SQUARE D
Instruction Bulletin

Bulletin No. 6055-2
November, 1993
Replaces 6055-2 dated 10-87
Smyrna, TN, U.S.A.

SF_6 Circuit Breaker Type FG-2 Drawout

Series 2

NOTICE

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this bulletin to warn of potential hazards and to call attention to additional information which clarifies or simplifies a procedure.

⚠ DANGER

Used where there is a hazard of severe bodily injury or death. Failure to follow a "DANGER" instruction ***will*** result in electric shock, ***severe*** bodily injury, or death.

⚠ WARNING

Used where there is a hazard of bodily injury or death. Failure to follow a "WARNING" instruction may result in bodily injury or death.

⚠ CAUTION

Used where there is a hazard of equipment damage. Failure to follow a "CAUTION" instruction may result in damage to equipment.

NOTE

Provides additional information to clarify or simplify a procedure.

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SECTION 1—INTRODUCTION

This bulletin provides installation, operation, and maintenance procedures for the FG-2 SF_6 Series 2 drawout circuit breaker. The FG-2 circuit breaker employs the latest SF_6 technology, combining superior performance with low maintenance.

Table 1 below shows the ratings of available Type FG-2 circuit breakers. The Circuit Breaker Identification shows how to determine circuit breaker ratings from the model number.

Table 1
Circuit Breaker Ratings

Type of Circuit Breaker	Nominal Rating		Rated Cont. Current 60 Hertz Amps.–RMS	Rated Voltages			Insulation Level Rated Withstand		Interrupting Ratings Amps.–Symmetrical			Asym-metrical Rating Factor	Short Time Rating 3 Sec. Amps.–RMS	Close & Latch Rating Amps.–RMS	Inter-rupting Time Cycles
	Three Phase MVA	Voltage kV–RMS		Maximum Voltage kV–RMS	K-Factor Max. kV — Min. kV	Minimum Voltage kV–RMS	Low Frequency kV–RMS	ΔImpulse 1.2x50μs kV–CREST	Maximum kV Amps.–RMS	Nominal kV Amps.–RMS	Minimum kV Amps.–RMS				
FG-2-05025-12	250	4.16	1200	4.76	1.24	3.85	19	60	29,000	33,200	36,000	1.1	36,000	58,000	5
FG-2-05025-20	250	4.16	2000	4.76	1.24	3.85	19	60	29,000	33,200	36,00	1.1	36,000	58,000	5
FG-2-05025-30	250	4.16	3000	4.76	1.24	3.85	19	60	29,000	33,200	36,000	1.1	36,000	58,000	5
FG-2-05035-12	350	4.16	1200	4.76	1.24	3.85	19	60	41,000	46,900	49,000	1.1	49,000	78,000	5
FG-2-05035-20	350	4.16	2000	4.76	1.24	3.85	19	60	41,000	46,900	49,000	1.1	49,000	78,000	5
FG-2-05035-30	350	4.16	3000	4.76	1.24	3.85	19	60	41,000	46,900	49,000	1.1	49,000	78,000	5
FG-2-08050-12	500	7.20	1200	8.25	1.25	6.6	36	95	33,000	37,800	41,000	1.1	41,000	66,000	5
FG-2-08050-20	500	7.20	2000	8.25	1.25	6.6	36	95	33,000	37,800	41,000	1.1	41,000	66,000	5
FG-2-08050-30	500	7.20	3000	8.25	1.25	6.6	36	95	33,000	37,800	41,000	1.1	41,000	66,000	5
FG-2-15050-12	500	13.8	1200	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.1	23,000	37,000	5
FG-2-15050-20	500	13.8	2000	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.1	23,000	37,000	5
FG-2-15050-30	500	13.8	3000	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.1	23,000	37,000	5
FG-2-15075-12	750	13.8	1200	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.1	36,000	58,000	5
FG-2-15075-20	750	13.8	2000	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.1	36,000	58,000	5
FG-2-15075-30	750	13.8	3000	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.1	36,000	58,000	5
FG-2-15100-12	1000	13.8	1200	15.0	1.30	11.5	36	95	37,000	40,200	48,000	1.1	48,000	77,000	5
FG-2-15100-20	1000	13.8	2000	15.0	1.30	11.5	36	95	37,000	40,200	48,000	1.1	48,000	77,000	5
FG-2-15100-30	1000	13.8	3000	15.0	1.30	11.5	36	95	37,000	40,200	48,000	1.1	48,000	77,000	5

CIRCUIT BREAKER IDENTIFICATION:
FG-2 - 05 025 - 12
- 12 — Continuous Current Rating
- 025 — MVA Rating
- 05 — Voltage Rating
- FG-2 — Circuit Breaker Type

Theory Of Operation

Type FG-2 circuit breaker pole units contain three contact structures:

- arcing contacts
- tulip contacts
- main contacts

As the circuit breaker closes, the tubular-shaped arcing contacts are the first to "make" (close); these connect end-to-end (figure 1).

After the arcing contacts meet, a set of tulip contacts mounted on the moving arcing contact assembly slides over the moving and fixed stationary arcing contacts. This secondary set of contacts allows the arcing contacts to carry additional current, which is particularly important under fault conditions.

Theory Of Operation (cont.)

After the arcing and tulip contacts close, the main contacts close, enabling the pole unit to carry continuous current.

When the circuit breaker opens, the three contact structures open in the reverse of their closing sequence: first the main contacts, then the tulip contacts, and finally the arcing contacts. When the arcing contacts separate, the interrupting process begins.

1. Upper Current Terminal
2. Main Circuit
3. Main Contacts
4. Lower Current Terminal
5. Filter
6. Fixed Arcing Contact
7. Insulating Nozzle
8. Moving Arcing Contact
9. Tulip Contacts
10. Moving Piston
11. Insulating Rod
12. Operating Shaft
13. Shaft Seal

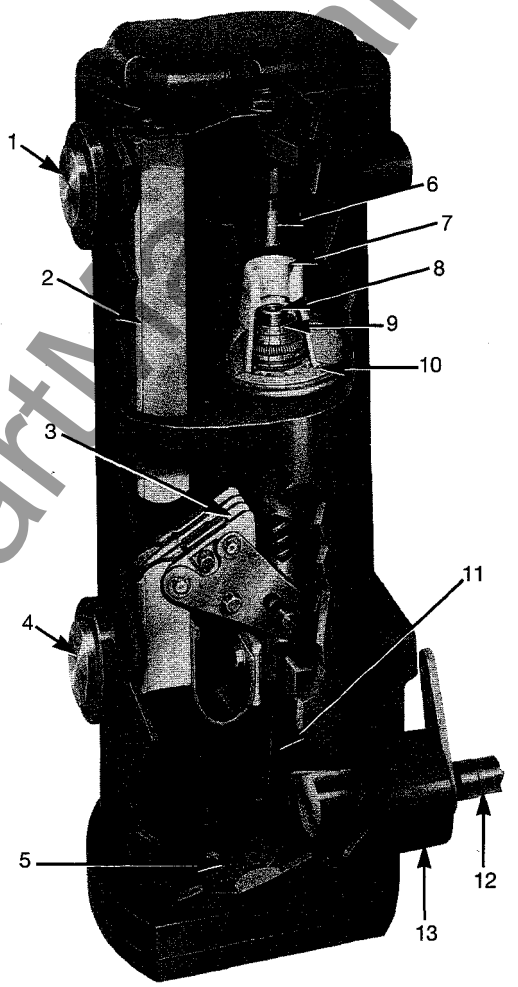

Figure 1: Interrupter bottle cross section

The FG-2 circuit breaker uses the SF_6 (sulphur hexafluoride) puffer principle of arc interruption. While the main and tulip contacts are opening, SF_6 gas is being compressed in a cylinder within the pole unit. The compressed gas passes through a nozzle which directs a high velocity flow of gas across the arc as the contacts part. The flow of gas forces the arc into the tubular arcing contacts. The arc usually extinguishes at the first current zero. The properties of SF_6 gas—high electron negativity, high thermal conductivity, and insulating properties—work together to ensure a restoration of the dielectric strength of the gas at the current zero. These properties are enhanced at elevated pressures. Thus, the SF_6 gas ensures the pole units perform at their intended rating.

SECTION 2 — SAFETY PRECAUTIONS

This equipment is constructed and tested in accordance with safety-related requirements of ANSI C37.04, C37.06, and C37.09. Square D is not responsible for special design requirements of local codes and ordinances not specified in the purchase documents. Each user is responsible for implementing a safety program that satisfies local codes and protects against the types of hazards involved.

Due to the nature of electrical power and circuit breakers of this type, certain risks exist. Known potential hazards of this equipment include electrocution, burns from arcing equipment, and pinching or crushing from the discharge of stored mechanical energy.

Implementation of an appropriate safety program covering installation, operation, and equipment service is the user's responsibility. Because of the various conditions which may exist at any site, the following safety precautions are not all-encompassing.

⚠ DANGER

HAZARD OF BODILY INJURY OR EQUIPMENT DAMAGE.

- All personnel involved in handling, site preparation, installation, testing, operation, and maintenance should be thoroughly familiar with the information in this instruction bulletin and in provided customer drawings **before** working on this equipment. They must have a thorough understanding of high voltage equipment in general, the specific operation of this particular equipment, and the types and severity of potential injury.
- Always assume that all high voltage parts are energized until you are certain they are de-energized.
- Check interconnection diagrams and make sure there are no potential backfeed sources.
- Do not open a circuit breaker door unless the circuit breaker is tripped.
- Use out-of-service tags and padlocks when working on equipment. Leave the tags in place if you leave the area, or until the work is completed and the equipment is ready for service again.
- Do not use liquid fire extinguishers or water on electrical fires! Before extinguishing fires within the assembly, be absolutely certain the main power source is disconnected, and the main and all feeder circuit breakers are tripped.
- Perform all maintenance in accordance with local codes and under the following conditions:
  - The circuit breaker must be removed from its cell and isolated from the high voltage.
  - Control voltage must be removed from the controls.

(DANGER notice continued on next page)

Safety Precautions (cont.)

⚠ DANGER

(Continued from previous page)

– The circuit breaker must be in the *open* position.

– Operation and maintenance of this equipment should be well-planned and in accordance with safety practices. Have adequate safety equipment and appropriate maintenance tools readily available.

- Never work on or near electrically energized parts where accidental contact is possible.
- Be certain the circuit breaker mechanism is discharged or blocked before working on the circuit breaker; release of stored spring energy can result in serious personal injury.
- Use only test equipment rated for the service intended. Never use instruments or multimeters rated for low voltage service on high voltage circuits; incorrect use of such instruments can result in an explosion and serious personal injury.
- FG-2 circuit breaker interrupters contain sulphur hexafluoride (SF_6) gas at 22 psig or 37 psig pressure, depending on the rating. SF_6 is a colorless, odorless, non-flammable, non-toxic, and chemically inert gas. It has no known ill effects. However, as the gas is exposed to electric arcs inside the circuit breaker interrupter, some of the gas decomposes into potentially toxic compounds, both gaseous and solid. Therefore, if any pole unit is accidentally opened, the following precautions must be taken:

  – Avoid breathing gases coming from the equipment.

  – Thoroughly ventilate the area.

  – Wear gloves to avoid direct skin contact with any internal pole unit components.

  – If personnel must remain near a damaged unit, air masks or breathing apparatus with self-contained oxygen should be used.

  – Some gases formed from the SF_6 have a rotten egg odor and may be smelled long before concentrations of the toxic gases are harmful. Halogen detectors may be used to determine the relative concentration of gases present in the atmosphere.

- When in doubt, stop! Re-read the instruction bulletin or refer to the customer drawings before proceeding. Eliminate dangerous and costly human errors!
- This instruction manual does not cover all possible equipment combinations. Nor does it cover field conditions that may arise during handling, site preparation, installation, testing, operation, or maintenance. For additional information, or if unforeseen site conditions or problems exist, contact your local Square D field office.

Failure to observe these precautions will result in severe personal injury, death, or equipment damage!

SECTION 3—RECEIVING, HANDLING, AND STORAGE

Receiving

Inspect each box for external damage or indications of rough handling before accepting the shipment. If there is indication of external damage or mistreatment, or if the correct number of crates is not received, make note of the problem on the shipping papers before signing them. Immediately file a formal damage claim with the carrier. Notify your local Square D field office about the extent of damages or shortages, and attach a copy of the formal damage claim.

Open each unit by carefully removing the bands from the box cover. Carefully lift the box cover off the shipping pallet. If no damage is detected, replace the box cover for storage prior to installation.

Handling

The circuit breaker is packaged for moving and handling with a forklift. Each packaged circuit breaker weighs approximately 570 lbs.

Lifting hooks can also be used to move the circuit breaker (figure 2); follow these steps:

1. Cut off the bands and lift the box cover off the shipping pallet.
2. Loosen the bolts on the lifting plates attached to the circuit breaker; rotate the lifting plates into an upright position. Securely retighten the bolts.
3. Insert hooks into the holes in the lifting plates; gradually lift the unit.
4. After lifting is complete, return the lifting plates to the storage (retracted) position.

Figure 2: Circuit breaker lifting

Storage

If the circuit breaker is not installed upon receipt, store it indoors in the shipping packaging. The packaging is designed for indoor storage at temperatures of 50°F–130°F with relative humidity up to 80% for a maximum of two years. Do not stack packaged circuit breakers more than two high.

Operate the circuit breaker at least once yearly to keep the seals lubricated and to refresh the bearing lubrication. If a circuit breaker is stored for more than two years, completely inspect, test, and lubricate it prior to placing it into service.

SECTION 4—DESCRIPTION

General

The circuit breaker is designed and manufactured in accordance with ANSI C37.04. The stored energy spring operating mechanism has two-step operation and is trip-free.

Operating Mechanism

The stored-energy mechanism consists of high energy closing springs and a ratcheting system for charging the springs. The circuit breaker cannot be closed until the springs are fully compressed. Opening and closing speeds are independent of the method by which the springs are charged (manual or electrical).

The springs are charged in one of two ways:

- electrically, by the gear motor, immediately after the circuit breaker closes
- manually, with the manual charging handle (figure 3)

See page 19 for information on electrically and manually charging the circuit breaker.

Manual Closing And Opening

The circuit breaker manual closing and opening push buttons (figure 4) operate the same mechanisms mechanically that the closing and opening solenoids operate electrically.

Figure 3: Manual charging

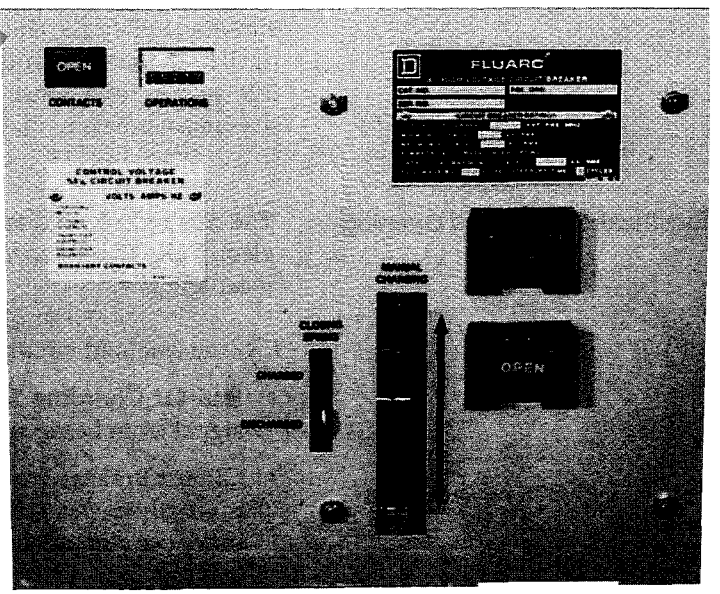

Figure 4: Circuit breaker operating controls

Manual Closing And Opening (cont.)

The closing push button, through a series of mechanisms, releases the closing spring latch, causing the main contacts to close. The closing mechanism is equipped with an interlock which allows the push button to move. However, the closing mechanism can be mechanically disconnected from the closing spring latch, preventing the circuit breaker from closing. The interlock is interconnected to the trip mechanism so that the closing mechanism disconnects before the trip (open) operation occurs. A tripping signal always takes precedence over a closing signal. A closing or opening signal must be removed before the interlock will reset, and the closing process can be activated.

If the circuit breaker is in the *open* position and simultaneous closing and opening signals are received, the trip signal disconnects the closing mechanism before the closing spring latch can release. The circuit breaker remains in the *open* position.

If the circuit breaker is in the *open* position and a closing signal is received slightly ahead of an opening signal, the circuit breaker makes a complete close-open cycle. During part of the closing stroke, the trip mechanism activates; however, the circuit breaker continues to close with full closing and latching capability. As soon as the circuit breaker fully closes, it immediately trips open with full interrupting capability.

If the circuit breaker is in the *closed* position and the *close* button is pushed, nothing happens.

If the circuit breaker is closed and the *close* and *open* push buttons are pushed simultaneously, the circuit breaker opens. The circuit breaker remains open until both the open and close buttons are released, allowing the closing interlock to reset. Once the interlock has reset, push the close button to close the circuit breaker.

Electrical Closing And Opening

The closing solenoid and the opening solenoid operate the same mechanisms electrically that the circuit breaker manual push buttons operate mechanically.

Closing solenoid circuits have three electrical protective features:

- **End-Of-Charging Switch**—The end-of-charging switch prevents a closing signal from being applied until the closing springs are fully charged.
- **Circuit Breaker Position Auxiliary Contact**—At circuit breaker closure, a normally-closed (b) auxiliary circuit breaker contact opens; this removes the close signal from the closing solenoid, preventing the solenoid's overheating.

The opening solenoid circuit includes a normally-open (a) auxiliary circuit breaker contact which prevents the solenoid's overheating.

- **Anti-Pump Relay**—If a continuous close signal is applied, followed by an opening signal, the anti-pump relay prevents multiple close-open operations. The circuit breaker will not reclose until the closing signal is removed and then reapplied.

Charging Mechanism

The charging mechanism provides the mechanical energy to open and close the circuit breaker under all conditions. Energy is required to perform the following operational functions:

- closing the circuit breaker into short circuit currents
- operating the auxiliary switches
- charging the opening springs
- operating the MOC switches (if so equipped)

With the circuit breaker open and the closing springs uncharged, there is no stored energy and no functions can be performed. With the circuit breaker open and the closing springs charged, enough energy is stored for the circuit breaker to perform one complete close-open cycle.

The stored energy is greatest when the circuit breaker is closed and the closing springs are charged; both the opening and closing springs are charged at that time. Thus, the breaker is capable of opening, closing, and reopening without recharging the springs.

All of the energy for one close-open cycle is supplied by a single charging of the closing springs. The closing springs can be recharged immediately following a closing operation.

Follow these steps to complete a close-open cycle:

1. Charge the closing springs
2. Release the closing spring latch by pushing the *close* button
3. Release the opening latch by pushing the *open* button

During the closing operation, a portion of the closing energy is used to charge the opening springs.

Components of the charging mechanism are described below.

Closing Springs And Charging Mechanism—The closing springs attach to cranks at both ends of a hexagonal shaft. The shaft and mechanism rotate 360° in one direction only. A notched wheel and pawl assembly is arranged so that, as the pawl assembly is oscillated, the hexagonal shaft is rotated from the rest position to a position just past 180° from the uncharged position. The pawl assembly is oscillated manually or by an electric motor. An electric motor and gear box is equipped with an eccentric cam which oscillates the pawl assembly.

The notched wheel has a space among the gear teeth which, when the springs are fully charged, is located at the motor-driven pawl. The space prevents damage to the mechanism and gear box from kinetic energy remaining in the motor after it is switched off.

Charging Mechanism (cont.)

The hexagonal shaft also connects to the cam that closes the circuit breaker. A roller in this cam contacts the closing spring latch just as the charged springs go over center. This stops the shaft from rotating and the circuit breaker from closing until the closing spring latch is released.

Closing Spring Latch—The closing spring latch is a compound latch assembly. The primary latch consists of a roller mounted on the closing cam, and the main closing latch arm (figure 5). The latch arm is subsequently held by a secondary closing latch shaft with a machined cut in the side. As the closing latch shaft rotates, it releases the latch arm. The released latch arm slips by the roller in the closing cam, permitting the hexagonal shaft to rotate. This discharges the spring energy into the closing cam.

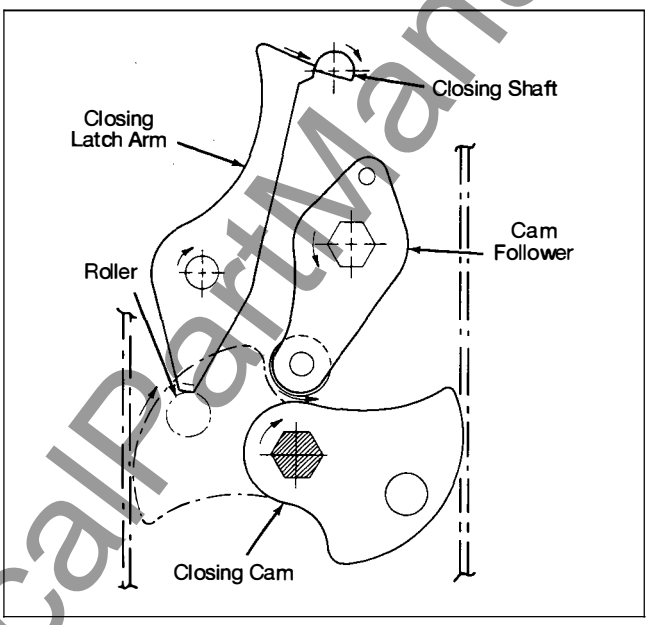

Figure 5: Closing mechanism

The closing latch shaft (with the machined cut) has a disconnecting link interlock. This interlock interconnects with the opening shaft so that, whenever the opening shaft operates, the interlock activates. When the interlock activates, the input to the closing latch is disconnected; thus, the closing springs cannot release to close the circuit breaker. This interlock is arranged so that a closing signal must first be removed before the interlock resets, allowing the application of a closing signal to the closing spring latch.

The closing signal from the *close* button or closing solenoid is applied as input to the closing latch.

None of these mechanical systems is adjustable. To ensure proper operation, observe the closing latch interlock sequence. The interlock linkage should disconnect the closing latch with an initial motion of the opening latch shaft; this should occur before the opening latch releases. The linkage should reconnect when the opening latch is in the rest position. If the interlock functions as described, and the circuit breaker closes within the specified time (70–90 milliseconds), the closing mechanism is working adequately.

Charging Mechanism (cont.)

Opening Latch—The opening latch is a compound latch assembly. The primary latch operates in conjunction with the closing cam follower. As the circuit breaker closes, the cam follower latches in the closed position with the primary opening latch prop. The latch prop is carried by a bell crank which toggles with an opening arm. This arm is finally latched by the opening shaft with one flat side.

The primary opening prop is positioned so that, with the opening latch system in the latched position, the cam follower pushes the prop to a stop mounted on the bell crank (figure 6). As the latch system releases, the bell crank moves so that the forces on the prop rotate the prop away from the stop. This permits the cam follower to open freely. Although not adjustable, the condition of the prop is critical. If a malfunction occurs, check the prop per instructions under **Opening Prop Check**, page 38.

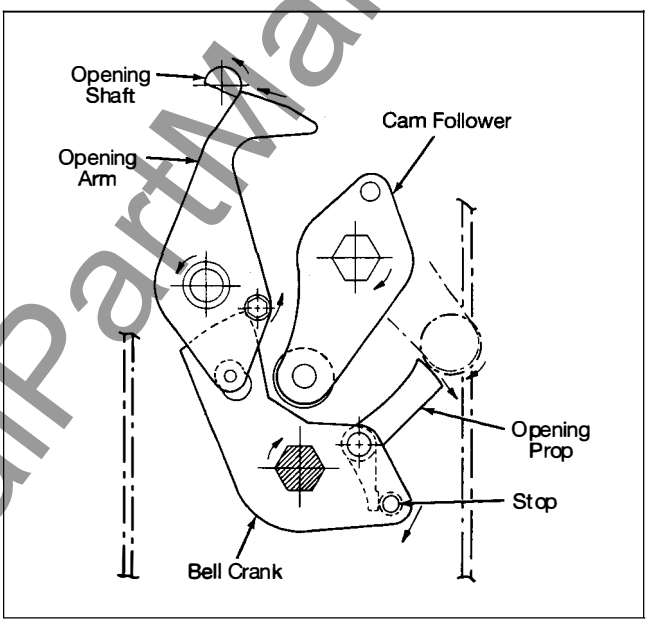

Figure 6: Opening mechanism

The opening shaft normally prevents the bell crank from turning. Any mechanical signal applied to the opening shaft at any time releases the opening latch system, permitting the circuit breaker to open (or, if in the process of closing, to reopen). If an opening signal is applied while the circuit breaker is closing, the circuit breaker closes completely and then opens.

A tapered screw provides a stop for the rotational motion of the opening shaft. The position of this stop controls the amount the opening shaft overlaps with the opening arm. Insufficient overlap can cause excessive wear and nuisance tripping. Excessive overlap can result in longer trip times and higher trip currents being applied to the solenoids.

Release-Free (Trip-Free) Operation

The FG-2 circuit breaker has an advanced design trip-free mechanism in accordance with ANSI C37.04 and ANSI C37.100. The trip-free mechanism allows an opening (trip) operation to prevail over a closing operation during specified parts of the closing operation.

Per ANSI, and for safe operation, the circuit breaker is also designed to close with full force in order to withstand a full rated fault. In addition, to provide full interrupting capability, the main contacts must travel to their fully closed position in order to completely fill the SF_6 puffer cylinder with interrupting gas.

The circuit breaker mechanism is arranged so a trip signal always takes precedence over a closing signal. However, when the closing signal leads the trip signal by enough time to release the closing spring latch, the circuit breaker completes a full close-open cycle, ensuring full circuit breaker performance under all conditions.

Drawout Operation

The drawout circuit breaker has a worm gear racking mechanism. The circuit breaker is moved in and out of the circuit breaker cell by inserting the racking crank into the racking port (figure 7) and cranking in the appropriate direction: clockwise to rack in, counterclockwise to rack out. An interlock on this mechanism prevents racking the circuit breaker with the main contacts closed. The secondary control circuit connection automatically connects or disconnects, and can be manually operated in the *test* position.

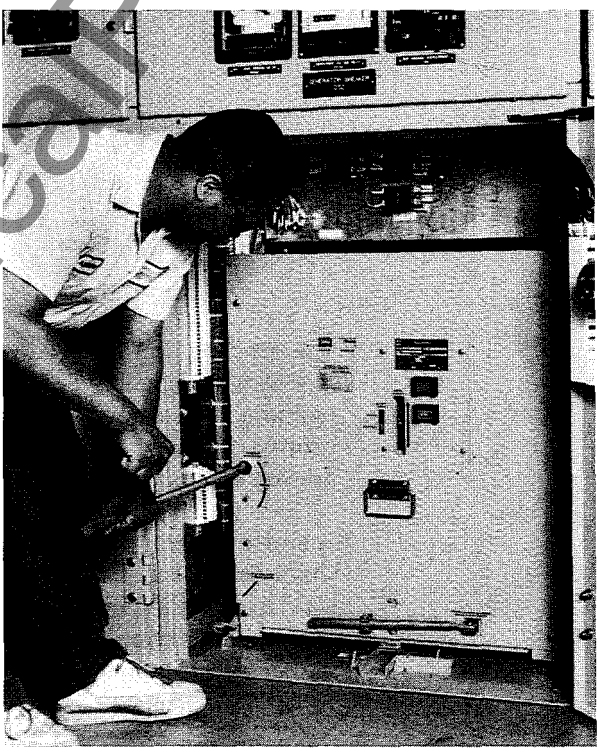

Figure 7: Drawout operation

Racking Interlock

A shutter blocks the racking port, preventing the insertion of the racking crank while the circuit breaker is closed. The circuit breaker must be tripped, opening the shutter.

Racking Mechanism

The circuit breaker is moved between the *test/disconnected* position and *connected* position by levering arms on the sides of the circuit breaker (figure 8). The arms are driven by a worm gear (figure 9).

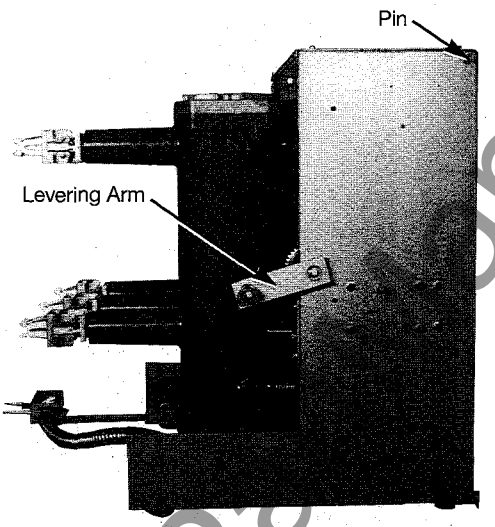

Figure 8: Levering arm, TOC actuation pin

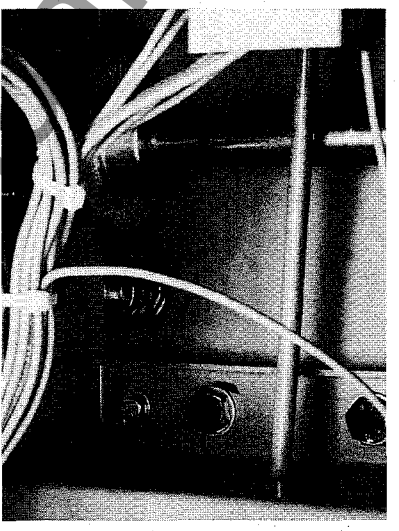

Figure 9: Racking mechanism

Truck Operated Contact Assembly (Optional)

An optional truck operated contact assembly (TOC) is available. The TOC is normally required on switchgear with an automatic transfer scheme. The TOC actuation pin, mounted on the upper left side of the circuit breaker (figure 8), changes the state of the structure mounted contacts when the circuit breaker moves from the *test* to the *connected* position and vice versa. The TOC signals the circuitry that the circuit breaker is in the *disconnected* or *connected* position.

Mechanism Operated Contact Assembly (Optional)

The stationary-mounted mechanism operated contact assembly is normally required on switchgear with an automatic transfer scheme. The MOC roller (figure 10), located on the right side of the circuit breaker, is activated through a series of linkages on the circuit breaker. This linkage connects to the right-hand pole unit operating shaft arm. The structure-mounted MOC assembly is activated by movement of the MOC roller. Like circuit breaker auxiliary contacts, the MOC indicates whether the circuit breaker is open or closed.

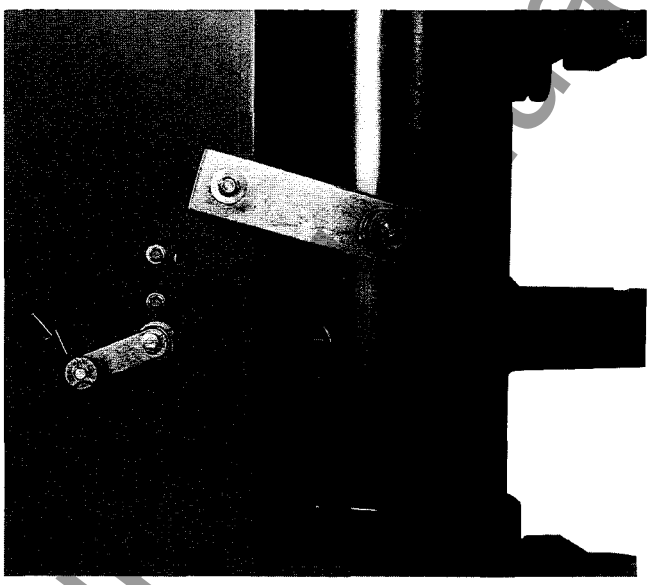

Figure 10: MOC roller

Racking Interlock

A shutter blocks the racking port, preventing the insertion of the racking crank while the circuit breaker is closed. The circuit breaker must be tripped, opening the shutter.

Racking Mechanism

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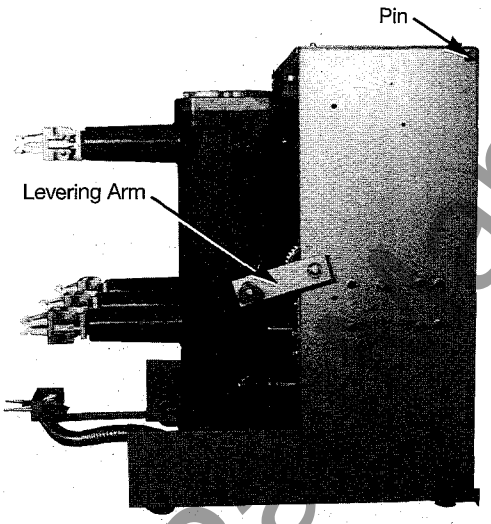

Figure 8: Levering arm, TOC actuation pin

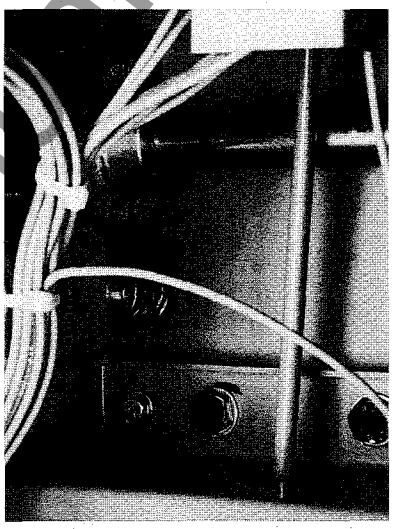

Figure 9: Racking mechanism

Truck Operated Contact Assembly (Optional)

An optional truck operated contact assembly (TOC) is available. The TOC is normally required on switchgear with an automatic transfer scheme. The TOC actuation pin, mounted on the upper left side of the circuit breaker (figure 8), changes the state of the structure mounted contacts when the circuit breaker moves from the *test* to the *connected* position and vice versa. The TOC signals the circuitry that the circuit breaker is in the *disconnected* or *connected* position.

Circuit Breaker Pole Units

SF_6 Type FG-2 pole units (figure 11) are manufactured in different ratings as specified in this manual and ANSI standard C37.06, Table 2. Specifications for these pole units are shown in table 2 below.

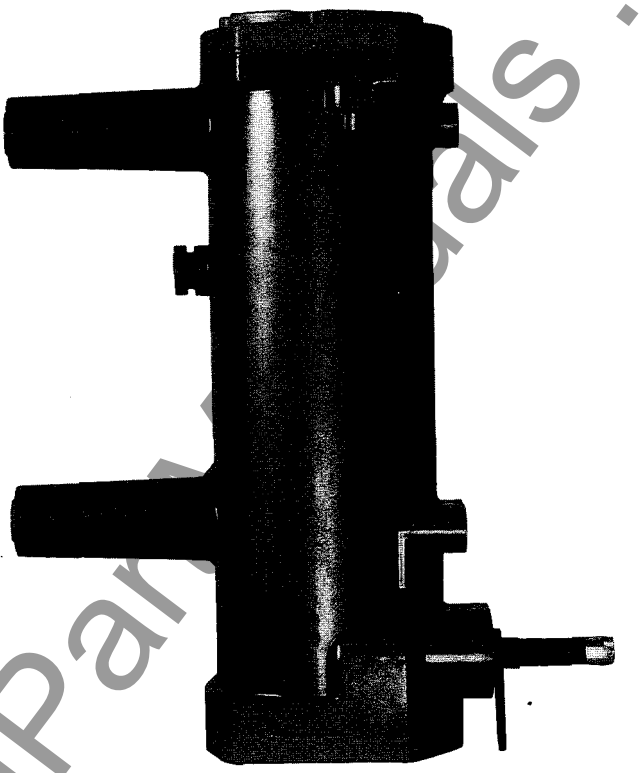

Figure 11: SF_6 Type FG-2 pole unit

Table 2
Circuit Breaker Pole Units

Catalog Number	Continuous Current (A)	SF_6 Gas Pressure @ 20° C.(PSIG)
FG-2-05025-12	1200	36.25
FG-2-05025-20	2000	36.25
FG-2-05025-30	3000	36.25
FG-2-05035-12	1200	36.25
FG-2-05035-20	2000	36.25
FG-2-05035-30	3000	36.25
FG-2-08050-12	1200	36.25
FG-2-08050-20	2000	36.25
FG-2-08050-30	3000	36.25
FG-2-15050-12	1200	21.75
FG-2-15050-20	2000	21.75
FG-2-15050-30	3000	36.25
FG-2-15075-12	1200	36.25
FG-2-15075-20	2000	36.25
FG-2-15075-30	3000	36.25
FG-2-15100-12	1200	36.25
FG-2-15100-20	2000	36.25
FG-2-15100-30	3000	36.25

Circuit Breaker Pole Units (cont.)

The pole units are sealed for life; gas servicing is not required. Each is charged with sulphur hexafluoride gas (SF_6) at the factory to an initial pressure shown in table 2. Pole units are designed to remain in service for the life of the equipment without servicing. Do *not* check the gas pressure.

Arcing Contact Wear—The circuit breaker life is limited primarily by arcing contact wear. The rate of contact wear is affected by closing currents, interrupted currents, and related factors. Applications such as capacitor switching expend contact tip material when closing on the circuit; other applications might cause wear upon interruption of the current. To an extent, life-load performance is predictable. Use figure 12 as a guide to predict arcing contact life *based only upon interruptions of symmetrical currents*. Closing on high currents, as well as asymmetrical interruptions, significantly shortens contact life.

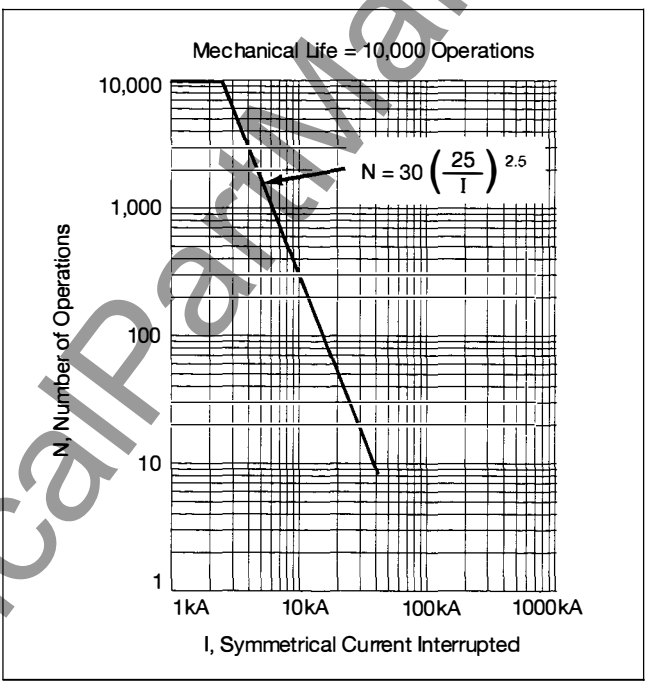

Figure 12: Life-load performance

Circuit Breaker Auxiliary Switch Block (Upper Switch Block)

Each FG-2 circuit breaker is equipped with a five-circuit auxiliary switch block (figure 13) as standard. This block contains two normally closed (b) contacts and three normally open (a) contacts. Each is a standard contact with short contact cams. The timing of these contacts is factory set and should not require adjustment. The type of contacts, as well as the contact numbering, is different than on the nine-circuit auxiliary switch block (figure 14). Note these differences to ensure that the proper switch block is used if replacement becomes necessary.

Auxiliary Switch Block (Lower Switch Block)

Each FG-2 circuit breaker is equipped with a nine-circuit auxiliary switch block (figure 14) as standard. Only five of these circuits may be wired through the control power plug. Additional circuits are available through the use of the cell-mounted MOC assembly. Nine-circuit switch blocks have five normally closed (b) contacts and four normally open (a) contacts. One of the normally closed contacts is equipped with a wide cam to provide a late break contact. One of the normally open contacts is equipped with a wide cam to provide an early make contact. Standard wiring provides two normally open contacts and three normally closed contacts.

The mix of contacts may be changed by rewiring the auxiliary switch block. For example, move the wires from the terminals of a normally closed contact to the terminals of a normally open contact to change the mix to three normally open contacts and two normally closed contacts.

The contact cams have indentations permitting up to 34 different timing positions. These adjustable cams provide the specific timing necessary on critically-timed circuits.

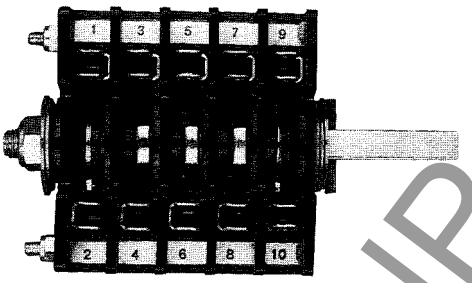

Figure 13: Five-circuit auxiliary switch block

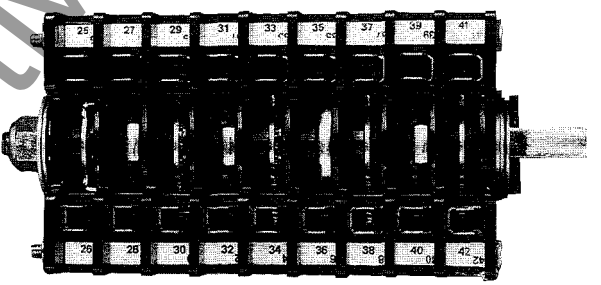

Figure 14: Nine-circuit auxiliary switch block

Contact Position Indicator

A window and flag arrangement indicates the position of the circuit breaker main contacts (figure 4, page 7). A red flag with the word *closed* indicates that the circuit breaker main contacts are closed. A green flag with the word *open* indicates that the circuit breaker main contacts are open.

⚠ WARNING

HAZARD OF PERSONAL INJURY OR EQUIPMENT DAMAGE.
Never use the contact position indicator as a final indication of the safety of the power circuit.

Failure to observe this precaution can result in severe injury or death!

Operations Counter

The operations counter (figure 4, page 7) shows the number of close-open cycles. The counter advances by one on the circuit breaker's opening stroke. The circuit breaker mechanism is capable of at least 10,000 close-open cycles; however, the life of the interrupters can be considerably less, depending upon the amount of current switched with each operation. See **Arcing Contact Wear**, page 16, for specific life-load information.

SECTION 5—OPERATING INSTRUCTIONS

General

Closing springs can be charged electrically or manually. The circuit breaker can be closed electrically, or manually by operating the spring release latch. This latch releases the stored energy from the charged closing springs, closing the circuit breaker. During the closing operation, the opening springs are charged by a transfer of energy from the closing springs.

The circuit breaker can be opened either electrically, or manually by operating the trip latch, which releases the opening spring energy. The circuit breaker can be opened, closed, and reopened in rapid sequence without momentary stops for spring recharging.

Closing Spring Charging

Electrical—Each circuit breaker is equipped with a spring charging motor rated for the control system voltage. The control circuits are typically arranged to charge closing springs immediately after a breaker closes. If requested, the control circuit can be arranged so the springs are charged immediately after the circuit breaker opens.

If control power is available, the closing springs are automatically charged upon connection of the secondary control power plug. At rated voltage, charging time is approximately six seconds.

Circuit breaker and circuit breaker cell interlocks prevent the circuit breaker from closing unless it is in the *connected* or *test* position. Springs automatically discharge when the circuit breaker is moved from the *test* position out of the cell. The circuit breaker can be moved between the *test* and *connected* positions with the springs charged or discharged.

Manual—The closing springs can be charged manually when control power is not working or when the circuit breaker is removed from the cell. Manual charging is also necessary for checking contact wear and for other maintenance functions. To manually charge the closing springs, follow these steps:

1. Insert the charging handle into the manual charging slot (figure 3, page 7).
2. Pump the handle up and down. Charging force is applied with each downstroke. Near the end of the charging cycle, the resistance lessens considerably. At the end of the cycle, the mechanism produces a loud snap. The spring charge status indicator (see below) suddenly moves from the *discharged* to the *charged* position. When the springs are fully charged, the charging handle cannot be pumped further. The circuit breaker cannot close until the springs are fully charged.

Spring Charge Status Indicator—The spring charge status indicator is located to the left of the manual charging handle slot (figure 4, page 7). This indicator shows whether the closing springs are fully charged or discharged. When springs are partially charged, the indicator is in the *discharged* position.

Racking In Procedure

To rack the circuit breaker into the cell, follow these steps:

1. Check to ensure the circuit breaker is open. If it is not, open it. Using the racking handle, move the levering arms (figure 8, page 13) to a position 15° below horizontal, pointing to the rear of the circuit breaker.
2. Roll the circuit breaker into the cell to the *test/disconnected* position. The arrow on the guide at the front of the circuit breaker aligns with the *test/disconnected* position label on the cell floor. As the circuit breaker enters the cell, circuit breaker trip rollers contact cams mounted on the cell floor. This interlock causes the circuit breaker to cycle through a close-open operation, discharging stored energy if the closing springs are charged. If the springs are not charged, the circuit breaker does not operate.
3. Insert the racking crank; turn it clockwise to rack the circuit breaker to the *connected* position. Crank until the racking mechanism comes to a firm stop. ***Do not overtorque***. The arrow in the guide rail at the front of the circuit breaker aligns with the *connected* position label on the cell floor.

Racking Out Procedure

To rack the circuit breaker out of the cell, follow these steps:

1. Ensure the circuit breaker is open. If it is not, open the circuit breaker by pressing the *open* button.
2. Insert the racking crank; rotate it counterclockwise, racking the circuit breaker out to the *test/disconnected* position. Crank until the racking mechanism comes to a firm stop. ***Do not overtorque***.

NOTE

The *test/disconnected* position is a combination of the *test* and *disconnected* positions.

3. To completely remove the circuit breaker from the cell, lift the latch on the lower left side of the circuit breaker and roll the circuit breaker out of the cell.

⚠ CAUTION

HAZARD OF EQUIPMENT DAMAGE.

When removing a circuit breaker from the top cell of two-high metal-clad switchgear, use a Square D circuit breaker lift truck. Follow lift truck instructions, making sure the lift truck is secured to the cell before removing the circuit breaker.

Failure to follow these precautions can result in equipment damage.

Secondary Control Disconnect

The circuit breaker is equipped with a 19-pin secondary control disconnect (figure 15) for automatic connection and disconnection of control circuits to the circuit breaker. The secondary disconnect is mounted on the end of a retractable slide handle, permitting connection in either the *test* position (figure 16) or *connected* position (figure 17) .

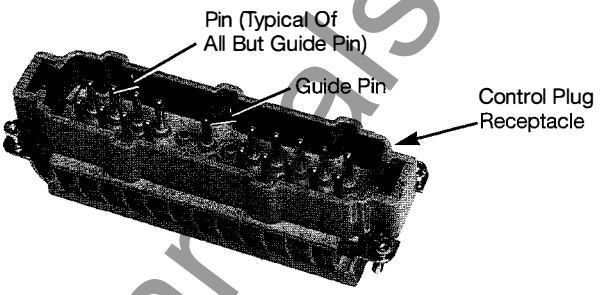

Figure 15: Secondary control disconnect

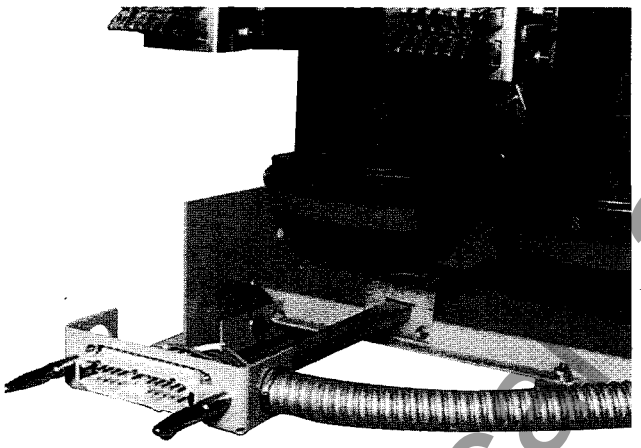

Figure 16: Extended secondary control disconnect—test position

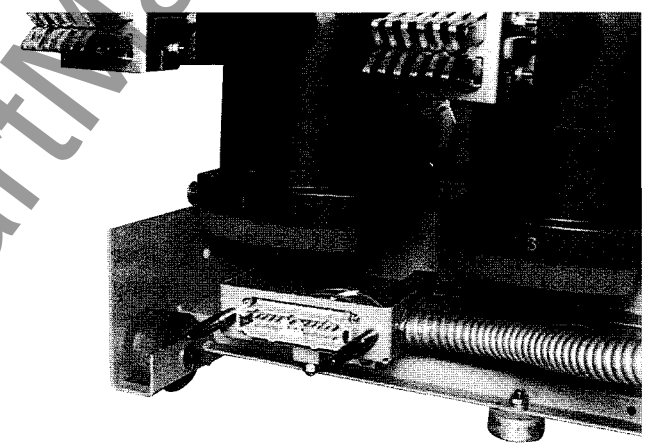

Figure 17: Retracted secondary control disconnect—connected position

To connect the secondary control disconnect, with the circuit breaker in the *test* position, follow these steps:

1. Rack the circuit breaker into the *test* position of the cell by following steps 1 and 2 of the **Racking In Procedure**, page 20. Do not rack the circuit breaker completely into the cell.
2. The secondary control disconnect slide handle is mounted on the front of the circuit breaker (figure 3, page 7). Pull the handle out of its retaining clip; rotate it so it is protruding straight out from the circuit breaker.
3. Lift slightly on the handle and push it into the breaker as far as possible.

Secondary Control Disconnect (cont.)

4. The control circuits of the circuit breaker are now connected to the cell.
5. To retract the secondary control disconnect, reverse steps 1–4 above.

> **NOTE**
>
> The circuit breaker can also be moved into the *connected* position with the secondary control disconnect in the extended position; the slide handle automatically retracts, latching in the retracted position.

Auxiliary Switch Block Cam Timing

Follow these steps to adjust auxiliary switch block cam timing:

1. Disconnect all power to the circuit breaker.
2. Note the position of each cam with the circuit breaker closed and open (making a pencil sketch is recommended).
3. Open or close the circuit breaker to position the cam to be changed in the *open* position.
4. Hold the square end of the auxiliary switch block shaft, using an 8 mm open end wrench.
5. Loosen the locknut on the opposite end of the shaft one or two turns, using a 13 mm wrench.
6. Insert a thin-bladed screwdriver between the metal cam and the notched ring of the contact to be adjusted; separate and release the indentation in the metal cam from the notched ring (figure 18).
7. Rotate the cam to the new position.
8. Reclose the gap between the metal cam and the notched ring by inserting the screwdriver between the nut and washer at the end of the block (figure 19). If necessary, move the cam slightly to align the indentation and the notch.

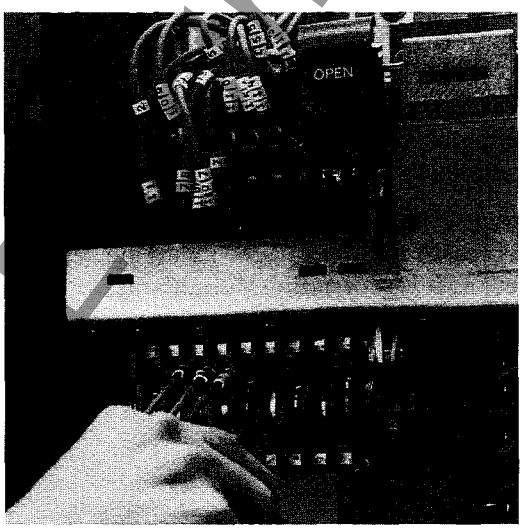

Figure 18: Auxiliary switch block cam timing

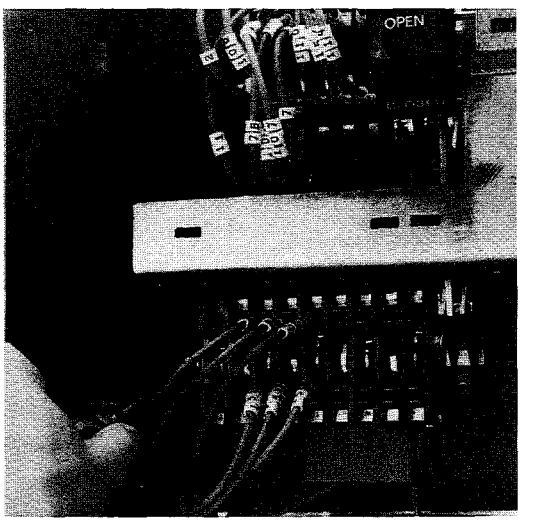

Figure 19: Reassembling auxiliary switch block

Auxiliary Switch Block Cam Timing (cont.)

9. Retighten the 13 mm locknut, making certain all other cams are in their original position and all cam indentations are properly seated in their respective notches.
10. Operate the circuit breaker; ensure that the adjustment accomplishes the purpose intended, and that all other cams operate as before.

⚠ CAUTION

HAZARD OF EQUIPMENT DAMAGE.

Special cam settings may produce unintended operation by overtravel at the end of either the open or close operation. To ensure that the contacts do not change state at the end of travel, apply torque to the auxiliary switch shaft in both directions, using an 8 mm open end wrench. Do this with the circuit breaker in both the open and closed positions.

Failure to follow this precaution can result in equipment damage.

SECTION 6—CONTROL CIRCUITS

Figure 20 illustrates a typical control circuit schematic with ac or dc closing and ac tripping. Figure 21 shows ac or dc closing and dc tripping.

In addition to the circuit breaker mounted auxiliary contacts, up to 12 additional circuit breaker operated auxiliary contacts can be mounted on the circuit breaker cell. As illustrated, circuit breaker control circuits can operate at different control voltages. For example, a circuit breaker may have closing circuit components rated for 120 Vac and trip circuit components rated for 125 Vdc.

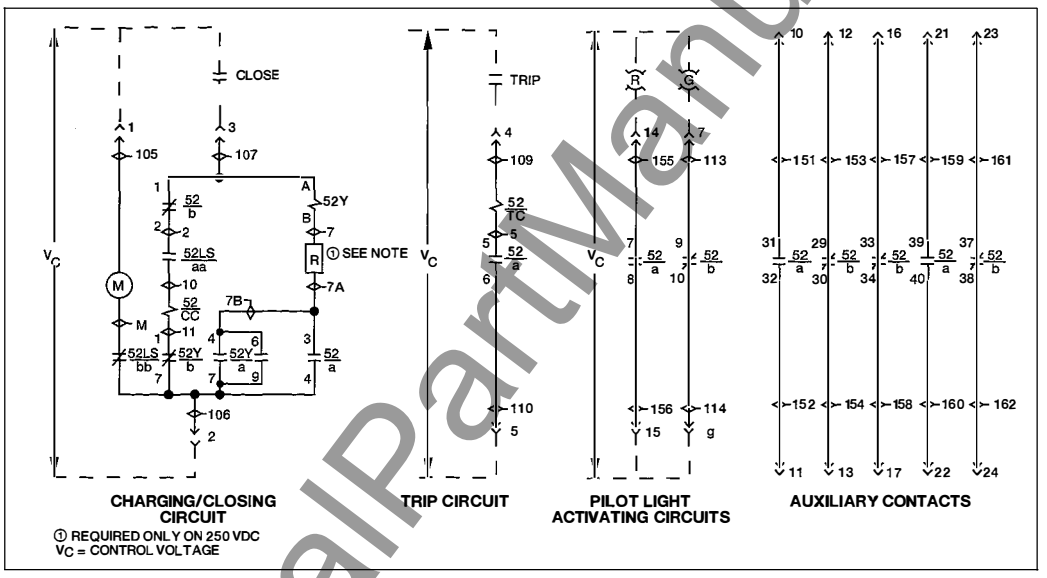

Figure 20: Control circuit schematic—ac or dc close, ac trip

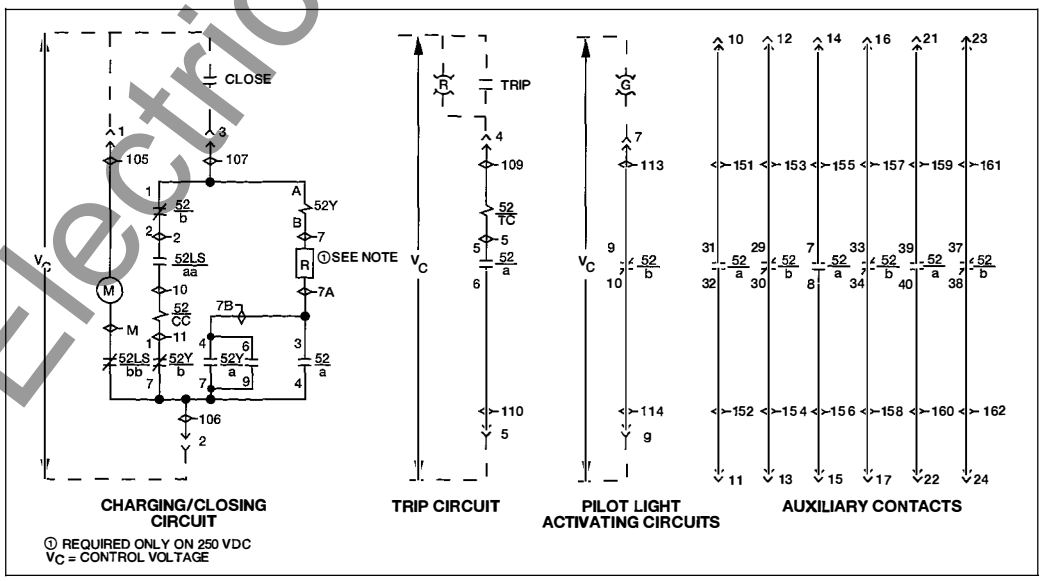

Figure 21: Control circuit schematic—ac or dc close, dc trip

SECTION 7—MAINTENANCE

Frequency Of Maintenance

Schedule maintenance every three years or 2000 operations, whichever comes first. Depending on specific environmental conditions, maintenance may be scheduled more or less frequently. In environments with high temperatures or contaminated atmospheres, consider scheduling maintenance more frequently.

Mechanism Cleaning

Cleanliness and proper lubrication of bearing surfaces is extremely important. Dirt on exterior surfaces of parts does not necessarily indicate the condition of bearing surfaces. In many instances it is better to lubricate without cleaning, as long as dirt is not forced into bearing surface areas.

When cleaning, first disassemble parts to be cleaned. After thoroughly cleaning them, apply new lubricants. Except for isolated cases, limit cleaning to mechanism parts that can be disassembled, cleaned, inspected, lubricated, and reassembled.

Lubrication Materials

The following materials are necessary to lubricate specific FG-2 circuit breaker parts:

- Multi-grade oil (SAE 10W40)
- Mobilgrease 28
- Mobilux EP-1

Mobilgrease 28 is a mechanical low temperature grease rated for temperatures from –65°F to 350°F. Mobilux EP-1 is an electrical, unleaded, extreme pressure grease rated for temperatures from –20°F to 150°F.

⚠ CAUTION

HAZARD OF EQUIPMENT DAMAGE.

Incorrect use of lubricants may cause improper operation. For example, excessive use of grease not intended for cold weather operation may cause the mechanism to not operate, or to operate slower than specifications.

Failure to observe this precaution can result in equipment damage.

Field Lubrication

In most instances, field lubrication consists of adding lubricants without cleaning. Follow these steps:

1. Locate all mechanical bearing surfaces such as rotating shafts in bearings or parts sliding in relation to each other, including ball bearings. Apply sufficient quantities of SAE 10W40 multi-grade oil as directly as possible, ensuring that the oil is applied to the intended surfaces. Lubricate all the

Field Lubrication (cont.)

points shown in figures 22, 23, and 24. Operate the mechanism a few times and relubricate to enhance the flow of lubricant. Wipe off excessive lubricant, taking care not to force dirt into lubricated areas.

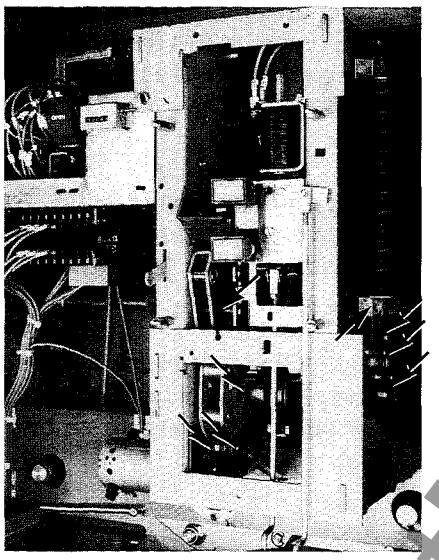

Figure 22: Mechanism lubrication

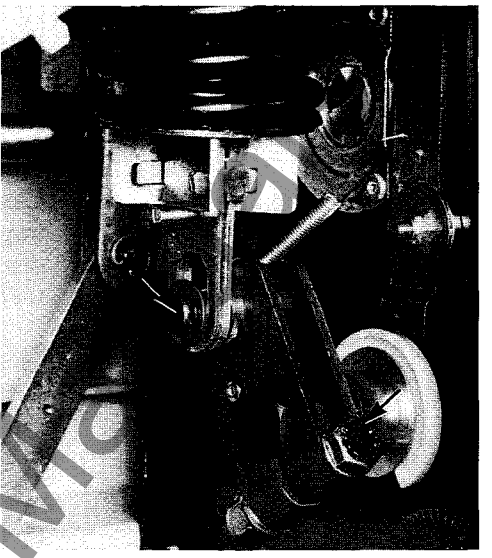

Figure 23: Mechanism lubrication

2. Lubricate the opening and closing spring guide slides (figure 25) using a low temperature grease such as Mobilgrease 28.

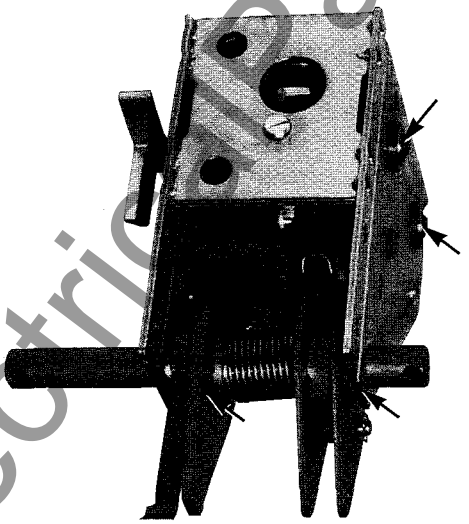

Figure 24: Latching mechanism lubrication

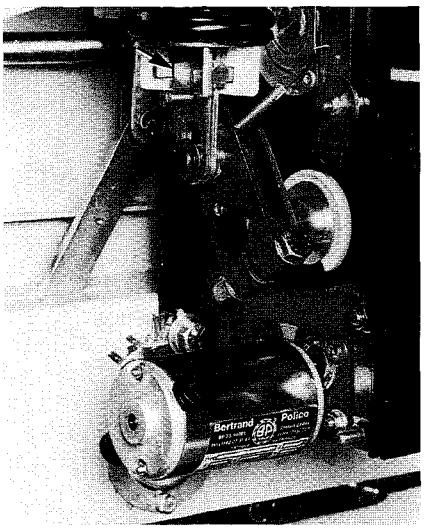

Figure 25: Spring guide lubrication

Field Lubrication (cont.)

3. Lubricate trip latch surfaces (figure 26) and gears (figure 27), using Mobilgrease 28.

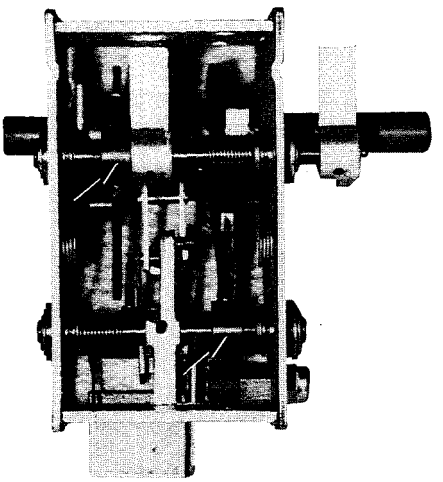

Figure 26: Latch lubrication

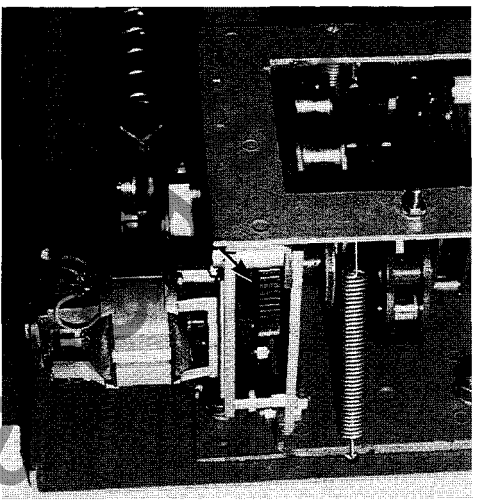

Figure 27: Gear lubrication

4. Clean the primary disconnect fingers, and lubricate with Mobilux EP-1 grease.

Measuring Arcing Contact Wear

The remaining life of a pole unit can be estimated by measuring the arcing contact wear. This is done by measuring the distance between a reference mark, located on the opening spring link, and the circuit breaker frame.

To measure arcing contact wear, follow these steps:

1. Remove the circuit breaker from its cell. Make sure the closing springs are discharged and the circuit breaker is open. If the springs are charged, discharge them by closing and then opening the circuit breaker.
2. Locate the holes in the lower end of the outer closing spring guide.
3. Using the manual charging handle, slowly charge the springs until the holes in the inner spring guide clear the bottom end of the outer spring guide.
4. While applying force to the charging handle, insert a 7/32" diameter blocking pin (approximately 3/4"–1" long) through this hole on each closing spring (figure 28). Slowly release the charging handle, letting the spring pressure rest on the inserted pin (figure 29). This releases the pressure from the upper and lower mounting pins.

   If the spring pressure is not resting on the inserted pin, charging has gone too far. In this case, remove the pin, fully charge the springs, close and then open the circuit breaker, and start over at step 3. Be sure to insert pins into both sets of closing springs.

Measuring Arcing Contact Wear (cont.)

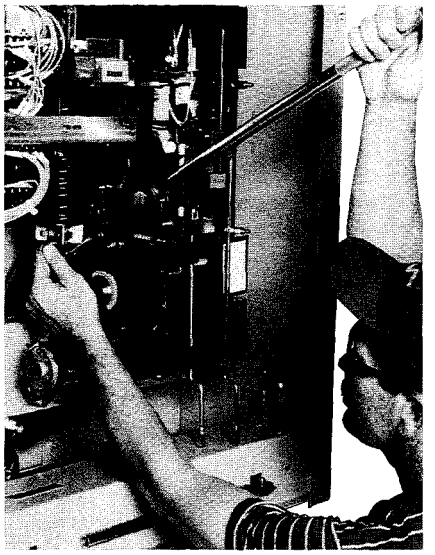

Figure 28: Manually charging while inserting blocking pin

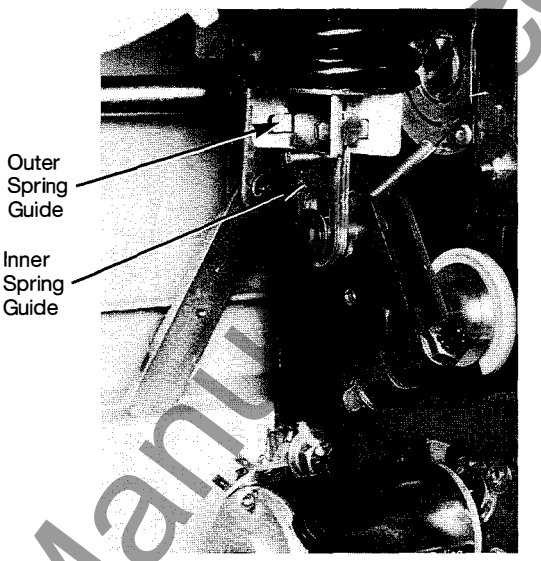

Figure 29: Inserted blocking pin

5. Remove the retaining rings from the bottom mounting pins; remove the spring assemblies. Note the position of any washers and bushings removed so they can be reinstalled in the same order.
6. Attach a continuity test device (light, bell, or ohmmeter) across each pole unit to indicate when the main contacts meet (figure 30).

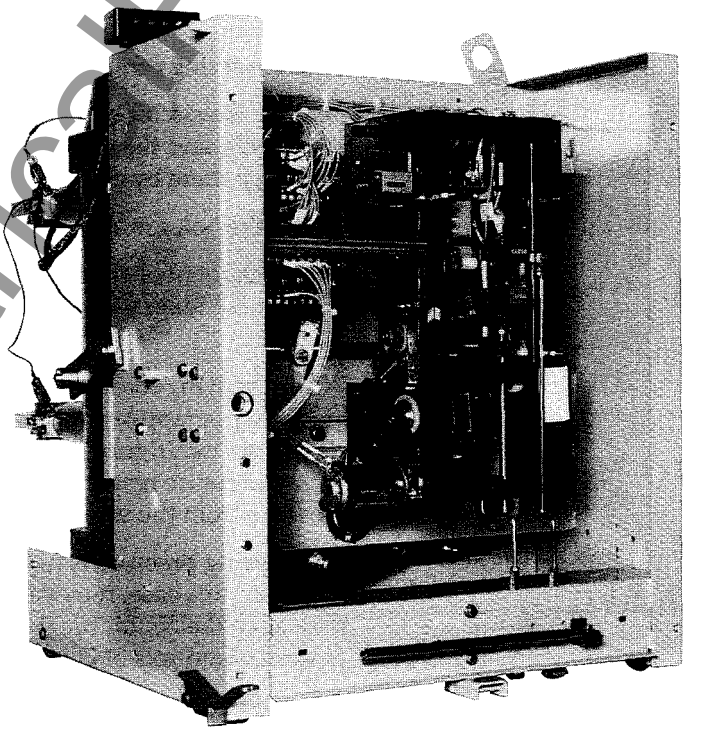

Figure 30: Continuity test device

Measuring Arcing Contact Wear (cont.)

7. Using the manual charging handle, charge the mechanism to the end of the charging cycle. When the lower spring mounting pin rotates to the bottom of its travel, pull it forward by hand to complete the cycle.
8. Push and hold the *close* button; begin slow closing the circuit breaker with the charging handle (figure 31).

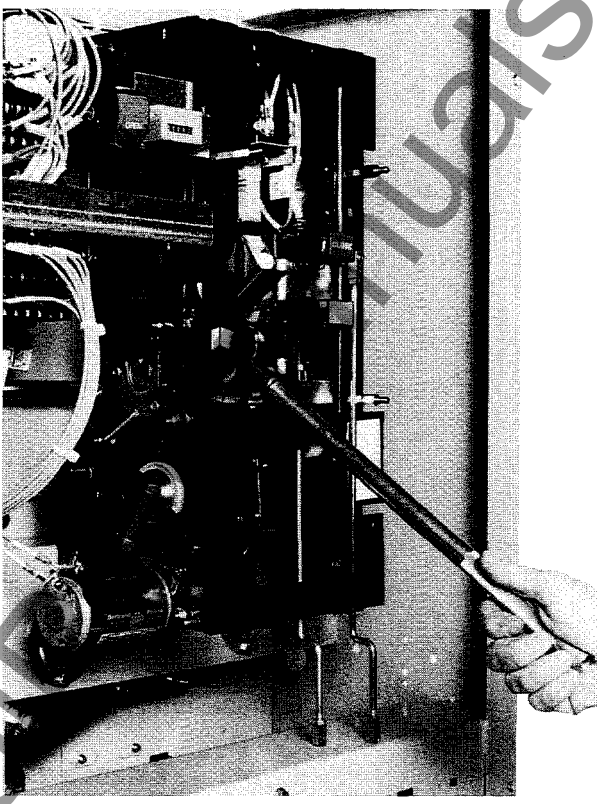

Figure 31: Slow closing

9. As soon as the continuity test device shows the arcing contacts have just barely touched, stop slow closing the circuit breaker.
10. If necessary, repeat this operation to ensure that the arcing contacts just barely touch without overclosing. Uneven arcing contact wear may require additional measurements made at two or three positions where arcing contacts barely touch.

Measuring Arcing Contact Wear (cont.)

11. Measure and record the vertical distance from the top of the frame to the center of the red dot (figure 32).

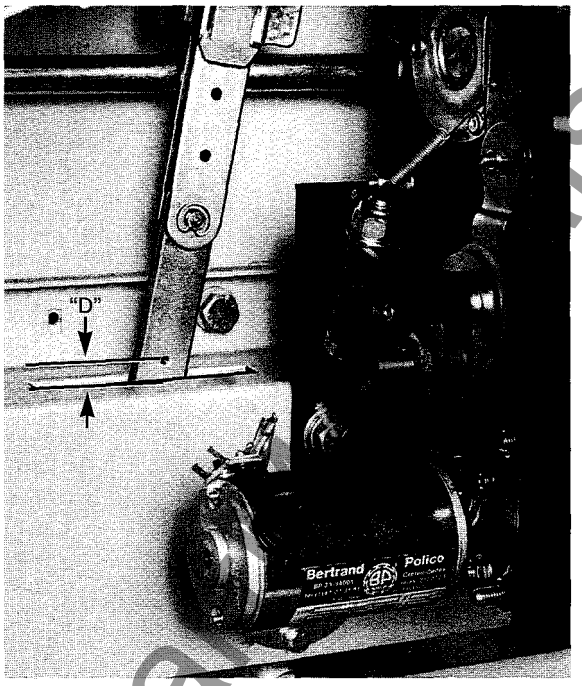

Figure 32: Contact wear measurement

12. For a new circuit breaker, the vertical distance should measure 0.41" (10.4 mm). Compare the distance measured to the values in table 3 to estimate remaining arcing contact life.

Table 3
Estimated Remaining Arcing Contact Life

Measurement "D"	Remaining Life (%)
0.41" (10.5 mm)	100
0.33" (8.5 mm)	75
0.26" (6.5 mm)	50
0.18" (4.5 mm)	25
0.10" (2.5 mm)	0

13. If the bottom of the red dot is at or below the top of the frame, the arcing contacts are completely worn out. Square D recommends replacing all three pole units at the same time. See **Pole Unit Replacement**, page 31.
14. Using the manual charging handle, resume slow closing the circuit breaker until it is fully closed. When the closing cycle is complete, an audible click will be heard.
15. Push the *open* button to open the circuit breaker.
16. Reinstall the closing springs on the mechanism. Be sure to install all washers and bushings in the same order and position as before removal.

Measuring Arcing Contact Wear (cont.)

17. Replace the spring clips on the top mounting pins and the retaining rings on the bottom pins, ensuring that each ring seats in its proper groove.
18. Manually charge the closing springs until spring pressure is removed from the inserted 7/32" blocking pins; remove the blocking pins from both closing spring assemblies.

Pole Unit Replacement

Square D recommends replacing all three pole units at one time.

All references to left or right pole units are as viewed when facing the front of the circuit breaker.

⚠ WARNING

HAZARD OF BODILY INJURY OR EQUIPMENT DAMAGE.

Each pole unit weighs approximately 75 pounds. It contains pressurized gas and must be protected from shock. Therefore, each pole unit *must* be held in position while removing the mounting screws. Support the pole unit with a sling attached to a hoist, or by other suitable means.

With use, some SF_6 gas within a pole unit may decompose into potentially-toxic compounds, both gaseous and solid. Therefore, if a pole unit is ruptured or accidentally opened, follow the safety procedures on page 4.

Failure to follow these precautions can result in severe personal injury, death, or equipment damage!

Follow these steps to replace pole units:

1. Ensure that the circuit breaker is open and all springs are discharged.
2. Remove and replace one pole unit at a time; never remove more than one bottle at a time. Each replacement pole unit must be properly aligned and spaced relative to the other pole units before proceeding to the next pole unit (figure 33).

For 1200A units, skip to step 6. For 2000A and 3000A units proceed to step 3.

⚠ WARNING

HAZARD OF ILLNESS FROM EXPOSURE TO POTENTIALLY TOXIC SUBSTANCES.

Do not loosen bolts around outer flange where the pole unit attaches to the runback (4, figure 34), or gas could leak from the pole unit.

Failure to follow this precaution can result in personnel illness.

3. Remove four 10-32 screws (1, figure 34) and slide the contact assembly from both runback tubes.

Pole Unit Replacement (cont.)

4. Remove the contact spacer assembly from inside both runback tubes (2, figure 34).
5. On both runback tubes, remove two M12-1.75 cap screws with a 10 mm allen socket and long extension (3, figure 34). The runback tubes are now separated from the interrupter bottle.

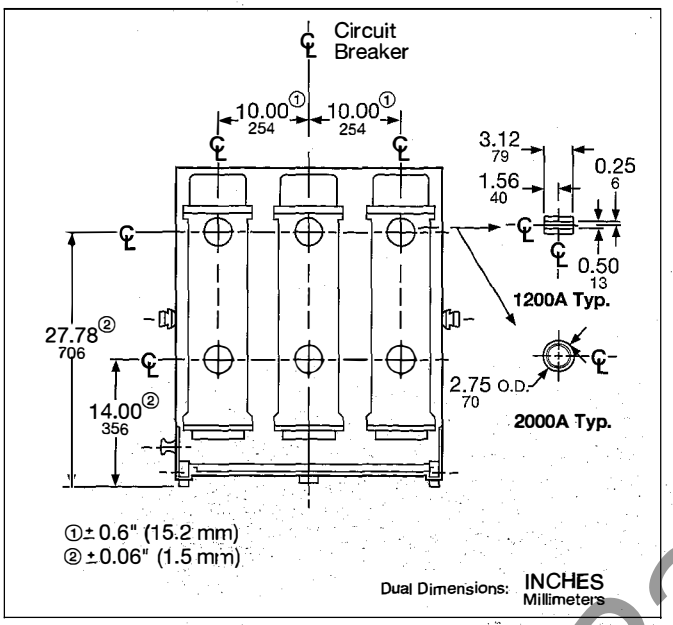

Figure 33: Alignment and spacing

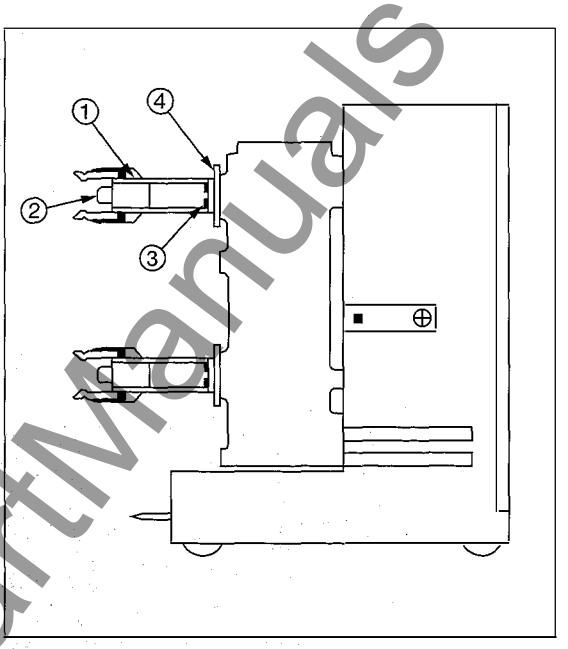

Figure 34: Removal of 2000A/3000A pole units

6. Remove the spring clips at the rear of the cross link pins; remove the cross link pins on the outer two pole units.
7. Remove the bolt securing the auxiliary switch actuating plate to the operating shaft arm on the left-hand pole unit. (If the circuit breaker is equipped with an MOC assembly, remove the bolt holding the MOC actuating plate to the right-hand pole unit operating shaft arm).

If not replacing the left-hand pole unit, skip to **Right-Hand Pole Unit Replacement**.

If replacing only the center pole unit, skip to **Center Pole Unit Replacement**.

Left-Hand Pole Unit Replacement—Follow these steps to replace the left-hand pole unit:

1. Complete **Pole Unit Replacement** procedure, page 31, before proceeding.
2. Remove the four mounting screws holding the pole unit to the breaker frame. Carefully remove the pole unit so that the auxiliary contact block actuating plate and linkage are not damaged.
3. Install a new pole unit, ensuring that the auxiliary switch actuating plate is placed on the pole unit operating shaft and that the operating shaft arm is located between the cross links (figure 35).

Pole Unit Replacement (cont.)

Figure 35: Operating shaft arm

4. Make sure the pole unit is properly aligned and spaced relative to the remaining pole units; reinstall the four mounting screws. Adjustment of the finger runback may be necessary to obtain proper alignment (figure 33).

If replacing only the left-hand pole unit, skip to **Pole Unit Assembly Completion,** page 36. If not replacing the right-hand pole unit, skip to **Center Pole Unit Replacement**, page 34.

Right-Hand Pole Unit Replacement—Follow these steps to replace the right-hand pole unit:

1. Complete the **Pole Unit Replacement** procedure, page 31, before proceeding.
2. Remove the four mounting screws holding the pole unit to the circuit breaker frame. Use care when removing the pole unit so that the MOC actuating plate and linkage are not damaged (if the circuit breaker is equipped with an MOC assembly).
3. Install a new pole unit, ensuring that the MOC actuating plate (if so equipped) is placed on the pole unit operating shaft and that the operating shaft arm is between the cross links (figure 35).
4. Make sure the pole unit is properly aligned and spaced relative to the remaining two pole units; reinstall the four mounting screws. Adjustment of the finger runback may be necessary to obtain proper alignment (figure 33).

If not replacing the center pole unit, skip to **Pole Unit Assembly Completion**, page 36.

Pole Unit Replacement (cont.)

Center Pole Unit Replacement—Follow these steps to replace the center pole unit:

1. Complete the **Pole Unit Replacement** procedure, page 31, before proceeding.
2. Remove the support channel below the pole units by removing the seven mounting screws (figure 36).
3. Remove the closing spring assemblies, following steps 1–5 under **Measuring Arcing Contact Wear**, page 27.
4. Using the manual charging handle, charge the mechanism to the end of the charging cycle. When the lower spring mounting pin rotates to the bottom of its travel, pull it forward by hand to complete the cycle.
5. Push and hold the *close* button in; using the charging handle, begin slow closing the circuit breaker.
6. Continue slow closing until the opening spring assembly begins to compress and the holes in the outer spring guide clear the bottom end of the inner spring guide. While continuing to put slight pressure on the charging handle, insert a 7/32" diameter pin through the holes in both opening spring guides.
7. Release the handle. The force of the springs should now be held on the inserted blocking pins or bolts (figure 37).
8. Remove the spring clip and mounting pin to uncouple each opening spring assembly from the spring connecting link (figure 37).

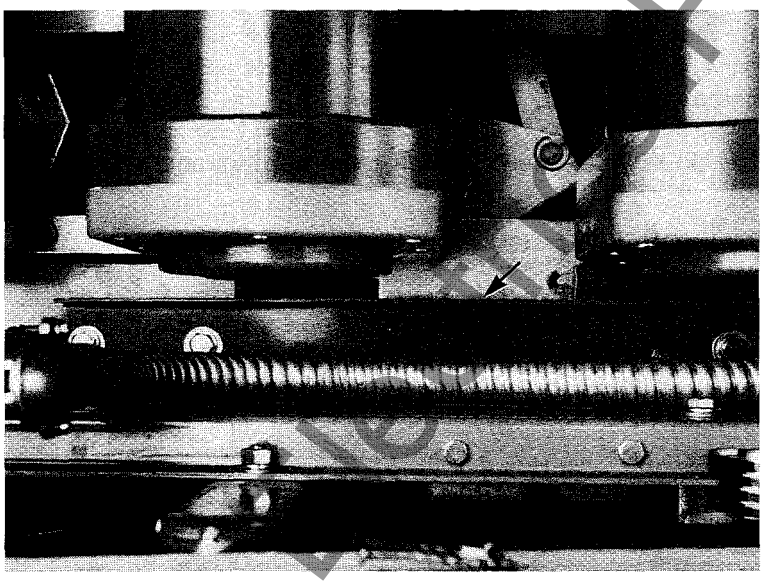

Figure 36: Support channel

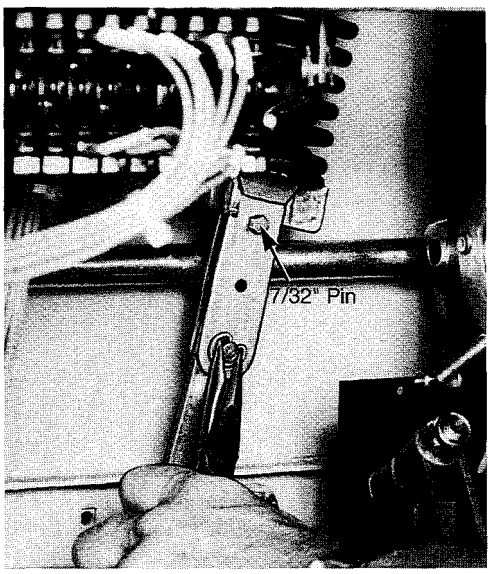

Figure 37: Disconnecting opening springs

9. Remove the cotter pin from the shock absorber axle (figure 38). Remove the axle from the rear, and drop the shock absorber down out of the way. Note the position of the spacers for later reinstallation.

Pole Unit Replacement (cont.)

10. Remove the retaining clip securing the cross link to the pole unit; remove the cross link (figure 39).

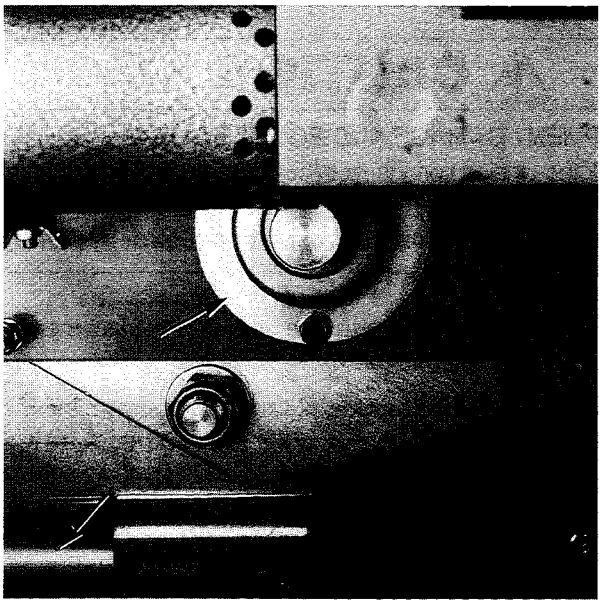

Figure 38: Shock absorber and bearing cover

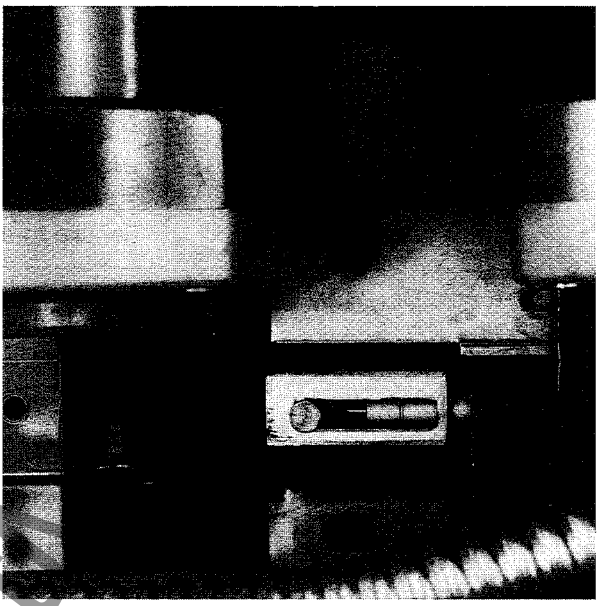

Figure 39: Cross link removal

11. Remove the bearing cover (figure 38) by removing the three mounting screws; remove the bearing and spacers. Note the number and position of the spacers for later reinstallation.
12. Remove the four mounting screws securing the pole unit to the breaker frame. Remove the mechanism bell crank (figure 12, page 16) from the pole unit operating shaft.
13. Install a new pole unit, ensuring that the mechanism bell crank is placed on the pole unit operating shaft.
14. Reinstall the four mounting screws and finger tighten.
15. Replace the spacers and the bearing removed in step 11 above, centering the pole unit operating shaft in the bearing hole. Replace the bearing cover, securing it with the three mounting screws.
16. Ensure that the pole unit is properly aligned and spaced relative to the remaining pole units. Adjustment of the contact finger runback may be necessary to obtain proper alignment (figure 33). Tighten the mounting screws.
17. Reinstall the cross link; reinstall the retaining clip onto the pin.
18. Position the shock absorber, and reinstall the spacers removed in step 9. Reinstall the shock absorber axle, securing it with the cotter pin.
19. Reconnect each opening spring assembly to the connecting link by installing the pin from the rear; reinstall the spring clip.

Pole Unit Replacement (cont.)

20. Using the manual charging handle, slow close the circuit breaker slightly to remove pressure from the 7/32" blocking pins; remove the pin from each opening spring assembly.

> **⚠ CAUTION**
>
> **HAZARD OF EQUIPMENT DAMAGE AND BODILY INJURY.**
>
> Pins inserted to block the closing springs *must* be removed before the circuit breaker is placed back into service.
>
> **Failure to observe this precaution can result in equipment damage.**

Pole Unit Assembly Completion—To complete pole unit replacement, follow these steps:

1. Reconnect the auxiliary switch actuating plate to the operating shaft arm on the left-hand pole unit. If the circuit breaker is equipped with an MOC assembly, reconnect the MOC actuating plate to the operating shaft arm on the right-hand pole unit.
2. Reinstall the pins connecting the cross links to the left and right pole unit operating shaft arms; install the spring clips. Be sure to pivot the stuck blade interlock so that it is on top of the auxiliary switch actuating plate.

If the center pole unit was replaced, complete the steps below. If it was not replaced, reassembly of the circuit breaker is complete. Ensure that all hardware, pins, clips, etc. are properly installed in the correct position. Before placing the circuit breaker into service, the opening stop *must* be readjusted ; see **Opening Stop Adjustment**, below.

Center Pole Unit Assembly Completion—To complete center pole unit replacement, follow these steps:

1. Reinstall the support channel below the pole units; reinstall the seven mounting screws.
2. Reinstall the closing spring assemblies per steps 14–18 under **Measuring Arcing Contact Wear**, page 27.

Reassembly of the circuit breaker is complete. Ensure that all hardware, pins, clips, etc., are properly installed in the correct position. Before placing the circuit breaker into service, the opening stop *must* be readjusted (see **Opening Stop Adjustment** below).

Opening Stop Adjustment

Follow these steps to adjust the opening stop:

1. Remove the closing spring assemblies, following steps 1–5 under **Measuring Arcing Contact Wear**, page 27.
2. Disconnect the opening spring assembly, following steps 4–7 under **Center Pole Unit Replacement**, page 34.

Opening Stop Adjustment (cont.)

3. Disconnect the mechanism main link (figure 40) from the mechanism operating arm by removing the spring clip and pin behind the main operating mechanism.

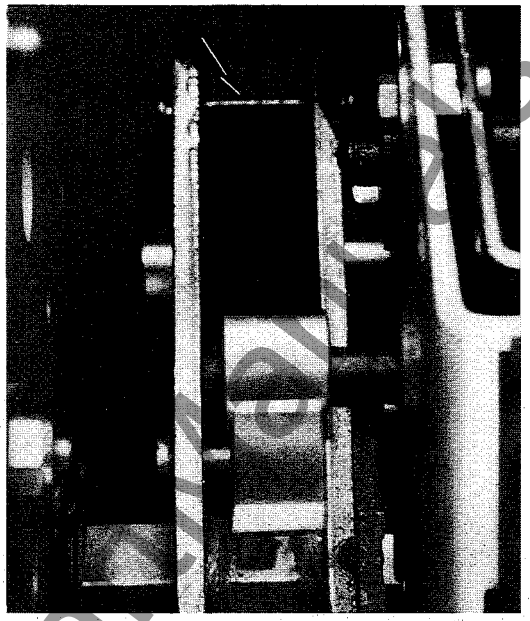

Figure 40: Mechanism main link

4. Loosen the locking nut; remove the stop screw and locking nut.
5. Move the cross links as far to the left as possible. Measure the distance between the stop block surface and the surfaces of the cross links which come into contact with the stop screw (D_1, figure 41).
6. Coat the threads of the stop screw and locking nut with Loctite. Install the screw and locking nut so that the distance from the stop block surface to the top of the screw head equals distance D_1 + 0.22″ (5.5 mm). This distance is shown in figure 42 as D_2. Secure the locking nut.

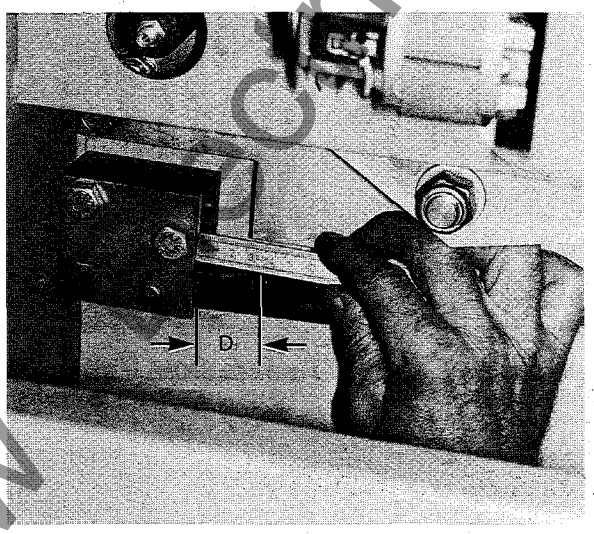

Figure 41: Stop block measurement

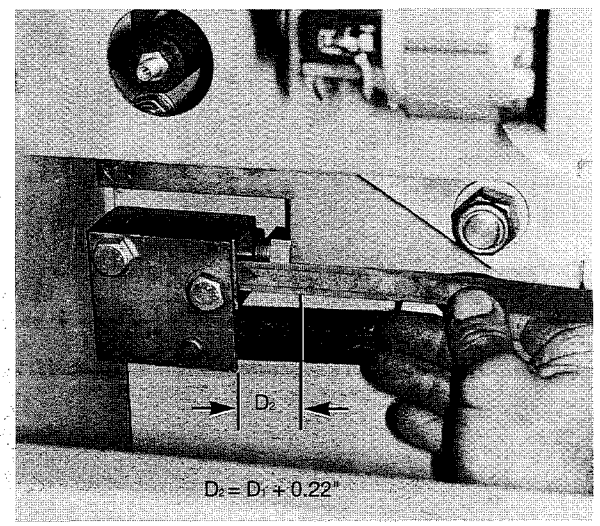

Figure 42: Stop screw installation

7. Reconnect the mechanism main link to the mechanism operating arm, using the pin and spring clip (figure 40).
8. Reconnect the opening spring assemblies, following steps 19 and 20 under **Center Pole Unit Replacement**, page 34.
9. Reinstall the closing spring assemblies, following steps 14–18 under **Measuring Arcing Contact Wear**, page 27.

The opening stop adjustment is complete.

Opening Prop Check

It is possible, through wear or contamination (e.g., dirt in the mechanism), for a circuit breaker to trip open without mechanical or electrical prompting. If this occurs, follow these steps to check the condition of the opening prop:

1. Close the circuit breaker.
2. Force a 0.08" (2 mm) thick wedge between the opening prop and bell crank-mounted stop.
3. If this forces the prop over center and the circuit breaker opens, the circuit breaker requires servicing. Contact your local Square D field office.
4. If forcing the wedge into the stop does not cause the circuit breaker to open, the circuit breaker is tripping for a different reason. If the cause can not be determined, contact your local Square D field office.

Primary Disconnecting Finger Assemblies

There are three ratings of primary disconnecting finger assemblies: 1200A(figure 43), 2000A(figure 44), and 3000A (figure 45).

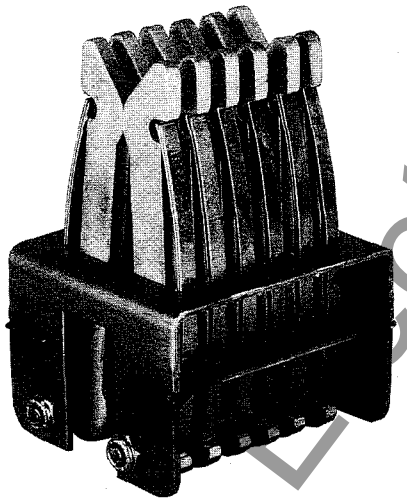

Figure 43: 1200A primary disconnecting 12-finger assembly

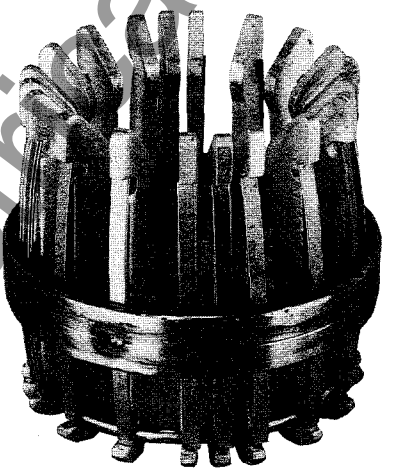

Figure 44: 2000A primary disconnecting 20-finger assembly

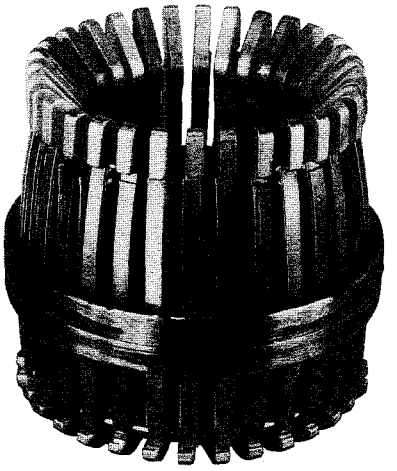

Figure 45: 3000A primary disconnecting 32-finger assembly

Primary Disconnecting Finger Assemblies (cont.)

The fingers for each of the three ratings are the same. Force is applied by two leaf springs. The fingers are made of copper and have a 0.0002" silver plating. See page 42 for replacement part numbers.

Under extreme service conditions, the silver plating may wear off of some areas of the fingers, exposing the copper. Or, if the surfaces become pitted or contaminated, they can be polished down to bare copper. In either case, replate the exposed copper using a portable silver replating process such as "Kool-Amp."

Some primary disconnecting finger assemblies are coated at the factory with Mobilux EP-1 grease. Use this grease on any of the disconnecting finger assemblies if contact surface maintenance becomes necessary or if adverse atmospheric conditions exist.

1200A Disconnecting Finger Replacement—To service the 1200A disconnecting finger assembly(figure 43), follow these steps:

1. Remove the two 10-32 screws securing the assembly.
2. Slide the finger assembly from the retainer.

When reinstalling, be sure the screws are behind the pins in the connector block and that they secure each finger to the assembly.

2000A And 3000A Disconnecting Finger Replacement—To service the 2000A (figure 44) and 3000A (figure 45) disconnecting finger assemblies, follow these steps:

1. Remove the four 10-32 screws holding the retaining anchors.
2. Remove the plug from the center of the finger cluster.
3. Slide the finger cluster off the runback.
4. To remove individual fingers from the cluster, first remove the leaf springs.

To reassemble, reverse the above procedure.

Primary Disconnect Alignment

The primary disconnect provides full ratings even if out of alignment with the fixed stab in the circuit breaker cell by as much as 0.125" (3 mm).

Pole Unit Resistance Check

Follow these steps to check pole unit resistance:

1. Use a four terminal resistance bridge to take low resistance measurements.
2. With the circuit breaker closed, use two current probes to pass high current (about 100A dc) through the pole unit.
3. Place the two voltage probes just behind the primary disconnect finger assemblies to read the resistance.

Pole Unit Resistance Check (cont.)

Measured resistance readings can vary up to 100% from actual resistance. Check the resistance values listed in table 4 below for the appropriate pole unit current rating. Variations of more than 100% indicate the pole unit may need replacing.

Table 4
Pole Unit Resistance

Current Rating	Resistance µ-Ohms
1200A	20–26
2000A	7–11
3000A	7–11

Dielectric Test

With the circuit breaker open, apply 27 kV 60 Hz or 38 kV dc from each terminal to ground and between each set of terminals, including across each open pole unit.

With the circuit breaker closed, apply 27 kV 60 Hz or 38 kV dc from each pole to ground and between the poles.

The circuit breaker must carry this test voltage for one minute without failure. If it does not, contact your local Square D field office.

Gas Pressure Check

Gas pressure checks are *not* recommended as part of normal maintenance. The pole units are sealed for life and require no service.

SECTION 8 — REPLACEMENT PARTS

Recommended Spare Parts

Keep sufficient renewal parts in stock to ensure prompt replacement of worn, broken, or damaged parts. A list of recommended renewal parts is provided in table 5 below.

Because of wide variations in operating uses and environments, the table is presented only as a recommended minimum requirement. Each operating company should develop its own renewal parts stock, based on operating experience, to maintain circuit breakers in proper condition.

Table 5
Recommended Spare Parts

Part Considered for Stock	Number Of Circuit Breakers In Service			
	1	2–3	4–10	11–30
Charging Motor	—	—	1	2
Auxiliary Switch Block	—	—	1	2
End-of-Charging Switch	1	1	1	2
Anti-Pump Relay	—	1	1	2
Closing Solenoid	1	1	1	2
Opening Solenoid	1	1	1	2
Pole Unit	—	—	1	3
Primary Disconnect Finger Assembly	—	1	3	6
Secondary Control Power Plug	—	1	1	2

Available replacement parts are listed in table 6.

Replacement Parts

Table 6
Replacement Parts

Description	Part Number	Fig. No.
Primary Disconnecting Finger Assembly		
1200A (12-finger)	46001-263-51	43
2000A (20-finger)	46001-445-50	44
3000A (32-finger)	46001-445-51	45
Charging Motor	See Table 7	46
Closing Solenoid	See Table 8	47
Opening Solenoid	See Table 9	48
Anti-Pump Relay	See Table 10	49
Ground Shoe	C1504	50
End-Of-Charging Switch	25710904	51
Secondary Control Power Plug		15
24-contact male crimp plug	46049-25911	
Male crimp contact, 14AWG	46049-25913	
Male relay (short) crimp contact, 14AWG, gold-plated	46049-25914	
Five-Circuit Control Switch Block	877942K	13
Nine-Circuit Auxiliary Switch Block	877942C	14
Pole Unit	Contact Field Office ①	11
Opening Spring Assembly	Contact Field Office ①	53
Closing Spring Assembly	Contact Field Office ①	52

① Have complete nameplate information ready before contacting field office.

Table 7
Charging Motors

Rated Voltage	Part Number	Current At Rated Voltage
48 Vdc	886658	6.0A
125 Vdc	886661	3.2A
250 Vdc	886662	1.6A
120 Vac	886661	3.0A
240 Vac	886662	1.6A

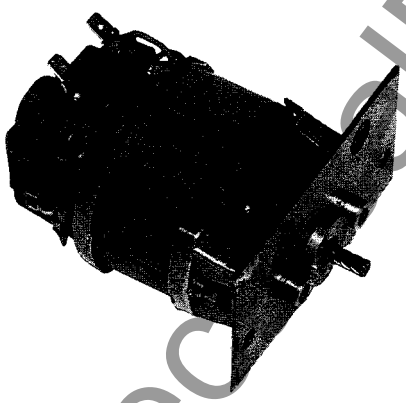

Figure 46: Charging motor

Replacement Parts (cont.)

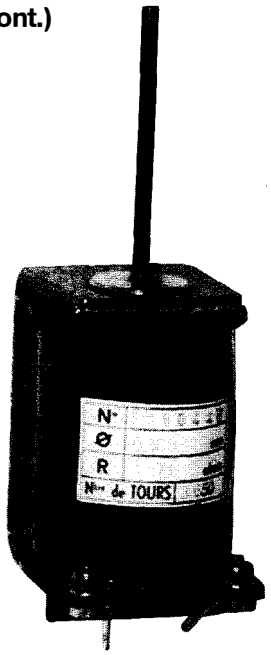

Figure 47: Closing solenoid

Table 8
Closing Solenoids

Rated Voltage	Part Number	DC Resistance @ 20°C (Ω)
48 Vdc	887191 AH	68
125 Vdc	887191 AD	480
250 Vdc	887191 AA	1700
120 Vac	887191 AL	17.6
240 Vac	887191 AJ	44.5

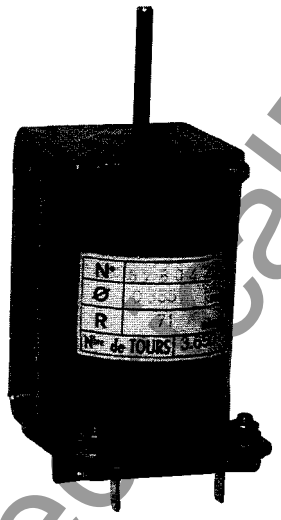

Figure 48: Opening solenoid

Table 9
Opening Solenoids

Rated Voltage	Part Number	DC Resistance @ 20°C (Ω)
24 Vdc	887191 BN	6.75
48 Vdc	887191 BJ	44.5
125 Vdc	887191 BF	184
250 Vdc	887191 BB	1100
120 Vac	887191 BJ	44.5
240 Vac	887191 BF	184

Replacement Parts (cont.)

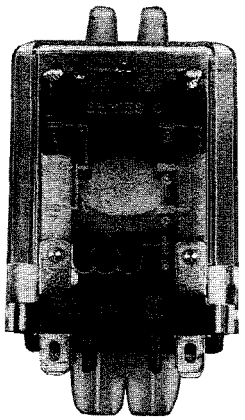

Figure 49: Anti-pump relay

Table 10
Anti-Pump Relays

Rated Voltage	Part Number	DC Resistance @ 20°C (Ω)
48 Vdc	44080-684-02	1,800
125 Vdc	44080-684-03	10,000
250 Vdc	44080-684-03 ①	17,500 ②
120 Vac	44080-684-05	2,250
240 Vac	44080-684-06	7,200

① Resistor required (part number 26160-21765).
② Included resistor of 7,500Ω.

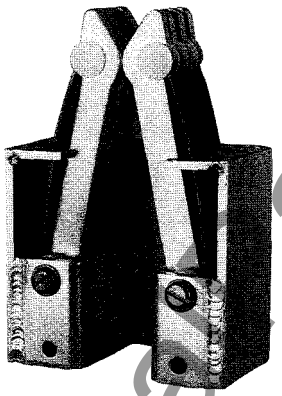

Figure 50: Ground shoe

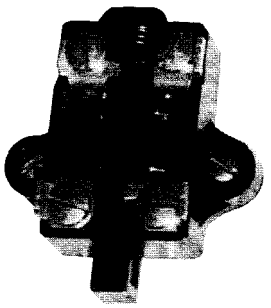

Figure 51: End-of-charging switch

Figure 52: Closing spring assembly

Figure 53: Opening Spring Assembly

SECTION 9—INSTALLATION AND MAINTENANCE LOG

INSTALLATION AND MAINTENANCE LOG (cont.)

INSTALLATION AND MAINTENANCE LOG (cont.)

INSTALLATION AND MAINTENANCE LOG (cont.)

Square D Company
330 Weakley Road
Smyrna, TN 37167 U.S.A.

Order No. 6055IM9101R6/93 5M FP 11/93
(Replaces 6055-2 dated 10/87)

SQUARE D

Part No. 6055-2
Printed in U.S.A.