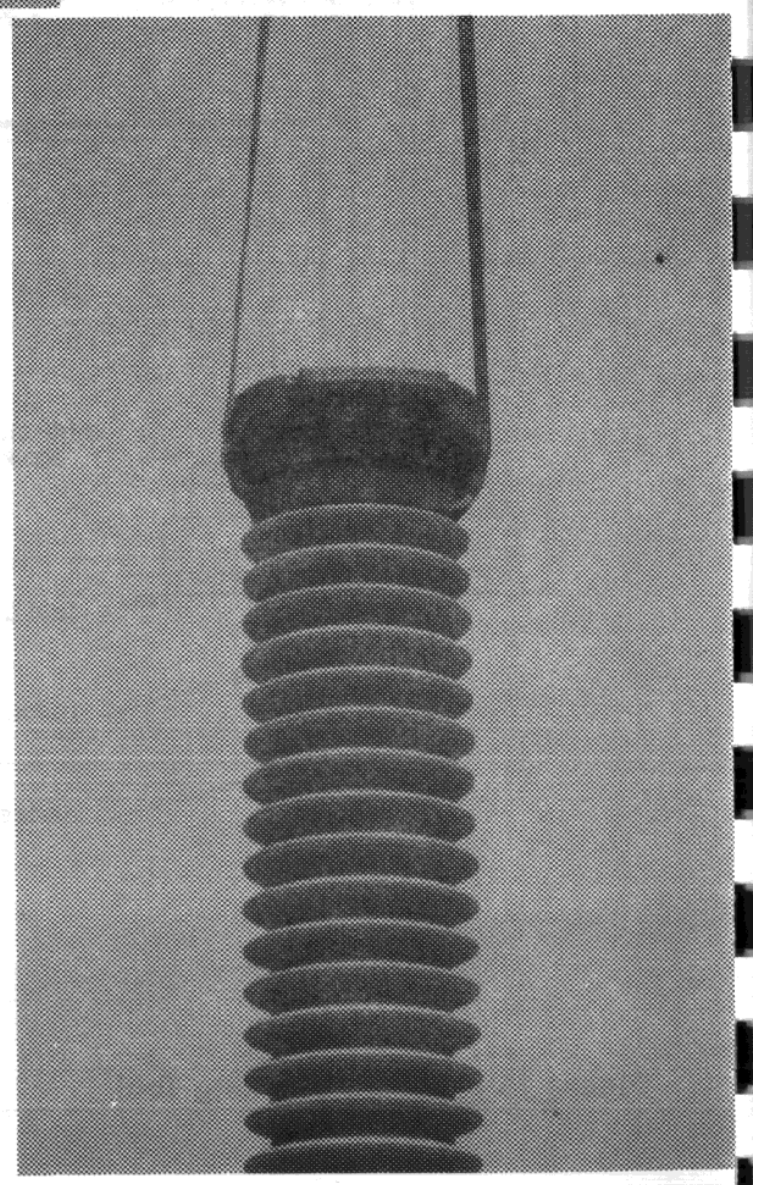


a. Horizontal Lift

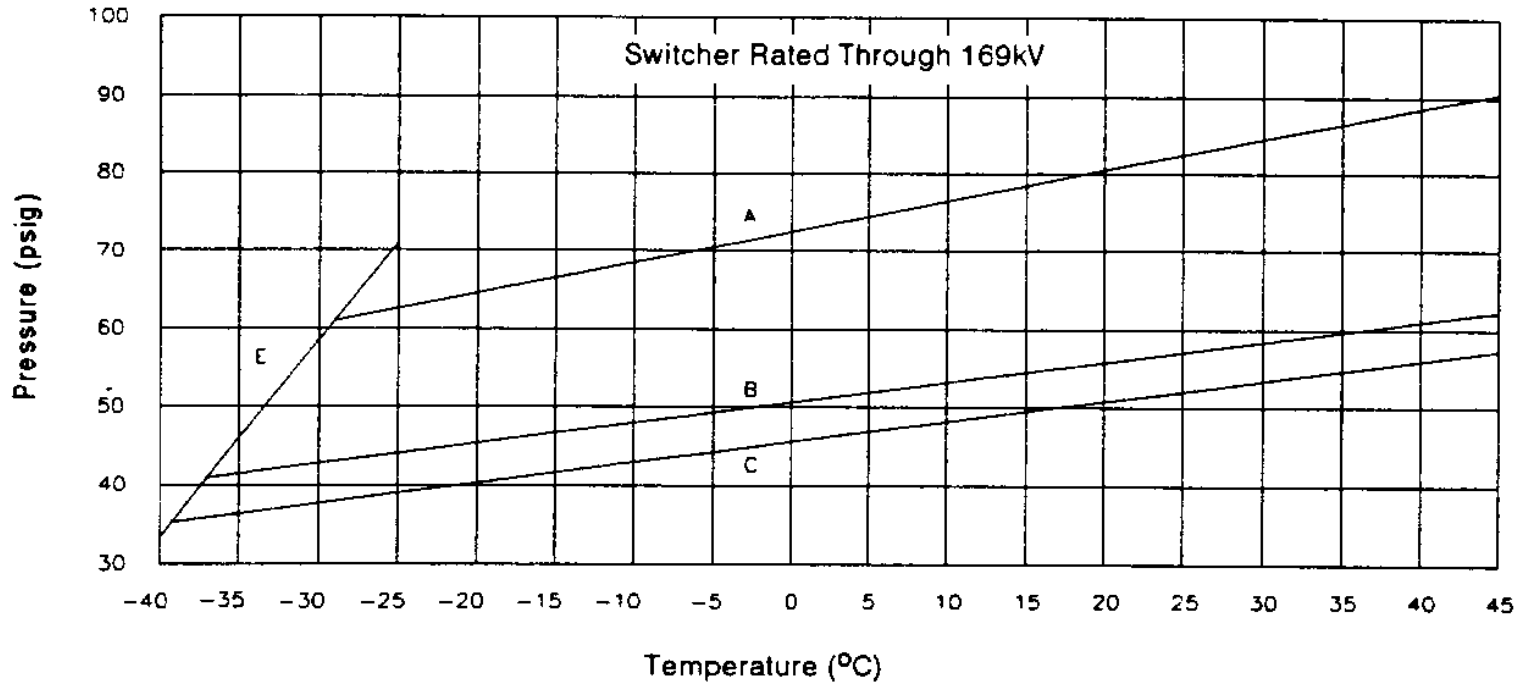


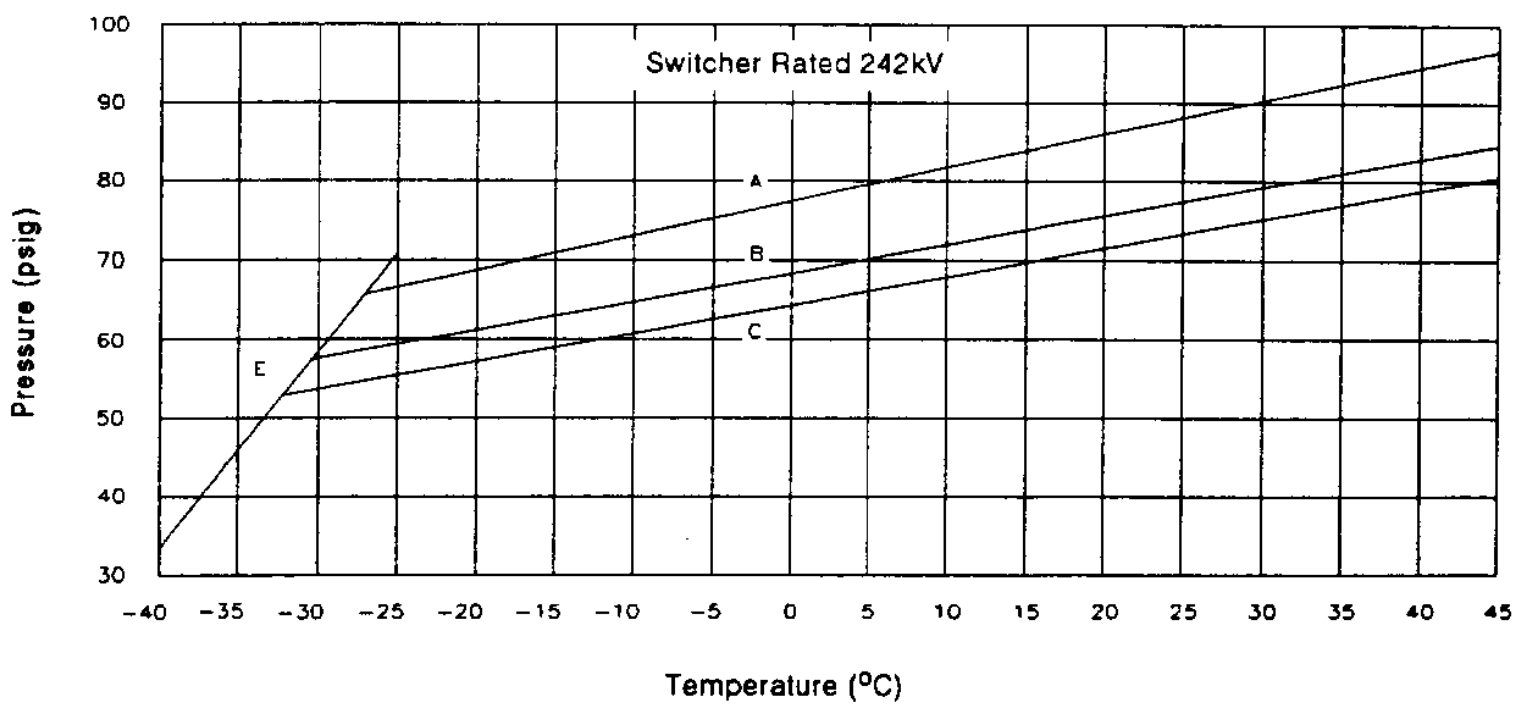
b. Beginning a Vertical Lift



c. Vertical Lift

Figure 16. Lifting A Pole Unit





A - Fill Pressure
B - Low Pressure Alarm
C - Minimum Pressure
D - Condensation

Figure 17 -- Temperature Vs. SF_6 Pressure Chart **72-265-100-402**

Illustrations

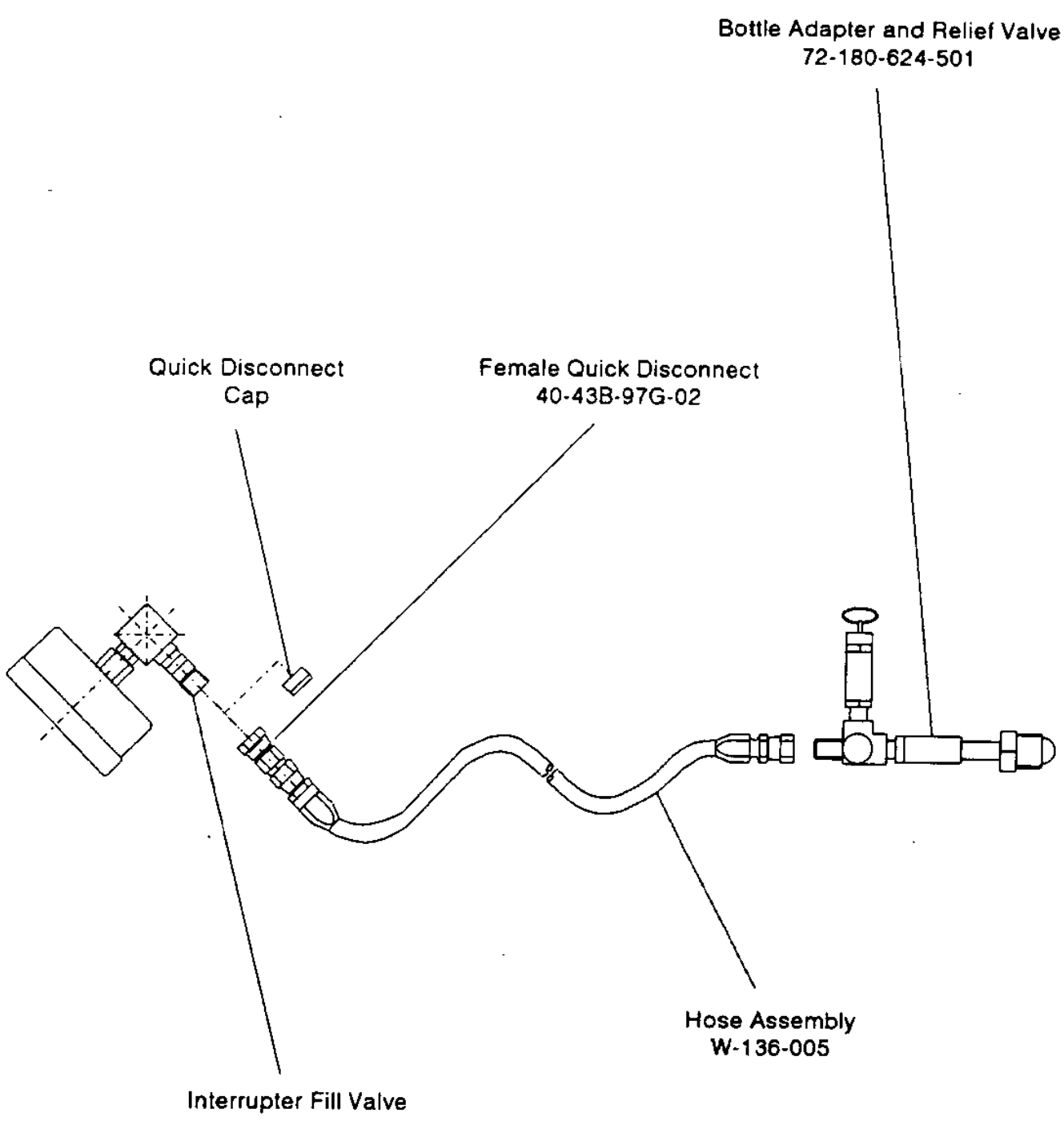


Figure 18 -- SF_6 Fill Kit

72-265-100-420

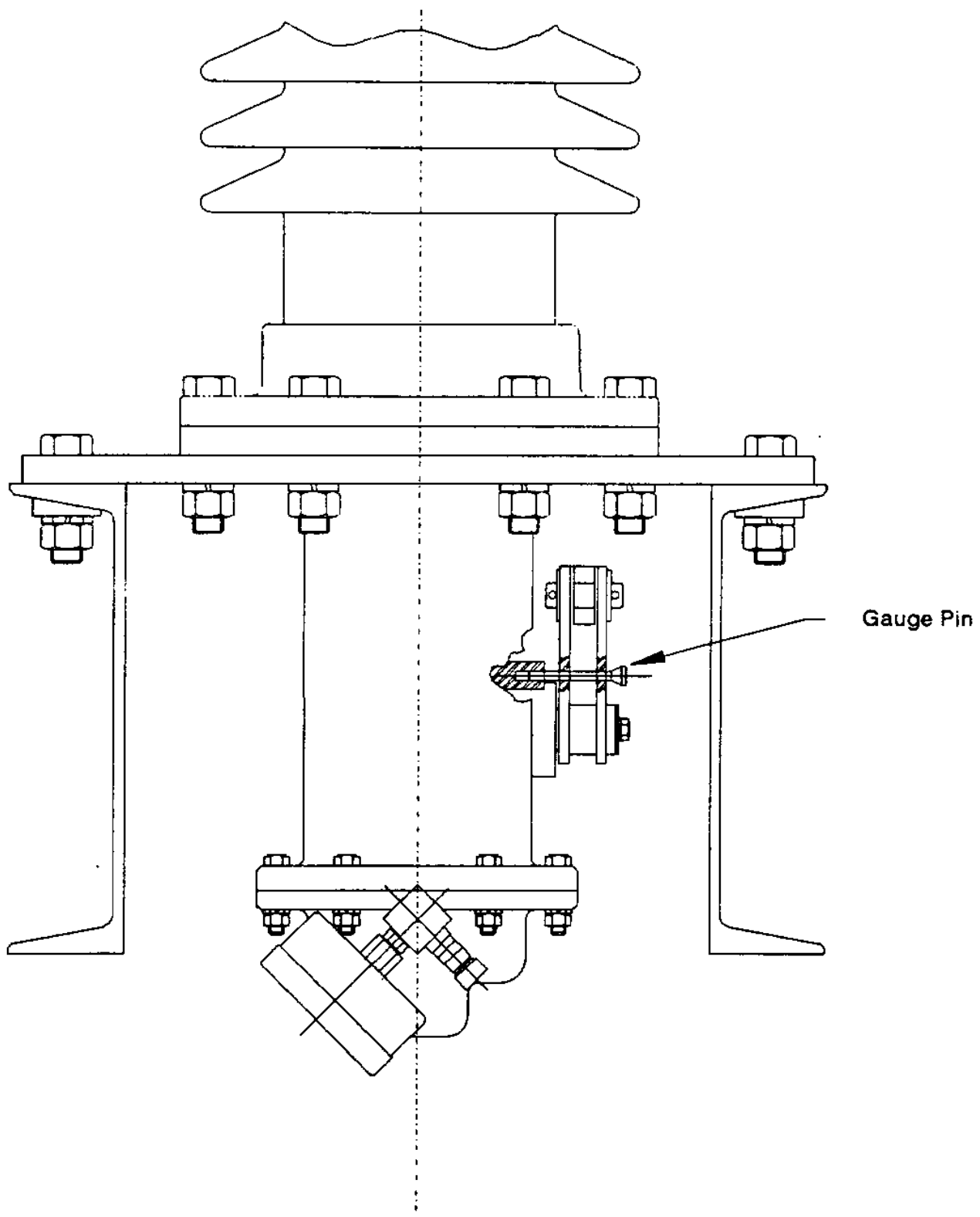


Figure 19 -- Use of Gauge Pin to Set Pole Unit Open Position

72-265-100-405

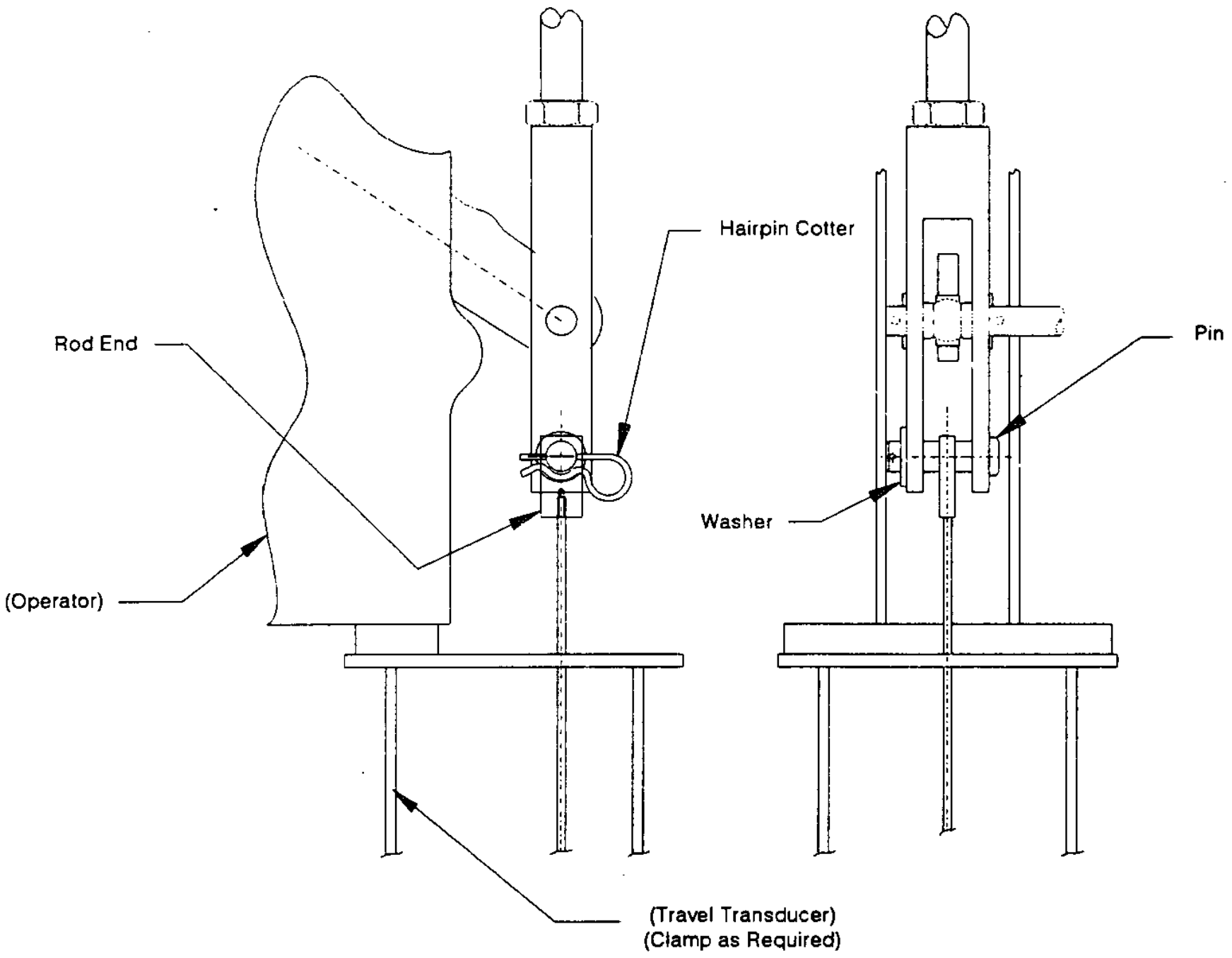
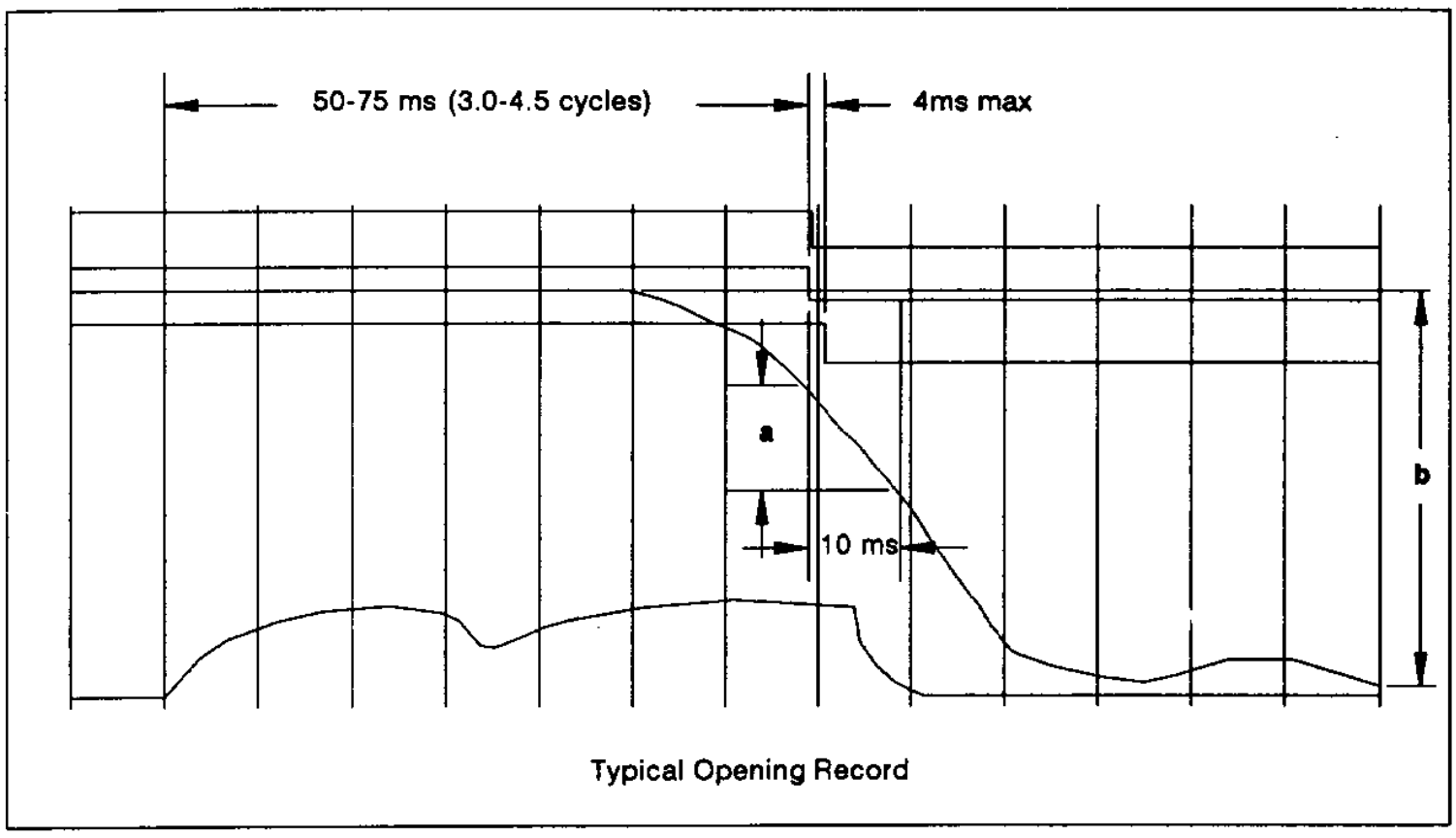


Figure 20 -- Travel Transducer Application

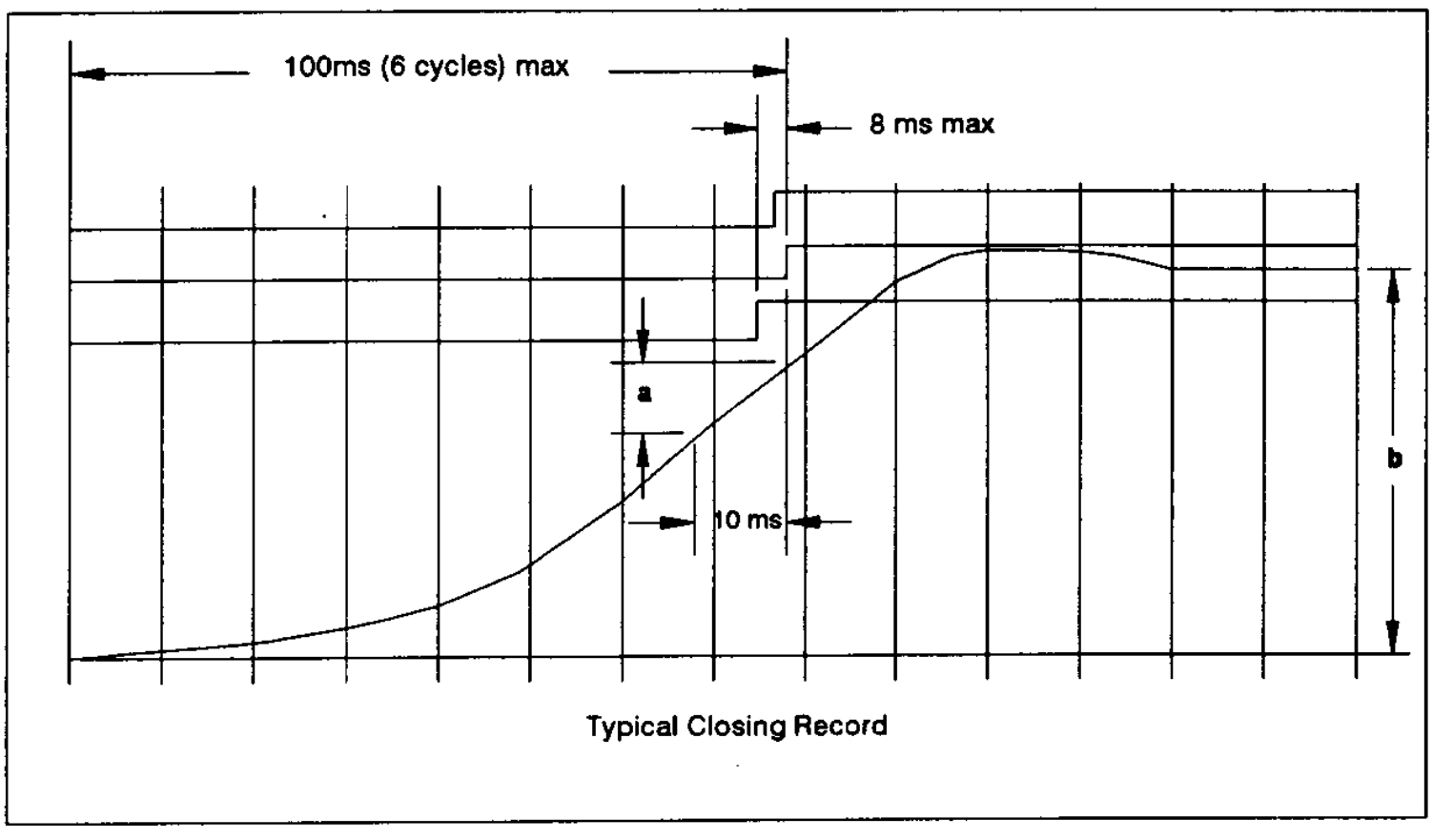
72-265-100-419

Illustrations



Typical Opening Record

Figure 21 - Trip Timing **72-265-100-424**



Typical Closing Record

Figure 22 - Close Timing **72-265-100-424**

Calculation for Contact Velocity
V = 21.3 a/b meters/sec (a, b may be measured in any consistent unit)

Illustrations

Note: The charging tool must make 6.5 revolutions to advance the ratchet wheel by one tooth.

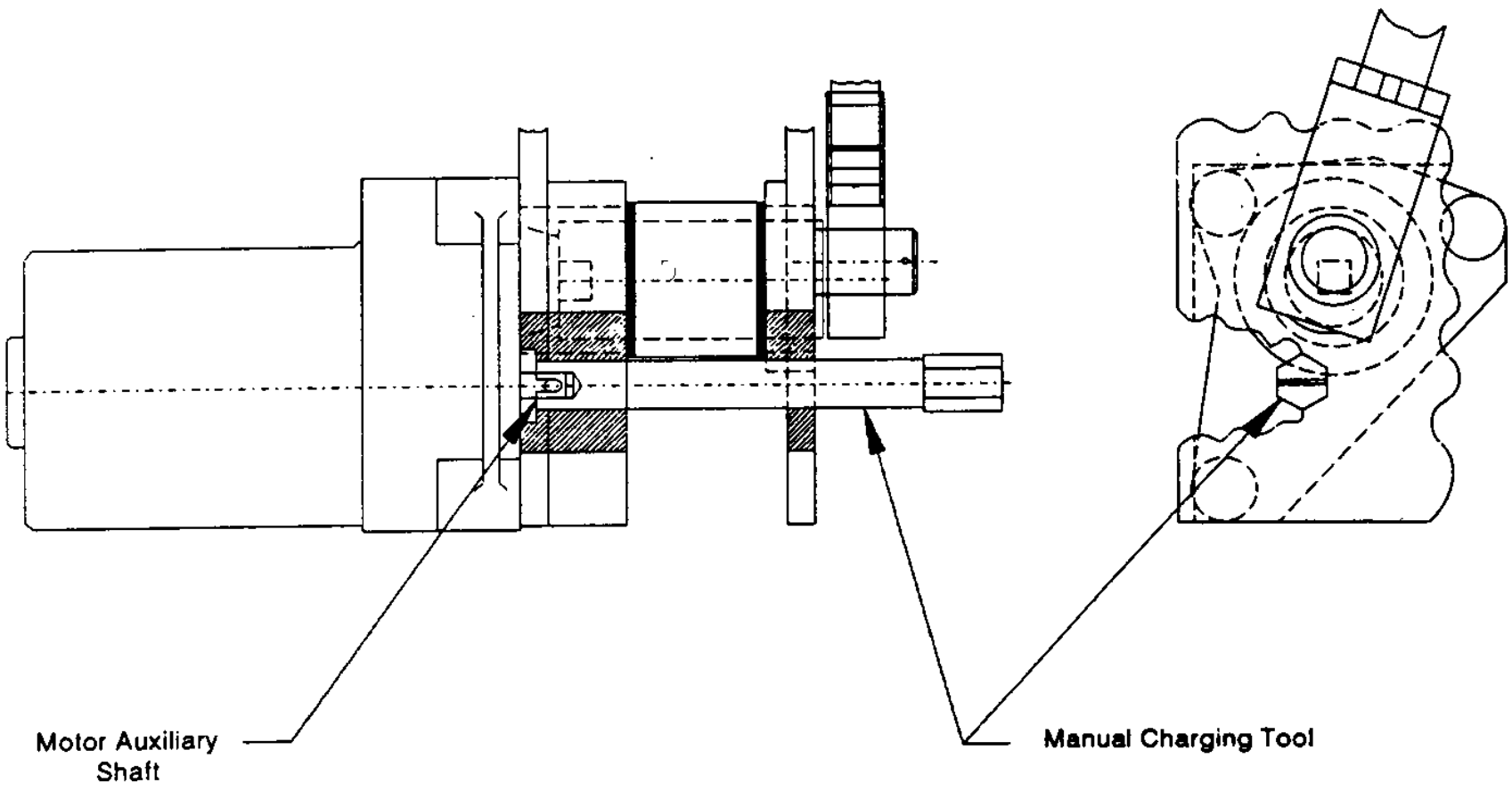
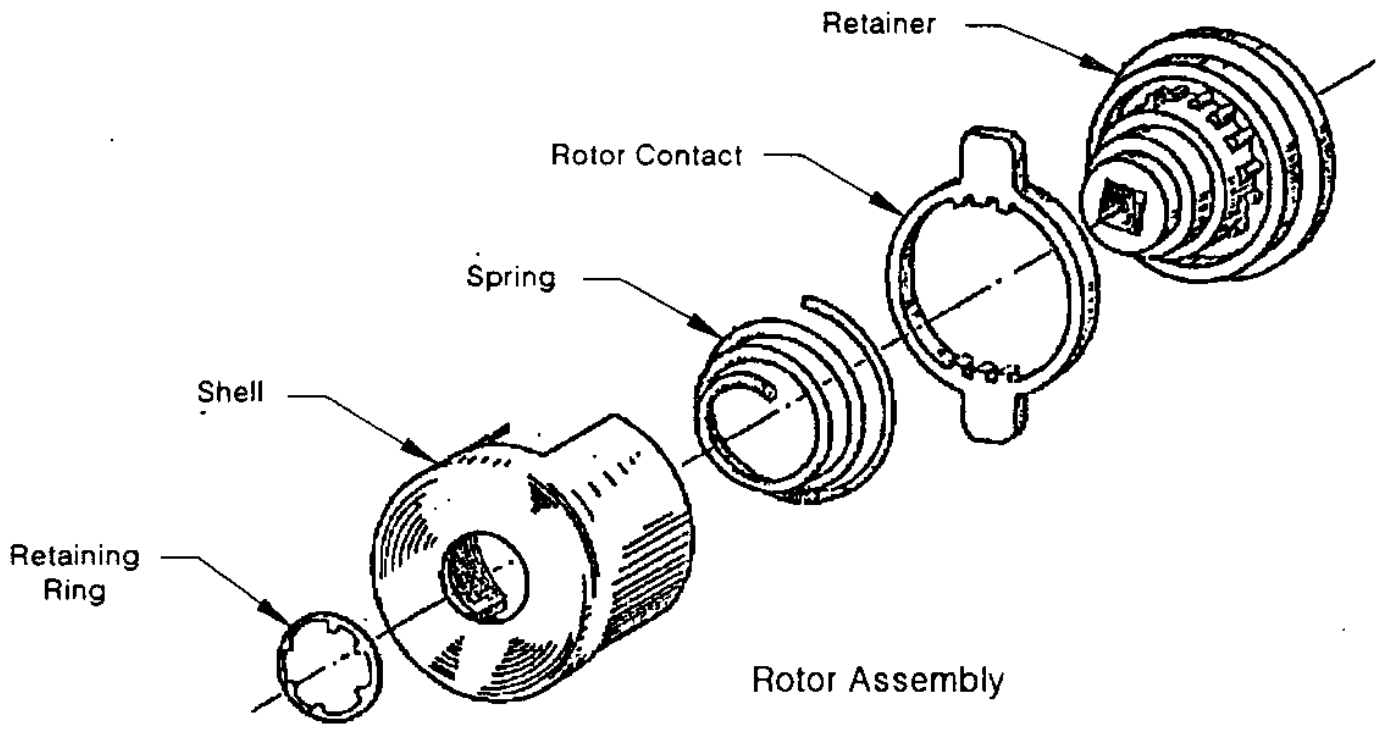


Figure 23 -- Application of Manual Charging Tool **72-265-100-428**



Rotor Assembly

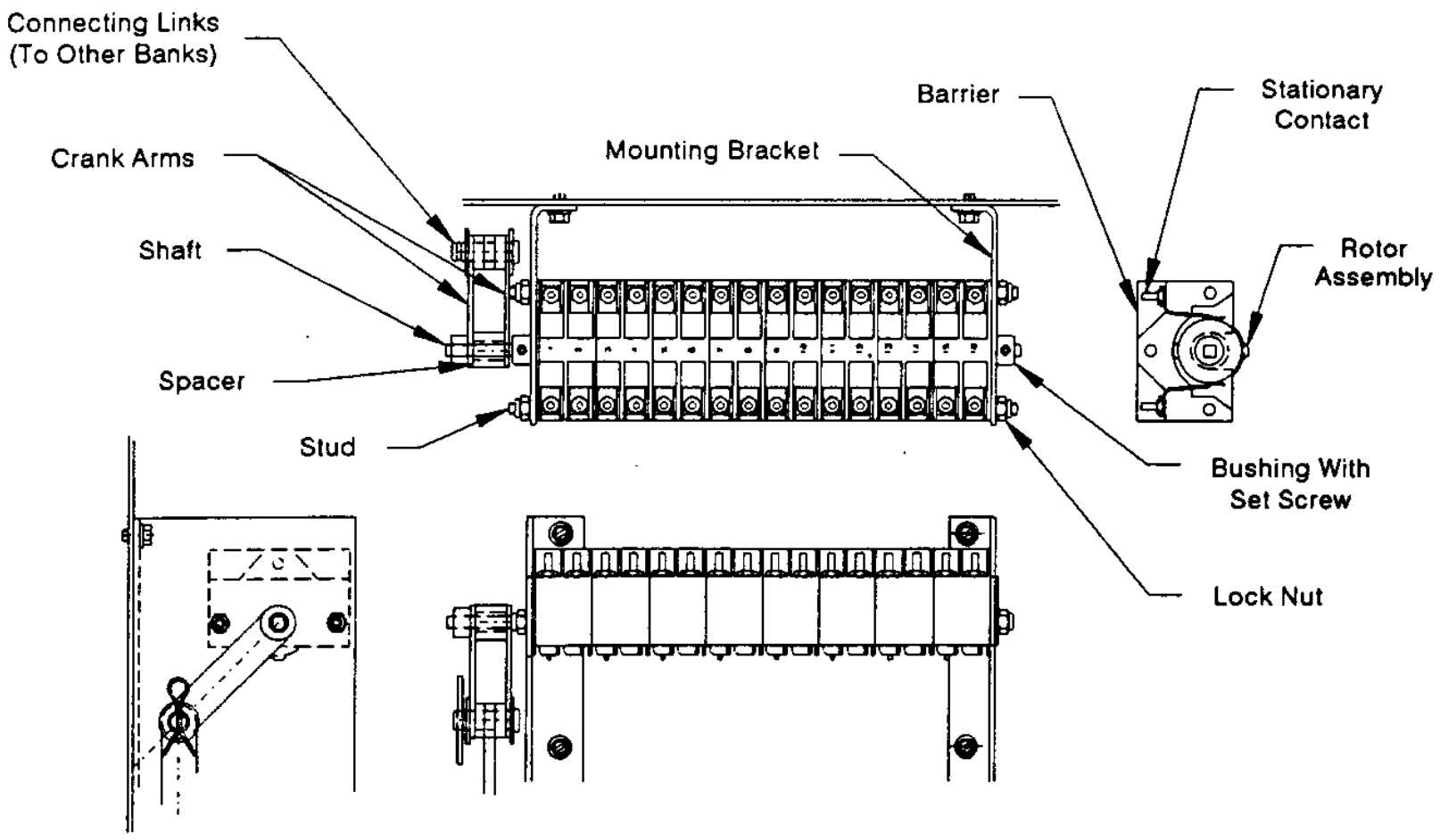


Figure 24 -- Auxiliary Switch Adjustment

72-265-100-422

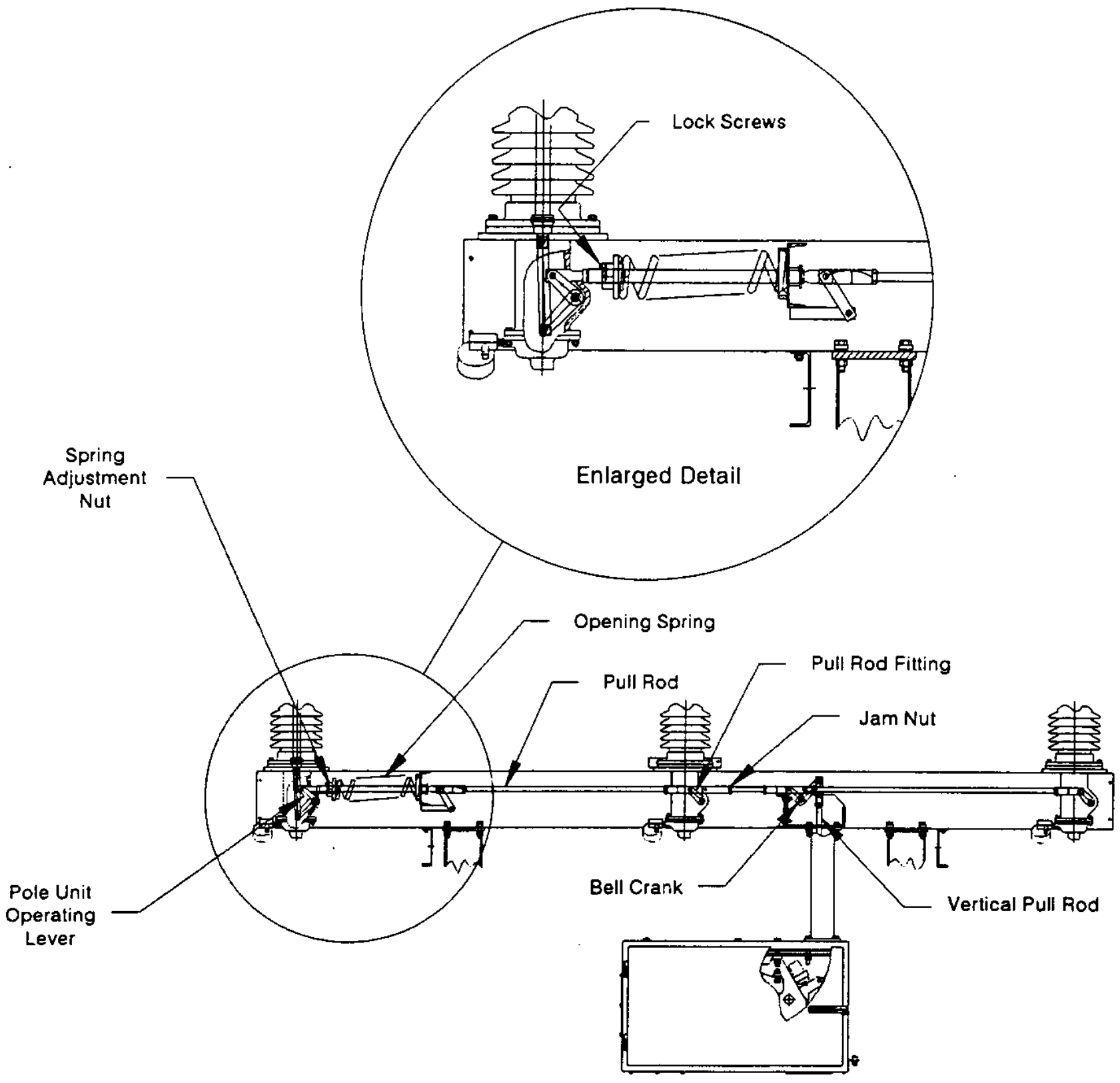


Figure 25 -- Mechanism Linkage

72-265-100-401

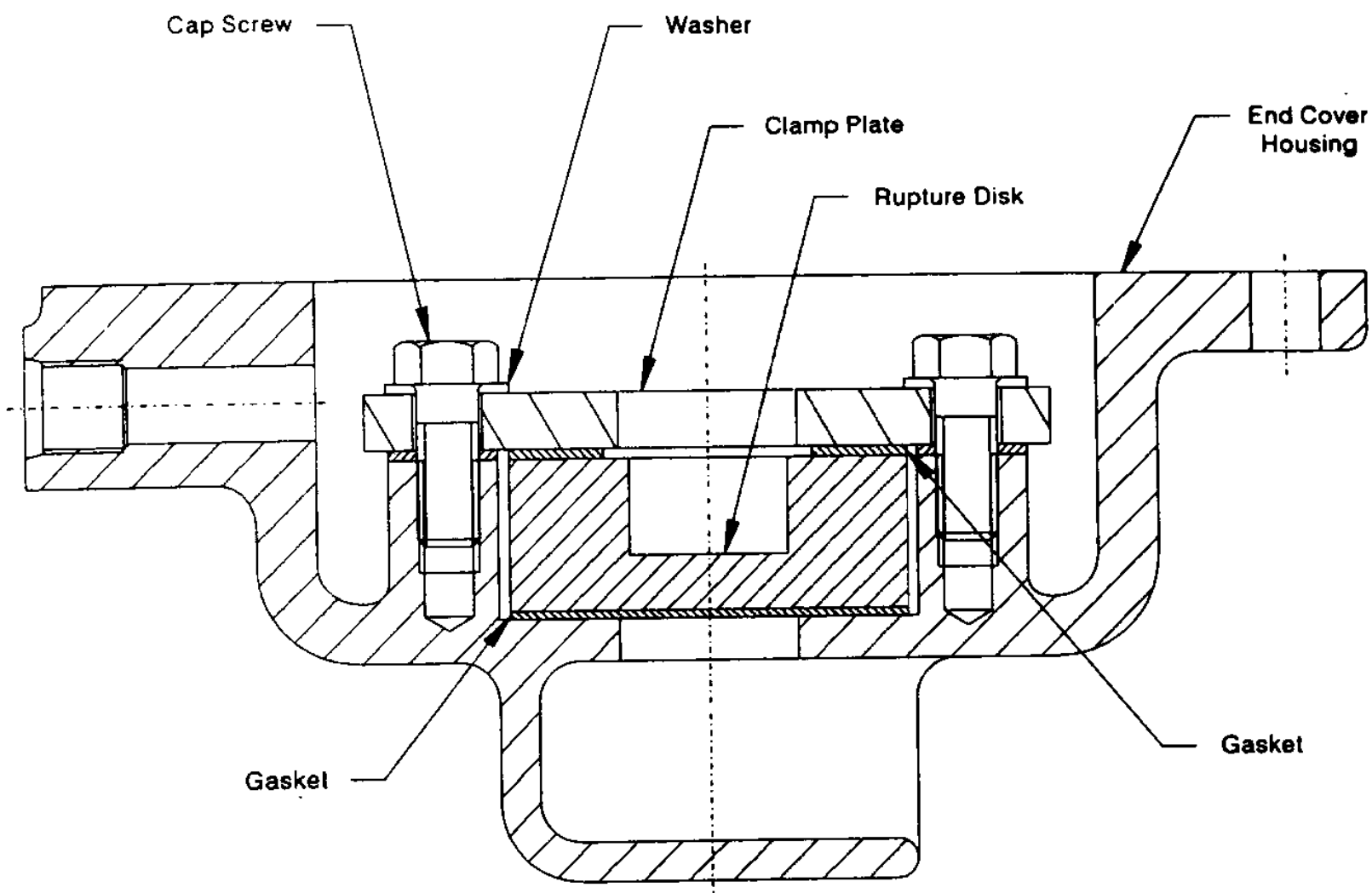


Figure 26 -- Rupture Disk Replacement

Illustrations

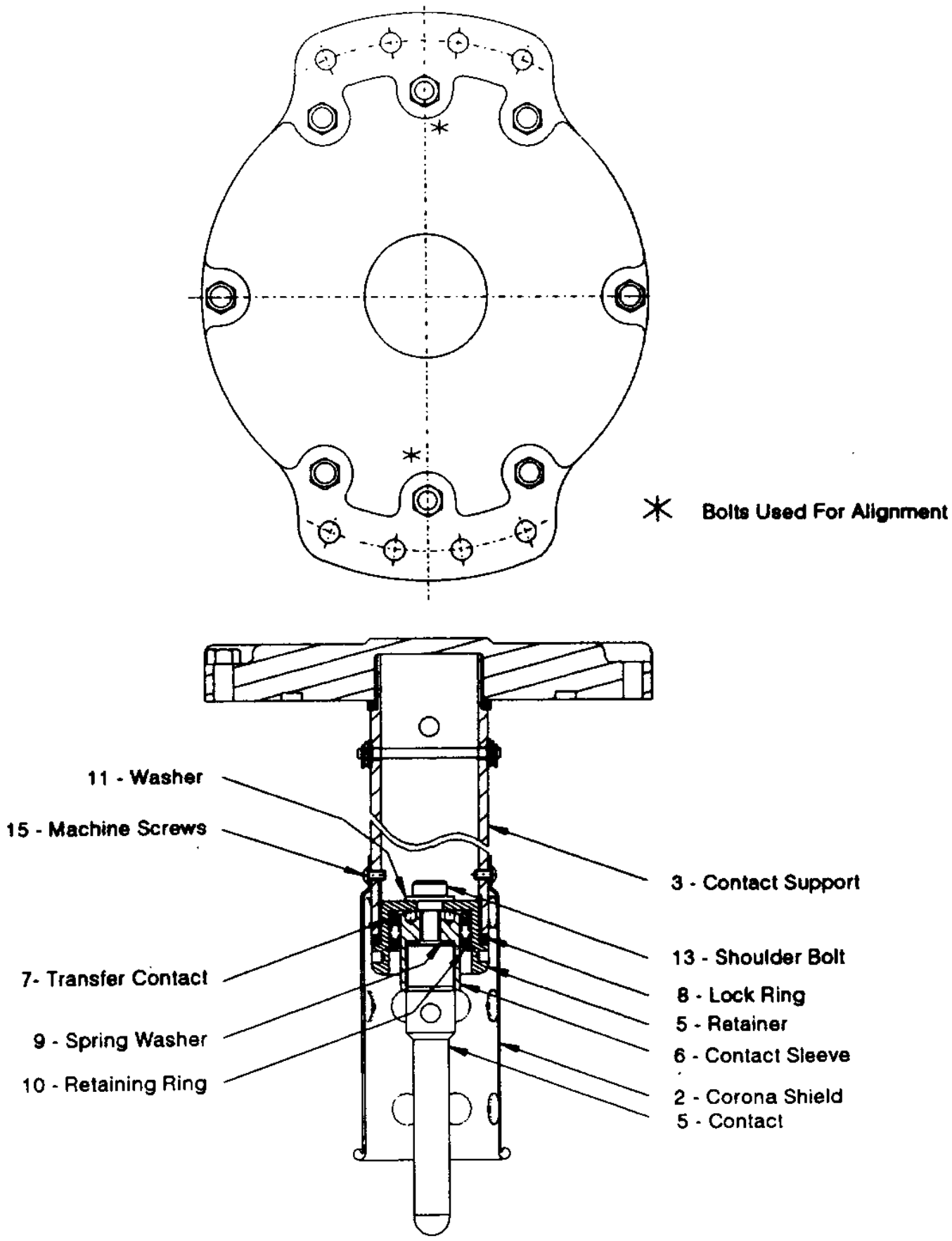


Figure 27 -- Stationary Contact

72-265-100-409

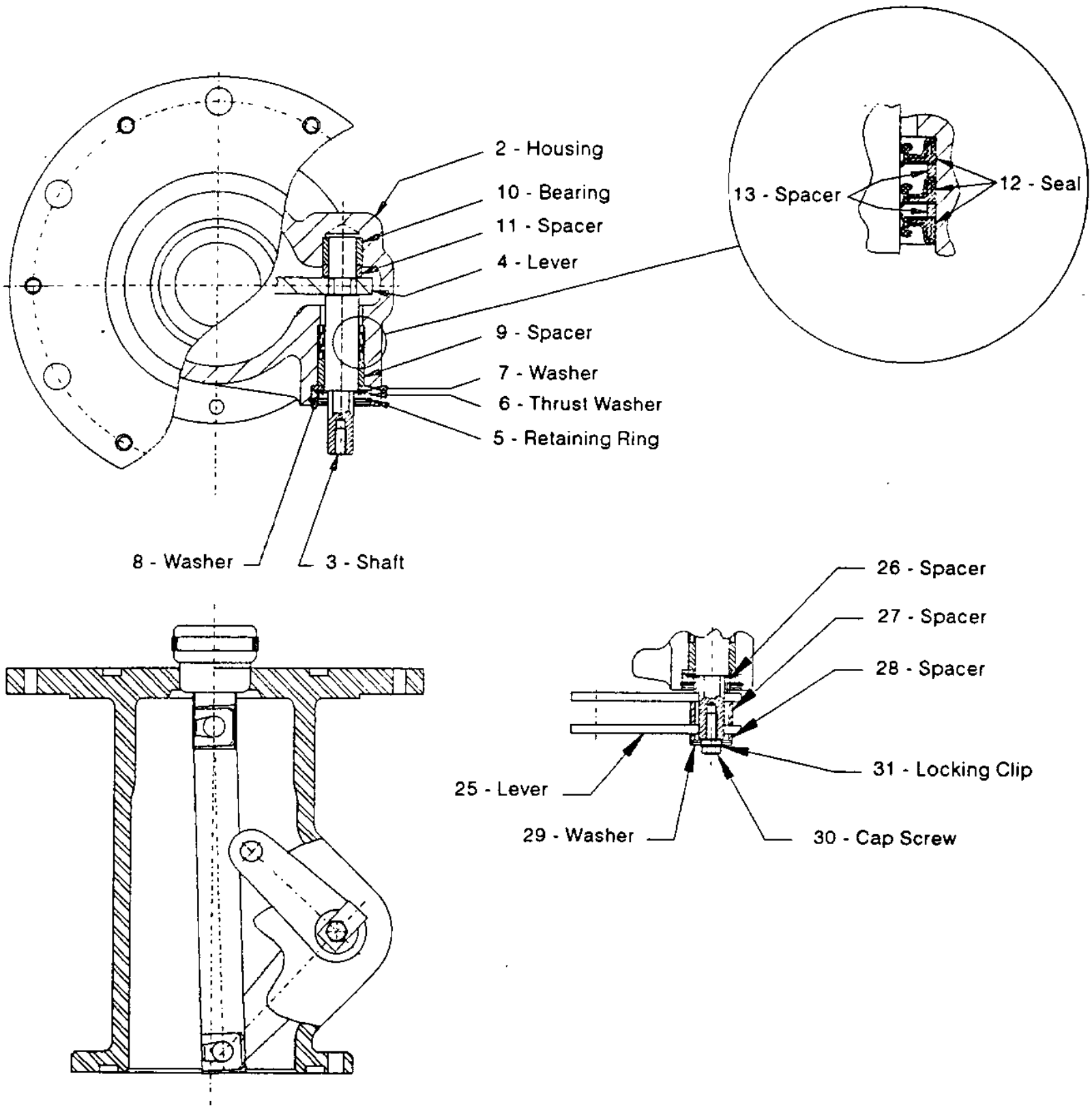


Figure 28 -- Housing/Seal Assembly

Illustrations

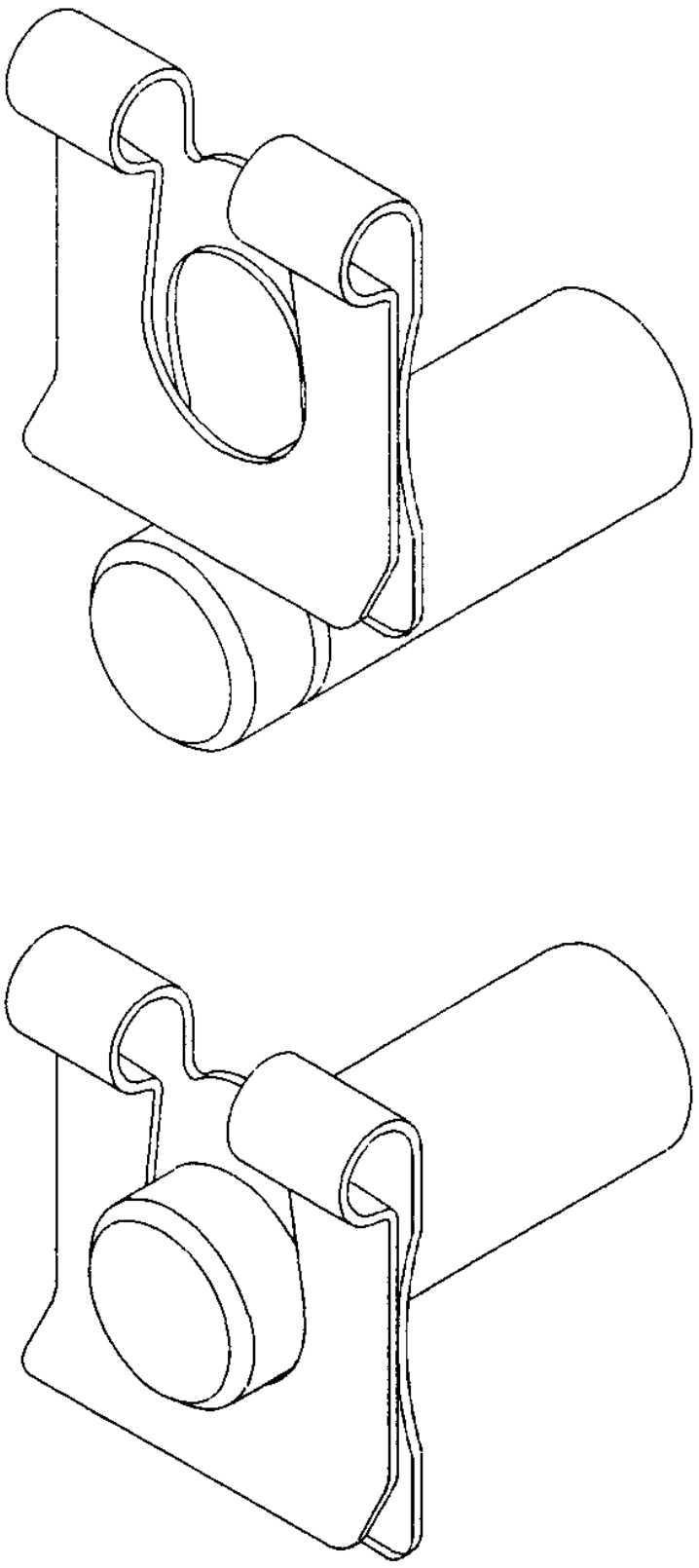


Figure 29 -- Locking Clip

72-265-100-425

Illustrations

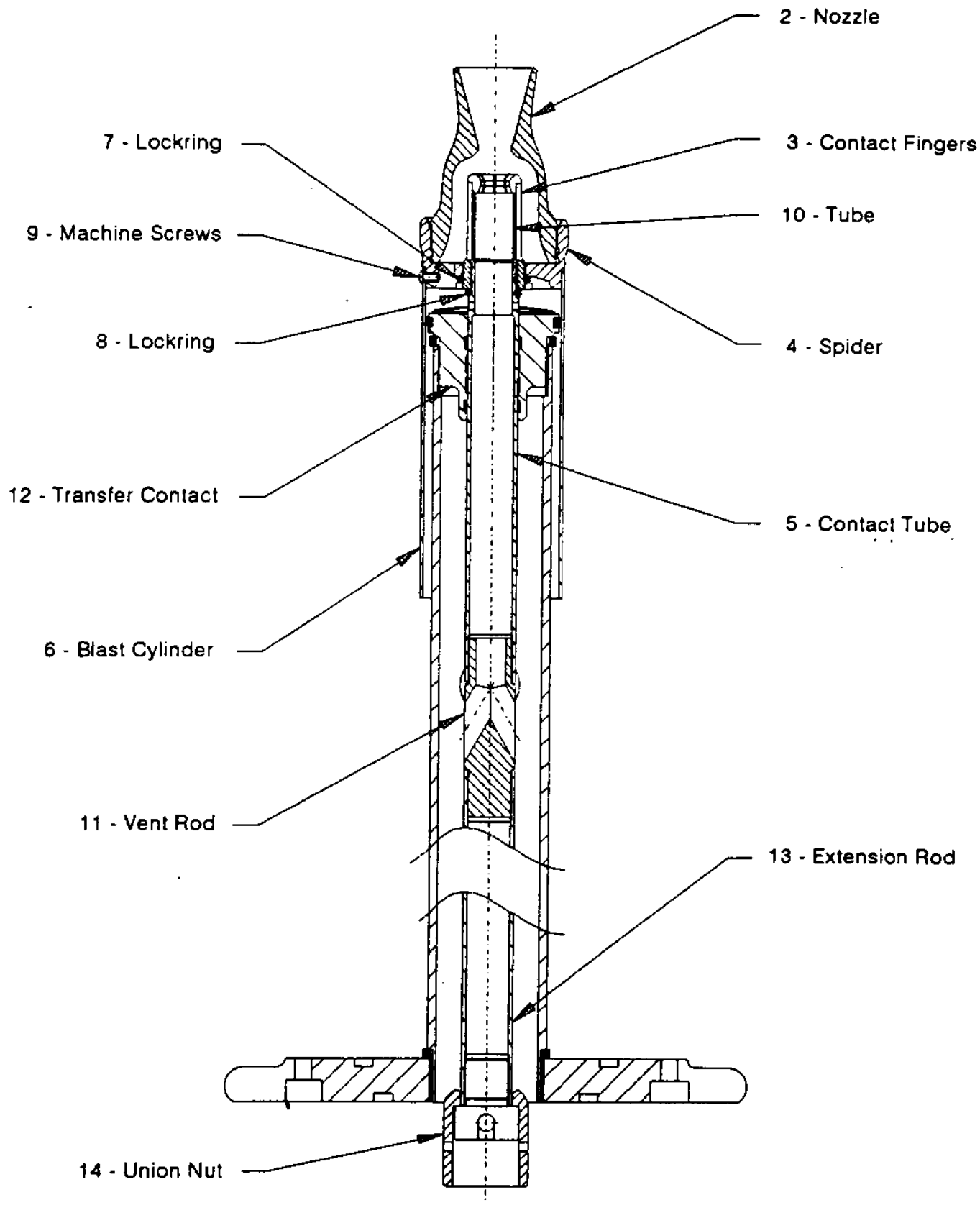


Figure 30 - Movable Contact

72-265-100-415

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