SIEMENS

Instructions

Installation
Adjustment
Maintenance

Type SPS-121, 145 and 169 Gas Circuit Breaker Spring Operating Mechanism

PB 3508-01

For Emergency Service
Call: 1-800-241-4453

Siemens Energy & Automation, Inc.

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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.

General

Introduction

The SF_6 circuit breaker is one of the most important units in electrical power systems. The protection, stability, and continuity of service of the entire system depend largely on the efficiency of its operation. Designed for use on 121/145 kV systems, Siemens Type SPS circuit breakers protect electric utility systems by interrupting fault currents and switching line, load, and exciting currents.

Siemens outdoor circuit breakers are precision built devices designed to function efficiently under normal operating conditions. They are designed and manufactured to operate within the ANSI C37 standards applicable to the breaker rating.

The successful field performance of these breakers 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.

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 breakers. For proper installation and operation - resulting 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, they 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.

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 from electrical shock, burns and entanglement in moving parts will result from misuse.

To prevent:

Do not service or touch until you have de-energized high voltage, grounded all terminals and turned off control voltage. Grounding terminals with line to ground capacitors may produce a small arc.

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.

Installation and Maintenance Alerts

Pre-Operational Checks

When installing, adjusting, maintaining, inspecting or replacing parts of a breaker, the following pre-operational checks should be followed for ease of operation and safety.

1. Read the circuit breaker instruction book supplied with the breaker.
2. Check for proper installation and/or alignment by following the "installation" section.
3. Check for the proper maintenance procedures by following the "Maintenance/Parts Replacement" section.
4. Do not operate the breaker until the items listed above are completed and functioning properly.

⚠ DANGER

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

To prevent:

This equipment should be installed, operated and maintained only by qualified persons thoroughly familiar with equipment INSTRUCTION MANUALS and drawings.

No attempt to operate the breakers should be made until all shipping braces and/or ties have been removed, the breaker has been inspected and the breaker has been filled with SF_6 gas.

The wiring and schematic connection diagrams supplied with the breaker should be used when testing and checking the operating mechanism and control circuits. Check all wiring for looseness.

Maintenance

Work on the breaker should be performed only by qualified personnel. The breaker should be in the open position and with the operator's system indicating discharged. In addition, all electric power to the breaker and its controls should be disconnected and properly grounded. When performing maintenance or adjustments requiring the breaker to be closed and charged, the release latch should be blocked in position to prevent accidental tripping and possible 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:

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 breaker while working on it, since the parts move rapidly and can cause injury.
3. Discharge the breaker's energy storage system before performing maintenance or inspection.
4. Breaker 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 operate the breaker manually while it is energized or control power is connected.
8. 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 Closing Device

The breaker contacts may be "slow opened-closed" for adjustment and alignment inspection using the maintenance closing device.

DANGER

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

To prevent:

Do not service or touch until you have de-energized high voltage, grounded all terminals and turned off control voltage. Grounding terminals with line to ground capacitors may produce a small arc.

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.

The hand closing device is a screw type jack with a ratchet handle and is supplied separately as an installation and maintenance tool. The closing device is attached for maintenance use only. For slow opening with the closing 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 (see Figure 20, Page 83).

Current Transformers

DANGER

Hazardous voltage.
Death, serious injury, or damage to the circuit breaker will result.

To prevent:

Current transformers must not be operated with an open circuit and must be either connected to a burden or short circuited and grounded at the terminal blocks.

If a short circuit is to be made, the connection should be across the taps of the highest ratio, otherwise, dangerous voltages may occur across the open transformer secondary terminals.

Description

Breaker Overview

Each breaker consists of three identical pole units mounted on a breaker frame. Each pole unit consists of two SF_6 gas bushings mounted on a grounded metal housing which contains the interrupter. Each interrupter is mechanically connected to the operating mechanism through a connecting rod, operating shaft assembly, lever, tie bar, and horizontal pull rod. A spring acts to open the breaker and the spring operating mechanism closes the breaker. Bushing type current transformers, when ordered, are mounted to each pole unit. The circuit breaker is filled with 5 psig SF_6 gas at the factory to maintain a positive pressure. In the field SF_6 is added during installation. See breaker nameplate for fill pressure.

Supporting Legs

To facilitate shipment the breaker was designed with a low profile. Four telescoping legs are shipped attached to the breaker frame. At installation raise the breaker using the lifting lugs and lower the legs to the proper height.

Spring Operating Mechanism

A Type SPS-SE-4 stored energy mechanism is used to operate the Type SPS breaker. The mechanism is electrically trip-free. Each mechanism is complete with its own motor for open-t-close-open operations. The weatherproof cabinet has a large access doorway, sealed with rubber gaskets, to provide easy access for inspection and maintenance. A heater provides continuous inside-outside temperature differential, with additional thermostatically controlled heaters for winter use when required. Included in the housing are necessary auxiliary switches, cut-off switch, alarm switch and operation counter. The control relays and control switches (one each for the control circuit, motor, and heater circuit) are also mounted inside. Terminal blocks inside the housing are provided for control and transformer wiring. The SPS-SE-4 mecharism provides reclosing speeds of approximately four and one-half cycles.

⚠ DANGER

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

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.

Operating Linkage

The components of the operating linkage contained in the mechanism cabinet and linkage cover are as follows:

1. An adjustable horizontal pull rod which connects the mechanism bellcrank lever to the tie bar and operating lever assemblies.

2. The tie bar and pole unit operating lever assemblies which convert horizontal motion into rotational motion at the pole unit operating shafts.

3. The opening spring, which is connected to the outboard bearing lever, provides the force necessary to open the breaker.

4. A hydraulic shock absorber which minimizes overtravel at the end of the opening stroke.

Description

Bushings

The bushings are SF_6 gas insulated and have porcelain weather casings.

SF_6 Puffer Interrupter

The interrupter is two subassemblies mounted inside each pole unit pipe. Electrical connections to the bushings are made through plug-in connections which are part of the interrupter subassembly. Each interrupter consists of a stationary contact assembly and a moving contact assembly.

Current Transformers

⚠ DANGER

Hazardous voltage.
Death, serious injury, or damage to the circuit breaker will result.

To prevent:

Current transformers must not be operated with an open circuit and must be either connected to a burden or short circuited and grounded at the terminal blocks.

If a short circuit is to be made, the connection should be across the taps of the highest ratio, otherwise, dangerous voltages may occur across the open transformer secondary terminals.

Current transformers can be mounted at the base of each bushing. Transformers are usually of the multi-ratio type, having five leads to provide a range of ratios. Transformer leads are brought through conduit to the mechanism cabinet where they are connected to terminal blocks. The transformers are normally of the relaying accuracy class; however, single ratio metering accuracy transformers and linear couplers are available.

Rupture Disc And Guard

A rupture disc and guard assembly is mounted in the pole unit housing end cover. Should the pressure in the pole unit accidentally reach 154 psig ± 8 psig, the disc would rupture exhausting the SF_6 gas to atmosphere. The guard acts as a baffle directing the exhausted gas and rupture disc fragments upward.

Pressure Gauge

A Bourdon tube type pressure gauge (30 inches vacuum to 160 psig) for indicating the SF_6 gas pressure of all three phases is mounted inside the cabinet. Fluctuations will be noted with ambient temperature changes.

Ground Pads

Two NEMA standard ground pads are mounted on the breaker frame, one on the left front and one on the right rear. One NEMA standard ground pad is mounted on the cabinet.

Lifting Lugs

Four lifting lugs are bolted to the breaker support frame.

Characteristics of Sulfur Hexafluoride

Sulfur hexafluoride in a pure state is inert and exhibits exceptional thermal stability. It has excellent arc quenching properties. These characteristics combined with its good insulating properties make it an excellent medium for use in circuit breakers.

Chemically, SF_6 is one of the most stable compounds. In the pure state, it is inert, non-flammable, non-poisonous, odorless, and produces no harmful effects on personnel. However, after the gas has been exposed to an electric arc there will be some breakdown of the gas. Molecular sieve filters are used in the apparatus to remove most of the gaseous by-products and some of the gas-borne

powders. These by-products are injurious and exposure to them should be avoided by maintenance personnel. The precautions to be followed in handling the gas are covered in detail in the MAINTENANCE/PART REPLACEMENT section.

There is some depreciation of the gas properties after extended periods of arcing; however, such change is very slight and has a negligible effect upon the dielectric strength and arc interrupting ability. Furthermore, the solid arc products formed at arc temperatures are the metallic fluorides, which are good insulators under the conditions existing in the breaker.

Sulfur hexafluoride is furnished in standard industrial type cylinders, color-coded green at the top end and the balance silver for easy identification. The cylinders have special size (.965" diameter - 14 threads/inch Nat. Std. left hand) pressure connections supplied for absolute safety. The adapter for connection to the cylinder is a CGA #590 bullet-shaped coupling nipple with .960 left hand, external male thread, 14 threads/inch. The gas is stored in the cylinders at approximately 300 psig pressure which is the vaporization pressure at 75°F, and each cylinder contains 115 pounds of gas. Smaller cylinders containing 25 pounds of gas are also available.

The breaker requires approximately 75 lbs. of sulfur hexafluoride (SF_6) to fill to the recommended operating pressure, shown on the density chart (Figure 11, Page 52).

SF_6 Density Switch

The breaker has a temperature compensated pressure switch, which is located inside the cabinet. The temperature sensing bulb extends through the cabinet and into the pole unit end cover and is protected by flexible conduit.

See breaker nameplate for switch alarm and cutout settings.

Receiving, Handling and Storage

Receiving

All type SPS breakers are assembled and production tested at the factory, after which they are carefully inspected and prepared for shipment. Breakers covered by this instruction book are normally shipped completely assembled, except for the four legs which are retracted to facilitate shipment. Each breaker is shipped from the factory with approximately 5 psig SF_6 gas to insure a dry atmosphere during transit in order to protect the insulation.

NOTE Upon receipt of a circuit breaker, it should be examined for any damage sustained in transit. Damage should be reported immediately to the carrier and the nearest Siemens sales office.

Unpacking Parts and Accessories

Check all parts against the shipping list as they are unpacked and identified. Search the packing material carefully for bolts, nuts, screws, etc., which may have loosened in transit. Instruction books, cards, or leaflets shipped with the breaker should be kept with the breaker.

Handling Procedure

⚠ WARNING

Heavy equipment with a high center of gravity.
Death, serious injury, or damage to the circuit breaker could result.

To prevent:

Follow instructions below during handling to prevent the breaker from tipping over and/or being suddenly dropped.

The weight of the breaker is listed on the nameplate. Breakers must be lifted by hooking onto four lifting eyes on the breaker support structure. Four cables of the proper length (9' long) should be used to avoid interference with the bushings.

⚠ WARNING

Pressurized bushings.
Death, serious injury, or damage to the circuit breaker during handling could result.

To prevent:

Do not strike, shock or strain the bushings or in any way cause the bushings to rupture.

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

When moving breaker, do not lash the breaker down by the bushings.

Storage Of Breaker And Breaker Parts

Even though the breaker may not be placed into service immediately, installation in its permanent location is recommended. If this is not practicable, it should be stored in a place where it can be protected from mechanical damage. The following precautions should be taken:

Each breaker is shipped from the factory charged with approximately 5 psig of SF_6 to ensure a dry atmosphere during transit in order to protect the insulation. This positive pressure must be maintained during storage. Pressure readings should be monitored and recorded monthly during storage. If for some reason the shipping pressure is lost and leakage is suspected, the source of leakage should be located and repaired. The breaker should be purged of moist atmosphere by evacuating to approximately 2 millimeters of mercury. SF_6 should then be admitted to a pressure of 5 psig and maintained during storage.

All accessories, spare parts, and tools should be stored indoors and protected from dirt and moisture.

The operating mechanism and controls should be protected against corrosion. This is best accomplished by closing the cabinet doors and energizing the space heaters. This is recommended even if it requires the use of a temporary electrical circuit to the heaters.

Installation

NOTE The Type SPS breaker has been completely assembled, tested, and inspected at the factory and requires a minimum of field checks during installation.

The installation checklist located at the end of this section is intended to provide a tabulation of those checks and tests necessary to effect a proper installation. Actual measured values should be entered on the blank spaces rather than an indication that the values were within the prescribed tolerances as the installation checklist is also intended to be used as a reference when inspection and maintenance is performed.

Tools And Service Equipment

The following material and equipment is required for the installation of the Type SPS circuit breaker, and should be available before commencing work. These items are not supplied by Siemens.

1. Leak-tec for leak testing.
2. Six (6) ton crane with a working height of 25 feet.
3. Four (4) hook chains 9 feet long.
4. Ten (10) foot "A" frame step ladder to work at the top of the breaker.
5. Shim material - various thicknesses.
6. Wrenches - standard sizes of open end or box type.
7. 0 to 100 ft.-lb. and 0 to 400 ft.-lb. torque wrench and sockets.
8. Thermometer accurate within 2°F.
9. 1/4 inch blade screwdriver.
10. Timing equipment and mounting hardware - see Final Tests, Page 10.
11. Corrosive-resistant conductive joint compound and wire brush or steel wool.
12. Ductor or equivalent 100 Amp. DC source with micro-ohmmeter.

The following items are more difficult to procure and are provided by Siemens with each breaker order.

1. Adapter fitting for SF_6 filling.
2. Service hose for SF_6 filling.
3. SPS-SE 4 linkage hand closing device.
4. SF_6 gas, if ordered.
5. Timer mounting bracket.

Selecting The Location

The breaker should be installed with sufficient space for cleaning, inspecting, opening doors, and operating the hand closing device. Refer to the outline drawing located in the pocket of the mechanism cabinet door.

The foundation should be prepared before the breaker arrives and should be level within .25" at the four stud locations. Use shims to level breaker when setting breaker on foundation. Consult the outline for necessary dimensions and foundation bolt locations. The breaker foundations should be high enough to prevent flood water from entering the mechanism housing.

Placement Of The Circuit Breaker

Place the breaker on the permanent foundation. The precautions described under "Handling Procedure", Receiving, Handling and Storing section, Page 7, must be observed.

⚠ WARNING

Pressurized bushings.
Death, serious injury, or damage to the circuit breaker during handling could result.

To prevent:

Do not strike, shock or strain the bushings or in any way cause the bushings to rupture.

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

Installation

The breaker must be lifted in order to extend the four legs. The legs should be first assembled to the breaker, then the breaker assembly bolted to the foundation. Bolts should be firm but not tight to allow proper alignment. Insert shims, if necessary, under the legs to level the breaker before tightening the foundation bolts. The circuit breaker should be level so that moving parts within the breaker can operate freely; otherwise, friction may develop and undue strains may be imposed which could result in breaker malfunction. When breaker and legs are properly aligned and leveled, tighten all bolts securely to the torque value specified on Figure 1, Page 42.

Grounding Connections

Two NEMA standard ground pads are located on the breaker mechanism housing, one on the left side and one on the right side. One NEMA standard ground pad is located on the 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.
Death or serious injury due to electrical shock could result.

To prevent:

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

Avoid poor grounds because they can give a false feeling of security to those working on the circuit breaker.

Control Wiring

All control wires to the circuit breaker should be in conduit where practicable. A control wiring diagram is located in the pocket on the inside of the mechanism cabinet door. The control wiring should be installed so that trouble with any other equipment cannot be communicated to the control wiring of this breaker. The breaker requires the full rated control voltage as specified on the nameplate in order to perform a close or trip operation.

The proper wire size should be selected to minimize the voltage drop; otherwise, tripping time could be increased.

Connecting Current Transformers

⚠ DANGER

Hazardous voltage.
Death, serious injury, or damage to the circuit breaker will result.

To prevent:

Current transformers must not be operated with an open circuit and must be either connected to a burden or short circuited and grounded at the terminal blocks.

If a short circuit is to be made, the connection should be across the taps of the highest ratio, otherwise, dangerous voltages may occur across the open transformer secondary terminals.

Bushing-type current transformers, supplied only when ordered, are mounted externally around the pole unit (see Figure 1, Page 42).

Transformers are usually of the multi-ratio type with five leads to provide a wide range of ratios. These leads are brought into the mechanism cabinet to terminal blocks. Each lead has an identification lettered on the terminal block marking strips. Refer to the table on the current transformer nameplate, which is mounted to the inside of the cabinet door, to determine the transformer taps required to obtain the desired ratio. Care must be exercised so as not to confuse the polarity of the transformers. If there is any question as to the proper method of connection, refer to the polarity, ratio, and connection diagrams. These diagrams are supplied as part of the detail drawings for the order.

Filling A De-energized Breaker With SF_6

Each breaker is shipped with a positive pressure of approximately 5 psig of SF_6. Evacuation is not required before filling. Before filling with SF_6 check the pressure gauge 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 pull a vacuum to 2 mm of Hg before filling with SF_6.

Before the breaker is operated or placed into service it must be filled with sulfur hexafluoride gas to the proper pressure taking into consideration the ambient temperature (see Figure 11, Page 52).

The SF_6 can be supplied from a service unit, or directly from a gas cylinder. If it is necessary to evacuate the breaker, use of a service unit is recommended; otherwise, it is more convenient to fill directly from a bottle. The fill valve is located inside the cabinet (see Figure 2, Page 43).

Equipment required to fill from a bottle:

1. SF_6 pressure regulator (preferred) or the SF_6 cylinder adapter supplied with the breaker tool kit.
2. Hose supplied with the tool kit.
3. Adapter fitting supplied with the tool kit.
4. Wrenches
   a. 11/16"
   b. 5/8"
   c. 1"
   d. 3/4"
   e. 3/8" Hex Key
   or 8" and 10" adjustable wrenches
5. Thermometer for ambient temperature measurement. One 115 lb. - cylinder of SF_6 will be required to completely fill a breaker. Proceed as follows:
   a. Remove cap from the SF_6 cylinder fitting and attach the SF_6 pressure regulator or the special adapter.
   b. Remove cap from the breaker fill valve fitting.
   c. Attach and tighten hose to regulator or adapter.
   d. "Crack" SF_6 cylinder valve and the hose end quick connect fitting and allow SF_6 gas to flow through hose, thereby purging air from hose.
   e. Shut off cylinder valve and connect the hose to the fill valve.
   f. Open SF_6 cylinder valve slowly and fill to proper SF_6 pressure determined by ambient temperature measurement and reference to Figure 11, Page 52.
   g. After the proper pressure is obtained shut the cylinder valve. Disconnect the hose from the breaker fill valve fitting. Replace the cap on the breaker fill valve.

Refill and check for leaks if the pressure falls below the minimum curve shown in Figure 11, Page 52.

The moisture content of the SF_6 should be no higher than 300 ppm(v). If the pole units have not been opened or exposed to a humid atmosphere, it will not be necessary to check for moisture after filling from an SF_6 bottle. If there is reason to suspect high moisture, do not use the rubber filling hose for checking. Use stainless steel tubing for this purpose.

Checking The Spring Operating Mechanism

Read carefully the Operating Mechanism Instruction Book (Appendix I) included with this instruction book for information on the operating and maintenance of the spring mechanism. Inspect all insulated wiring for damage.

Breaker Inspection

The Type SPS breaker has been completely assembled, tested, and inspected at the factory. However, to preclude breaker malfunction due to shipping damage, it is recommended that a final check should be made for loose hardware, wire connections and locking devices.

Final Tests

To check the breaker timing, a Doble travel analyzer or slide wire/oscillograph may be used.

The travel analyzer transducer or slide wire may be mounted on the mechanism as shown in Figure 3, Page 44.

Make a trip operation and measure the contact part time. If the contact part time exceeds 33.3 ms (2.0 cycles), the difficulty may be due to excessive voltage drop in the d-c control cable to the breaker.

In some instances, breaking of the main contacts may be followed in one or more poles by intermittent touching of the arc ring and the stationary contact. On a travel analyzer trace or an oscillogram, this would appear as if the main contacts reclose, or "bounce", for a period of up to 3 ms following contact separation. This behavior is completely normal and not cause for concern.

Perform a close operation and measure contact make time. Contact make time should be 3.9 to 6.0 cycles (65 to 100 ms).

As with an open operation, arc rings touching the stationary contacts may result in premature, intermittent indication of contact make, up to 5 ms before actual contact make. Contact velocity during open and close

operations is set at the factory and need not be checked or adjusted prior to installation. If, however, you check contact velocity and find it out of limits, be sure the test equipment is functioning properly. If possible, recheck the results with another test set. If the breaker is still out of specification, consult the factory.

Perform an open-close-open operation. Measure the reclose time and the in-contact time. Unless specifically ordered otherwise, the reclose time will be approximately 10 cycles. If a special reclose time was ordered, an adjustable time-delay relay (79X) will be provided. Adjust this relay, if necessary, to obtain the desired close time.

In-contact time should be 35 - 45 ms. If a substantially different time is measured, check the angular position of the auxiliary switch 52a contact in the trip circuit. This contact should be positioned in a horizontal plane with the breaker in the open position (see Figure 19, Page 82). Refer to the APPENDIX I section of this manual for auxiliary switch adjustment instructions.

Contact Resistance

Measure the contact resistance terminal to terminal with a ductor, or equivalent 100 amp d-c source. Record the contact resistance of each pole to provide a permanent base-line reference against which future measurements can be compared.

Establishing a base-line value is particularly important for contact resistance measurements. Small variations in the chemical makeup of the conductor alloy from one lot to another are inevitable, and these can result in appreciable 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 the resistance.

Maximum values for new contacts are 150 micro-ohms for 2000 amp breakers and 105 micro-ohms for 3000 amp breakers.

Line Connections

Line connections should have sufficient flexibility and support to limit the load on the bushings (150 lbs. max.). Conductor and connector must have adequate current carrying capacity to prevent heat transfer into the breaker bushing. All joints must be clean, bright and free from burrs or surface roughness, and assembled using "joint compound".

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

Bushings

The porcelain bushings should be cleaned with alcohol, or other approved solvent.

Final Installation, Connections and Inspection Summary

Station _____ Bus or Line _____

Installation Date _____

1. Nameplate Data

   1.1 Breaker Type _____ Amp. _____

   Serial-S.O. _____ I.B. PB-3508

   1.2 Mechanism Type SPS-SE-4 I.B. APPENDIX-I

   Control Diagram _____ Control Voltage _____

   Motor and Heater Voltage _____

2. General Condition of Breaker when Received: _____

Note The following checks are to be made after the breaker has been set, leveled, and bolted to its permanent foundation.

3. Breaker Bolted to its Permanent Foundation and Shipping Braces Removed

4. Grounding Connections Installed (Left)

   (Right)

   (Cabinet)

CAUTION

Improper operation may result in breaker damage.

To prevent:

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

5. Control Wiring Installed

6. Current Transformer

DANGER

Hazardous voltage.
Death, serious injury, or damage to the circuit breaker will result.

To prevent:

Current transformers must not be operated with an open circuit and must be either connected to a burden or short circuited and grounded at the terminal blocks.

If a short circuit is to be made, the connection should be across the taps of the highest ratio, otherwise, dangerous voltages may occur across the open transformers secondary terminals.

6.1 Connections made

7. Fill Breaker with SF_6

8. Spring Mechanism (See Appendix I)

9. Breaker Inspection

9.1 Final check for loose hardware.

10. Timing Tests (These tests are to be made at normal operating voltage.)

10.1 Trip coil energized until contacts part (33.3 milliseconds max.) Open velocity 4.2-4.5 msec (Figure 4, Page 45). _____ milliseconds

10.2 Close and coil energized until contacts touch (100 msec max.). _____ milliseconds

10.3 Close velocity, check close velocity limits; 2.7 m/sec. minimum, 3.5 m/sec. maximum during 10 ms before contact touch (Figure 5, Page 46). _____ Phase 1
_____ Phase 2
_____ Phase 3

10.4 Reclose time (if required) trip coil energized until contact touch (approximately 180 milliseconds based on an average close time of 85 millisecond and 66 millisecond time delay). _____ milliseconds

SF_6 Pressure _____ psig

Ambient Temperature _____ ^{o}F

10.5 Close-open in-contact time (35 - 45 msec).

11. Contact resistance terminal to terminal measured with ductor or equivalent 100 amp d-c source 150 micro-ohms max. (2000A) or 105 micro-ohms max. (3000A) for new contacts.

(Pole 1) _____ micro-ohms

(Pole 2) _____ micro-ohms

(Pole 3) _____ micro-ohms

12. SF_6 Pressure Switch Operation

Temperature-Compensated Sw.

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

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

The temperature-compensated switch operation can be checked by dropping the pressure at the quick disconnect fill fitting inside the cabinet. The switch should be set to operate to follow the curve in Figure 11, Page 52 within +2 psig. See Figure 14, Pages 55-56, for setting directions.

13. Operation Counter Reading as Left _____

14. SF_6 Gas Pressure As Left

SF_6 Pressure _____ psig

Ambient Temperature _____ °F

15. Elapsed Time Meter Reading as Left

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

Principles of Operation

Closing

CAUTION

Improper operation may result in breaker damage.

To prevent:

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

To close the breaker, a low energy electrical signal actuates a solenoid on the Type SPS-SE-4 mechanism. The closing force is transmitted through a bellcrank to the horizontal linkage which charges the opening spring and draws the moving contacts to the closed position. Having reached the full closed position a mechanical latch in the Type SPS-SE-4 mechanism is engaged to hold the breaker in the closed position.

Opening

Energy for opening is stored in the opening accelerating spring located inside the linkage cover. When tripped, the spring transmits its energy to a single, horizontal linkage located in the linkage cover to a lever at each interrupter which transfers the motion to the moving contact assemblies. As the breaker opens, the moving contacts move horizontally and an electrical arc is formed in the chambers of the interrupters between the moving and stationary contacts. The internal construction of the interrupter assures efficient extinction of the arc. Since the interrupter performance is velocity dependent, the opening spring controls the moving contact velocity throughout the opening stroke. A hydraulic shock absorber provides the necessary shock absorbing action at the end of the opening motion.

Spring Operating Mechanism

The Type SPS-SE-4 spring mechanism is used to operate the Type SPS breaker. Details of the operation of the mechanism are contained in Instruction Book APPENDIX I.

Bellcrank Assembly

(Figure 6, Page 47)

The primary function of the bellcrank assembly is to convert the motion of the mechanism into horizontal motion. The motion of this lever is transmitted through a horizontal pull rod to a tie bar crank housing. The tie bar is attached to the operating linkage. With the breaker and mechanism in the open position, the spring is at the upper limit of its travel. A position indicator is located in the mechanism cabinet and is attached to the auxiliary switch. Its motion and position coincide with that of the bellcrank lever. Closed and open position overtravel stop bolts are positioned to contact the bellcrank lever.

Operating Shaft Assemblies

Attached to the horizontal tie bar through the operating levers are the operating shaft assemblies. These convert horizontal motion of the operating linkage through rotary motion to straight line motion of the moving contact connecting rods. Each of the three operating shaft assemblies incorporates a seal arrangement to prevent SF_6 gas leakage from the interrupters.

Opening Spring

The opening spring is located inside the linkage cover. This is the main force to open the breaker at the proper velocity and provide the proper contact part time. When the breaker closes, the spring is compressed and is in position for the next open operation.

Interrupter Assemblies

(Figures 7-10, Pages 48-51)

The interrupter consists of two separate assemblies -- a moving contact assembly and a stationary contact assembly. The moving contact is attached to the operating shaft assembly casting with a bolted flange joint. The stationary contact is attached to the pole housing casting also with a bolted flange joint. Each assembly contains a flange, an insulating support tube, and a contact carrier to which the contacts are assembled. Both contact carriers contain spring loaded, finger type plug in contacts for the bushing leads. There is no fiberglass or polyester insulating tube between the stationary and moving contact assemblies.

Principles of Operation

Interrupter Operation

With the interrupter in the closed position, the main current path is through the continuous current fingers which are parallel to the arcing contacts. Since the continuous current fingers are not arced during interruption, they maintain low resistance for the life of the interrupter.

During the opening operation, the piston compresses the SF_6 in the compression volume. When the arcing contacts have parted, gas flows through the heating volume and along the arc which is contained in the teflon nozzle and exhausts through the hollow moving arcing contact and through the stationary contact assembly. This puffer action is sufficient for low current faults and switching operations. During high current interruptions, heat from the arc causes the pressure to rise in the heating volume which closes the check valve. The pressure in the heating volume continues to rise until the throat of the nozzle clears the stationary arcing contact, allowing the high pressure gas from the heating volume to flow through the nozzle extinguishing the arc. The gas that is trapped in the compression volume after the check valve closes is vented into the tank across the relief valve in order to prevent a decrease in contact velocity during high current interruptions. All of the hot gas and arc products are contained in the pole unit housing.

Hydraulic Shock Absorber

A hydraulic shock absorber is mounted on the mechanism bellcrank assembly and is contacted by the bellcrank lever during the opening stroke. This shock absorber serves to control the deceleration phase of the opening stroke and minimizes overtravel. The hydraulic shock absorber is factory sealed and adjusted and normally requires no maintenance.

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 breaker. 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 breaker has been required to interrupt.

Record keeping of this type will permit accurate evaluation of the conditions of the breaker 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, contact timing, etc., 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. Breakers installed in areas of severe environmental conditions may require more frequent inspection procedure. 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 deenergized high voltage, grounded all terminals and turned off control voltage. Grounding terminals with line to ground capacitors may produce a small arc.
2. Never trip or close the breaker while working on it, since the parts move rapidly and can cause injury.
3. Discharge the breaker's mechanical systems before performing maintenance or inspection.
4. Secure the operator against accidental tripping when adjustments require breaker in closed position.
5. Breaker and its mechanism must be disconnected from all electrical power before performing maintenance or inspection. Grounding leads should be properly attached and framework grounded.
6. Never slow operate the breaker while it is energized or control power is connected.
7. Remove the maintenance closing device before operating the breaker.
8. 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 breaker 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 breaker has been disconnected from power lines, attach the grounding leads properly before touching any of the circuit breaker parts.

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

STEP 4

Be sure the circuit breaker 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 breaker 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 breaker. 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 breaker. By making the checks identified on the list, it can be verified whether or not the breaker is satisfactory for continued service without performing a Major Inspection.

Major Inspection

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

1. The accumulated interruptions equal 10-40kA faults or 25-20kA faults.
2. 2,000 mechanical operations have been made.

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

Inspection

Notes/Comments:

Periodic Inspection Checklist

Station _____ Bus or Line _____

Date of Inspection _____

1. Nameplate Data

   1.1 Breaker Type _____ Amp. _____

   Serial-S.O. _____ I.B. PB-3508

   1.2 Mechanism Type SPS-SE-4 I.B. APPENDIX-I

   Control Diagram _____ Control Voltage _____

   Motor and Heater Voltage _____

Monthly Checks

2. General Condition of Breaker: _____

3. Spring Mechanism (Appendix I)

   Operation Counter Reading _____

4. Breaker Checks

   SF_6 Gas Pressure

   SF_6 Pressure _____ psig

   Ambient Temperature _____ °F

6 Month Checks
(In Addition to Monthly Checks)

5. Spring Mechanism (Appendix I)

Check all labels and nameplates attached to the breaker 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. Check contact position indicator with breaker in closed position. See Figure 6.

Pole 1 _____

Pole 2 _____

Pole 3 _____

Inspection

3-Year Inspection Checklist

Station _____ Bus or Line _____

Date of Inspection _____

1. Nameplate Data

   1.1 Breaker Type _____ Amp. _____

   Serial-S.O. _____ I.B. PB-3508

   1.2 Mechanism Type SPS-SE-4 I.B. APPENDIX-I

   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 breaker, trip the breaker and open adjacent breaker disconnect switches, solidly ground all bushing terminals to remove residual electrical charge and open all A-C and D-C switches. Grounding terminals with line to ground capacitors may product a small arc.

2. General Condition of Breaker: _____

3. Breaker Hold Down Bolts Tight _____

4. Grounding Connections Tight (Left) _____

   (Right) _____

Inspection

CAUTION

Improper operation may result in breaker damage.

To prevent:

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

5. Spring Mechanism (APPENDIX I)

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/ ADJUSTMENT AND LUBRICATION Section of the Mechanism Instruction Book. _____

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. _____

WARNING

Operation with jumper could result in damage to the circuit breaker.

To prevent:

Remove jumper after test.

5.2 Minimum operating voltages (See Mechanism nameplate for voltage ranges).

Close _____ Vd-c

Trip _____ Vd-c

6. Breaker Checks

6.1 Check contact position indicator with breaker in closed position.

(Pole 1) _____

(Pole 2) _____

(Pole 3) _____

6.2 Jack breaker to the open position.

Measure mechanism bellcrank travel from full closed to full open position (8.40 ± .03 inches). Remove maintenance hand jack from mechanism and timing device rod from tie bar.

_____ in.

7. Contact resistance terminal-to-terminal measured with ductor or equivalent 100 amp d-c source. 165 micro-ohms maximum for used contacts 2000A or 120 micro-ohms maximum for used contacts for the 3000 Ampere breaker. 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 (See Installation Checklist) for checking instructions.

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 Breaker Type _____ Amp. _____

Serial-S.O. _____ I.B. PB-3508

1.2 Mechanism Type SPS-SE-4 I.B. APPENDIX-I

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 breaker, trip the breaker and open adjacent breaker disconnect switches, solidly ground all bushing terminals to remove residual electrical charge and open all A-C and D-C switches. Grounding terminals with line to ground capacitors may product a small arc.

2. General Condition of Breaker: _____

_____

_____

3. Breaker Hold Down Bolts Tight _____

4. Grounding Connections Tight (Left) _____

(Right) _____

Inspection

CAUTION

Improper operation may result in breaker damage.

To prevent:

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

5. Spring Mechanism (APPENDIX I)

   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/ADJUSTMENT and LUBRICATION section, Page 40. _____

   5.3 Mechanism mounting bolts tight (250 ft.-lb.). _____ ft.-lb.

6. Breaker Checks

   6.1 Install maintenance hand jack and check the tie bar and make sure all three interrupter connecting rods operate freely and without interference during a manual (hand jack) operation.

   Interrupter 1 _____

   Interrupter 2 _____

   Interrupter 3 _____

   Mechanism _____

   6.2 Check contact position indicator with breaker in closed position (Figure 6, Page 47). _____

   6.3 Check minimum contact touch. (Refer to "Lubrication" in MAINTENANCE/ADJUSTMENT and LUBRICATION Section.

   (Pole 1) _____

   (Pole 2) _____

   (Pole 3) _____

   6.4 Check lever system open position stop clearance. There should be no clearance between the bellcrank lever and the stop bolt. (Refer to Figure 6, Page 47, and "Open Position Adjustments" in MAINTENANCE/ PART REPLACEMENT Section, Page 36.

   _____ in.

6.5 Final check for loose hardware. Remove maintenance hand jack. Reconnect the bushing line connections. (See "Line Connections" in INSTALLATION Section, Page 11.)

7. Mechanism Operational Checks. Reference APPENDIX I.

WARNING

Operating with jumper could result in damage to the circuit breaker.

To prevent:

Remove jumper after test.

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. Attach timing device to mechanism. (See Figure 3, Page 44.)

9.1 Trip coil energized until contacts part. (33.3 milliseconds max.) _____ milliseconds

9.2 Opening velocity-measured (4.2-4.5 msec). (See Figure 4, Page 45.) _____ m/sec

9.3 Close coil energized until contacts touch. (100 milliseconds max.) Close velocity 2.7-3.5 msec. (See Figure 5, Page 46.) _____ milliseconds

9.4 Reclose time (if required) trip coil energized until contacts touch (approximately 180 milliseconds based on average close time of 85 millisecond and a 66 millisecond time delay). _____ milliseconds

10. Contact resistance terminal to terminal measured with ductor or equivalent 100 amp d-c source 165 micro-ohms max. for used contacts on the 2000 ampere breaker; 120 micro-ohms max. for used contacts on 3000 breaker. 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 (See Installation Checklist) for checking instructions.

    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 Breaker Type _____ Amp. _____

   Serial-S.O. _____ I.B. PB-3508

   1.2 Mechanism Type SPS-SE-4 I.B. APPENDIX-I

   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 breaker, trip the breaker and open adjacent breaker disconnect switches, solidly ground all bushing terminals to remove residual electrical charge and open all A-C and D-C switches. Grounding terminals with line to ground capacitors may product a small arc.

2 General Condition of Breaker: _____

3. Breaker Hold Down Bolts Tight _____

4. Grounding Connections Tight

(Left) _____

(Right) _____

> **CAUTION**
>
> Improper operation may result in breaker damage.
>
> To prevent:
>
> Do not operate the breaker until all tests and inspections are done.

5. Spring Mechanism (APPENDIX I)

   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 (250 ft.-lb.). _____ ft.-lb.

6. Internal Inspection:

   6.1 Remove SF_6 gas from pole units as per Page 37, "Opening the Pole Units."

> **WARNING**
>
> Hazardous arc products.
> Death or serious injury could result.
>
> To prevent:
>
> Refer to MAINTENANCE Section for precautions to be observed when handling arced SF_6 gas.

   6.2 See MAINTENANCE/ADJUSTMENT AND LUBRICATION Section beginning with "Opening the Pole Units".

7. Mechanism Operational Checks. Reference APPENDIX I.

> **WARNING**
>
> Operating with jumper could result in damage to the circuit breaker.
>
> To prevent:
>
> Remove jumper after test.

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. Attach timing device to mechanism. (See Figure 3, Page 44.)

   9.1 Trip coil energized until contacts part. (33.3 milliseconds max.) _____ milliseconds

   9.2 Opening velocity-measured 4.2-4.5msec). (See Figure 4, Page 45.) _____ m/sec

   9.3 Close coil energized until contacts touch (100 milliseconds max.). Close velocity 2.7-3.5msec (See Figure 5, Page 46.) _____ milliseconds

   9.4 Reclose time (if required) trip coil energized until contacts touch (approximately 180 milliseconds based on average close time of 85 millisecond and a 66 millisecond time delay). _____ milliseconds

10. Contact resistance terminal to terminal measured with ductor or equivalent 100 amp d-c source 165 micro-ohms maximum for used contacts on the 2000 ampere breaker; 120 micro-ohms maximum for used contacts on 3000 breakers. 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

Inspection

11. SF_6 Pressure Switches (See Installation Checklist for checking instructions)

    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/Part Replacement

General

This instruction book section describes procedures to be followed when adjustments or part replacement is necessary as determined by the Installation, Periodic, 3 Year, 6 Years or Major Inspection Checklist or by circuit breaker malfunction. The step-by-step instructions given should be followed carefully to assure proper equipment operation. Reference to the included instruction leaflets and instruction books may be necessary.

Thorough, periodic inspection is important to satisfactory operation. Inspection and maintenance frequency 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.

Inspection and maintenance can be improved and simplified by using tools available from Siemens identified as Major Inspection Tool Kit (72-181-776-802).

⚠ WARNING

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

To prevent:

Inspection and maintenance can be improved and simplified by using the gauge and tools available from Siemens identified as Major Inspection Tool Kit (72-881-776-802).

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 breaker 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 breaker has been disconnected from power lines, attach the grounding leads properly before touching any of the circuit breaker parts.

⚠ 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:

1. **Do not service or touch until you have de-energized high voltage, grounded all terminals and turned off control voltage. Grounding terminals with line to ground capacitors may produce a small arc.**
2. **Never trip or close the breaker while working on it, since the parts move rapidly and can cause injury.**
3. **Discharge the breaker's energy storage system before performing maintenance or inspection.**
4. **Secure the operator against accidental tripping when adjustments require breaker in closed position.**
5. **Breaker and its mechanism must be disconnected from all electrical power before performing maintenance or inspection. Grounding leads should be properly attached and framework grounded.**
6. **Never operate the breaker manually while it is energized or control power is connected.**
7. **Remove the maintenance closing device before operating the breaker.**
8. **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.**

STEP 3
Be sure that the breaker is in the open position and that the mechanism closing spring is discharged before it is inspected or repaired.

STEP 4
Inspect the operating mechanism periodically and keep the bearing surfaces of the toggles, rods, and levers adequately lubricated where required. See "Lubrication of the Mechanism," Appendix I.

STEP 5
Keep the mechanism clean.

STEP 6
Be sure the circuit breaker is well grounded.

STEP 7
See that bolts, nuts, washers, cotter pins and all terminal connections are in place and tight.

STEP 8
After all inspections or maintenance operate the breaker 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, tampering by unqualified personnel, or incorrect adjustments could result in dangerous conditions which can cause serious injury or equipment damage.

To prevent:

Follow all safety instructions contained herein.

Ordering Replacement Parts

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

1. Breaker serial number. (On breaker and operator nameplates.)
2. Type of operator. (On operator nameplate.)
3. Type of breaker.
4. Rated amperes of breakers.
5. Rated voltage of breaker.
6. Description of part. Use instruction book description insofar as possible.
7. Operator instruction book number. (On breaker nameplate.)
8. Instruction book reference number.
9. Number of pieces required.

While the operator can be identified by the serial number alone, all additional information that is given will serve as a check to be certain that the part or parts furnished are correct for the operator in question. Without this serial number Siemens cannot be sure of the correct identify of the desired parts.

If any doubt exists as to the instruction book reference number of the description, a dimensional sketch of the desired part will help to properly 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. A list of recommended spare parts is sent with the breaker.

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

Maintenance/Part Replacement

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 24 feet and 2 rope slings (for removing the bushings, and if so equipped, the capacitor assemblies).

(MI) 10. 0-50 ft.-lb. torque wrench - 3/8" drive, (Snap-on Model TE 50 FFU-A Recommended) and 0-100 ft.-lb. torque wrench.

(6I) (MI) 11. Timing equipment and mounting hardware. (See "Final Tests" 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. Service hose and adapter for SF_6 filling (4).

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

(MI) 24. Contact alignment tool. (1)

(MI) 25. Manual Operator. (4)

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

(MI) 27. Bushing o-rings (3). (2)

(MI) 28. Vessel end cover o-ring (3). (2)

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

(MI) 30. Contact finger assembly tool. (1)

(MI) 31. Teflon nozzle gauge. (1)

(MI) 32. Spanner wrench. (1)

(MI) 33. Beacon #325 grease.

(MI) 34. Molecular sieve. (2)

(MI) 35. Dow Corning III.

(1) Available from Siemens as Major Inspection Tool Kit, Part No. 72-181-776-802.

(2) Available from Siemens as Major Inspection Parts Kit, Part No. 72-181-779-805.

(3) Shelf life 1 year.

(4) Available from Siemens as Installation Tool Kit, Part No. 72-181-776-801.

Spring Operating Mechanism

For maintenance, adjustment and lubrication of the Type SPS-SE-4 spring mechanism, refer to Appendix I.

Linkage Adjustment

(Figure 6, Page 47)

Closed Position Adjustments

Close the breaker using the slow close device until it latches. Back the slow close device off enough to ensure that the mechanism is latched in the closed position. There should be a small gap (a) between the mechanism bellcrank (2) and the closed position stop bolt (3). Adjust the horizontal pull rod (4) until pole unit indicators (5) are aligned with the closed position marks on the shaft housing (6). Apply Loctite 242 to the horizontal pull rod threads and tighten the lock nuts.

Open Position Adjustments

Unlatch the mechanism and open the breaker using the slow close device. The pole unit indicators (5) should be aligned with the open position marks on the shaft housing (6). If the indicators are not within the open position marks on the shaft housing, adjust the horizontal pull rod (4) and recheck in the closed position. If it is not possible to adjust the pull rod so that the pole unit indicators (5) are between the marks in both positions, consult a Siemens representative for mechanism adjustment.

Shock Absorber Adjustment

The shock absorber (8) should only require adjustment after resetting the open position stop bolt (7).

To adjust the shock absorber, loosen the M8 socket head set screw (9). Screw the shock in until it bottoms out. Additional turns of the shock will move the mechanism bellcrank (2) off of the open position stop bolt (7). Back the shock out one turn (360 degrees) from the bottomed out position. Tighten the set screw.

Travel curves should be taken after any linkage adjustment and the opening spring (10) should be adjusted from the initial 18.25 length to bring the opening and closing velocities within specification as required.

Opening Spring Adjustments

Any adjustment of the opening spring (10) will change both the opening and closing velocities. Shortening the length of the opening spring will increase opening velocity and decrease closing velocity. Both velocities must be within specification.

To adjust the opening spring (10), loosen the lock nut (11) and turn the adjusting nut in the desired direction. After adjustment, retighten the lock nut.

Take travel curves to ensure that the opening and closing velocities are within specification.

Closing Spring Adjustment

(Figure 22, Page 85)

The closing velocity can be adjusted after opening spring adjustments by shortening the initial length of the closing spring. This adjustment does not change the opening velocity. Adjustment of the opening spring changes both closing and opening velocities. The closing velocity should be the minimum velocity (within specification) required to reliably operate the breaker. Increasing the velocity above this point may increase wear and shorten the life of the mechanism. It is not good practice to set both closing and opening velocities to the maximum specified.

To adjust the closing spring with the spring discharged, loosen the locknut on the spring rod (19) and turn the rod "into" the rod end (18) in 1/4 turn increments. Tighten the locknut and recheck the velocity.

Opening The Pole Units

Place the breaker in the open position before removing SF_6 in preparation for opening the pole units. Remove SF_6 from the breaker through the fill valve until approximately 5 psig remains. Disconnect the SF_6 manifold from the pole unit to be opened. This isolates an individual pole from the rest of the breaker and allows opening the pole unit without contaminating the rest of the breaker. Evacuate the remaining SF_6 from the pole unit to be serviced through the pole unit quick disconnect fitting.

Burst Disk Replacement

(Figure 13, Page 54)

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

WARNING

Filling a breaker with SF_6 with one or more disconnect fittings at the pole unit not connected could cause death, serious injury, or damage the circuit breaker when the breaker is energized.

To prevent:

Connect all disconnect fittings at all three pole unit coverplates.

Pull vacuum and fill the breaker with SF_6 following the below procedure.

a. To replace the rupture disk remove the end cover from the pole unit.

b. Remove the deflector plate, spacers, clamp ring, gaskets and any remaining pieces of the rupture disk. Insert the new rupture disk and gaskets, oriented as shown in Figure 13, Page 54.

c. Replace the clamp ring, spacers, and deflector ring.

d. Torque the retaining bolts to 15 ft.-lb.

e. Replace the end cover using a new o-ring coated with Dow Corning III and torque end cover bolts to 90 ft.-lb.

f. Connect disconnect fittings at all three pole unit coverplates. Failure to connect all fittings will leave atmospheric air inside the pole unit(s).

WARNING

Oxygen deficiency and hazardous arc products could result in death or serious injury.

To prevent:

1. Do not breathe large volumes of the sulfur hexafluoride gas (SF_6); in the pure state the gas is colorless, odorless, tasteless and non-toxic.
2. Toxic decomposition products are formed in the gas when arcing occurs in it.
3. 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.
4. If for some reason a significant amount of arc-formed toxic gas is present, an unpleasant stinging odor or irritation of the upper respiratory tract and eyes should give an early and sufficient warning within seconds to the personnel in the vicinity before a significant toxic reaction should occur.
5. The absence of any detectable odor or nasal irritation should indicate safe working conditions.
6. Molecular sieves are incorporated in all SF_6 breakers.
7. This material is efficient in removing the chemically active product formed during arcing.
8. A sufficient amount of this filter material is used to remove the expected toxic gases produced from arcing between maintenance operations on the breaker.
9. Usually only a small percentage of gas remains in the vessel after removal of gas, and most of it escapes after opening the cover plates.
10. Caution should be observed to prevent the inhalation of the fine metallic fluoride dust.
11. 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.
12. It is recommended that workmen exposed to arc powders wash carefully to remove the metal salts from their skin.

Maintenance/Adjustment and Lubrication

Removing The Stationary Contact

Remove the end cover containing the rupture disk. Remove the stationary contact bushing terminal plate bolts. Raise the terminal plate/bushing conductor approximately three inches above the top of the bushing and block in place. The stationary contact can now be removed by removing the four (4) flange bolts and pulling the contact assembly out horizontally, being careful not to damage the teflon nozzle attached to the moving contact.

Inspecting The Stationary Contact

(Figure 9, Page 50)

Visually inspect the arcing contact. Replacement is required if the contact is eroded. Minor pitting should be smoothed out with a fine file or emery paper after the contact has been removed.

Inspect the continuous current fingers. The fingers must be replaced if copper is visible beneath the silver plating or if erosion has occurred. The fingers can be removed by inserting the tool shown in Figure 9, Page 50, and removing six (6) socket flat head screws that retain the finger shield. The fingers, shield and tool are then removed as one unit. Remove the tool partially to expose the end of the contact fingers. Individual fingers can be removed by sliding them out of the open end of the shield while being careful not to lose the contact springs.

Stationary Contact Assembly

All parts should be cleaned with alcohol and a lint free wipe before reassembly. Lubricate contact fingers and mating surface with Beacon 325. Install contact fingers, spacers, and springs into the contact shield using the tool in a reverse procedure of the disassembly process. Insert the assembly and tool onto the contact support and replace the socket flat head screws. Torque the screws to 84 in.-lb. Remove the tool. Install the arcing contact and torque the retaining bolt to 32 ft.-lb. Lubricate plug-in contact fingers with a light coat of Beacon 325.

Insert the stationary contact assembly into the pole unit being careful not to damage the moving contact nozzle. Install the bottom two flange bolts finger tight. Use the tool shown in Figure 16, Page 58, and visually align the contact with moving contact nozzle. Torque the lower bolts to 50 ft.-lb., remove the tool, insert and torque the top two bolts. Observe the alignment of the stationary contact and the moving contact nozzle while manually closing the pole unit. Loosen the bottom two flange bolts, remove the top bolts, and realign the contact using the tool as necessary.

Moving Contact Inspection

(Figure 10, Page 51)

The moving contact nozzle and arcing contact can be inspected without removal from the pole unit casting once the stationary contact has been removed.

Use the go no-go gauge, Figure 10, Page 51, to inspect the teflon nozzle. Use a light and a small mirror to inspect the arcing contact for erosion. The moving contact assembly must be removed for maintenance if the teflon nozzle is larger than the gauge limits or if the arcing contact is eroded.

Removal and Disassembly Of The Moving Contact

Remove the round cover from the shaft housing. Disconnect the composite operating rod from the shaft levers by removing the pin. Do not loosen the locknut on the operating rod end. The moving contact assembly can be removed from the contact support by pulling on the heat cylinder. Remove the eight (8) socket head cap screws to separate the heat cylinder from the piston.

Remove the socket head capscrews and the retaining plate on the inside of the heating cylinder. Press the outer nozzle out of the heat cylinder. Use a spanner wrench to remove the contact retaining tube from the piston. Unscrew the inner nozzle from the contact retaining tube.

Maintenance/Adjustment and Lubrication

Assembly Of The Moving Contact

Clean all parts to be reused with alcohol and a lint free wipe. Vacuum the arc dust from the pole unit housing. Use a small nozzle to vacuum the inside of the stationary contact support. Install a new outer nozzle in the heat cylinder. Assemble the retaining plate and torque the socket head capscrews to 84 in.-lb. Assemble a new inner nozzle on a new contact retaining tube that contains a carbon arcing ring. Assemble a new arcing contact and contact retaining tube with inner nozzle to the piston assembly and tighten with a spanner wrench. Torque to 75 ft.-lb. Make sure that the check valve moves freely. Assemble the heat cylinder to the piston assembly and torque the socket head cap screws to 84 in.-lb.

Inspect the Multilam contacts in the contact support and replace if there is evidence of wear or burning. The Multilam contact retaining strips must be seated in the grooves and not protrude into the bore of the contact support. Replace the teflon-graphite guide ring.

Apply a thin coat of Beacon 325 grease to the Multilam contact, the inside surface of the arcing contact, the outside of the heating cylinder, and the plug in contact fingers.

Install the moving contact into the contact support. Rotate the heat cylinder in the contact support in the counterclockwise direction to align the operating rod end with the shaft levers. Install the pin that connects the operating rod to the levers.

Moving Contact Support Removal

Remove the moving contact bushing terminal plate bolts. Raise the terminal plate/conductor assembly approximately three (3) inches above the top of bushing and block in place. Remove the linkage cover and opening spring and disconnect the linkage from the pole unit. Remove the bolts from the shaft housing and pole unit flange. Carefully pull the shaft housing and moving contact support out of the pole unit housing.

Assembly of Moving Contact Support

Assemble the moving contact/shaft housing to the pole unit casting using a new o-ring coated with Dow Corning III. Torque the shaft housing bolts to 90 ft.-lb. Reassemble the linkage, opening spring, linkage cover, and bushing terminal plate/conductor. Check that the bushing conductor is properly inserted in the moving contact support plug-in contact by looking in the pole unit from the stationary contact side.

Molecular Sieve Replacement

Molecular sieve material is contained in a cloth bag located in the shaft housing of each pole unit (Figure 12, Page 53). The molecular sieve is effective in scavenging SF_6 arc products and moisture in the pole unit. It should be replaced after the pole unit has been opened to atmosphere or has lost all of its gas. The molecular sieve is supplied in foil pouches which should be opened just before placing the bag in the breaker. Evacuation of the pole unit should begin within 15 minutes of opening the pouch.

To replace the molecular sieve, remove the inspection cover from the shaft housing, cut the Ty-wrap and remove the old bag. Remove the new bag from the foil pouch and place in the shaft housing, securing it with a ty-wrap as shown in Figure 12, Page 53. Install a new o-ring coated with Dow Corning III and replace the inspection cover, tightening the bolts to 20 ft.-lb. Evacuate the breaker immediately in preparation for filling with SF_6.

Filling An Energized Breaker with SF_6 Gas

The preferred method of adding SF_6 gas to the breaker is with the breaker de-energized and isolated from the electrical system. However, SF_6 gas may be added to an energized breaker if the pressure has not fallen below lockout. The procedure for adding gas is the same as for filling the breaker during installation outlined on Page 9.

Maintenance/Adjustment and Lubrication

Leak Checking

(Figures 7, Page 48 and Figure 11, Page 52)

The breaker has been thoroughly leak tested at the factory and will be essentially leak-free between the major maintenance periods. There are a minimum of leak sources. The "o" rings, gaskets, and fittings shown on Figure 7, Page 48 provide the sealing to atmosphere on each phase.

Before beginning a leak check, pay careful attention to the pressure and temperature of the SF_6 gas. If the initial pressurizing is done according to the normal operating pressure curve in Figure 11, Page 52, any other readings should fall on the same curve.

Use Leak-tec or equivalent to detect leaks. No leakage is permitted at any of the joints. During maintenance, if any seal has been removed, the seal only should be leak-checked after a vacuum has been obtained and SF_6 added to the pole unit.

Paint (Powder Paint)

Minor Paint Repair -- Touch-Up

To repair surface scratches, abrasions, small cracking or chipped areas on the powder coated breaker cabinet, the following remedial action is recommended.

1. Remove loose particles of coating with a sharp putty knife, scraper and/or wire brush.

2. Use 80 grit sandpaper to feather the edges of the coating area damaged.

3. Use 180 grit sandpaper for finish sanding of the area to be touched-up. Remove sanding dust.

4. Re-coat the prepared area with the touch-up paint provided (Siemens Part No. W911241 for ANSI #70 Gray) with the breaker.

Major Paint Repair

To repair major powder coat damage, i.e. post welding, and base metal exposure or to refinish the entire breaker, refer to your Siemens representative for finish kit and procedure.

Lubrication

Mechanism lubrication is covered in the Mechanism Instruction Book APPENDIX 1 and should be performed at least once every three years. All other parts of the breaker have been lubricated at the factory and further lubrication is required only if that particular item has been disassembled.

a. Beacon #325 (W 962030) is used to lubricate the interrupter. See Stationary and Moving Contact Assembly.

b. Molycote (00-337-271-095) is applied to all the pins in the horizontal linkage, the end of the shock absorber plunger, and the bell crank lever "striking" surface.

c. Dow Corning III sealant (W 962026) is applied to all o-ring seals.

Recommended Torque Values

1. Adjustable leg bolts - 50 ft.-lb.

2. Breaker to foundation hold down bolts - 400 ft.-lb.

3. Mechanism mounting bolts - 250 ft.-lb.

4. 3/4 dia. bolts, pole unit bracket to frame - 250 ft.-lb.

5. 5/8 dia. bolts, pole unit cover, shaft housing cover, and pole unit to pole unit bracket - 90 ft.-lb.

6. Stationary and moving contact support flange bolts, bushing to pole unit bolts and terminal plate to bushing bolts - 50 ft.-lb.

7. M6 interrupter bolts - 84 in.-lb.

8. M10 Stationary arcing contact retaining bolt - 32 ft.-lb.

9. Moving arcing contact retaining tube - 75 ft.-lb.

10. Shaft housing inspection cover bolts - 20 ft.-lb.

Recommended Spare Parts List

DESCRIPTION	DRAWING OR CODE NUMBER	RECOMMENDED FOR STOCK	
		1-5 BRKRS	5 OR MORE
POLE UNIT			
Porcelain		1	2
Stationary Contact Support	72-280-903-501	1	2
Moving Contact Assembly	72-280-826-501	1	2
Moving Contact Support	72-280-901-501	1	2
Major Inspection Parts Kit (Includes Gaskets, Contacts, Nozzles)	72-181-779-801	1	2
Rupture Disks with Gaskets	W-101-006	1	2
Voltage Shields	72-280-827-001	2	4
MECHANISM			
Trip/Close Coil	*	1	2
Cam and Roller Assembly	72-181-337-501	1	2
Rod Assembly	72-181-330-501	1	2
Lever Assembly	72-181-361-501	1	2
Rod End Assembly	72-181-321-502	1	2
Pawl Assembly	72-181-356-501	1	2
Bushing Assembly	72-181-358-501	1	2
Rod End Assembly	72-181-565-502	1	2
Latch, Close	72-280-822-002	1	2
D-Latch, Close	72-280-807-001	1	2
Motor Shaft	72-280-687-001	1	2
Latch, Trip	72-280-820-002	1	2
D-Latch, Trip	72-280-766-001	1	2
Shock Absorber	1654B08H02	1	2
Bearing	516B888H05	1	2
Set Screw	512A416H01	1	2
Bearing, Roller	W-112-043	1	2
Needle Bearing	W-113-024	1	2
Needle Bearing	W-113-017	1	2
Needle Bearing	W-113-016	1	2
Spring, Ext.	W-392-035	1	2
Spring, Comp.	W-391-810	1	2
Spring, Comp.	W-391-809-02	1	2
Spring, Ext.	W-392-022	1	2
Spring, Ext.	W-392-043	1	2
Switch, Single	W-666-216	1	2
Switch, Double	W-666-217	1	2
Motor	**	1	2
* W-549-607 -- 125 VDC * W-549-608 -- 48 VDC * W-549-609 -- 250 VDC			
** 72-380-390-001 -- 48 VDC ** 72-380-390-002 -- 125 VDC/115 VAC ** 72-380-390-003 -- 250 VDC/230 VAC			
GENERAL BREAKER			
Density Switch - 2 Stage	72-280-776-001	1	2
Density Switch - 3 Stage	72-181-640-001	1	2
SF_6 Gauge	W-153-117	1	2

Illustrations

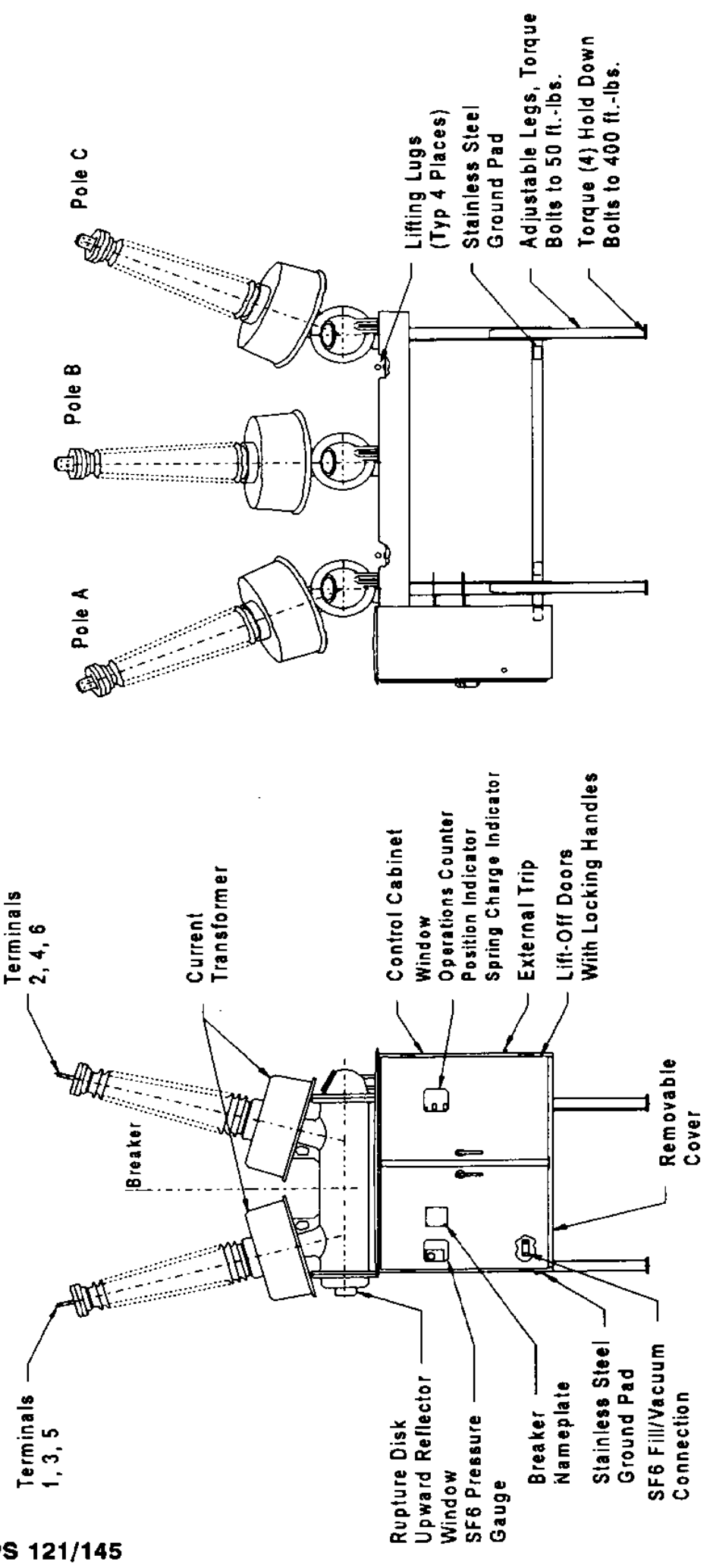


Figure 1. Outline -- SPS 121/145

72-280-862-401

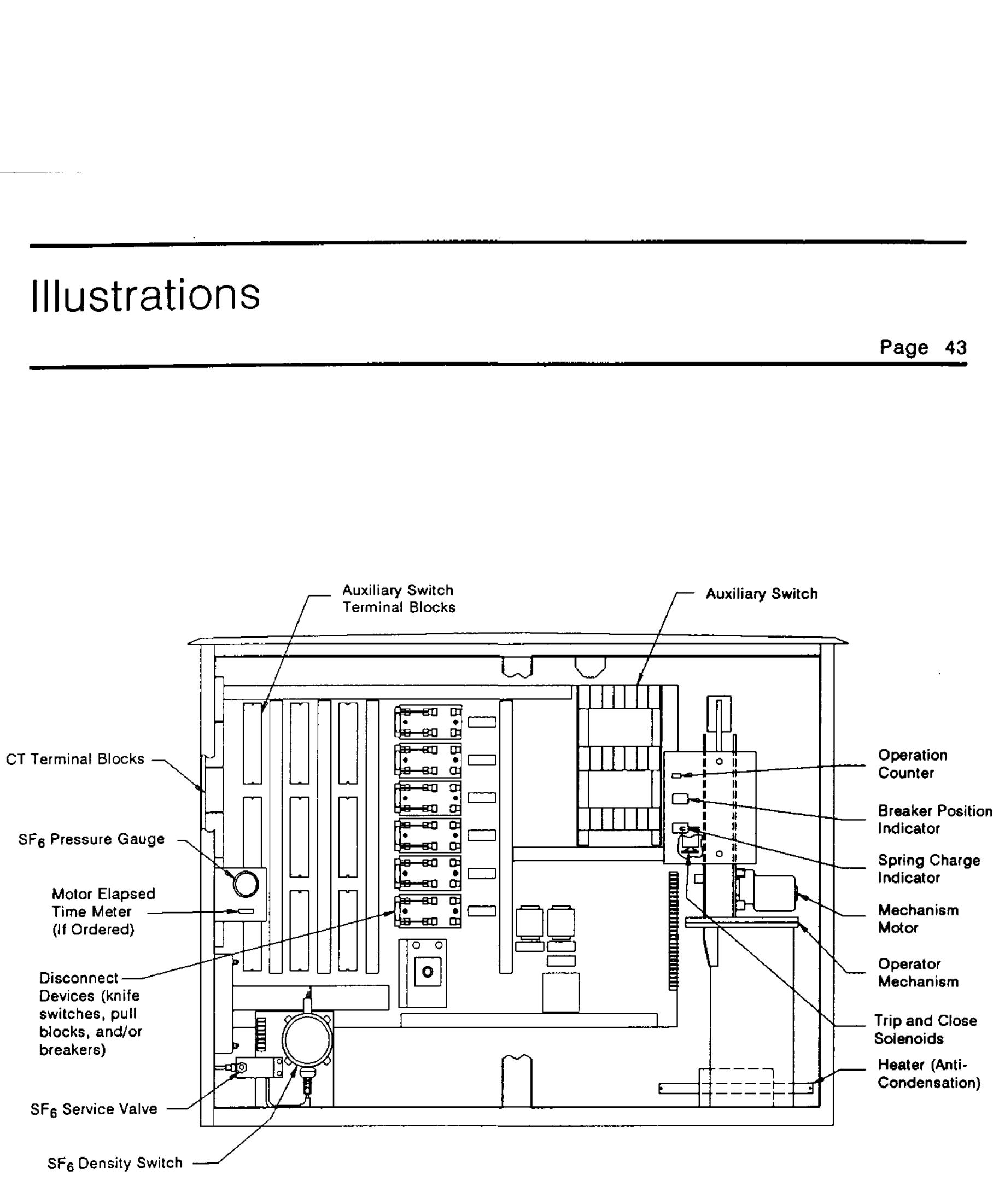


Figure 2. Cabinet Layout

Illustrations

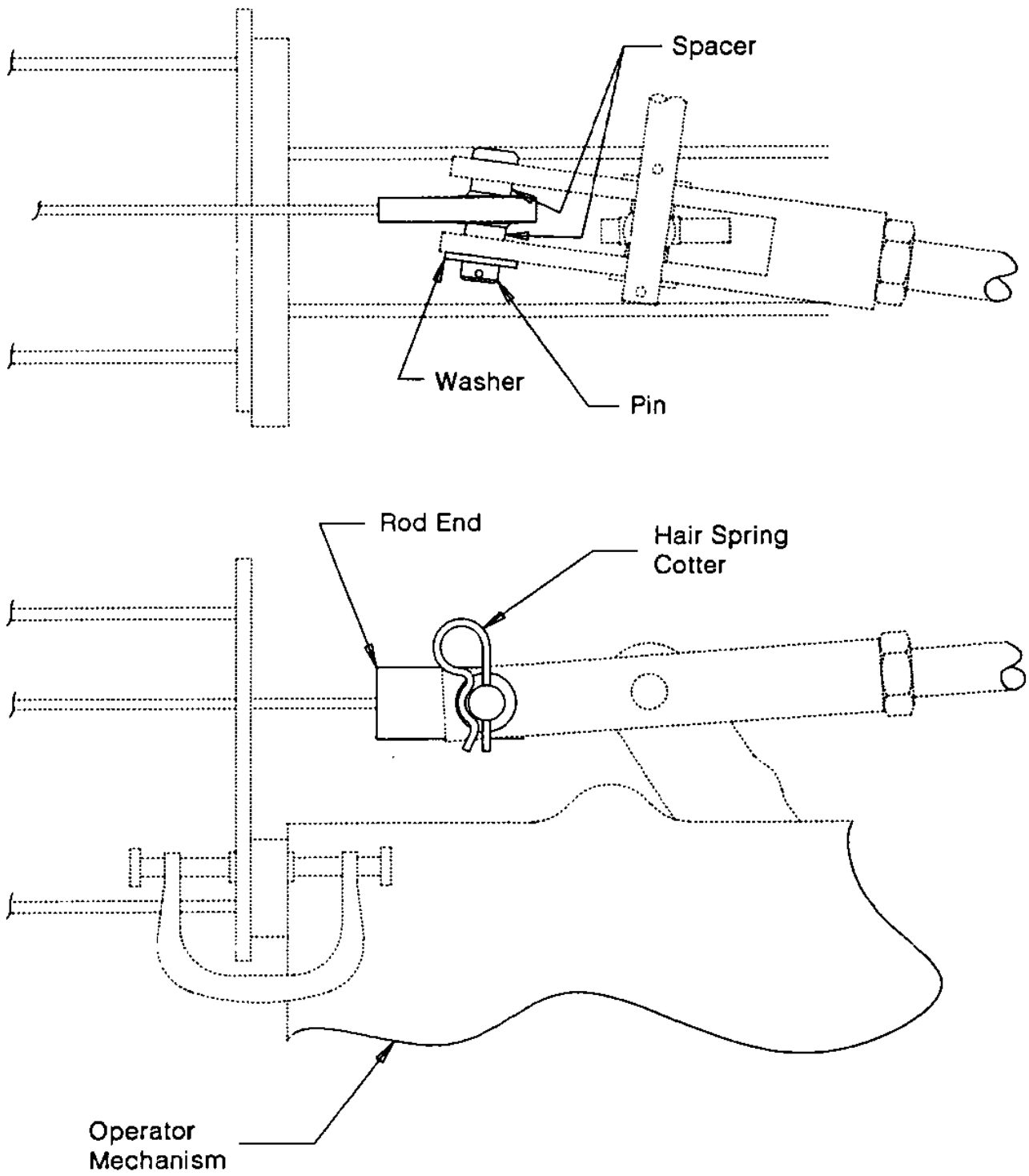


Figure 3. Mounting of Doble Travel Analyzer Transducer **72-181-792-401**

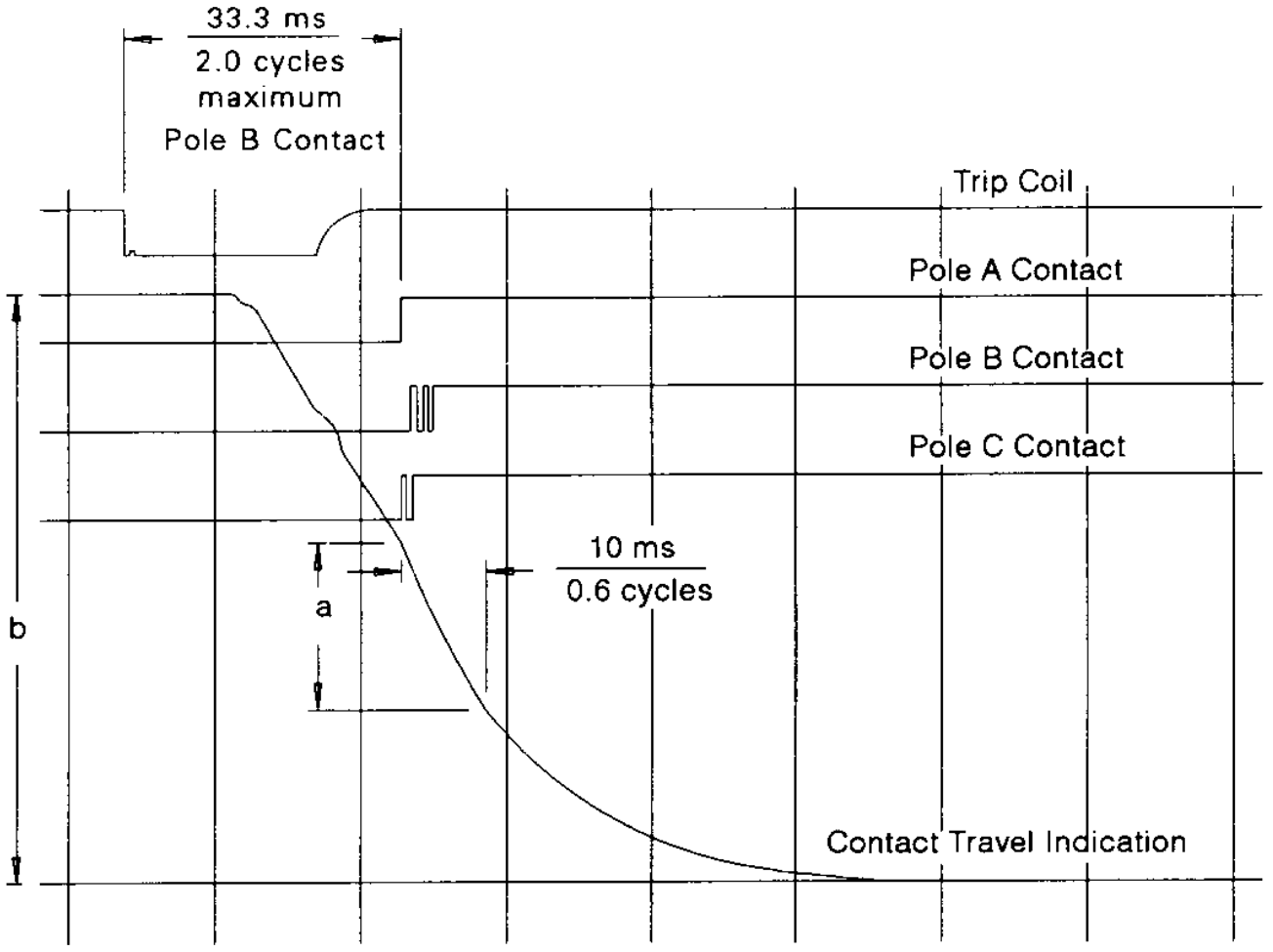


Figure 4. Sample Travel Analyzer Record For an Opening Operation

Example of Opening Operation Record

Calculation For Contact Opening Velocity =
V = 12.0a/b meter/second

Note: a and b may be measured in any consistent units.

For Programmable Timers

Transducer Stroke:	
Mounted on Operator	8.39 inches
Mounted at Tailspring	4.93 inches
Contact Stroke:	4.72 inches

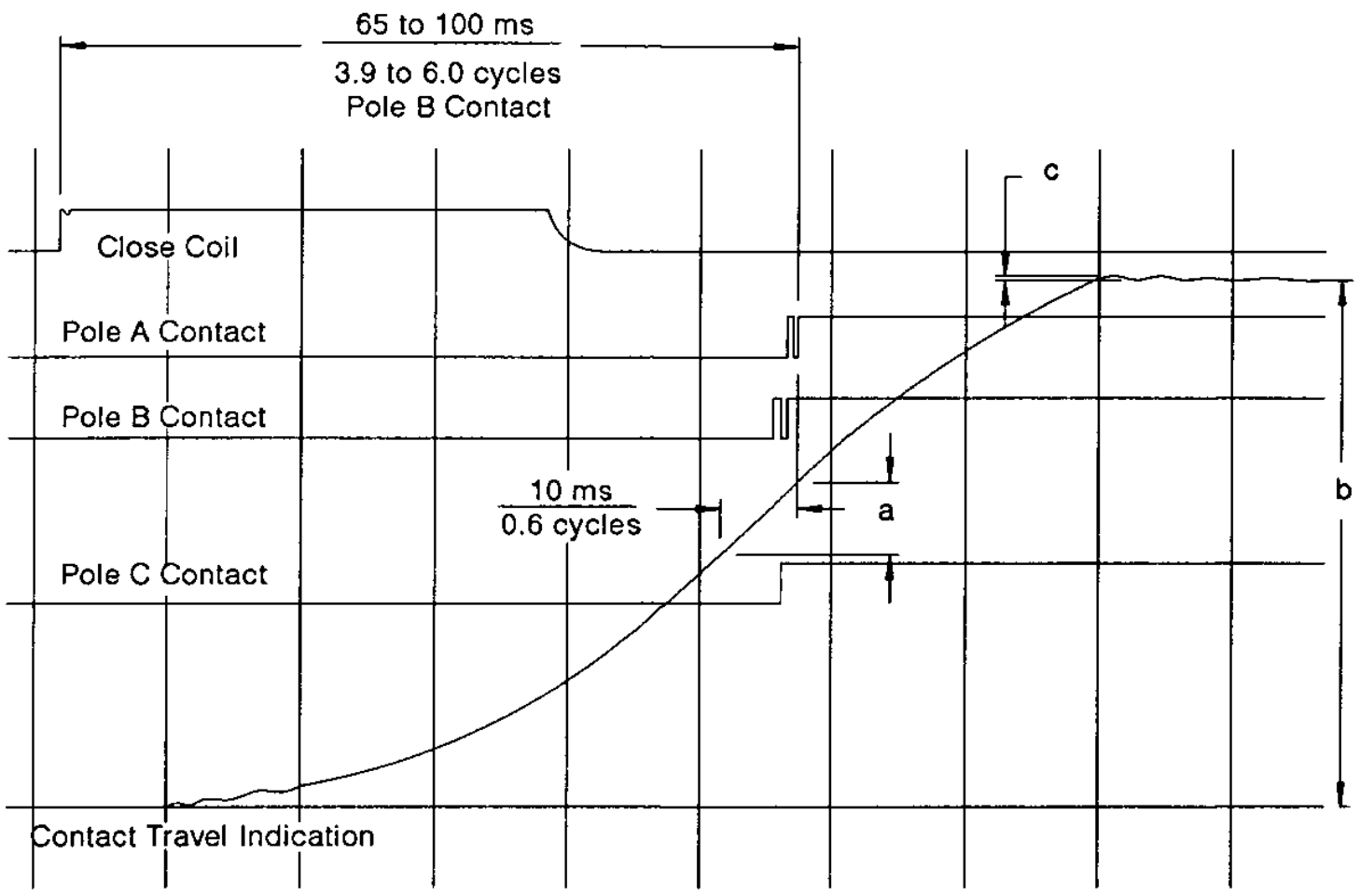


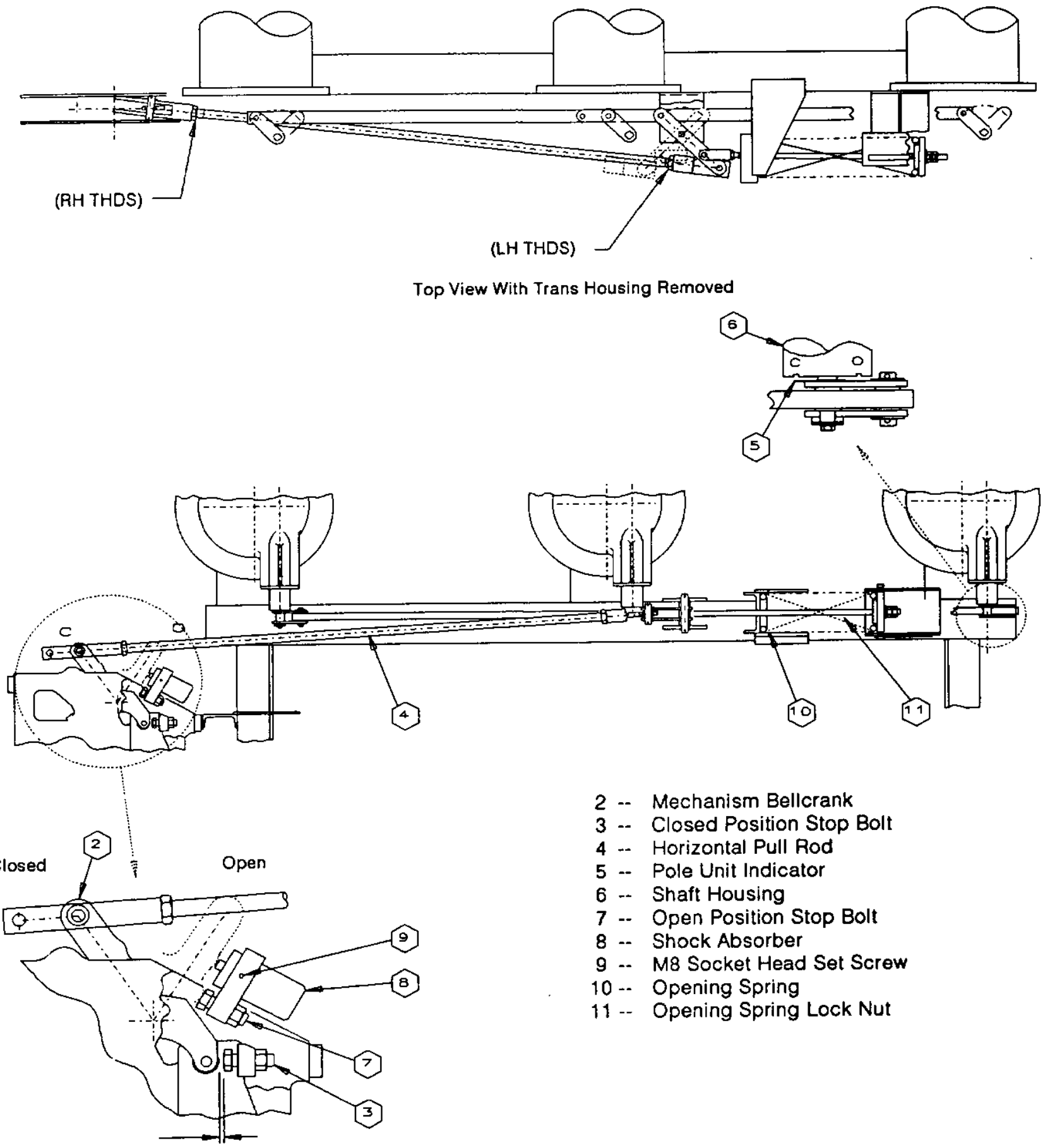
Figure 5. Sample Travel Analyzer Record For a Closing Operation

Example of Closing Operation Record

Calculation For Contact Closing Velocity =
V = 12.0a/b meter/second

Calculation For Overtravel/Rebound =
S = 12.0c/b meter/second

Note: a, b and c may be measured in any consistent units.



2 -- Mechanism Bellcrank
3 -- Closed Position Stop Bolt
4 -- Horizontal Pull Rod
5 -- Pole Unit Indicator
6 -- Shaft Housing
7 -- Open Position Stop Bolt
8 -- Shock Absorber
9 -- M8 Socket Head Set Screw
10 -- Opening Spring
11 -- Opening Spring Lock Nut

Figure 6. Linkage Adjustment

72-181-802-401

Illustrations

Fastener Torque Requirements

Item	Torque (ft. lb.)
19	50
20	50
21	90
22	50
24	20

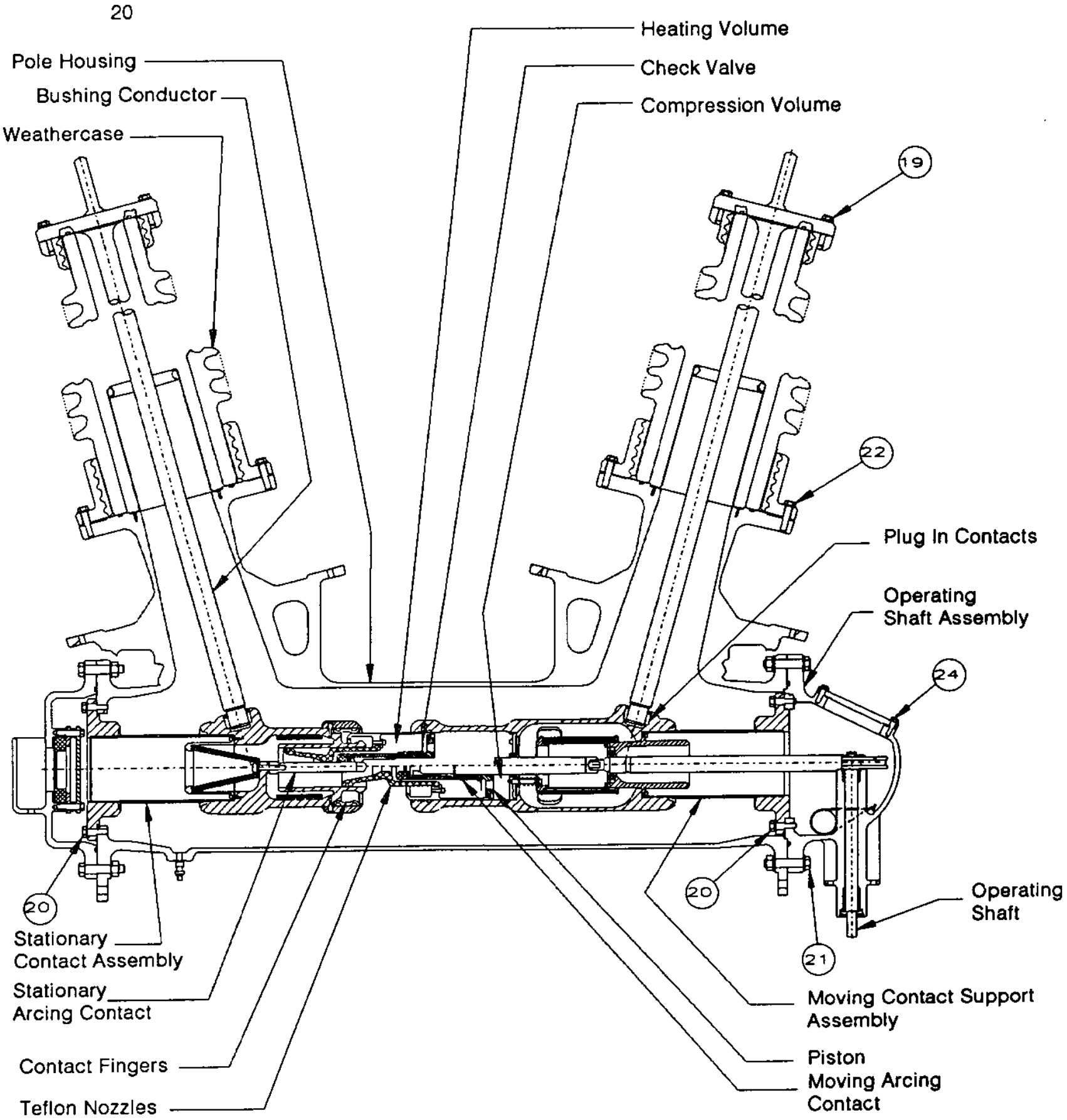


Figure 7. Pole Unit

72-181-794-401

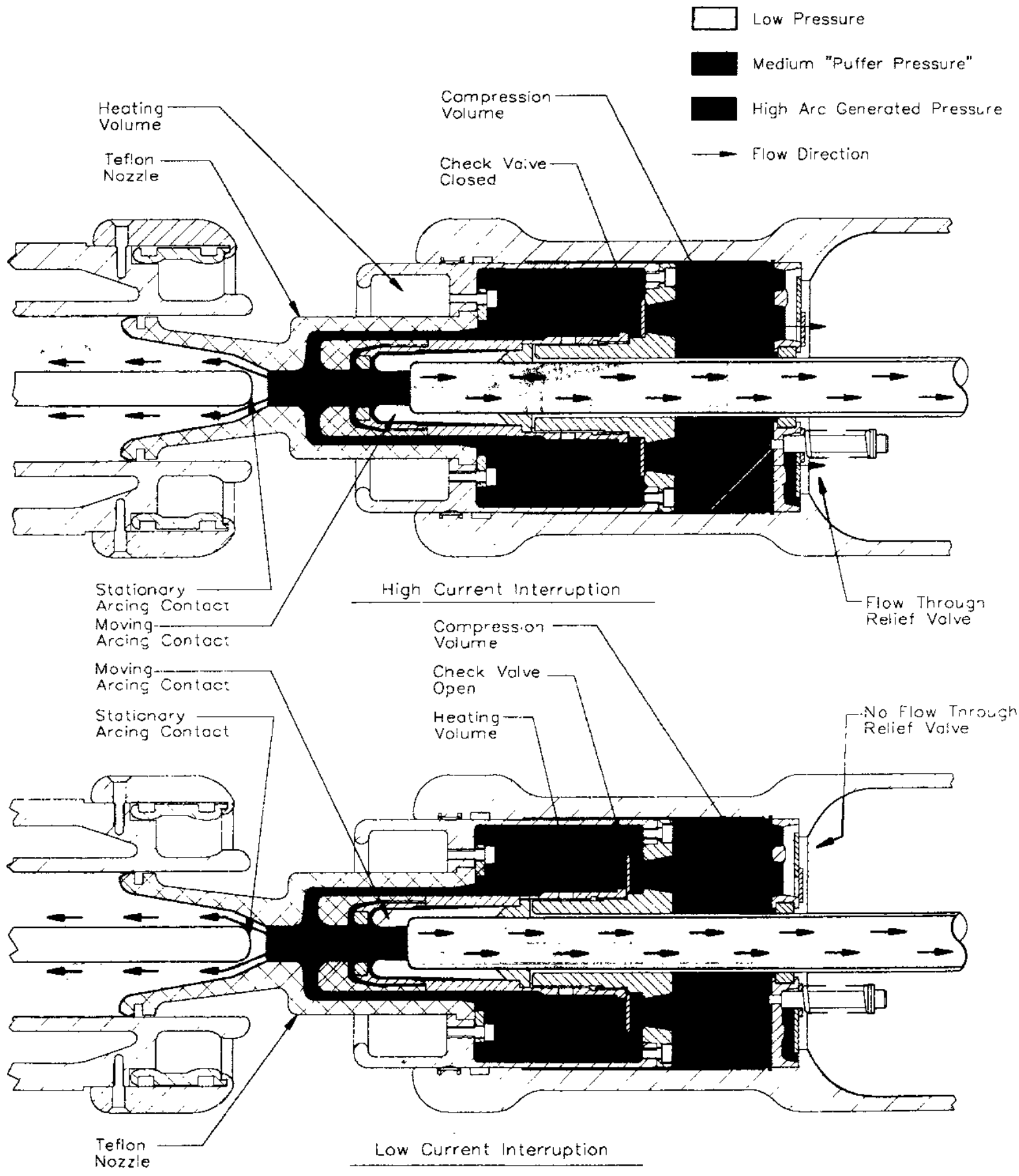


Figure 8. Interrupter Operation

72-181-805-401

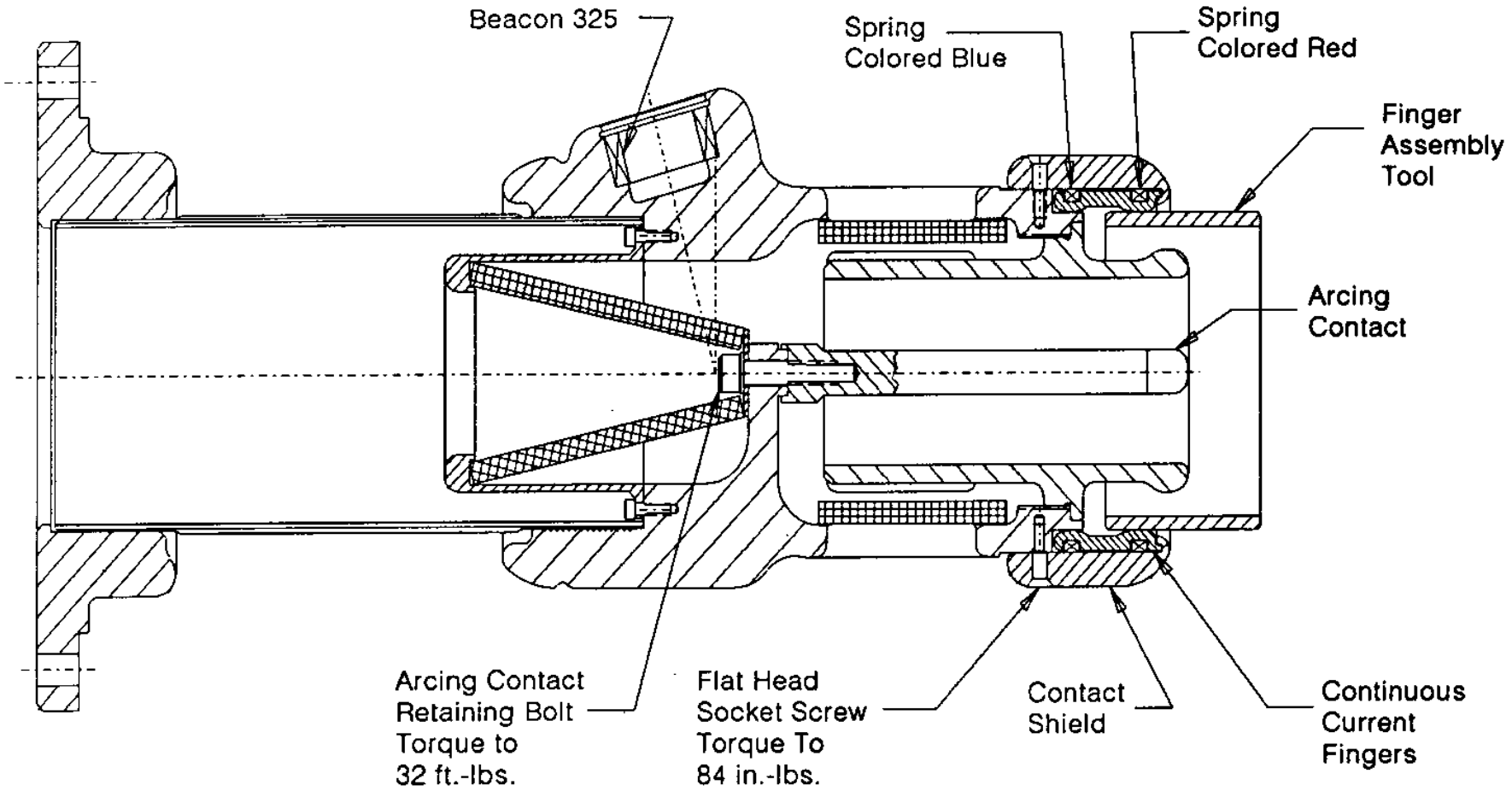


Figure 9. Stationary Contact Assembly

72-181-899-401

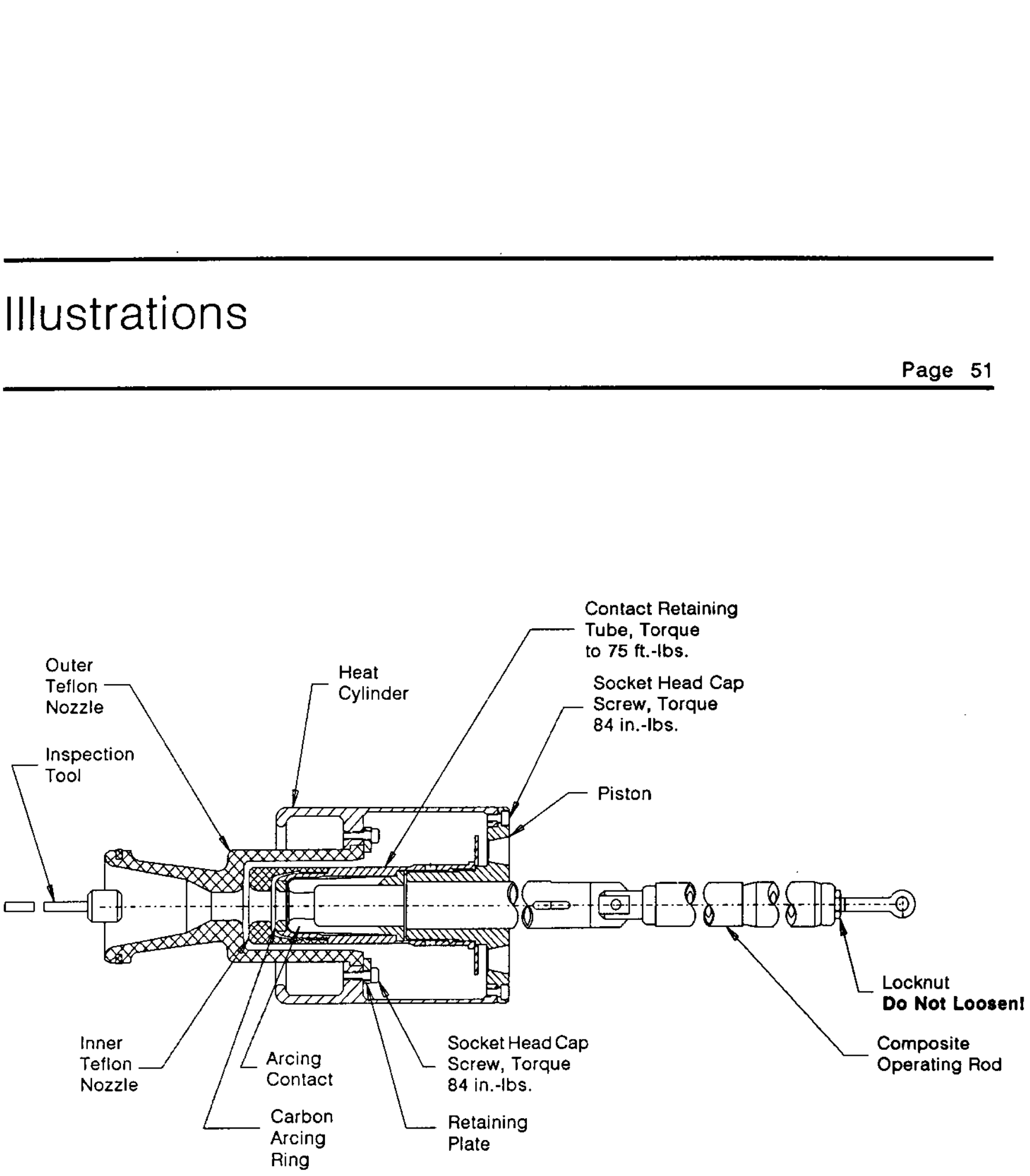
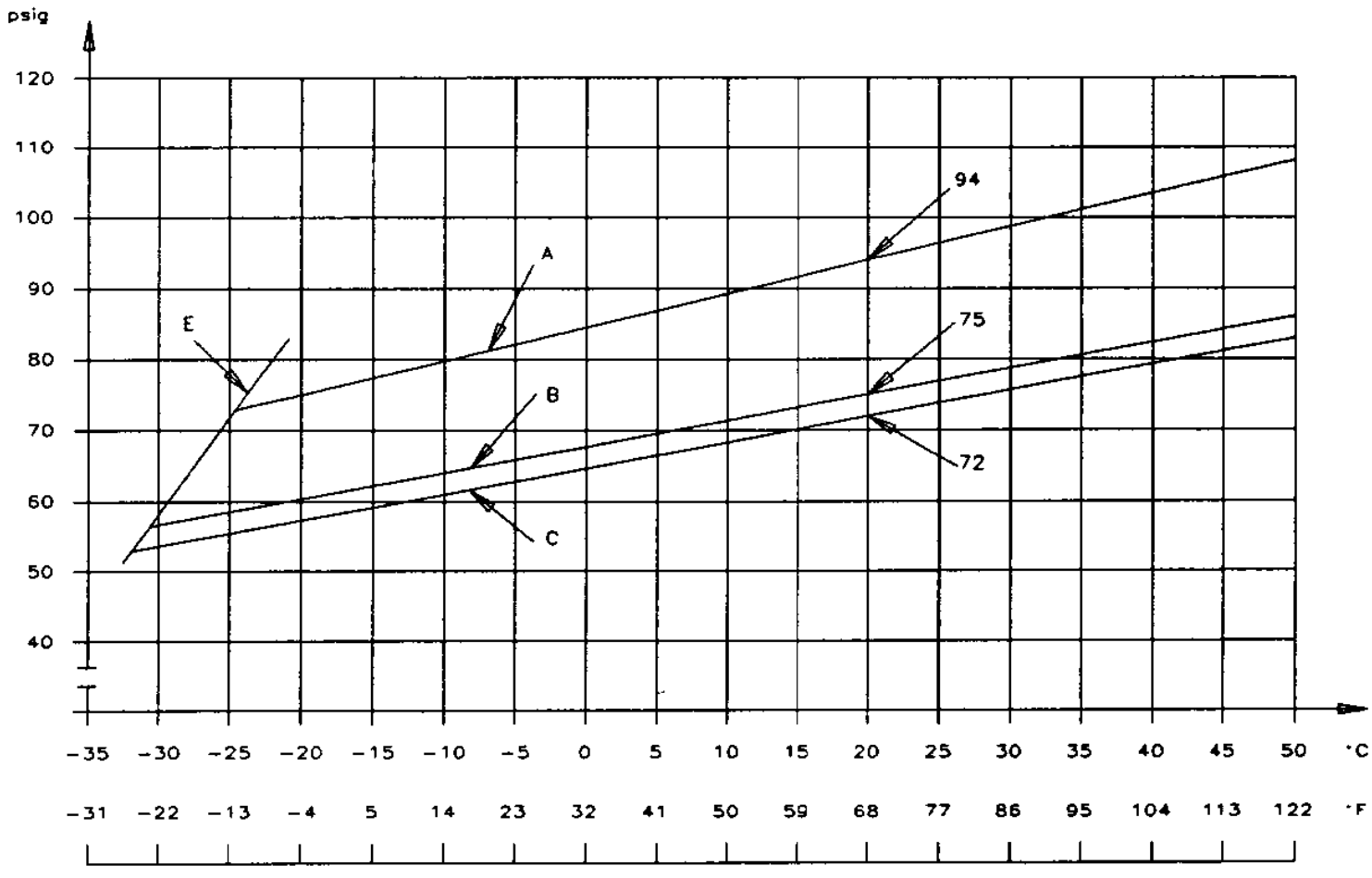


Figure 10. Moving Contact Assembly

72-181-900-401



A Fill Pressure

B Low Pressure Alarm

C Minimum Pressure

E Condensation

Figure 11. Typical SF6 Presure-Temperature Curve --See Breaker Nameplate and Fill Chart

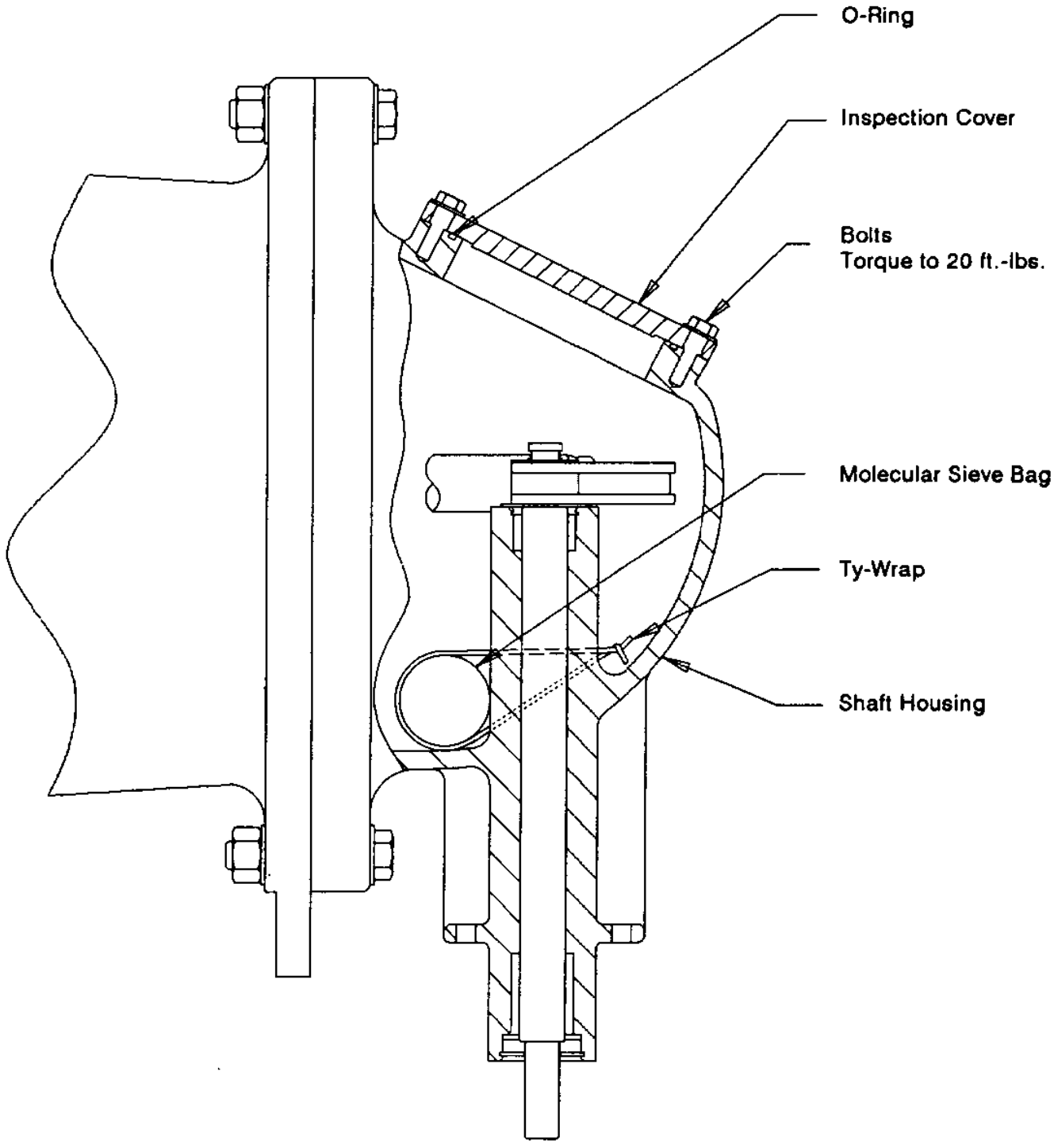


Figure 12. Molecular Sieve Installation

Illustrations

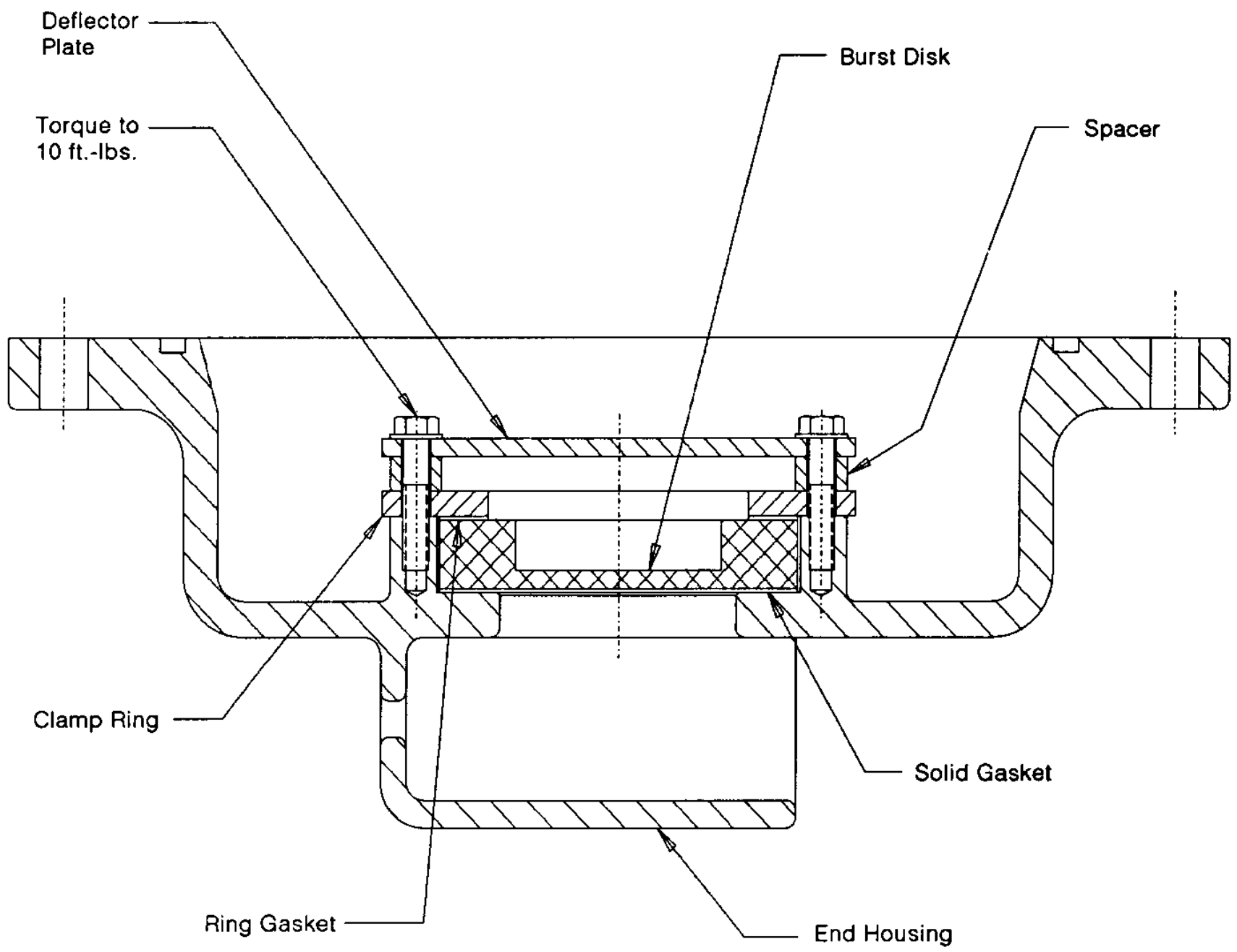


Figure 13. Burst Disk Installation

72-181-793-401

Illustrations

SF_6 Pressure Switches

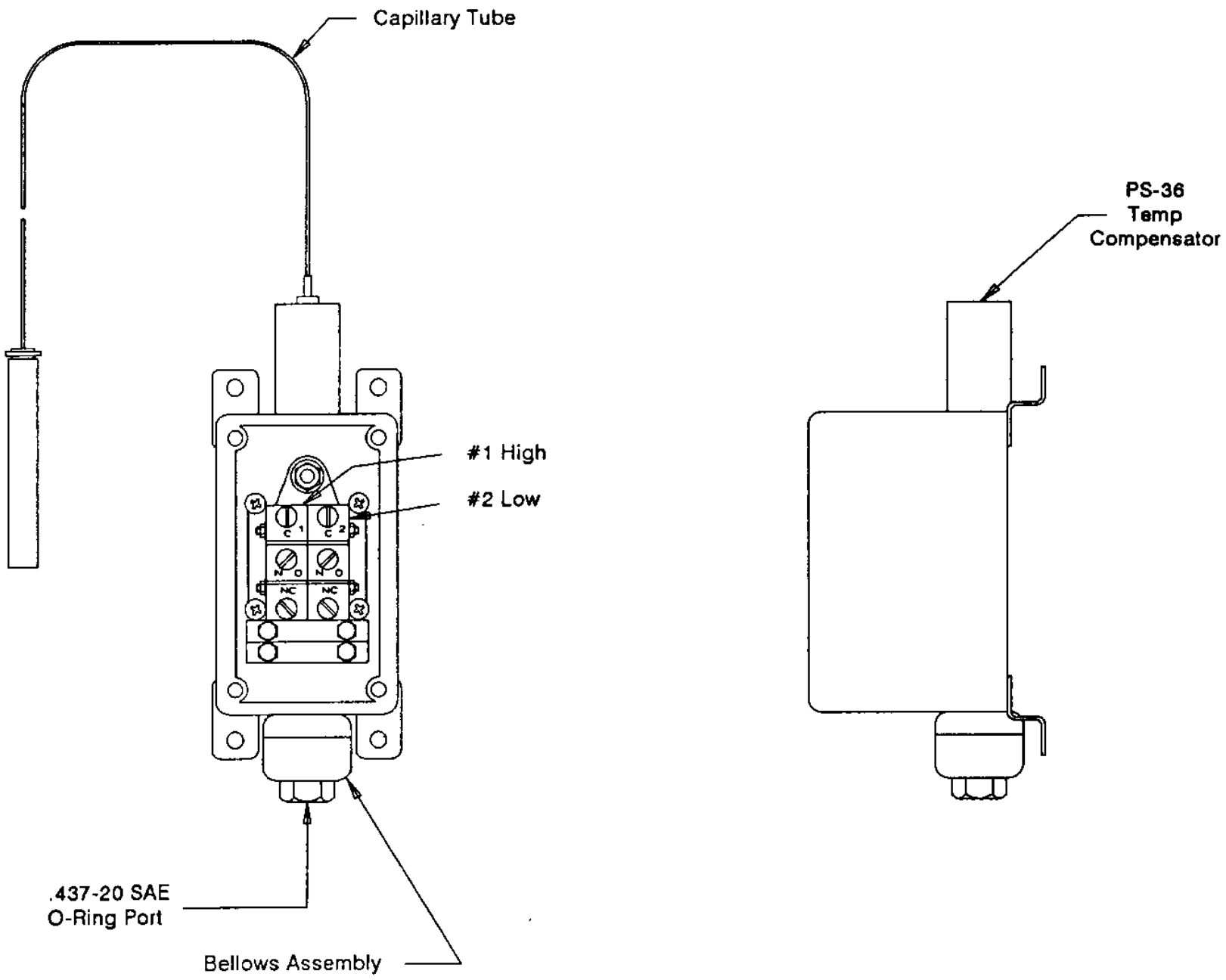


Figure 14. Temperature Compensated Pressure Switch

72-181-918-401

Illustrations

Page 56

Solon Pressure Switches Temperature Compensated Pressure Switches Remote Bulb Temperature Sensing

Temperature Compensated Pressure Switches automatically adjust the operating points of the pressure switch to higher or lower pressures as the temperature surrounding a remote bulb varies over a given temperature range. These switches are used in, but not limited to, applications where it is desirable to maintain a gas at a constant density where the gas is contained within a constant volume.

Temperature Compensation is achieved by mounting a charged bellows assembly in the housing of the pressure switch. This charged bellows assembly with a remote bulb at the end of a capillary tube is linked to the pressure switch force balance mechanism by a spring, the rate of which determines the slope of the temperature-pressure curve. In addition, bi-metal springs are located in the switch housing to compensate for changes in ambient temperature surrounding where the bellows actuator or the charged assembly is located. Thus, only the temperature change surrounding the bulb creates pressure changes in the set points of the pressure switch.

Temperature Compensation can be applied to bellows actuated 5PS or 6PS Solon Pressure Switches. These switches are built to customer specifications, particularly the slope of the pressure-temperature curve. However, the following general specifications apply:

1. All bellows pressure ranges are available from 0-15 PSI through 0-2000 PSI.

2. One to four electric switches are available.

   a. 5PS models can be supplied with one or two electric switches. Two electric switch models can be set to alarm at one pressure and trip at another pressure setting.

   b. 6PS models can be supplied with three or four electric switches. Each electric switch can be adjusted for separate or parallel pressure settings.

3. Ambient temperature compensation from -40°F to 150°F.

4. Pressure compensation from the remote bulb from -40°F to 140°F.

5. Capillary tube lengths of 8 feet, 16 feet, 24 feet.

6. Bulb 1/2" diameter by 3 3/4" long can be supplied with 1/2" N.P.T. male fitting of 1/2" N.P.T. male well.

Illustrations

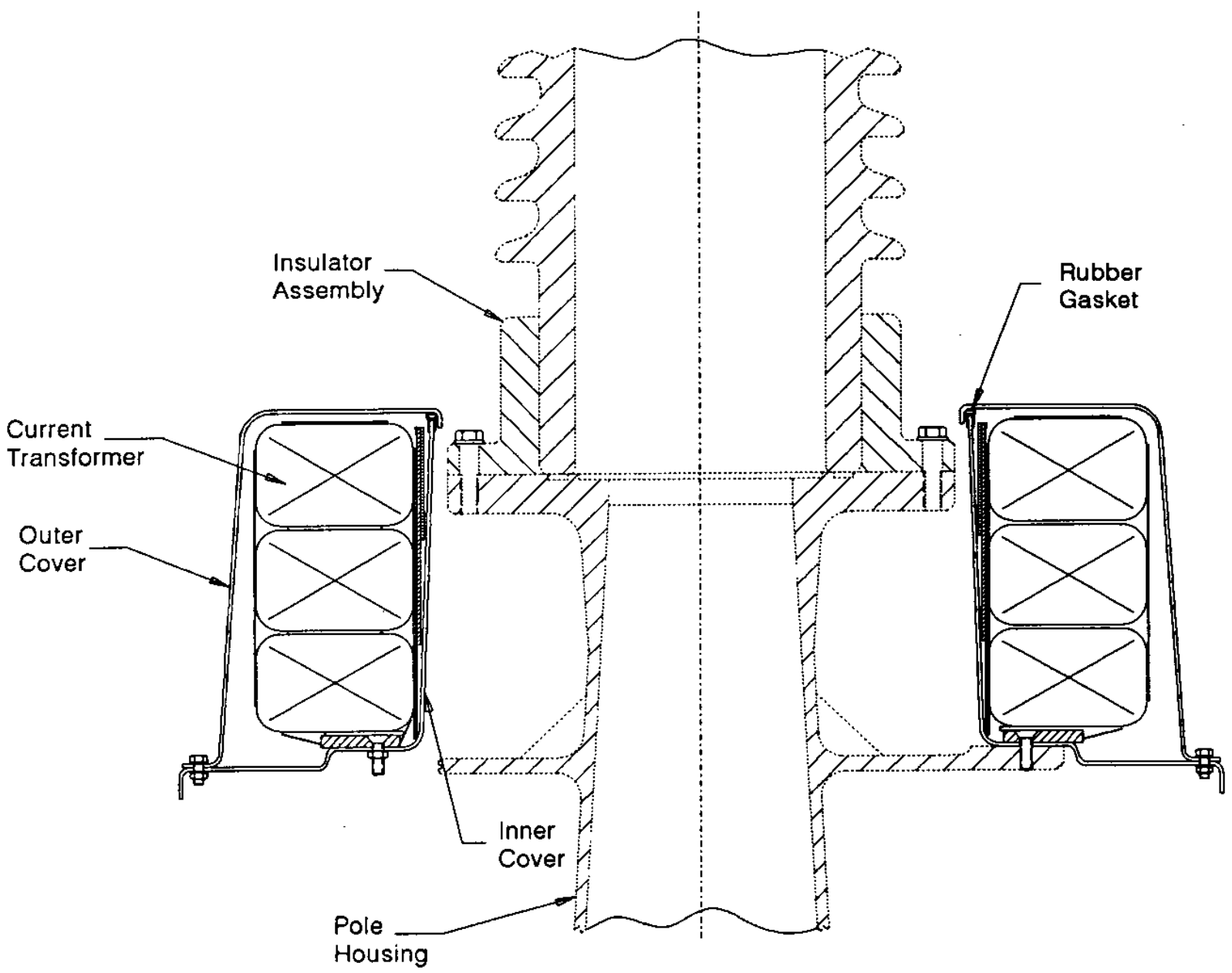


Figure 15. Current Transformer Layout **72-181-902-401**

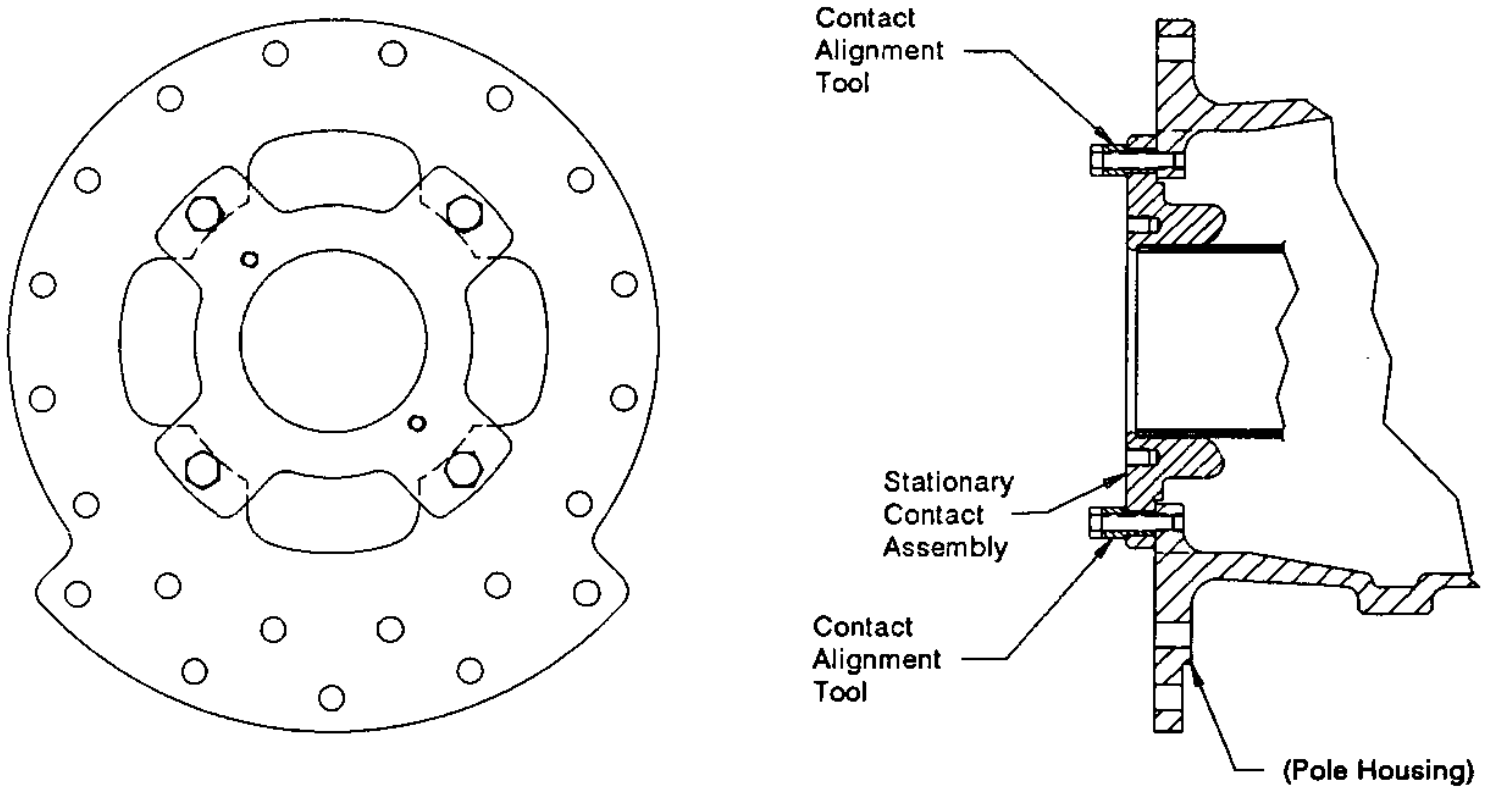


Figure 16. Stationary Contact Alignment **72-181-903-401**

Instructions

Installation
Adjustment
Maintenance

Instructions for Spring Operator Operating Mechanism Type SE-4 SF_6 Circuit Breakers Appendix I

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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.

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Introduction

The successful field performance of this operating mechanism and the breaker in which it is installed depends as much on proper installation and maintenance as it does on good design and careful manufacture. Refer to the appropriate section of this manual before performing any installation or maintenance.

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 breakers. For proper installation and operation -- resulting 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, they 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.

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 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 and grounded the breaker in accordance with safety instructions in the breaker instruction book, and have discharged the stored energy in the opening and closing springs.

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.

Appendix I

Safety Alerts

Pre-Operational Checks

When installing, adjusting, maintaining, inspecting or replacing parts of the operating mechanism, the following pre-operational checks should be followed.

1. Read the circuit breaker instruction book supplied with the circuit breaker. Check for proper installation and maintenance by following the appropriate sections of the book.

2. Read this entire instruction book. Become thoroughly familiar with all warnings, safety notices, instructions and maintenance procedures contained herein.

3. Discharge the energy storage springs, both the opening spring and the closing spring.

4. Disconnect control power to the operating mechanism.

⚠ DANGER

Manual operation of close or trip mechanisms in an energized breaker with insufficient SF_6 gas will result in death, serious injury, or damage to the circuit breaker.

To prevent:

Make sure that the SF_6 pressure is above the lockout value before manual operation.

⚠ CAUTION

Manually tripping the breaker without sufficient SF_6 gas may cause damage to the circuit breaker or the operating mechanism.

To prevent:

Make sure that the SF_6 pressure is above the lockout value before manual operation

Operating

The SE-4 operating mechanism stores the energy necessary to close the circuit breaker and at the same time charge the breaker opening spring. When operated, the mechanism moves with great speed and generates high forces. These factors dictate that the mechanism be installed and maintained correctly, and operated with due caution.

⚠ DANGER

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

To prevent:

This equipment should be installed, operated and maintained only by qualified persons thoroughly familiar with the equipment instruction manuals and drawings.

Appendix I

Description

Mechanism Overview

The SE-4 operating mechanism stores energy for use in closing a power circuit breaker. This energy is stored by compressing a powerful spring. An electrical motor with an integral gear reduction set (called a gearmotor) provides the energy 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 breaker. It takes several seconds for the motor to compress the spring, but the spring can discharge and close the breaker in less than 0.1 seconds.

In addition to storing energy, the operating mechanism provides the means to control the spring charging cycle and the breaker opening and closing operations. Starting with the closing spring discharged and the breaker open, if the gearmotor is energized the closing spring will become fully compressed and then the motor will automatically be de-energized. The mechanism will remain in this condition until a breaker close command is given. The command releases a latching mechanism and allows the closing spring to discharge causing the breaker to close under action of a driving cam. Closing of the breaker charges the breaker opening spring. The operator gearmotor is immediately energized, and another closing spring charge cycle accomplished.

At this point the breaker is closed and the operator is ready to perform another close operation. If a breaker trip command is given, the breaker will open and the operator will be able to immediately accept another close command, which could be closely followed by another trip command. Thus, the available duty cycle of the operator is open-close-open, and within a few seconds, the closing spring will be recharged and another close-open operation can be performed.

A drawing of the complete operator is shown in Figures 17 and 17A, Pages 79 and 80. An exploded view of the mechanism portion is shown in Figure 22, Page 85. Reference to these Figures 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 mechanism. It serves as the housing for shaft bearings, provides mounting surfaces for the closing spring, gearmotor and solenoids, and includes the mounting pads for fastening the mechanism to the circuit breaker.

Closing Spring and Housing

The closing spring is enclosed in a cylindrical housing bolted to the lower part 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.

A lever pivoted about a fixed point on the spring housing is attached to the spring carrier roller axle. A linkage connects the end of this lever to a semaphore which provides a visual indication of the spring charge/ discharge condition.

Gearmotor

The motor is a universal type, which means 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 five seconds.

Eccentric Drive

The output shaft of the gearmotor is directly coupled to an eccentric shaft (Figure 22, Page 85, 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 lower 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 rod length is adjustable. The upper 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

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Description

shaft, are located between the ratchet wheel and 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 the 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.

A rod extends from the pin projection of crank [4] to the closing spring carrier. 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, it is forced by the closing spring to rotate further until the latch roll attached to the cam [7] strikes the close latch. The main shaft is held in this latched position until a close command is given.

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 needle bearings housed in the frame.

The upper end of the lever has a spherical bearing which is pinned to the circuit breaker linkage which opens and closes the breaker. 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 breaker.

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

The lever has two protrusions which are case hardened and are designed to strike the shock absorber [23] and the overtravel stop bolt [47a].

Close Latches

The close latch [32] contacts a latch roll carried on the cam [7] to prevent rotation of the main shaft beyond the contact position. The face of the latch 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 [28] blocks this rotation. To release the close latch and cause the breaker to close, 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 main shaft is free to rotate and thereby close the breaker. Once the latch roll clears the latch, the latch return spring [75] and the release latch return spring return the latches to their latched positions.

Trip Latches

The trip latch [31] and release latch [27] are constructed, and function, similar to the close latches. The main difference in operation of the trip latches is that they are held in the 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.

Close Latch Interlock

A mechanical interlock [16] prevents the close release latch from turning when the breaker is already in the closed position. When the breaker is open, the trip latch, held in the unlatched position by the cam [14-13], pushes the interlock link clear of the close release latch, and the latch is free to rotate. When the breaker is closed, the close latch is retracted from the interlock link, and a return spring positions the link to interfere with rotation of the close release latch.

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Close Latch Check Switch

An electrical switch, actuated by the lever of the close release latch, is connected to prevent operation of the gearmotor unless the close latches are in their latched positions. If the close latches should fail to latch for some reason, and a spring charging operation occurs, the operator will discharge the closing spring as if making a close operation. If the breaker is already closed, damage to the operator would result.

Motor Control Switch

A switch actuated by a cam cut in the face of the ratchet wheel opens contacts and de-energizes the gearmotor when the close spring is fully charged. Discharging the spring, as by a close operation, closes the contacts and allows the motor to be energized.

Close and Trip Solenoids

Solenoids are provided to allow remote operation of the close and trip release latches. When ordered, a second, fully independent, trip solenoid is provided. The close and trip solenoids may, or may not, be physically identical, depending on the specified operating voltages and requirements for coil operating current.

The solenoids are designed so that at minimum rated voltage they can actuate the associated latch without pretravel of the solenoid armature. Also, latch release does not rely on dynamic overtravel of the latch system. These features ensure maximum reliability of the latch release mechanism.

Close Coil Interlock

A switch operated by the same cam as the motor control switch is connected to block operation of the close coil unless the closing spring is fully charged. Without this safeguard, the close coil could be energized without the possibility of causing a close operation, the coil would remain energized and burn out.

Auxiliary Switches

The 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 circuit interlocking devices, to prevent energizing of the breaker closing solenoid if the breaker is already closed, or to prevent the trip coils from becoming energized when the breaker is open.

Each rotor contact can be set to function as either a 52a or 52b, according to functional requirements. Adjustment can also be made at intermediate steps of 15 degrees.

To adjust the "making" or "breaking" point of any stage, use needle-nose pliers. Refer to Figure 19, Page 82.

Operation Counter

An operation counter, mounted on the instrument cluster column, is operated by the auxiliary switch operating arm. The counter records on the opening stroke.

Heater

A heater provided in the housing is energized continuously to maintain a temperature differential between the inside and the outside. This prevents undesirable moisture condensation within the housing.

Maintenance Closing Device

A screw type jack is available for closing the breaker during maintenance and inspection periods.

Manual Charging Tool

A manual charging tool can be provided for charging the closing spring when electric power is unavailable.

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An exploded view of the SE-4 operating mechanism is shown in Figure 22, Page 85. In the following, numbers contained in brackets refer to the item numbers of this Figure.

Spring Charging

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 tc 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 [19]. The opposite end of the rod 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.

A cam [7] is splined to the shaft between the ratchet wheel and the crank. Fixed to this cam is a latch roll [7-3] which contacts the close latch [32] when the crank reaches nine degrees over top dead center. At this position, the pawl is located at a portion of the ratchet wheel which has no teeth, and the gearmotor is allowed to freewheel until it is de-energized. A switch operated by a cam cut in the face of the ratchet wheel is actuated at this same position, and it promptly de-energizes the motor.

Closing

The close latch is constructed so that the force of the latch roll acting on it tends to cause the latch to rotate counterclockwise, which would free the main shaft to continue rotating. A release latch [28] blocks the rotation of the close latch until a command is given to close the breaker. The close command energizes the close solenoid which strikes the lever rod [29a] of the close release latch and rotates the release latch to a position at which the close latch can rotate through the release latch notch. This releases the main shaft, and the shaft and attached components are forced by the closing spring to rotate in a counterclockwise direction. As soon as the latch roll clears the close latch, the close latch and release latch are reset to the latched position by springs.

The cam [7] 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 breaker 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. As with the close latch, the trip latch is constructed so that the force of the latch roll tends to unlatch the roll. The trip release latch [27] blocks the trip latch and holds the breaker in the closed position.

Closing rotation of the main shaft also causes the motor control switch to be actuated by its operating cam. The gearmotor is thereby energized and another spring compression cycle occurs. At the completion of this cycle, the breaker is closed and the operating mechanism is charged and ready to perform another close operation. This is the normal condition for a breaker in service, and the breaker will remain in this condition until a trip command is given.

Opening

A trip command energizes the trip solenoid which strikes the lever rod [29b] 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

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counterclockwise and opens the circuit breaker. 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.

Close Open

The close-open operation is merely the combination of the closing and opening operations described previously. When the breaker closes on a fault, the protective relay energizes the trip coil, rotating the release latch and permitting the trip latch to release the latch roll. The output lever is driven counterclockwise by the breaker opening spring to contact the shock absorber and be brought to rest against the overtravel stop.

Initiation of the close operation causes the motor to start and begin recharging the opening spring. The spring charging operation does not interfere in any way with the trip operation.

Open-Close

Reclosing requires the use of a separately mounted reclosing relay of either the SGR-12 or RC type. When the protective relay energizes the trip coil, the action described previously under "opening" takes place. If the closing spring is charged, the reclose circuit can energize the close coil as soon as the auxiliary switch closes. A close latch check switch closure is not required because the close latch resets before the spring charging takes place.

Should a fault still exist as the breaker recloses, the mechanism will function as described under the "close-open" operation, and the breaker and mechanism will return to the open position. Due to the lockout feature of the Type SGR-12 and RC relay, the mechanism must be closed by the system operator before another reclosing operation can be performed.

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Inspection

Since operating conditions vary greatly from one area to another and even between installations in the same locality, it is difficult to recommend a specific time interval for inspection and maintenance. The important consideration in this regard is that a regular schedule is established and maintained in order that the condition of the equipment is known, and any deficiencies corrected before they can develop into a serious condition. The circuit breaker is highly dependent upon the proper functioning of the mechanism. Therefore, it should always be kept in good condition.

⚠ DANGER

Hazardous voltage and mechanisms. Death or serious injury 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 equipment, INSTRUCTION MANUALS and drawings.
2. Do not trip or close the breaker unless you are clear of all moving parts.
3. Disconnect the breaker 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 breaker's energy storage springs before performing maintenance or inspection.

No attempt to operate the breaker should be made until all shipping braces have been removed, and the breaker has been inspected and adjustments checked.

The wiring and schematic connection diagrams supplied with the breaker should be used when testing and checking the mechanism and control circuits. Check all wiring for looseness.

In order to be sure of the mechanism's sound condition and to check its readiness for satisfactory operation, especially in applications where the mechanism is not called on to operate for extended periods of time, several operations should be made at each inspection period.

Inspect the mechanism for any worn or damaged parts, and for any loose hardware.

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Maintenance and Adjustment

Work on the breaker or the mechanism should be performed only by qualified personnel. Before beginning any maintenance, the safety procedures outlined in the circuit breaker instruction book should be complied with. The breaker should be in the open position, and the close spring should be discharged. In addition, all electrical power to the breaker and its controls should be disconnected and properly grounded. When performing maintenance or adjustments requiring the mechanism to be closed and/or charged, the release latches should be blocked to prevent accidental tripping and possible injury.

The mechanism and breaker are fully adjusted and extensively tested at the factory. Further adjustment of the mechanism should not be necessary unless parts are replaced.

General

Thorough, periodic inspection is important to satisfactory operation. Inspection and maintenance frequency 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. Inspection and maintenance can be improved and simplified by using the gauge and tools available from Siemens identified as Major Inspection Tool kit 1658B22G01 (23kA) and 72-181-090-801 (31.5 and 40kA).

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 breaker 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 breaker has been disconnected from power lines, attach the grounding leads properly before touching any of the circuit breaker parts.

⚠ 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 deenergized high voltage, grounded all terminals and turned off control voltage. Grounding terminals with line to ground capacitors may produce a small arc.
2. Never trip or close the breaker while working on it, since the parts move rapidly and can cause injury.
3. Discharge the breaker's mechanical systems before performing maintenance or inspection.
4. Secure the operator against accidental tripping when adjustments require breaker in closed position.
5. Breaker and its mechanism must be disconnected from all electrical power before performing maintenance or inspection. Grounding leads should be properly attached and framework grounded.
6. Never slow operate the breaker while it is energized or control power is connected.
7. Remove the maintenance closing device before operating the breaker.
8. 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.

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STEP 3
Inspect the operating mechanism periodically and keep the bearing surfaces of the toggles, rods and levers adequately lubricated where required. See LUBRICATION OF MECHANISM, Page 73.

STEP 4
Keep the mechanism clean.

STEP 5
Be sure the circuit breaker is well grounded.

STEP 6
See that bolts, nuts, washers, cotter pins and all terminal connections are in place and tight.

STEP 7
Inspect the bushing (insulator) supports, as the vibration due to the operation of the circuit breaker may cause the bushings to move slightly and result in loose hardware.

STEP 8
Clean and, if necessary, dry the insulating materials across the interrupter and to ground or parts of different potential.

STEP 9
At all inspections operate the circuit breaker 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, tampering by unqualified personnel, or incorrect adjustments will result in dangerous conditions which can cause severe personal injury or equipment damage.

To prevent:

Follow all safety instructions contained herein.

Ordering Replacement Parts

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

1. Breaker serial number. (On breaker and operator nameplates.)
2. Type of operator. (On operator nameplate.)
3. Type of breaker.
4. Rated amperes of breakers.
5. Rated voltage of breaker.
6. Description of part - Use instruction book description insofar as possible.
7. Operator instruction book number. (On breaker nameplate.)
8. Instruction book reference number.
9. Number of pieces required.

While the operator can be identified by the serial number alone, all additional information that is given will serve as a check to be certain that the part or parts furnished are correct for the operator in question. Without this serial number Siemens cannot be sure of the correct identity of the desired parts.

If any doubt exists as to the instruction book reference number of the description, a dimensional sketch of the desired part will help to properly 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. A list of recommended spare parts is sent with the breaker.

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

Maintenance Closing Device

The breaker may be "slow opened" and "slow closed" for adjustment and alignment inspection using the SPRING

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Maintenance and Adjustment

maintenance closing device. Application of the maintenance closing device is shown in Figure 20, Page 83.

To open a closed and latched breaker using the maintenance closing 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. Closing spring must be discharged when using the maintenance closing device.
2. Never slow operate the breaker while it is energized or control power is connected.
3. Remove the maintenance closing device before operating the breaker.
4. Keep hands free of mechanism while operator is in motion.

Manual Charging Tool

If motor power is unavailable, the mechanism closing spring can be charged by use of the manual charging tool. The tool is applied as shown in Figure 21, Page 84. It engages a drive pin attached to an auxiliary shaft of the gearbox, and is operated by means of a standard wrench. (A socket wrench with a ratchet drive is recommended.)

The charging tool must make 6.5 revolutions to advance the ratchet wheel by one tooth. Approximately three of these revolutions are loaded by the closing spring, and the rest are unloaded. The peak torque required is about 6 ft-lb.

Spring Discharge

Normally, the opening and closing springs can be discharged by simply opening or closing the breaker 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 can be used.

Insert the manual charging tool through the frame as shown in Figure 21, Page 84 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.

Eccentric Drive

The length of the eccentric drive rod assembly (Figure 22, Page 85, 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.

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Maintenance and Adjustment

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 the end of the rod. The upper nut is right hand and the lower left hand. Turn the rods 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.

Release Latches and Solenoids

Adjustment is the same for either the trip or the close release latch. To check the adjustment of the trip release latch, it is necessary to put the output lever in the breaker closed position. This can be done by using the maintenance closing device to close the breaker, pulling it into a slight overtravel position to remove the load from the trip latch, and holding in this position. Alternatively, the maintenance closing device can be used to partially close the breaker to allow a block to be placed between the outboard bearing lever and the opening spring support bracket. Then the closing device can be removed, and the pin connecting the mechanism output lever to the horizontal pullrod can be withdrawn to allow free movement of the lever.

To check the adjustment of either release latch, turn the latch to the release position, and pry the main 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 main latch. In this position, the distance between the stop screw 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.

Close and Trip Latches

The close latch and the trip latch are made of hardened steel. The face of the latches which contacts the latch roll may be polished with fine emery cloth if they become dirty. **Do not attempt to grind the surfaces or change their 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.

Holding Pawl Stop

The holding pawl, Figure 22, Page 85, [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 .025 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. Check the adjustment by advancing the ratchet wheel position two or three teeth by use of the manual charging tool.

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.

Appendix I

Maintenance and Adjustment

A. If The Gearmotor Fails To Run

1. Check to see that the correct control voltage is available.
2. Check whether the cam-operated motor control switch is closed.
3. Check that the close release latch is reset and the latch check switch is closed.
4. Check motor circuit breaker.

B. If The Gearmotor Runs But Fails To Charge The Spring

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 Fails To Close The Breaker

1. Check that the closing spring is charged.
2. Check to see that the correct control voltage is available.
3. Check the closing relay to see that it closes contacts.
4. Check the voltage at the close coil terminals.
5. Check the terminals and contacts of the auxiliary switch to be sure they are making good contact.

D. If The Mechanism Closes The Breaker 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.

E. If The Mechanism Fails To Trip

1. Check the voltage at the trip coil terminals.
2. Check the terminals and contacts on the breaker 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.

Lubrication

The following lubricants are to be used as indicated:

Molykote (Siemens part number 00-337-271-095) is used for all breaker linkage pins, including the connection to the mechanism output lever, for the tip of the mechanism shock absorber, and for the surface of the latch cam, Figure 22, Page 85, [14-13].

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

The mechanism should be relubricated at least once every three years. If the breaker 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 breaker mechanism or linkage.

Appendix I

Part Replacement

General Instructions

DANGER

Hazardous voltage and mechanisms. Death or serious injury 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 equipment, INSTRUCTION MANUALS and drawings.
2. Do not trip or close the breaker unless you are clear of all moving parts.
3. Disconnect the breaker 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 breaker's energy storage springs before performing maintenance or inspection.

Following replacement of any part of the mechanism, adjustments affected by the replacement should be checked as indicated in the section "MAINTENANCE AND ADJUSTMENT". Before placing the breaker in service, trial operations should be made. Charge the spring, and then de-energize the gearmotor by opening the motor circuit breaker. Close the breaker by energizing the close solenoid. Trip the breaker by means of the trip solenoid, and check that the close latch resets and the latch check switch operates. Close the gearmotor circuit breaker and perform a few open and close operations with automatic motor control. If all goes well, then return the breaker to service.

Solenoids, Trip and Close

Disconnect the solenoid leads from the terminal block. If equipped with a manual operation pushbutton, remove this assembly by unscrewing the two slotted head screws which secure it to the solenoid bracket. Remove the two nuts which hold the solenoid and its bracket to the operator frame. Withdraw the solenoid assembly. Take care not to lose 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 nylon 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 hex 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.

Appendix I

Part Replacement

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 is retained by a sleeve 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 at the upper 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 to clear the drive rod clevis. 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 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 drive rod assembly rod end onto the eccentric shaft extension with the spacers located as on the original shaft. Align the clevis with the pawl arms and insert the pivot pin through the washers, spacers and pawl 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.

Eccentric Drive Rod

Removal and replacement of the drive rod 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, begin by removing the pawl pivot pin as described under "ECCENTRIC SHAFT". Next, unscrew the capscrew holding the retainer plate to the center of the main shaft. The splined collar 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 adjacent to the ratchet wheel 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 and the surface of the frame contacted by the spacers. Also clean the short section of splined sleeve 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

Part Replacement

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 over one flat of the capscrew head.

Main Shaft

Removal of the main shaft requires that the closing spring be disconnected from the crank. 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 on the spring rod 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 to screw it out of the end fittings. When the spring carrier comes to rest against the bottom of the breaker housing, the crank must be moved from bottom center toward the "5 o'clock" position so that turning of the rod can proceed. Turn the rod completely out of the rod end connected to the crank, and then stop turning. The lower end of the rod will remain connected to its rod end if turning is stopped at this point.

Remove the pawl arms and ratchet wheel as described in the previous section. Push the end of the main shaft into the frame until it reaches the edge of the cam. Hold the cam through the frame openings to keep it from falling. Reach around behind the frame to grasp the crank, and pull the shaft through the cam. Withdraw the cam from the frame, then finish pulling the shaft out the back of the frame. Remove the sleeves 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, place the spacer (s) from the back of the frame over the shaft and slip the shorter sleeve over the end of the shaft. From behind the frame, insert the sleeve into the rear main bearing until the shaft and sleeve are flush with the inside surface of the frame bearing boss. Let the shaft hang there with the crank in the bottom center position.

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. This mark identifies the spline tooth of the cam which must engage with the top center tooth of the shaft when the crank is in the bottom center position.

Hold the cam between the frame side plates with the point of the cam toward the left, and the punch mark at the top. Align the splined hole of the cam with the shaft, and slide the shaft into the cam and through the frame. Put the longer splined sleeve on the shaft and slide it into the front bearing. Push the sleeve into the bearing to force the cam and the 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. 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.

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 close latch roll rests against the close latch. In this position, the crank should be nine degrees over top center position, which corresponds to one-half of a spline tooth spacing. This means that the shaft should be positioned with a spline tooth trough at top center, and rotation of the shaft clockwise to put the next tooth crest at top center would also put the crank at top center position.

To re-connect the spring rod to the upper rod end, the rod end must be repositioned to the opposite side of 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 clear of the ratchet teeth, and rotate the main shaft clockwise to put the crank in approximately the "8 o'clock" position. Release the pawls.

Appendix I

Part Replacement

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 to maintain this setting.

Output Lever

Removal of the output lever requires that the lever be disconnected from the breaker horizontal linkage. Proceed as outlined under the topic "MAINTENANCE AND ADJUSTMENT/RELEASE LATCHES AND SOLENOIDS". Next, remove one of the cotter pins from the lever pivot pin. Hold the lever while withdrawing the pivot pin.

Wipe the pin and lever clean, and re-lubricate the pin and the lever cam with Beacon #325 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 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 and the connecting pin with Molykote.

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

Latches, Trip and Close

Removal of the latches is essentially the same for either the trip or the close latch. The only difference is that the trip latch must first be uncoupled from the cam which holds the trip latches in the unlatched position. This is accomplished as described in "MAINTENANCE AND ADJUSTMENT/RELEASE LATCHES AND SOLENOIDS". Then proceed as follows:

Reach through the opening in the frame and pull out the two hairpin cotters which retain the release latch. Lift the end of the release latch torsion spring 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. Unhook the end of the latch return spring 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 LATCHES AND SOLENOIDS".

Closing Spring and Carrier

To remove the closing spring and the spring carrier, begin by removing the access panel in the bottom of the breaker housing, and fully discharge the spring as described in the section "MAINTENANCE AND ADJUSTMENT/SPRING DISCHARGE". Disconnect the lever which operates the "charge/discharge" indicator from the spring carrier axle.

With the crank at bottom center position, the locknut on the spring rod can be reached and loosened through the

Appendix I

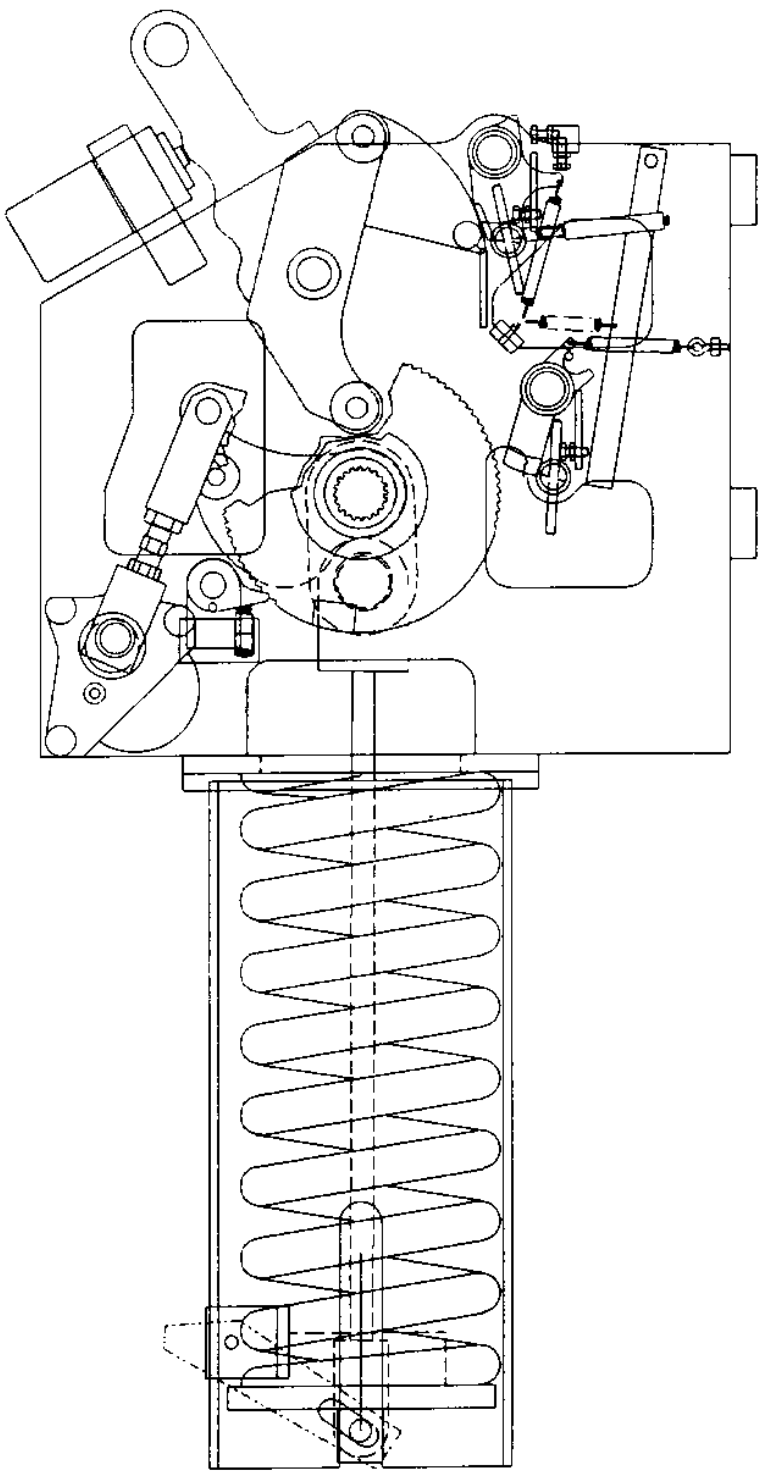
Part Replacement

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 to screw it out of the end fittings. Before proceeding, the spring carrier should be blocked to the ground to keep the spring and carrier from falling when the rod is screwed out of the rod end. The assembly weighs in excess of seventy pounds and would be difficult to hold by hand when the weight is suddenly released from the rod end.

Turn the spring rod to unscrew it from the top rod end. Remove the blocking and lower the spring carrier, spring and rod assembly to the ground. Lift the spring off of the carrier. Remove the cotter pin from one end of the carrier axle rod and slide the roller 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.

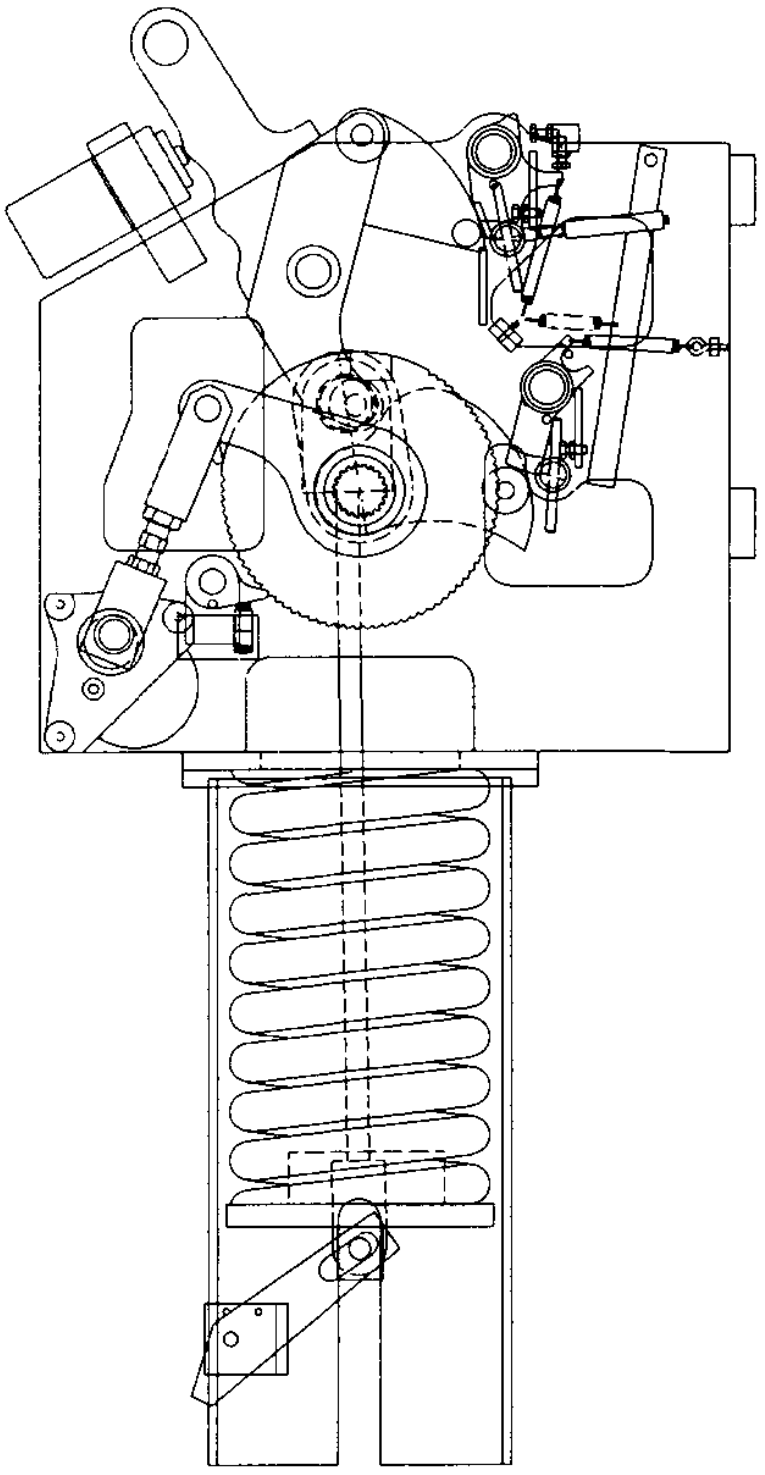
Before reassembling, clean and re-grease the axle, rollers, spacers and rod end bearing with Beacon #325. Assemble the carrier, and the carrier, spring and rod assembly to the frame, in the reverse order of their removal.

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



Spring Discharged, Breaker Open

A

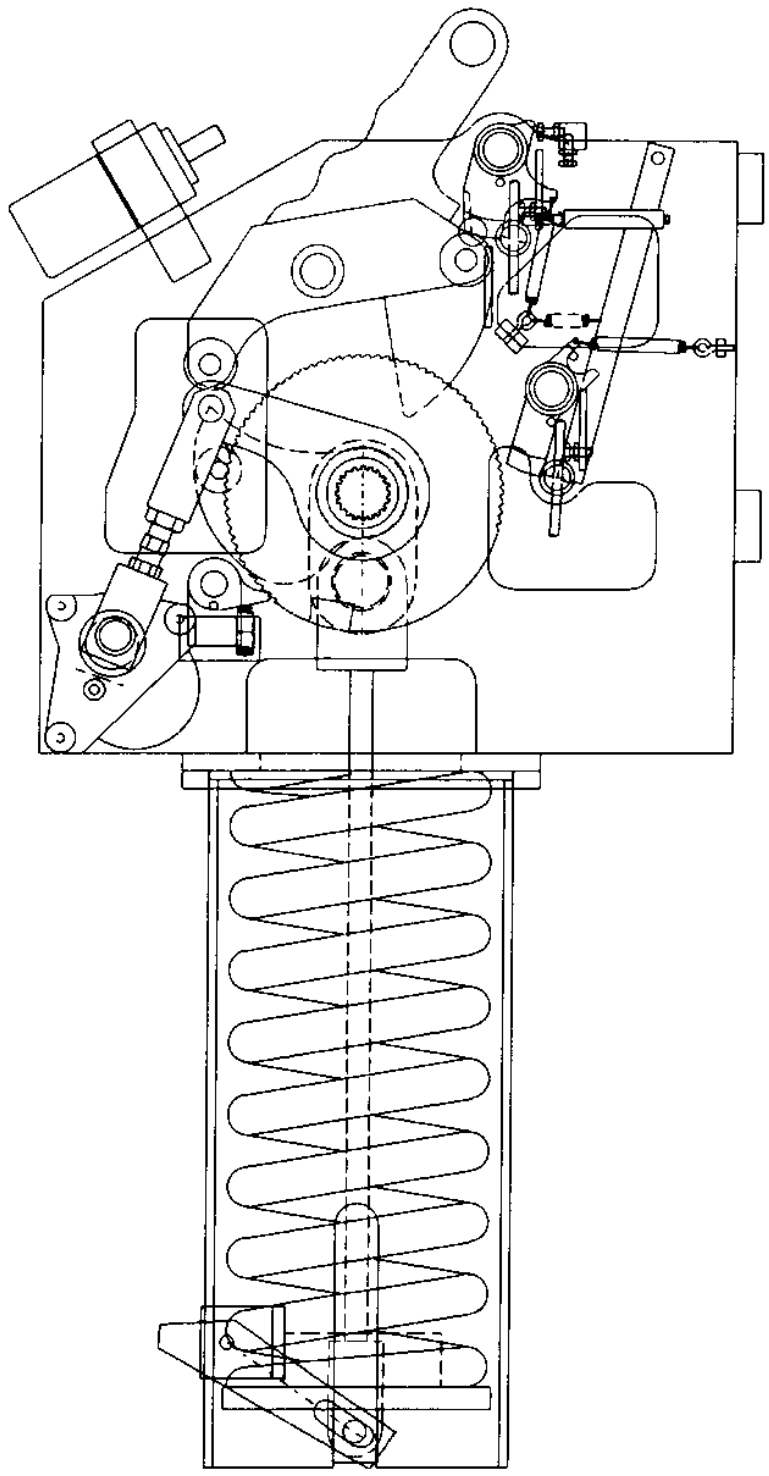


Spring Charged, Breaker Open

B

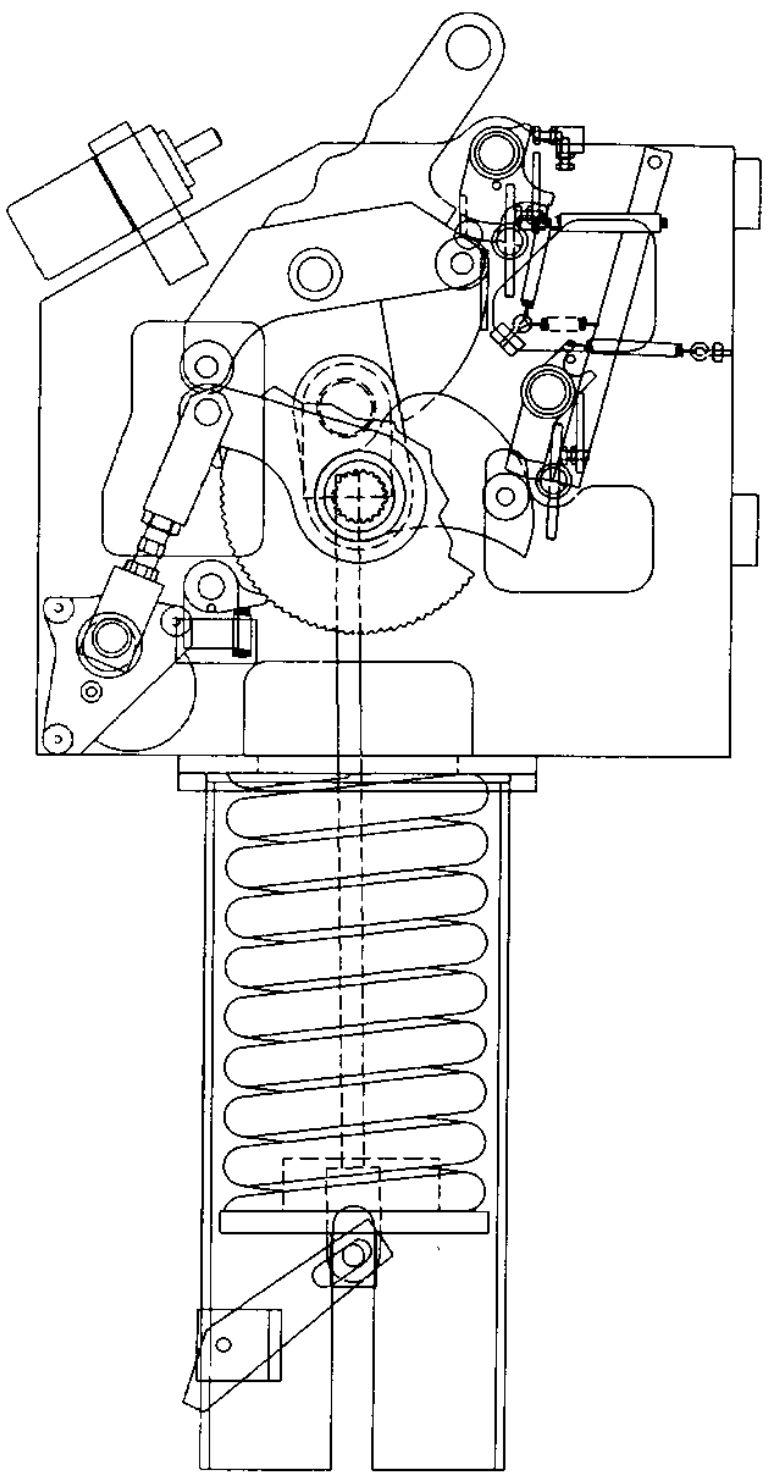
Figure 17 -- Mechanism Operating Positions

Illustrations



Spring Discharged, Breaker Closed

C



Spring Charged, Breaker Closed

D

Figure 17A -- Mechanism Operating Positions

Illustrations

Notes:

1 All Equipment Shown With:
Circuit Breaker Open
Control Voltage Off
Low SF_6 Pressure
Spring Discharged

- Pressure Switch Settings -
(Values in PSIG @ 20°C)

Low SF_6 Alarm ..... 75 ± 1.1 PSIG

General Lockout SF_6 ..... 72 ± 1.1 PSIG

Legend

01	Control Switch
08C	Control Power Switch
08H	Heater Power Switch
08M	Motor Power Switch
08T	Trip Power Switch
23	Heater Thermostat
52a,b	Breaker Auxiliary Switch
52C	Breaker Close Coil
52T	Breaker Trip Coil
52Y	Breaker Closing Cutoff Relay
63G SW#1	Low Pressure Alarm - (SF_6)
63G SW#2	Low Pressure Cutout - (SF_6)
63X	Interrupter SF_6 Low Pressure Cutout Aux. Relay
88	Motor
G	Green Indicator Light
H1,2	Cabinet Heater
LCC	Close Latch Checking Switch
LCS-CC	Spring Charge Switch (Closed When Spring Charged)
LCS-MS	Spring Charge Switch (Closed When Spring Discharged
PR	Protective Relays
R	Red Indicator Light

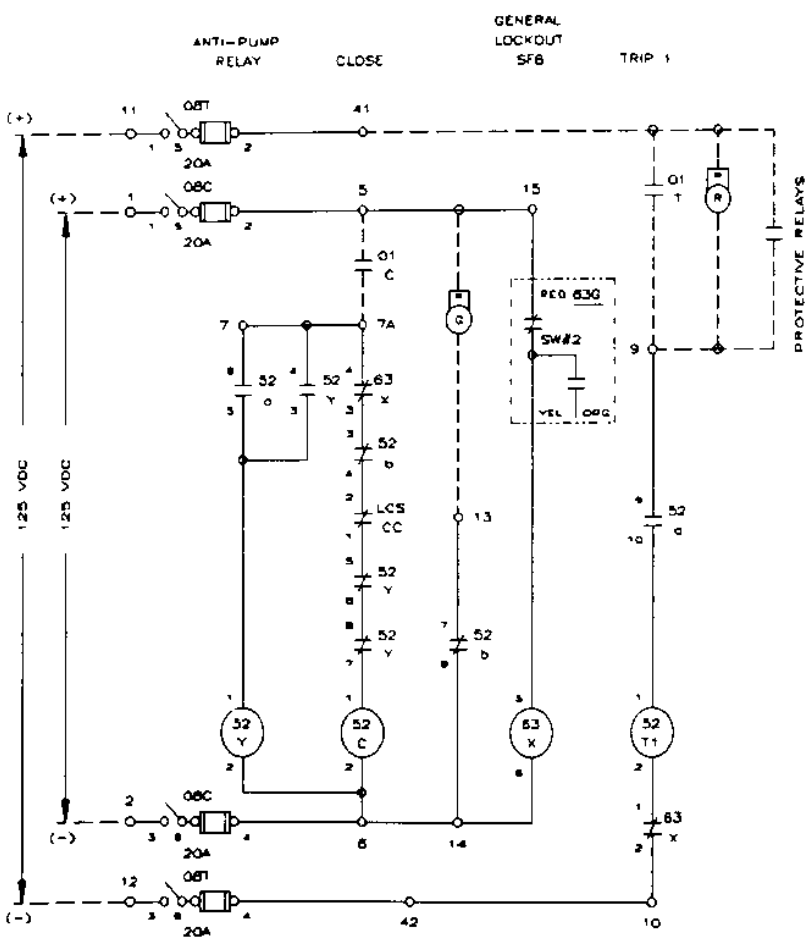


Figure 18 -- Typical Wiring Diagram

72-380-495-401

Illustrations

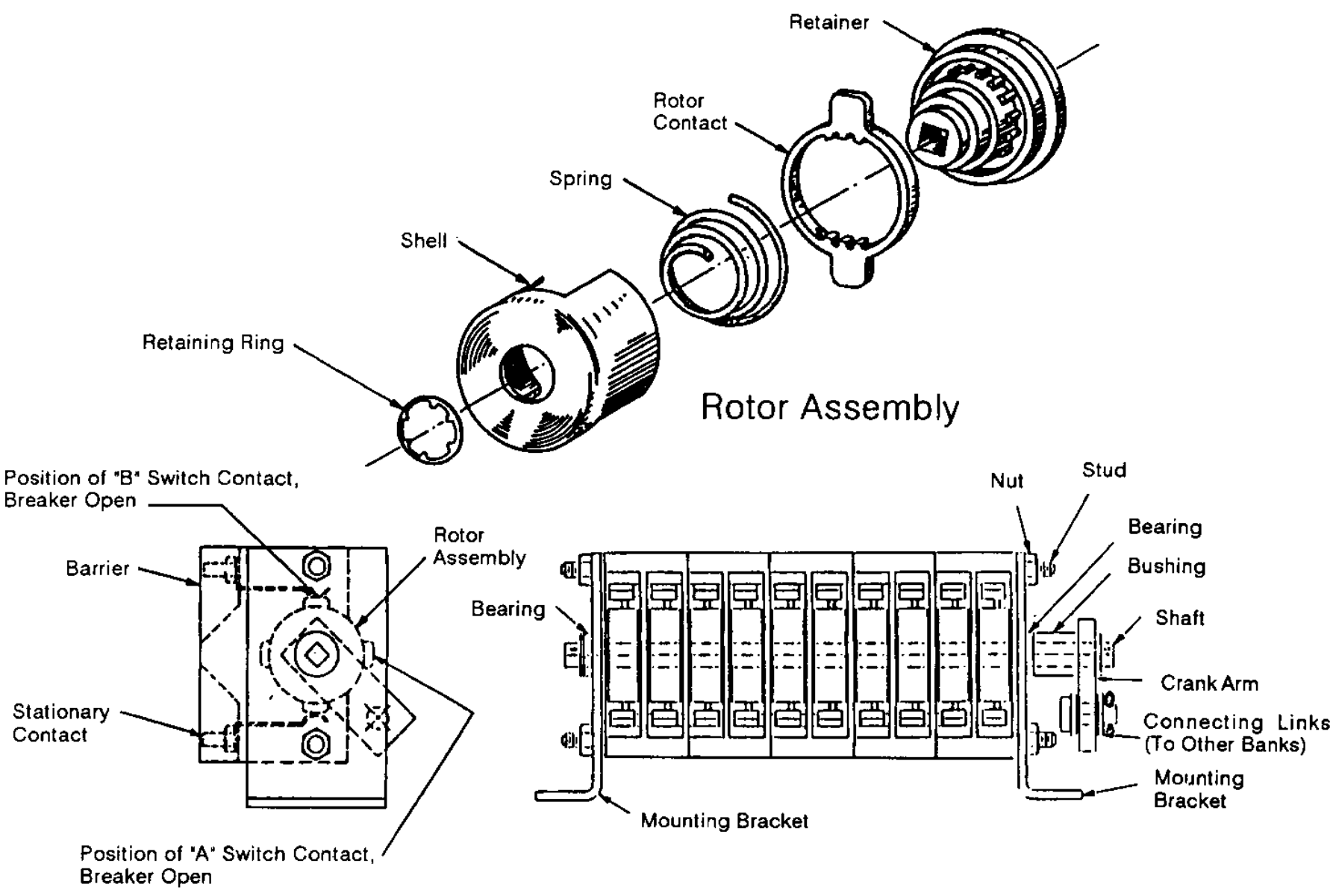


Figure 19 -- Typical Auxiliary Switch

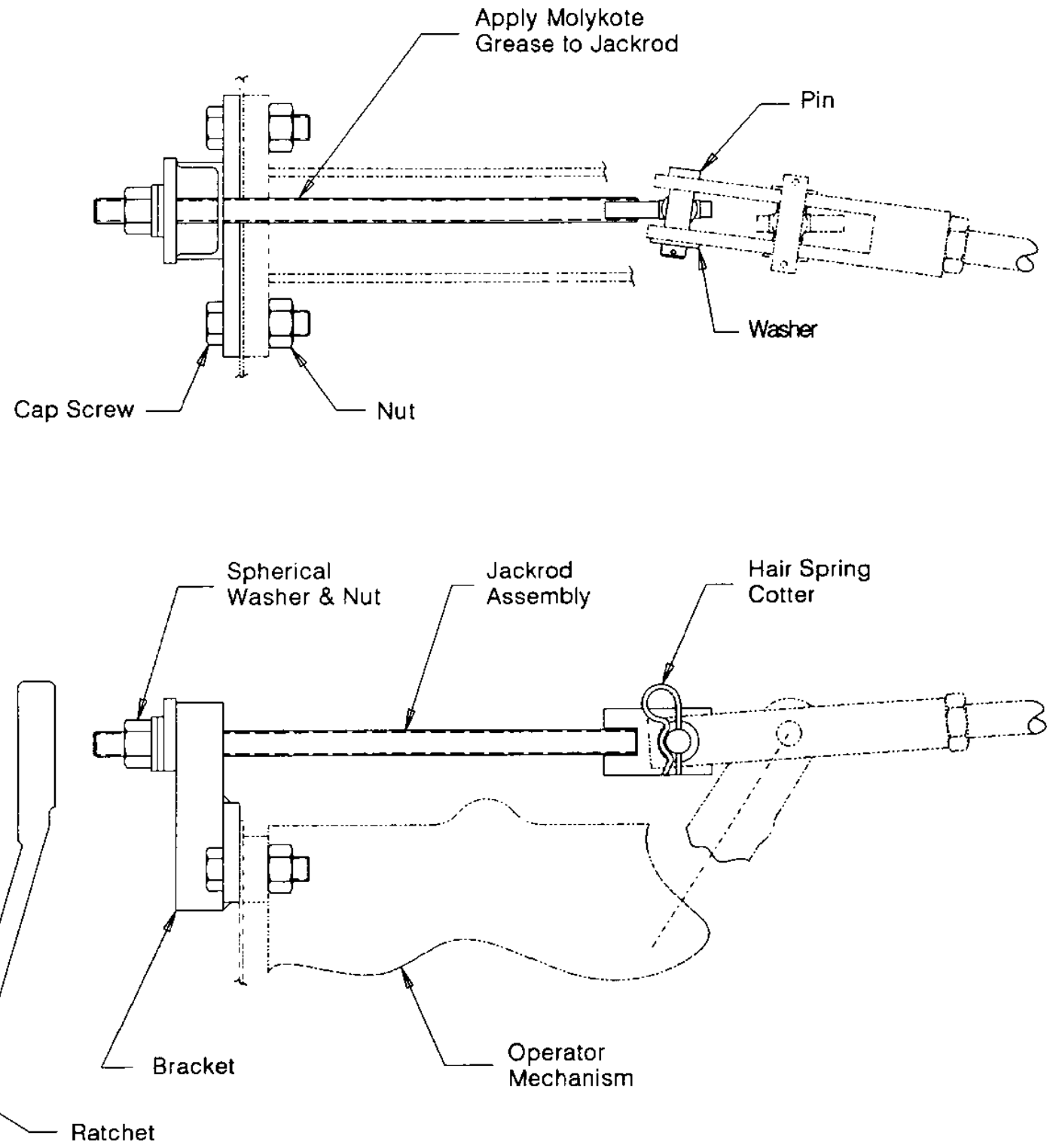


Figure 20. Slow Close Device

72-181-901-401

Illustrations

⚠ DANGER

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

To prevent:

1. Breaker must be in the open position and the mechanism closing spring discharged before attaching the hand charging device.
2. Never use the hand charging device when the breaker is energized or control power is connected.
3. Remove the hand charging device before operating the breaker.
4. Keep hands free of the breaker while the operator or jack is in use.

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

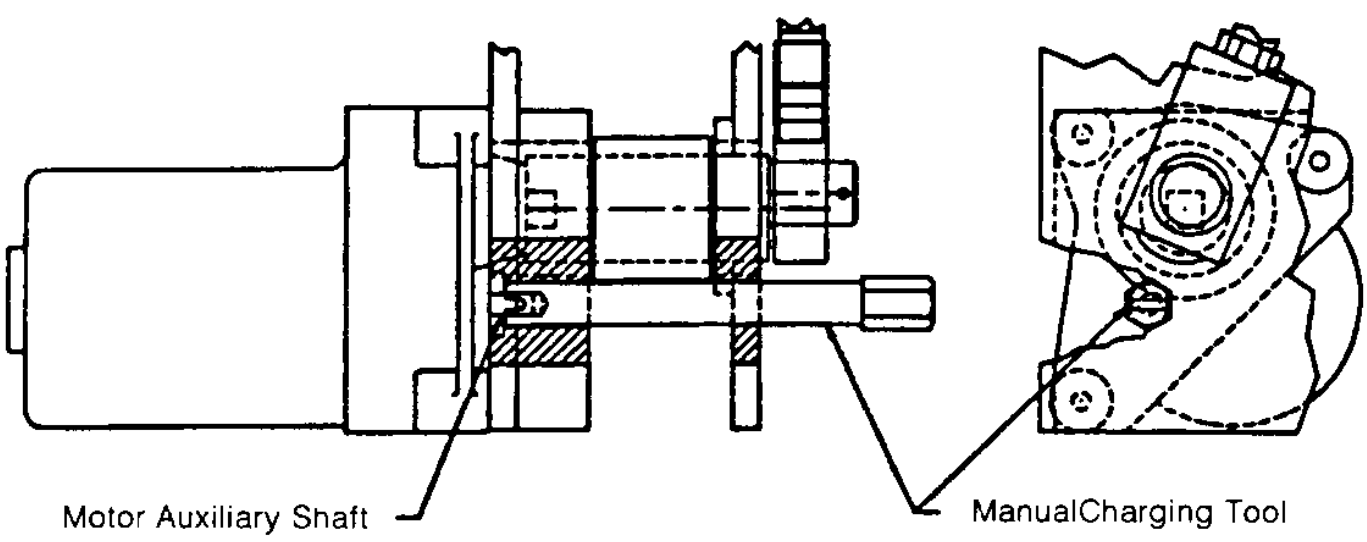


Figure 21 -- Application of Manual Charging Tool

Illustrations

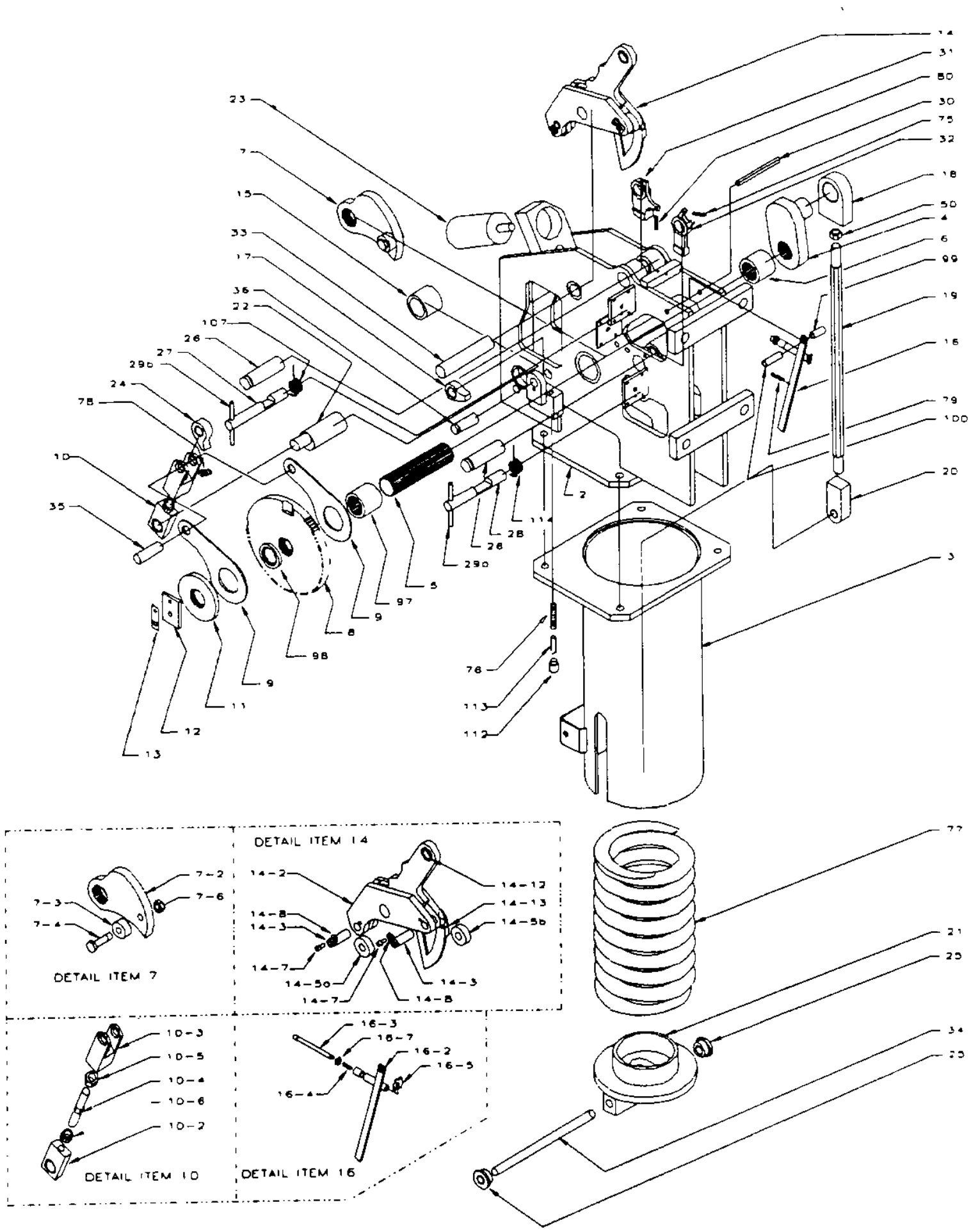


Figure 22 – SE-4 Spring Operator
72-380-436-401

Type SE-4 Spring Operated Mechanism
Mechanical Parts

72-480-301-810
Page 1 of 2

Ref. No.	Name of Part	Identification Number	Number per Unit
2	Operator Frame	72-480-378-001	1
3	Spring Housing Assembly	72-280-683-501	1
4	Crank	72-280-672-002	1
5	Shaft	72-181-335-001	1
6	Sleeve	72-181-332-001	1
7	Cam and Roller Assembly	72-181-337-501	1
8	Ratchet Wheel	72-280-761-001	1
9	Pawl Arm	72-181-331-001	2
10	Rod Assembly	72-181-330-501	1
11	Collar	72-181-327-001	1
12	Plate	72-181-383-001	1
13	Strip	72-181-339-001	1
14	Lever Assembly	72-181-361-501	1
15	Sleeve	72-181-563-001	1
16	Interlock Assembly	72-181-634-501	1
17	Pawl Assembly	72-181-356-502	1
18	Rod End Assembly	72-181-321-501	1
19	Bar	72-280-685-002	1
20	Rod End Assembly	72-181-565-502	1
21	Spring Support Assembly	72-280-684-501	1
22	Motor Shaft	72-280-687-001	1
23	Shock Absorber	1654B08H02	1
24	Pawl Assembly	72-181-356-501	1
25	Bushing Assembly	72-181-358-501	2
26	Pin	72-181-551-002	2
27	Shaft	72-280-766-001	1
28	Shaft	72-280-807-001	1
29	Pin	72-181-549-001	2
30	Pin	72-200-566-004	1
31	Latch	72-280-820-002	1
32	Latch	72-280-822-002	1
33	Pin	7353D68H11	1
34	Pin	72-181-363-002	1
35	Pin	72-181-363-003	1
36	Pin	72-181-348-001	1
50	Jam Nut	72-181-675-001	1
75	Spring	W 392035	1
76	Spring	W 391810	1
77	Spring	72-181-143-001	1
78	Spring	W 39180902	1
79	Spring	W 392156	1
80	Spring	W 392043	1
99	Spacer	W 34210901120	1

Type SE-4 Spring Operated Mechanism
Mechanical Parts

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Ref. No.	Name of Part	Identification Number	Number per Unit
100	Spacer	W 34210901124	1
107	Spring	72-181-531-001	1
112	Set Screw	72-181-619-001	1
113	Pin	72-181-620-001	1
114	Spring	72-181-628-001	1
7-2	Cam	72-280-677-001	1
7-3	Needle Bearing	W 113315	1
7-4	Screw	72-181-336-001	1
7-6	Jam Nut	W 31710813105	1
14-2	Lever	72-280-697-001	1
14-3	Pin	72-181-362-001	2
14-5	Needle Bearing	W 113318	2
14-7	CSCR Screw	00615114369	2
14-8	Washer	W 371113	2
14-12	Spher. Brg.	7249A61H01	1
14-13	Latch Cam	72-280-753-001	1
10-2	Rod End Assembly	72-181-334-501	1
10-3	Rod End Assembly	72-181-567-501	1
10-4	Bar	72-280-685-001	1
10-5	Jam Nut	W 31711011107	1
10-6	Nut	72-181-532-001	1
16-2	Lever Weldment	72-181-633-501	1
16-3	Rod	72-181-629-001	1
16-4	Spring	W 39181003	1
16-5	Washer	23600902004	1

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