

SIEMENS

5kV and 15kV Vacuum Circuit Breakers

Type GMI

Instruction
Installation
Operation
Maintenance

SG-3268-01

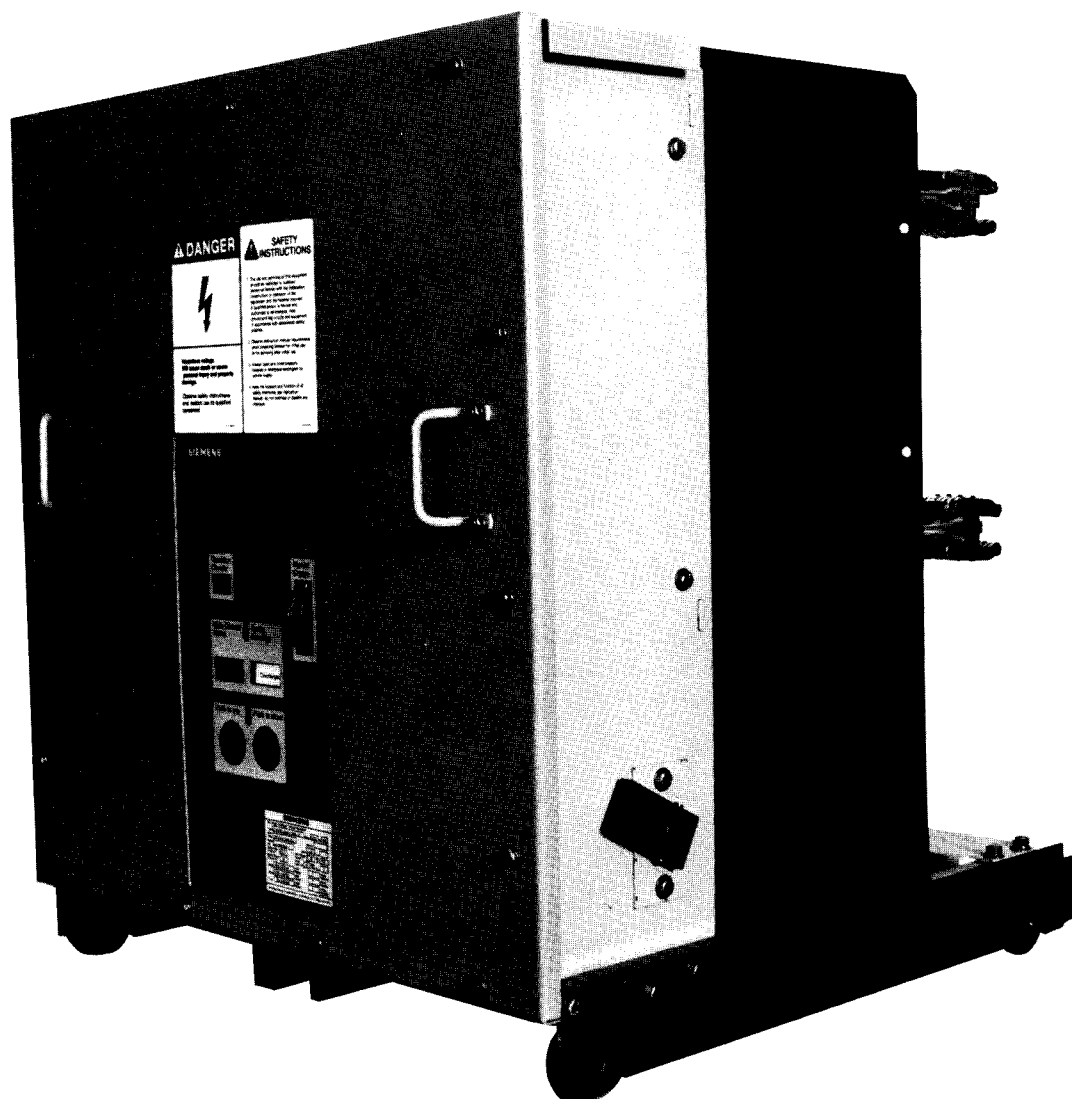


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Introduction

The GMI family of vacuum circuit breakers is designed to meet all the applicable ANSI, NEMA and IEEE standards. Successful application and operation of this equipment depends as much upon proper installation and maintenance by the user as it does upon the careful design and fabrication by Siemens.

The purpose of this Instruction Manual is to assist the user in developing safe and efficient procedures for the installation, maintenance and use of the equipment.

Contact the nearest Siemens representative if any additional information is desired.

Safety

This equipment contains hazardous voltages, and remotely controlled mechanical parts which move at high speed. Severe personal injury or property damage can result if safety instructions are not followed.

Only qualified personnel should work on or near this equipment after becoming familiar with all warnings, safety notices and maintenance procedures described in the manuals covering this equipment.

Qualified Person

A "Qualified Person" is familiar with the installation, construction and operation of this equipment. In addition, this person has the following qualifications:

- Training and authorization to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.
- Training in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses, face shields, flash clothing, etc., in accordance with established safety procedures.



Signal Words

The signal words "**Danger**", "**Warning**" and "**Caution**" used in this manual indicate the degree of hazard that may be encountered by the user. These words are defined as:

Danger—Indicates death, severe personal injury or major property damage *will* result if proper precautions are not taken.

Warning—Indicates death, severe personal injury or major property damage *can* result if proper precautions are not taken.

Caution—Indicates some personal injury or property damage may result if proper precautions are not taken.

	 DANGER
	<p>Power circuit breakers operate at high voltages and have spring-loaded mechanical parts which operate at high speed. When operated improperly, this equipment will cause death, personal injury and property damage.</p> <p>To avoid electrical shock, burns and entanglement in moving parts this equipment must be installed, operated and maintained only by qualified persons thoroughly familiar with the equipment, instruction manuals and drawings.</p>

Dangerous Procedures

In addition to other procedures described in this manual as dangerous, user personnel must adhere to the following:

1. Always work on a de-energized breaker. Always de-energize a breaker, and remove it from the metal-clad switchgear before performing any tests, maintenance or repair.
2. Always perform maintenance on the breaker after the spring-charged mechanisms are discharged (except for tests of the charging mechanisms).
3. Always let an interlock device or safety mechanism perform its function without forcing or defeating the device.

Field Service Operation

Siemens can provide competent, well-trained Field Service Representatives to provide technical guidance and advisory assistance for the installation, overhaul, repair and maintenance of Siemens equipment, processes and systems. Contact regional service centers, sales offices or the factory for details.

Introduction

Type GMI Vacuum Interrupter Circuit Breakers are normally installed in assembled metal-clad switchgear, and the Switchgear Manual contains the Receiving, Handling and Storage instructions for assembled metal clad switchgear.

This manual covers the Receiving, Handling and Storage instructions for Type GMI circuit breakers shipped separately from the switchgear. This section of the manual is intended to help the user identify, inspect and protect the circuit breaker prior to its installation.

Receiving Procedure

Inspection

Make a physical inspection of the shipping container before removing or unpacking the circuit breaker. Check for shipment damage or indications of rough handling by the carrier. Check each item against the manifest to identify any shortages.

Some accessories such as the manual charging lever, the racking crank and the plug jumper are shipped separately.

Shipping Damage Claims (When Applicable)

Follow normal shipment damage procedures, which should include:

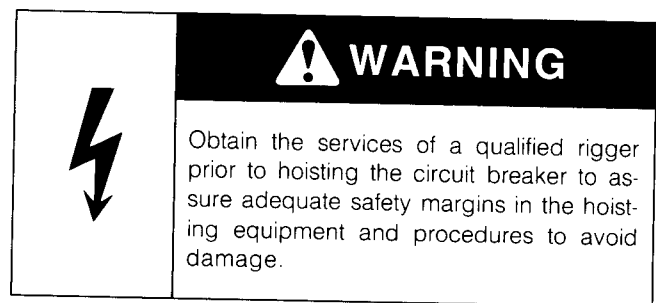
1. Check for visible damage upon arrival.
2. Visible damage must be noted on delivery receipt, and acknowledged with driver's signature. Notation, "Possible internal damage, subject to inspection" must be on delivery receipt.
3. Notify Siemens Sales office immediately of any shipment damage.
4. Arrange for carrier's inspection. Do not move the unit from its unloading point.

Handling Procedure

1. Carefully remove the shipping carton from the circuit breaker. Keep the shipping pallet for later use if the breaker is to be stored prior to its installation.
2. Inspect for concealed damage. Notification to carrier must take place within 15 days to assure prompt resolution of claims.

3. Each circuit breaker should be appropriately lifted to avoid crushing the side panels of the breaker, or damage to primary disconnect subassemblies.

Type GMI circuit breakers weigh between 385 to 575 pounds (175 to 261 kg). See Table A-1, Technical Data in Appendix.



4. The palletted circuit breaker can also be moved using a properly rated fork-lift vehicle. The pallets are designed for movement by a standard fork-lift vehicle.

Storage Procedure

1. Whenever possible, install circuit breakers in their assigned switchgear enclosures for storage. Follow instructions contained in the Switchgear manual.
2. When the breaker will be placed on its pallet for storage, be sure the unit is securely bolted to the pallet and covered with polyethylene film at least 10 mils thick.

Indoor Storage

Whenever possible, store the circuit breaker indoors. The storage environment must be clean, dry and free of such items as construction dust, corrosive atmosphere, mechanical abuse and rapid temperature variations.

Outdoor Storage

Outdoor storage is not recommended. When no other option is available, the circuit breaker must be completely covered and protected from rain, snow, dirt and all other contaminants.

Space Heating

Space heating must be used for *both indoor and outdoor* storage to prevent condensation and corrosion. When stored outdoors, between 150 to 200 watts per breaker of space heating is recommended.

Introduction

This section provides a description of the inspections, checks and tests to perform on the circuit breaker prior to operation in the metal-clad switchgear.

Inspections, Checks and Tests without Control Power

Vacuum circuit breakers are normally shipped with their primary contacts open and their springs discharged. However, it is critical to *first* verify the discharged condition of the spring-loaded mechanisms after de-energizing control power.

De-Energizing Control Power in Switchgear Mounted Circuit Breakers

When the circuit breaker is mounted in switchgear, open the control power disconnect device in the metal-clad switchgear cubicle. **Figure 1** shows the location of this disconnect in a standard two-high switchgear assembly.

NOTE

All figures of switchgear in this manual show the switchgear front hinged panel in the open position.

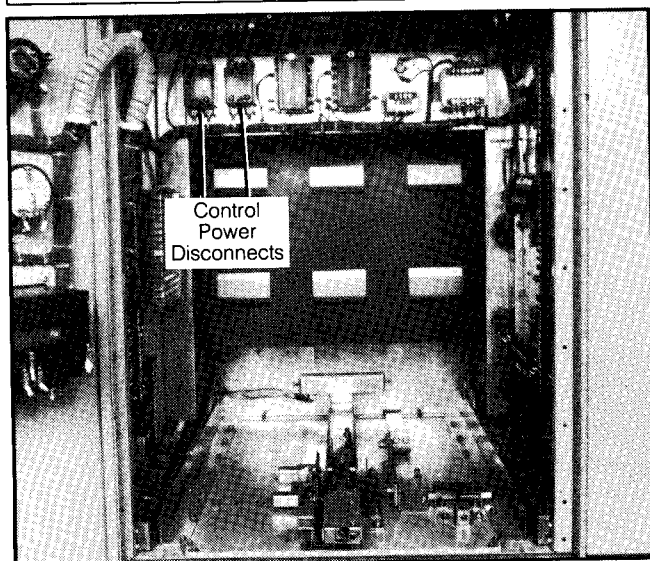




Figure 1. Control Power Disconnect.

The control power disconnect device is located on the device panel above the lower circuit breaker and below the upper circuit breaker. **Figure 1** shows a pullout type fuse holder. Removal of the fuse holder de-energizes control power to the circuit breaker in the respective switchgear cell. In some switchgear assemblies, a molded case circuit breaker is used in lieu of the pull out type fuse holder. Opening this circuit breaker accomplishes the same result: control power is disconnected.

Spring Discharge Check

Perform the Spring Discharge Check *before* removing the circuit breaker from the pallet or removing it from the switchgear.



 **DANGER**

Hazardous voltages and high-speed mechanical parts will cause death or severe personal injury and property damage.

Read instruction manuals, observe safety instructions and use qualified personnel.

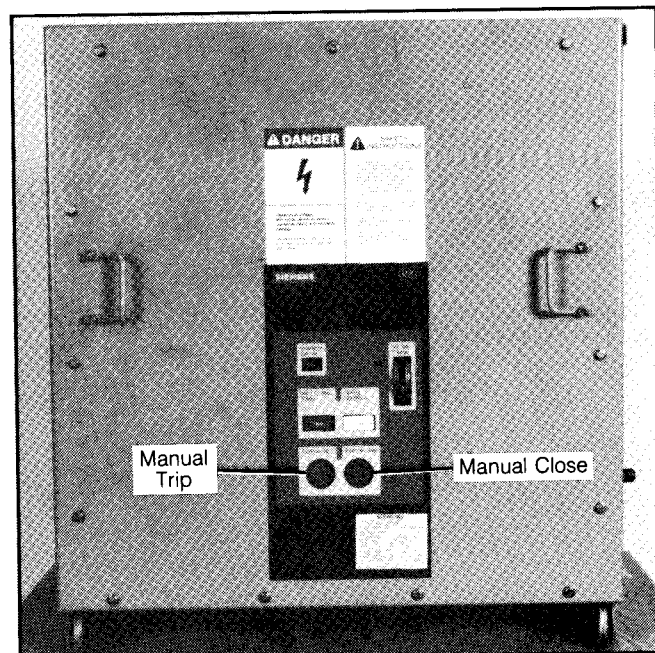


Figure 2. Standard Front Panel of Circuit Breaker.

The spring discharge check consists of simply performing the following tasks in the order given. This check assures that both the tripping and closing springs are fully discharged.

1. Press red Trip pushbutton.
2. Press green Close pushbutton.
3. Again press red Trip pushbutton.
4. Verify Spring Condition Indicator shows "DIS-CHARGED"
5. Verify Main Contact Status Indicator shows "OPEN."

Removal from Lower Cell (Indoor and Shelter-Clad Outdoor Switchgear)

After performing the Spring Discharge Check (with control power de-energized), remove the circuit breaker from its switchgear cubicle.

1. Push the racking interlock latch in and insert the racking crank on the racking screw on the floor of the breaker cell as shown in **Figure 3**.
2. With constant pressure on the racking crank, rotate *counterclockwise* until the breaker is Disconnect position.
3. Move the breaker release latch to the left, breaker can then be removed from cubicle.

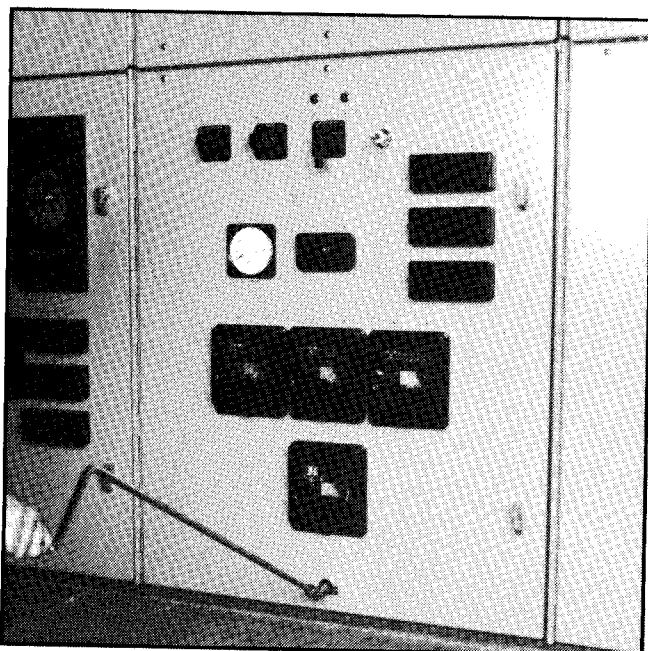


Figure 3. Racking Circuit Breaker in Switchgear.

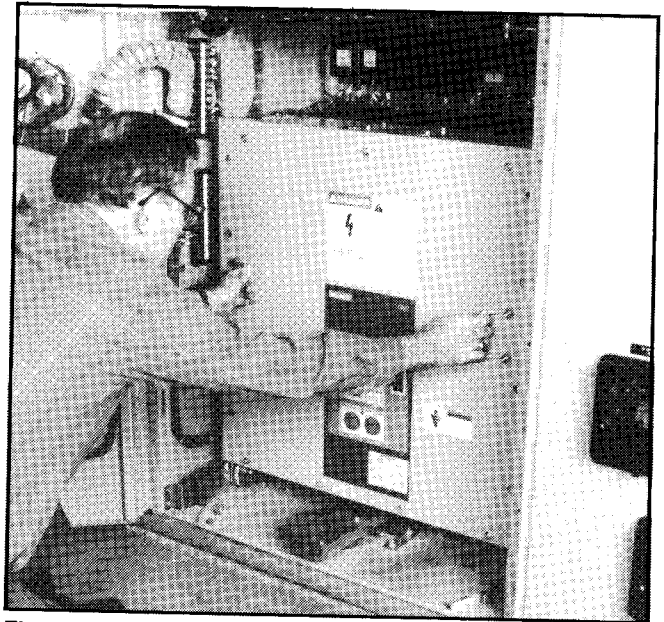


Figure 4. Removal of Circuit Breaker.

4. The circuit breaker is then free to be rolled out using the handles as shown in **Figure 4**. The wheels of the circuit breaker are virtually at floor level, and one person can easily handle the unit.

Removal from Upper Cell (Indoor and Shelter-Clad Outdoor Switchgear)

Removal of the upper breaker in a two-high assembly is similar to removal of a breaker from a lower cell, with several additional steps.

Figure 5 shows the two breaker extension rails that are inserted into the fixed rails within the upper cell of two-high switchgear equipment. The rails engage locking pins in the fixed rails to secure them in position.

The procedure for removal of an upper circuit breaker is:

1. Insert the two upper support rails into the fixed rails. Be sure rails are properly secured in place. (This can be done after Step 3 if preferred.)
2. Push the racking interlock in and insert the racking crank on the racking screw into the upper breaker in a manner similar to the step shown in **Figure 3**.
3. With constant pressure on the racking crank, rotate *counterclockwise* until the breaker is in the Disconnect position.

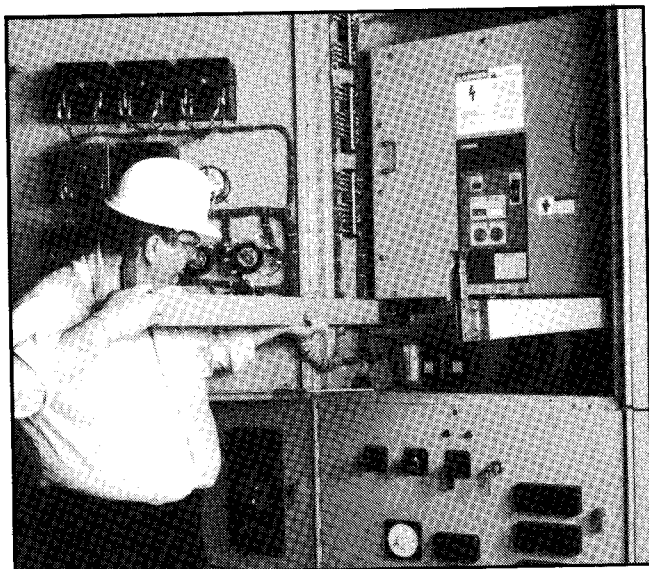
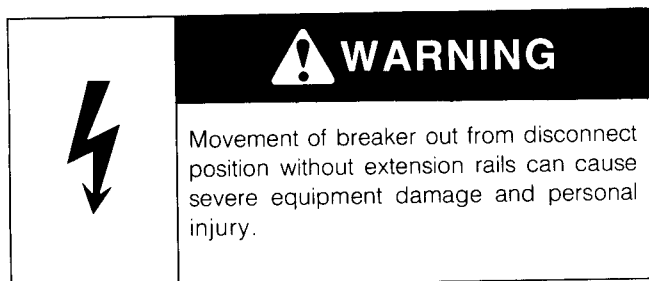


Figure 5. View of Upper Breaker Extension Rails.



4. Move the breaker release latch to the left. The breaker is then free to be rolled out on the two support rails using the handles.
5. Remove the breaker from the two extension rails using the approved Siemens breaker lifting device.
6. Lift the two extension rails and withdraw them from the switchgear.

Removal from Upper and Lower Cell in Outdoor Non-Walk In Enclosures

Because the floor level in non-walk-in outdoor enclosures is approximately 6 inches above grade (foundation) level, the lower breaker in either a one-high or two-high section of switchgear must be removed using the preceding procedure for upper breaker removal.

The approved breaker lifting device should be used for removal of both lower and upper breakers in outdoor non-walk-in enclosures.

Physical Inspections

1. Verify that rating of the circuit breaker is compatible with both the system and the switchgear.
2. Perform a visual shipping damage check. Clean the breaker of all shipping dust, dirt and foreign material.

Manual Spring Check

1. Insert the manual spring charging lever into the manual charge handle socket as shown in **Figure 6**. Operate the lever up and down until the spring condition indicator shows the closing spring is Charged.

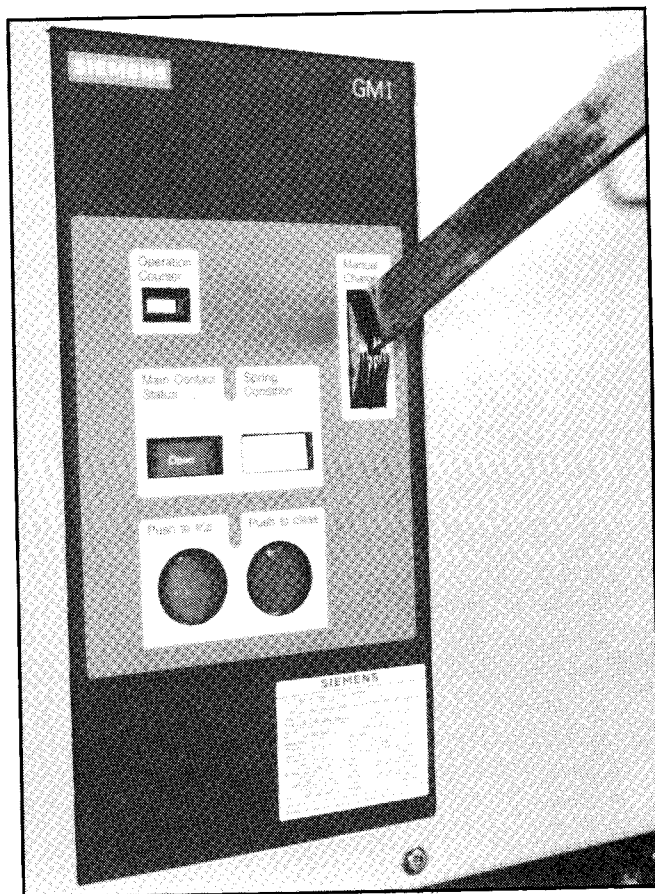


Figure 6. Manual Charging of Closing Springs.

2. Repeat the Spring Discharge Check.
3. Verify that the springs are discharged and the breaker primary contacts are open by indicator positions.

As-Found and Vacuum Check Tests

Perform and record the results of both the As-Found insulation test and the vacuum check high-potential test. Procedures for these tests are described in the Maintenance and Overhaul Section of this manual.

Automatic Spring Charging Check

NOTE

A temporary source of control power and test leads may be required if the control power source has not been connected to the switchgear. When control power is connected to the GMI circuit breaker, the closing springs should automatically charge.

The automatic spring charging features of the circuit breaker must be checked. Control power is required for automatic spring charging to take place.

1. Open control power circuit by removing pullout fuse holder shown in **Figure 1**.
2. Install breaker end of split plug jumper (if furnished) shown in **Figure 7** to the circuit breaker. The plug jumper is secured by means of screws, over the circuit breaker's secondary contacts.
3. Install the switchgear end of the plug jumper shown in **Figure 8** to the secondary disconnect block inside the switchgear cubicle. The plug jumper slides into place. The plug jumper interconnects all control power and signal leads (e.g., remote trip and close contacts) between the switchgear and the circuit breaker.
4. Energize (close) the control power secondary disconnect (**Figure 1**).
5. Use the Close and Trip controls (See **Figure 2**) to first Close and the Open the circuit breaker contacts. Verify contact positions visually.

6. De-energize control power by repeating Step 1. Disconnect the plug jumper from the switchgear first and next from the circuit breaker.

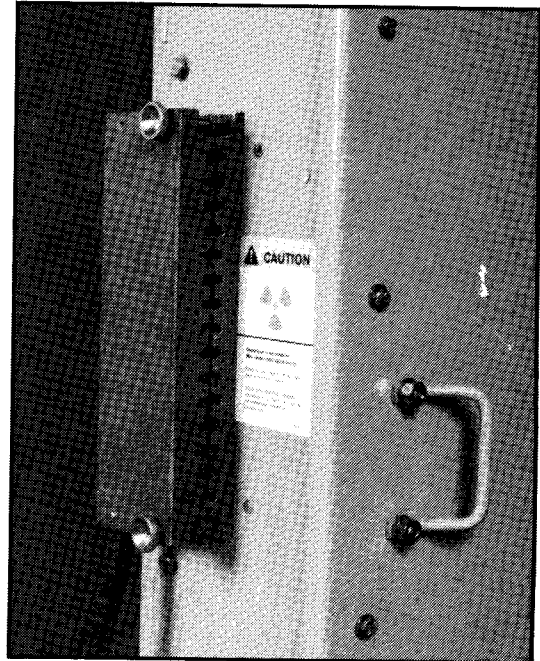


Figure 7. Connecting Split Plug Jumper to Circuit Breaker.

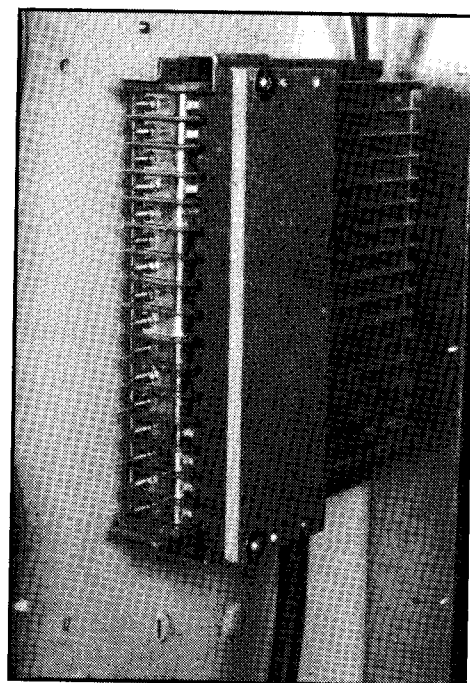


Figure 8. Connecting Split Plug Jumper to Switchgear.

7. Perform the Spring Discharge Check again. Verify that the closing springs are discharged and the primary contacts of the GMI circuit breaker are open.

Final Mechanical Inspections without Control Power

1. Make a final mechanical inspection of the circuit breaker. Verify that the contacts are in the Open position, and the closing springs are Discharged.
2. Check the upper and lower primary studs and contact fingers shown in **Figure 9**. Verify mechanical condition of finger springs and the disconnect studs.
3. Coat movable primary contact fingers, **Figure 9**, and the secondary disconnect contacts, **Figure 24**, with a light film of Siemens Contact Lubricant No. 15-171-370-002.
4. The GMI vacuum circuit breaker is ready for installation into its assigned cubicle of the metal-clad switchgear. Refer to removal procedures and re-install the circuit breaker into its switchgear.
5. Refer to Switchgear Instructions for functional tests of an installed circuit breaker.

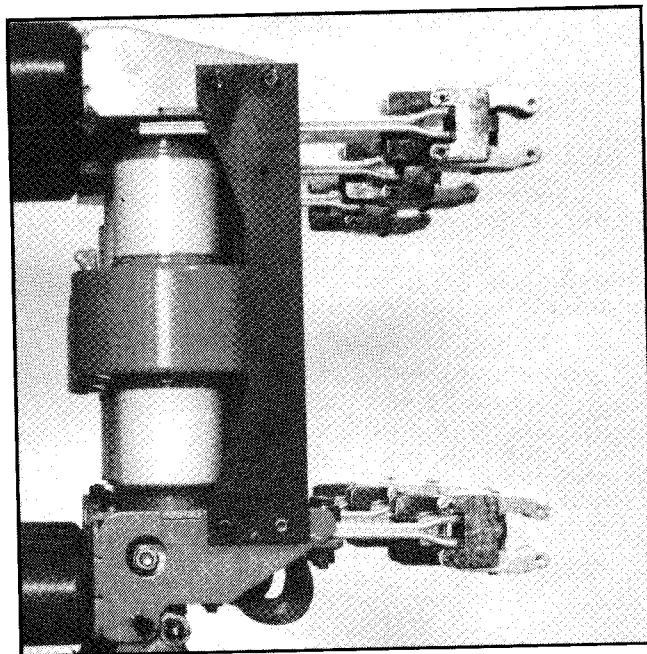


Figure 9. Primary Disconnect Studs and Contact Fingers.

Introduction

The Type GMI vacuum circuit breaker is of drawout construction designed for use in medium voltage, Metal-Clad switchgear. The GMI circuit breaker conforms to the requirements of ANSI standards C37.20.2, C37.04, C37.06, C37.09 and C37.010.

GMI circuit breakers consist of three vacuum interrupters, a stored energy operating mechanism, necessary electrical controls and interlock devices, disconnect devices to connect the breaker to both primary and control power and an operator housing. On some circuit breaker ratings insulating barriers are located between the vacuum interrupters or along the sides.

This section describes the operation of each major subassembly as an aid in the operation, installation, maintenance and repair of the GMI vacuum circuit breaker.

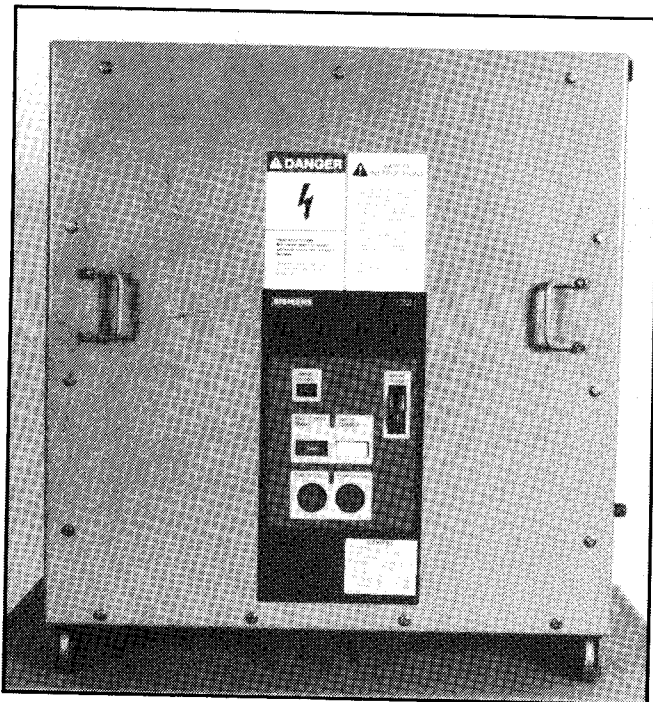


Figure 10. Front View of GMI Breaker.

Vacuum Interrupters and Primary Disconnects

The operating principle of the GMI vacuum interrupter is simple. **Figure 12** is a cutaway view of the vacuum interrupter. The entire assembly is sealed after a vacuum is estab-

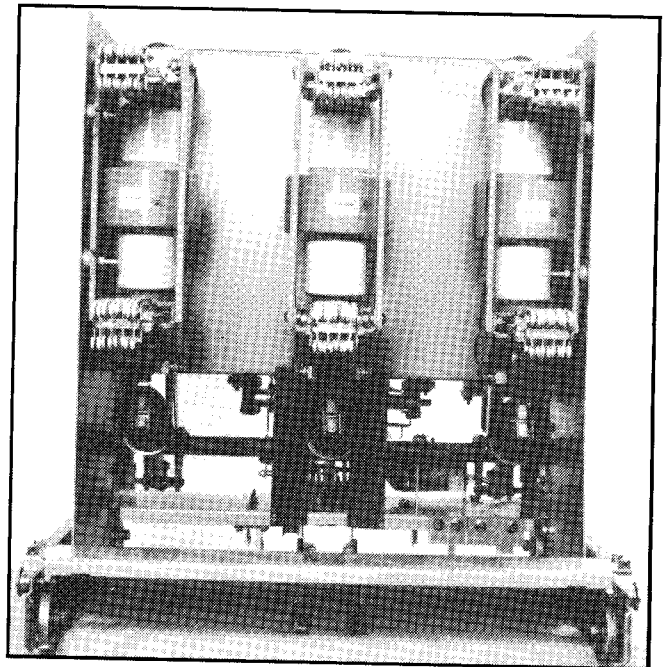


Figure 11. Rear View of GMI Breaker.

lished. The interrupter stationary contact is connected to the upper disconnect stud of the circuit breaker. The interrupter movable contact is connected to the lower disconnect stud and driving mechanism of the circuit breaker. The metal bellows assembly provides a secure seal around the movable contact, preventing loss of vacuum while permitting vertical motion of the movable contact.

When the two contacts separate an arc is initiated which continues conduction up to the following current zero. At current zero, the arc extinguishes and any conductive metal vapor which has been created by and supported the arc

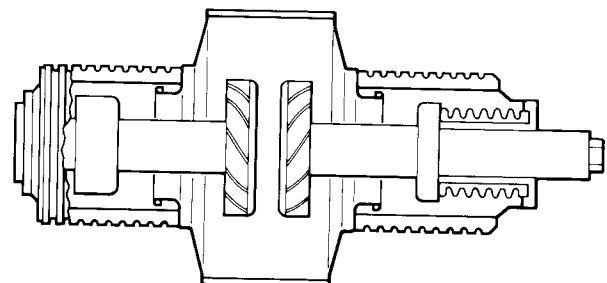


Figure 12. Cutaway View of GMI Vacuum Interrupter.

condenses on the surrounding vapor shield. Contact materials and configuration are optimized to achieve arc motion and to minimize switching disturbances.

Primary Disconnects

Figure 13 is a side view of the circuit breaker with a side phase barrier removed to show details of the primary disconnects. Each circuit breaker has three upper and three lower primary disconnects. Upper primary disconnects are connected to the stationary contacts of the vacuum interrupters, and the lower primary disconnects to the movable contacts. Each disconnect arm has a set of multiple spring loaded fingers that mate with bus bars in the Metal-Clad switchgear. The number of fingers in the disconnect assembly varies with the continuous and/or momentary rating of the circuit breaker.

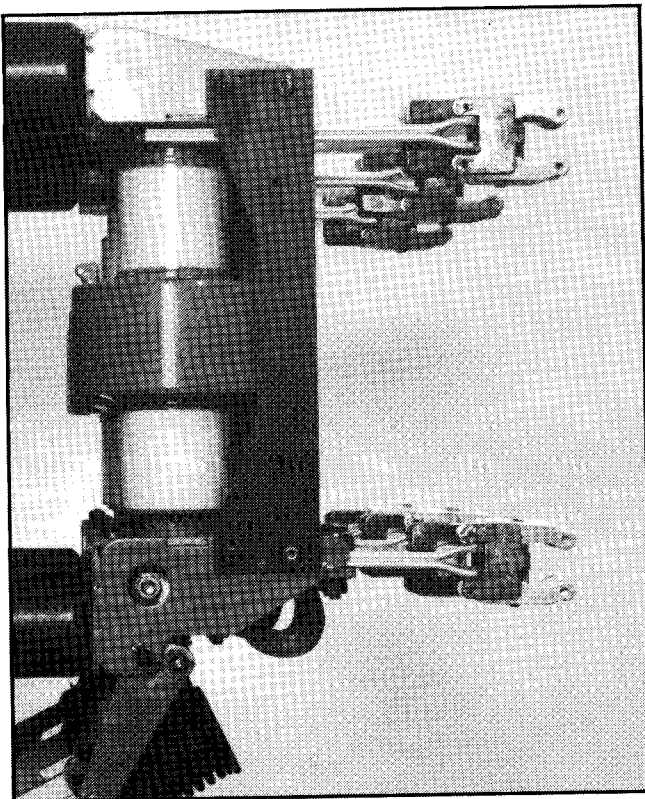


Figure 13. Upper and Lower Primary Disconnects.

There are three insulating push rods. Each push rod connects the movable contact of one of the vacuum interrupters to the jack shaft driven by the closing and tripping mechanism. Flexible connectors ensure secure electrical connections between the movable contacts of each interrupter and its bottom primary disconnect.

Phase Barriers

Phase barriers are variable among GMI breakers of dissimilar voltage and continuous current ratings.

Figure 14 is a rear view of a circuit breaker that shows the two outer (phase to ground) insulating barriers. Some circuit breaker ratings also have inner barriers (phase to phase). These four plates of glass polyester insulating material are attached to the circuit breaker housing and provide suitable electrical insulation between the vacuum interrupter primary circuits and the housing.

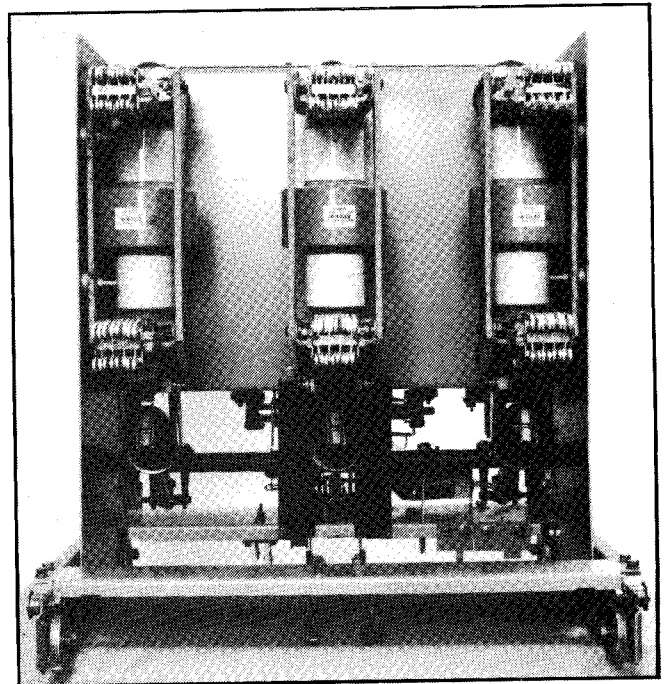


Figure 14. Breaker with Insulating Outer Phase Barriers.

Stored Energy Operating Mechanism

The stored energy operating mechanism of the GMI circuit breaker is an integrated arrangement of springs, solenoids, and mechanical devices designed to provide a number of critical functions. The energy necessary to close and open the contacts of the vacuum interrupters is stored in powerful tripping and closing springs. These springs are normally charged automatically, but there are provisions for manual charging. The operating mechanism that controls charging, closing and tripping functions is fully trip-free, i.e., spring charging does not automatically change the position of the

primary contacts, and the closing function may be overridden by the tripping function at any time.

Modes of Operation

Some maintenance procedures are more easily understood when the operating mechanism modes of operation are described in detail. The next few paragraphs explain the five modes or status conditions (charging, closing, trip-free, opening and rapid auto-reclosing) of the stored energy operating mechanism.

NOTE

All discussion of modes of operation assumes that the reader is viewing the operator from the front, or from the right hand side.

Spring Charging Mode

Figures 15 and 16 show several key components of the operator mechanism in positions corresponding to the breaker open, with the closing springs discharged (Figure 15) and charged (Figure 16). Figure 17 shows portions of the operator mechanism that manually or electrically

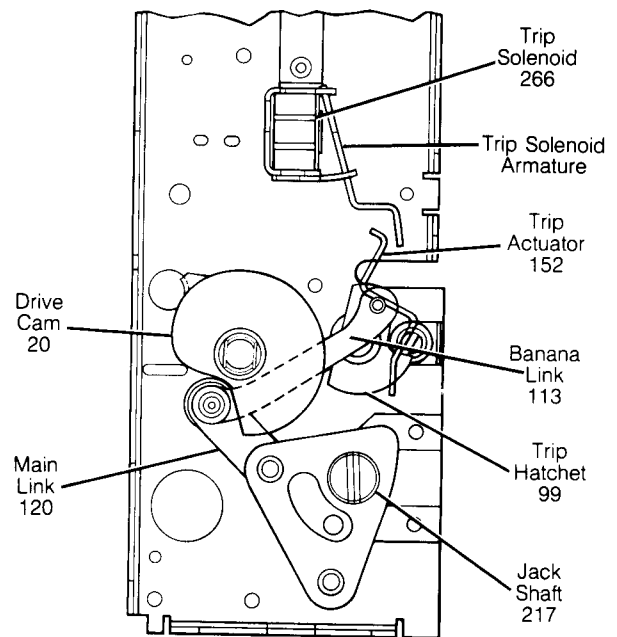


Figure 16. Breaker Open—Closing Springs Charged.

charge the closing springs. The drive cam (20), the closing spring crank arms (see Figure 19) and spring condition indicator cam (18) are directly keyed to the main cam shaft (3). The main cam shaft rotates counterclockwise. The clos-

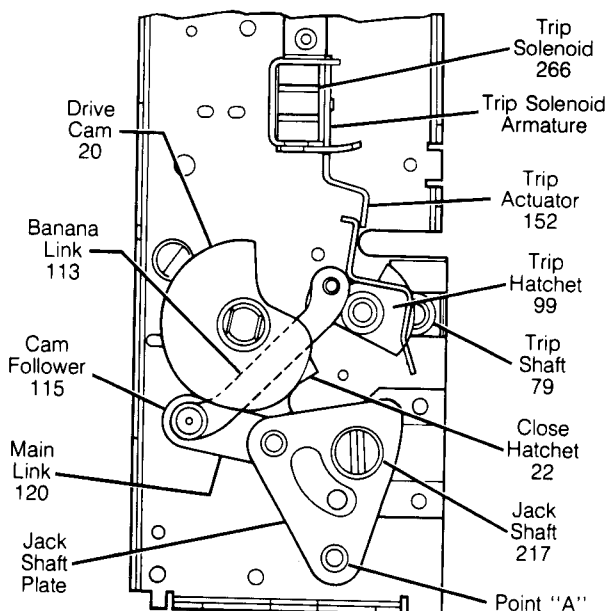


Figure 15. Breaker Open—Closing Springs Discharged.

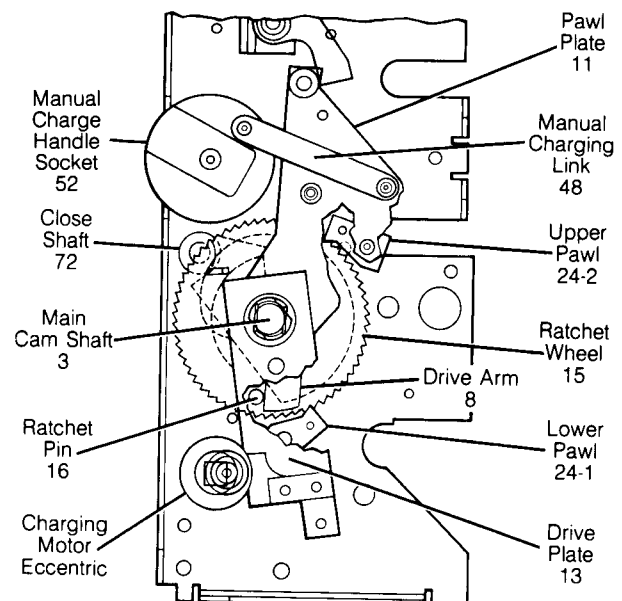


Figure 17. Pawl and Ratchet Drive.

ing springs are attached to the crank arms, and are extended during the charging cycle.

Figure 17 shows the ratchet wheel (15) which is free to rotate about the main cam shaft (3). The ratchet wheel is driven by either the charging motor or the manual charge handle socket (52). When the springs are charged electrically, the motor eccentric (100) introduces a rocking motion into the drive plate (13). As this plate rocks back and forth, the lower pawl (24-1) (which is connected to the drive plate) imparts counterclockwise rotation of the ratchet wheel (15), one tooth at a time. The upper pawl (24-2) acts as a holding pawl during electrical charging.

When the springs are charged manually, up and down pumping action of the spring charging handle in the manual charge handle socket (52) causes the pawl plate (11) to rock back and forth through the movement of the manual charging link (48). The upper pawl (24-2) drives the ratchet plate counterclockwise during manual charging, and the lower pawl (24-1) becomes the holding device.

At the beginning of the charging cycle, ratchet pin (16) is at the 6 o'clock position. The ratchet pin is connected to the ratchet wheel. Upon reaching the 12 o'clock position, this pin engages the drive arms (8) which are keyed to the main cam shaft. Consequently, counterclockwise rotation of the ratchet wheel causes the ratchet pin to drive the main cam shaft counterclockwise. When the ratchet pin reaches the 6 o'clock position, the closing springs are fully charged. Driving pawl (24-1) is disengaged, the spring condition indicator cam (18) has rotated allowing the spring charged flag (132) to drop into the lower (charged) position, which also operates the motor cutoff switch (LS1) and spring charged switch (LS2) (258). The closing springs are restrained fully charged by close hatchet (22) against close shaft (72).

Closing Mode (Figure 18)

Energizing the close solenoid (265) pulls the solenoid armature against the closing shaft actuator (75) and causes the close shaft (72) to rotate approximately 15°. If the closing spring are charged, the close hatchet (22) will be released by this rotation allowing the main cam shaft (3) to be driven by the closing springs. Depressing the manual close button on the operator panel causes the rotation of the close shaft (72) by the lower end of the close shaft actuator (75). Rotation of the main cam shaft (3) in a manual closing operation is identical to that of an electrical closing operation. As the main cam shaft (3) rotates, the cam follower (115) is driven by drive cam (20), and the main link (120) is forced outwards, and rotation of the jack shaft assembly (217) occurs. There are three drive links attached to Point 'A' of

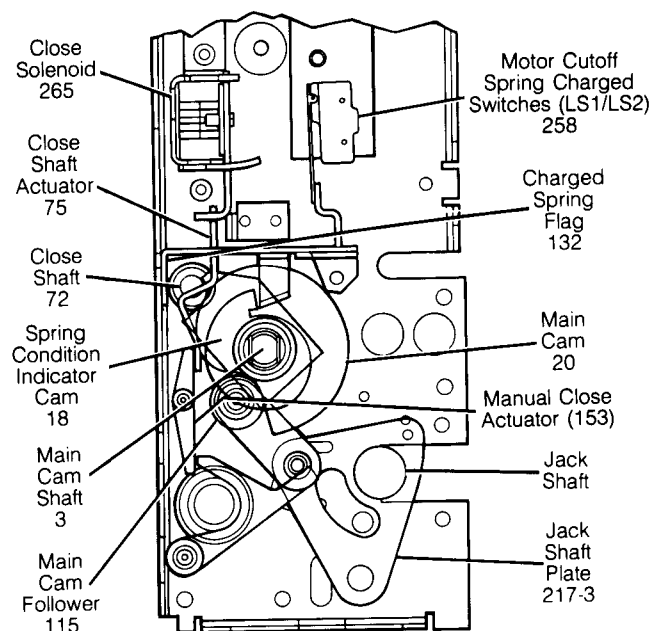


Figure 18. Closing Mode.

each of the three jack shaft drive plates. Each drive link is connected to the movable contact of one vacuum interrupter. Closing rotation (counterclockwise) of the jack shaft assembly closes the contacts of the three vacuum interrupters. During closing operation, rotation of jack shaft assembly (217) forces the opening (i.e., tripping) spring into its charged position.

Trip Free Mode

If at any time during breaker closing, the trip shaft (79), see **Figure 15**, operates as a result of either an electrical or mechanical trip, trip hatchet (99) is free to rotate. When the trip hatchet (99) rotates, cam follower (115) is displaced by drive cam (20) without motion of the jack shaft (217). Mechanical trip free operation is provided by manual tripping, electrical tripping and/or the mechanical interlocks.

Opening Mode

Opening or tripping the vacuum interrupter contacts is accomplished by rotation of the trip shaft (79). Rotation may be produced either electrically, by energizing the trip solenoid (266), see **Figure 16**, or manually by pressing the trip button. Energizing the trip solenoid causes the upper arm of the trip actuator (152) to rotate counterclockwise. Pressing the trip button causes the trip actuator lower arm to move, again producing rotation of the trip shaft. All of the linkages are trip free, and tripping or opening is unaffected

by charging status of the closing springs or position of the drive cam (20).

Rapid Auto-Reclosing Mode

The closing springs are automatically recharged by the motor driven operating mechanism when the breaker has closed. The operating mechanism is capable of the open-close - open duty cycle required for rapid auto-reclosing. A trip latch check switch prevents release of the closing springs if the trip hatchet (99) is not in its reset position. This ensures the mechanism does not operate trip free on an instantaneous reclosure.

Closing and Tripping Springs

The stored energy assembly consists of two dual closing springs and a single tripping spring. **Figure 19** shows the three springs and their linkages to the charging devices. The two closing springs are connected to crank arms mounted on the rotating main cam shaft. The closing springs are extended, and charged, by rotation of the crank arms connected to the movable ends of the springs. The fixed ends of these springs are attached to a support arm, which in turn is bolted to the structure of the circuit breaker.

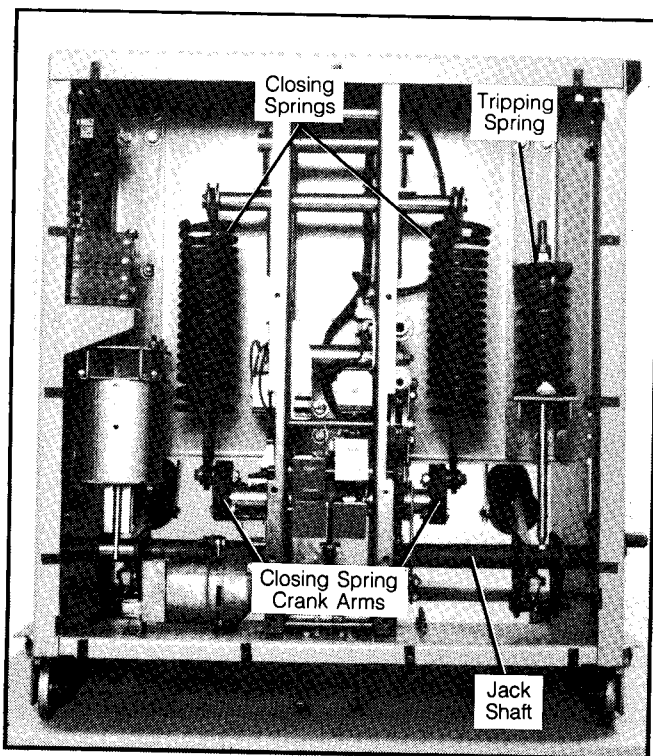


Figure 19. Closing and Tripping Springs.

The tripping spring is connected to the jack shaft. When the circuit breaker closes, rotation of the jack shaft causes the tripping spring push rod to compress and charge the tripping spring. Consequently, the tripping spring is automatically charged whenever breaker contacts are closed.

Trip Free Operation

The GMI circuit breaker is mechanically and electrically trip free. This important function enables the breaker to be tripped before, after or during a closing operation. Whenever the circuit breaker trip shaft is moved as the result of manual or electrical signals or mechanical interlocks, a) a closed breaker will open, b) a breaker in the process of closing will not complete the close operation and will remain open, or c) an open breaker will not be able to be closed.

Dashpot Assembly

GMI circuit breakers are equipped with a dashpot assembly to smooth the final motion of an opening operation. **Figure 20** illustrates major components of this assembly. The dashpot is a piston, with two internal Teflon sealing rings moving inside a cylinder vented to ambient air. Up and down motion of the piston creates an opposing force, controlling the opening speed of the circuit breaker.

The dashpot push rod is connected to the jack shaft by a crank linkage.

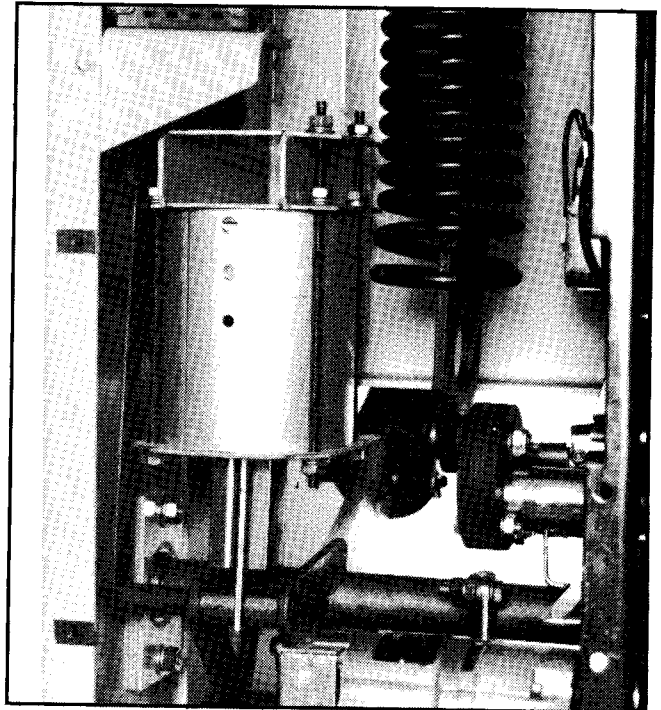


Figure 20. Dashpot Assembly.

Manual Spring Charging

Manual charging of the closing springs is accomplished using a lever in lieu of the spring charging motor. **Figure 21** shows the principal components of the manual spring charging mechanism.

The manual spring charging lever is inserted into a rectangular socket in the hand operator. This socket is accessible through the front panel of the circuit breaker. Moving the lever up and down in a cranking or pumping motion causes rotation of the internal spring charging components.

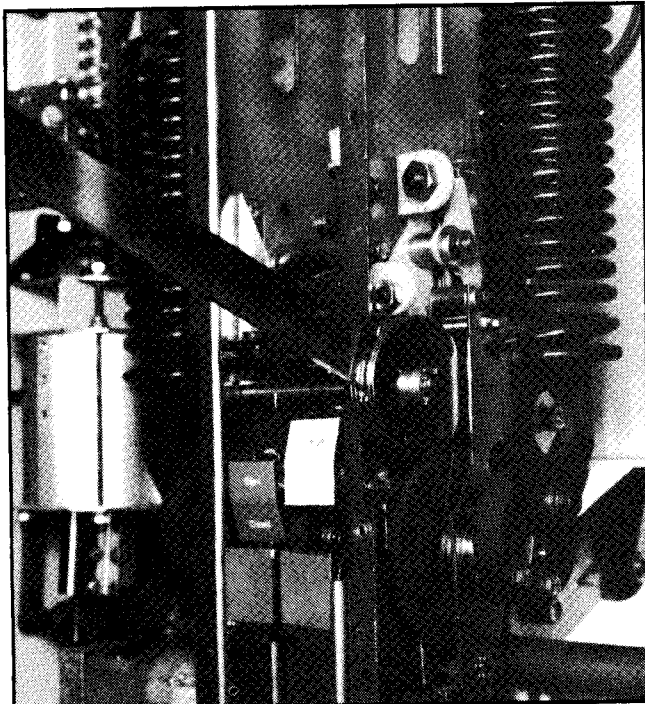
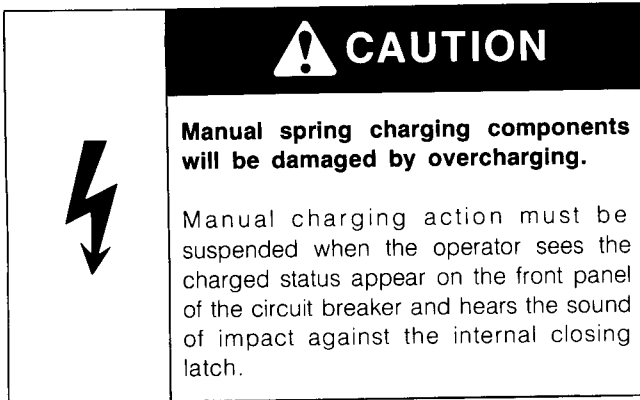


Figure 21. Manual Charging of the Closing Springs.

Spring Charging Motor

Figure 22 shows the spring charging motor mounted at the bottom of the left side of the circuit breaker housing. A mounting bracket holds the motor firmly in place. A universal motor is used to permit operation on either ac or dc control power.

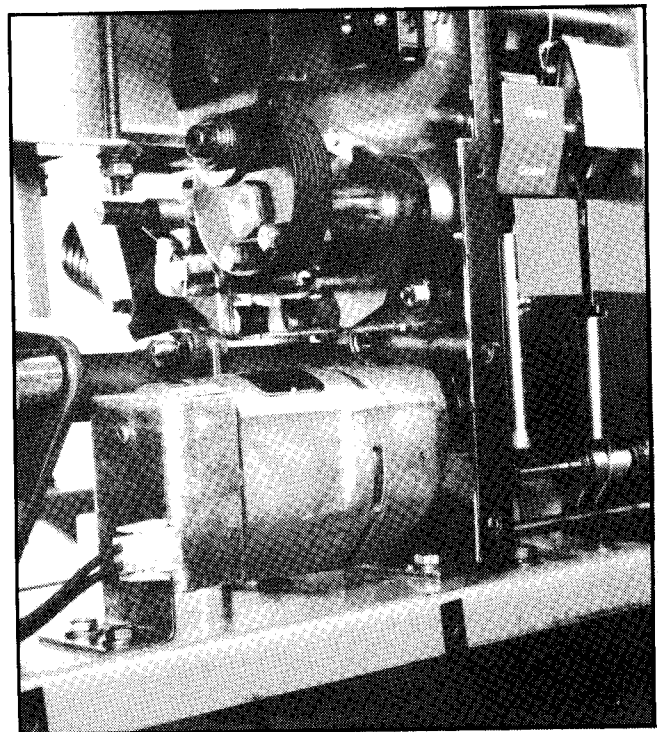


Figure 22. Spring Charging Motor.

The motor control circuits call for automatic charging of the springs by the motor whenever control power is available and the springs are discharged. The springs automatically recharge following a closing operation.

Electrical connections to the motor utilize quick disconnect terminations for easy inspections or removal.

Close Solenoid, Trip Solenoid and Anti-Pump Relay

Figure 23 shows the two solenoids controlling operation of the circuit breaker by external electrical signals.

When the close solenoid is energized it causes the two closing springs to be released from their extended or charged state. This forces the three insulating push rods to move the movable vacuum interrupter contacts vertically upwards, and close the circuit breaker.

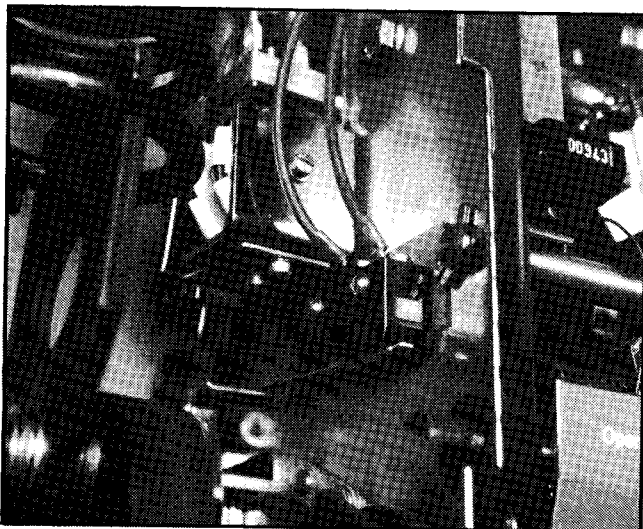
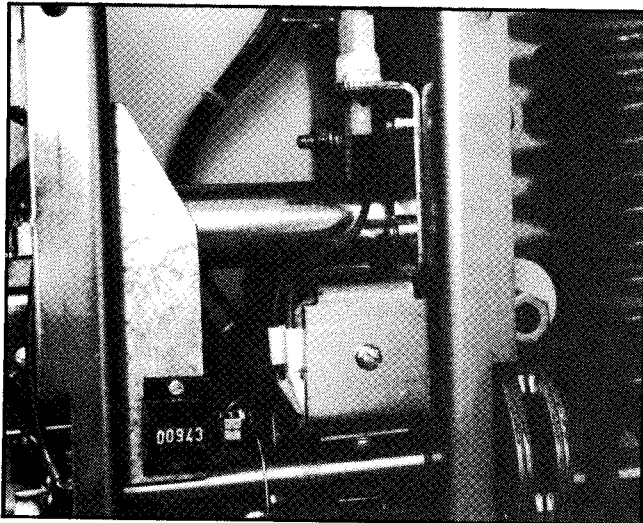


Figure 23. Close (Top) and Trip (Bottom) Solenoids.

The anti-pump relay (shown in **Figure 55**) electrically isolates signals to the close solenoid such that only one releasing action by the close solenoid can occur during each application of the close command. The circuit breaker must be tripped, the springs recharged and the closing signal removed (interrupted) before the close solenoid can be energized the second time.

When the trip solenoid is energized, it allows rotation of the jack shaft by the tripping spring. This rotation pulls the insulating push rods attached to the movable contacts of the three vacuum interrupters, and the circuit breaker contacts are opened.

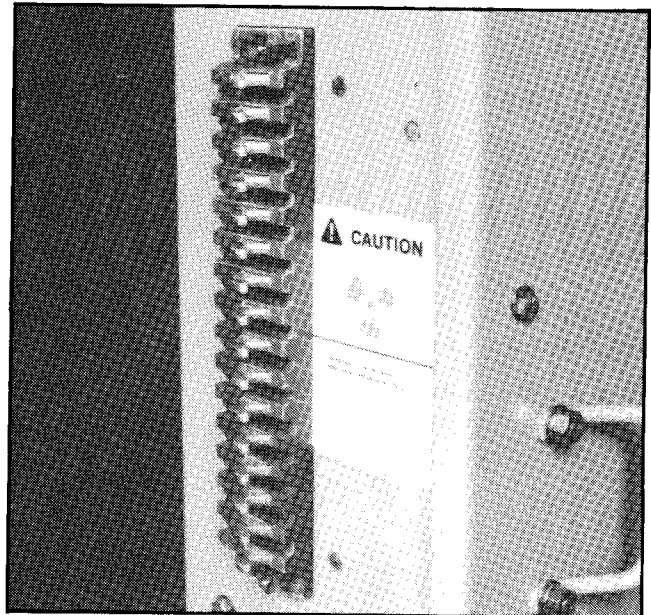


Figure 24. Secondary Disconnects.

Electrical connections to the close solenoid and trip solenoid are made through quick disconnect terminations.

Secondary Disconnect

Signal and control power is delivered to the internal circuits of the breaker by an arrangement of movable contact fingers mounted on the left side of the circuit breaker. These fingers are shown in **Figure 24**.

When the circuit breaker is racked into the Test or Connected positions in the Metal-Clad switchgear, these disconnect fingers engage a mating disconnect block on the inside of the switchgear shown in **Figure 25**. These electrical connections automatically disengage when the circuit breaker is racked from the Test to the Disconnect position.

All of the control power necessary to operate the circuit breaker is connected to this disconnect block inside the switchgear. The external trip and close circuits and status indicators are also connected to this same disconnect block.

Auxiliary Switch

Figure 26 shows the breaker mounted auxiliary switch. This switch provides auxiliary contacts for control of circuit breaker closing and tripping functions. Contacts are available for use in relaying and external logic circuits. This switch is driven by linkages connected to the jack shaft. The auxiliary switch contains both 'b' (Normally Closed) and 'a'

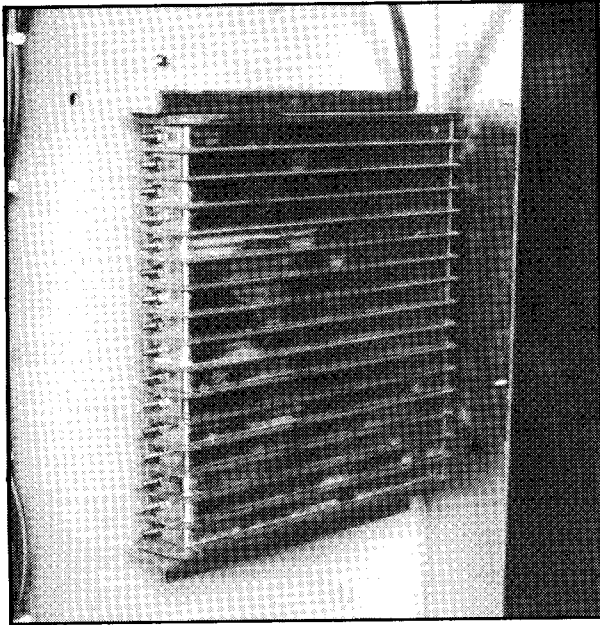


Figure 25. Mating Disconnect Block Inside Switchgear.

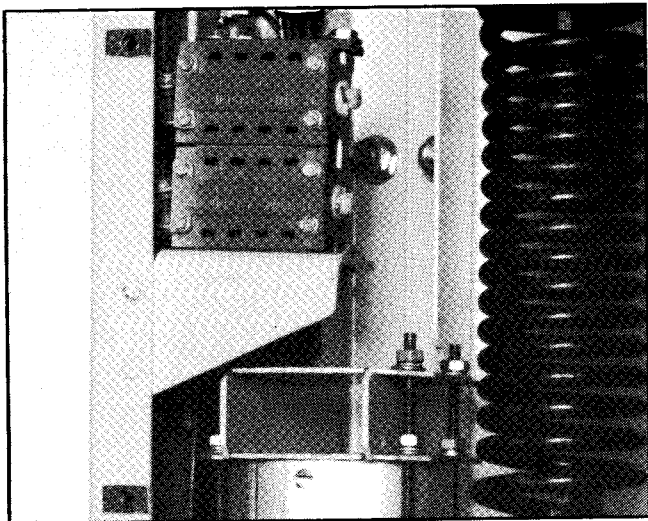


Figure 26. Auxiliary Switch.

(Normally Open) contacts. When the circuit breaker is open, the 'b' switches are closed and the 'a' switches are open.

MOC (Mechanism Operated Cell) Switch

Figures 27 and 28 show the principal components that provide optional control flexibility when operating the circuit breaker in the Test and Connected positions.

Figure 27 shows the MOC switch operating arm that projects from the right side of the circuit breaker, just above the bottom rail structure. The MOC switch operating arm is part of the jack shaft assembly, and directly reflects the open or closed position of the breaker primary contacts.

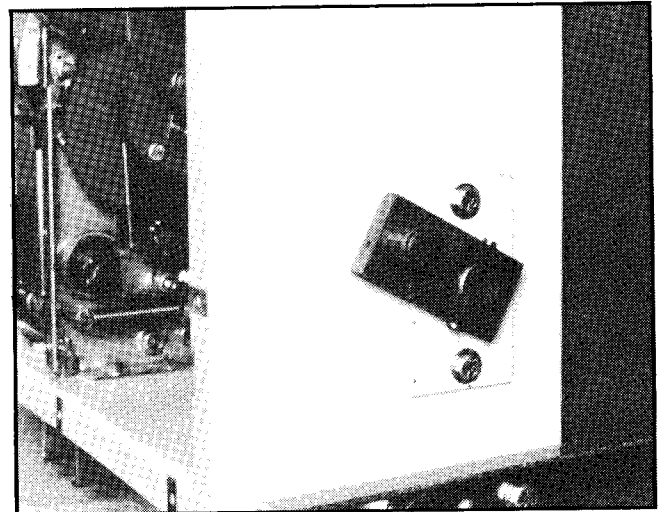


Figure 27. MOC Switch Operating Arm.

As the circuit breaker is racked into the appropriate position inside the switchgear, the operating arm passes a wiring protective cover plate, and engages the pantograph linkage shown in Figure 28. Operation of the circuit breaker causes the pantograph linkage to transfer motion to the MOC switches located above the pantograph. The 'a' and 'b' contacts can be used in relaying and control logic schemes.

All circuit breakers contain the MOC switch operating arm. However, MOC switches are provided in the switchgear only when specified.

The breaker engages the MOC auxiliary switch only in the connected (operating) position unless an optional test position pickup is specified in the contract. If a test position pickup is included, the breaker will engage the auxiliary switch in both positions. (Figure 28). Up to 24 stages may be provided.

TOC (Truck Operated Cell) Switch

Figure 29 shows the optional TOC cell switch. This switch is operated by the circuit breaker as it is racked into the Connect position.

Various combinations of 'a' and 'b' contacts may be optionally specified. These switches provide control and logic indication that a breaker in the cell has achieved the Connect (ready to operate) position.

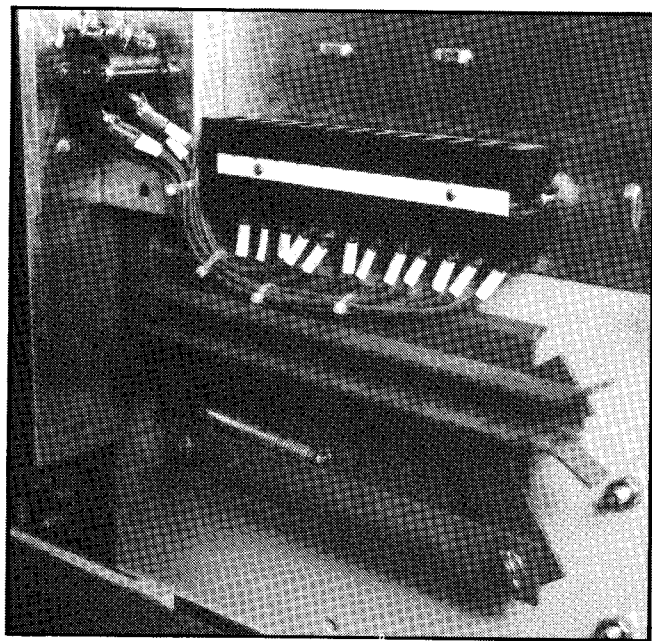


Figure 28. Mating Pantograph Linkage for MOC.

Limit Switches (Figure 30)

The motor cutoff switch (LS1) is used to sense the position of the driven mechanisms. This switch de-energizes the charging motor when the Charged position of the closing springs is reached. When the closing springs are discharged, this switch energizes the control circuit powering the spring charging motor.

Spring charged switch (LS2) operates simultaneously with motor cutoff switch (LS1). The spring charged switch allows the close solenoid to be energized only when the springs are charged, and also is part of the antipump circuitry.

The trip latch check switch (LS3) operates when the trip latch linkage is in the reset position.

The racking position switch (LS4) is driven by operating bars that sense when the breaker is in either the Test or Connected position inside the switchgear. Control circuitry prevents an electrical release of the closing springs unless the breaker is either in the Test or Connected position.

Standard Schematic and Wiring Diagrams

Inspection of the schematic diagram shown in **Figure 31** provides a clear picture of the logic states of the various devices for the three basic control functions.

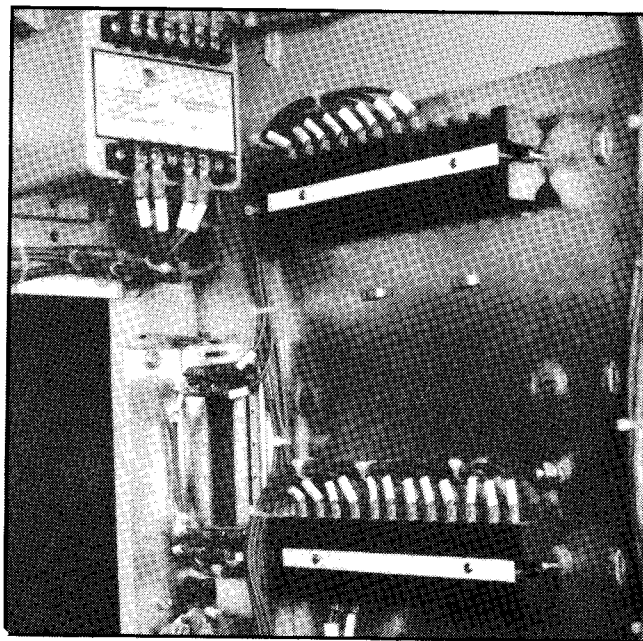


Figure 29. Optional TOC Switch.

These are: 1) automatic charging of the closing springs; 2) electrical closing of the primary contacts and 3) electrical tripping of the primary contacts.

Automatic spring charging by charging motor 88 occurs when secondary control power is available, and motor cutoff switch LS1 has not operated. The springs are automatically recharged after each closing operation.

Electrical closing occurs with closing control power applied and when *all* of the following conditions exist: 1) External control switch 01/C is closed; 2) Anti-pump relay 52Y is not energized; 3) Auxiliary switch 52b indicates the breaker is in open position; 4) Limit switch LS3 shows that the trip latch has been reset; 5) Limit switch LS2 indicates that the closing springs are charged; and 6) Limit switch LS4 indicates the breaker is in the Test position or the Connected position, or is out of the compartment. Electrical tripping occurs with tripping control power applied and when the auxiliary switch 52a shows the breaker is closed, and a trip signal is provided by the control switch 01/T or the protective relays. While external control power is required for either electrical closing or tripping; the circuit breaker can be manually charged, closed and tripped without external control power.

Figure 32 is a standard wiring diagram of the circuit breaker operating from dc control power. All of the device symbols are the same as shown in the schematic diagram.

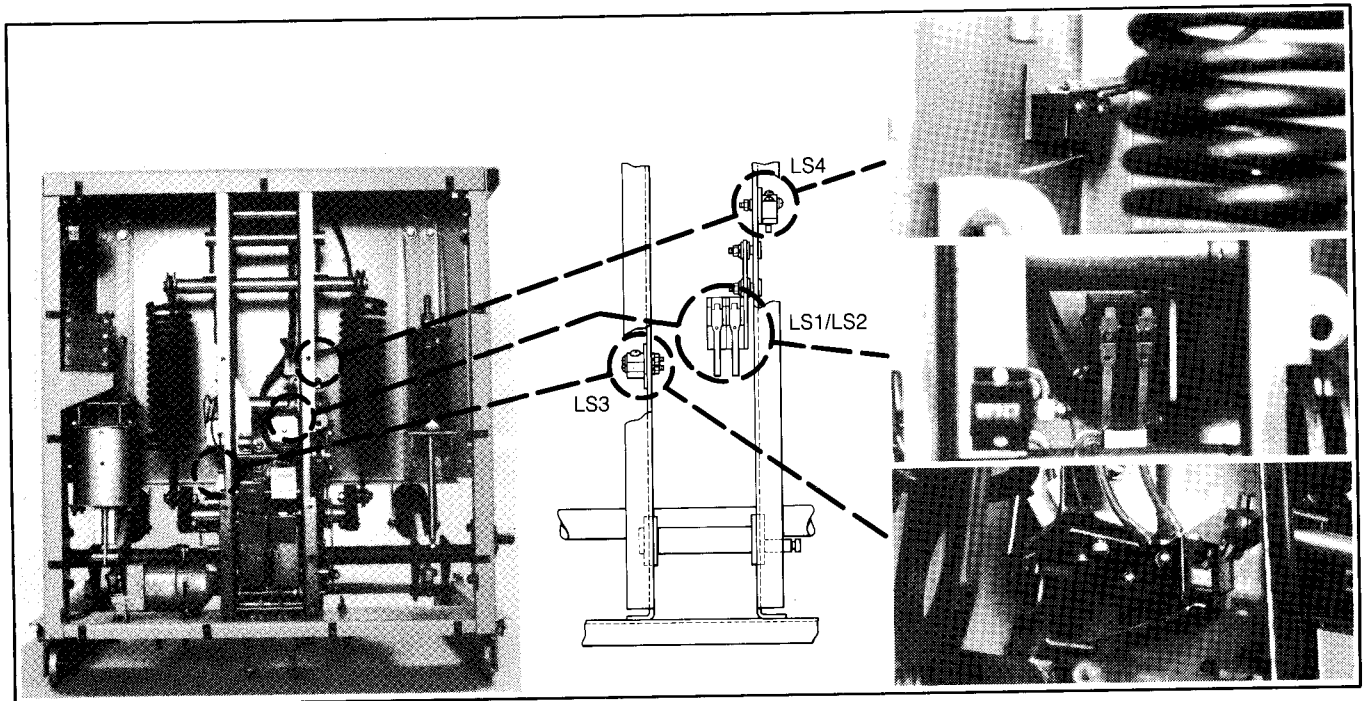


Figure 30. Circuit Breaker Limit Switches.

Interlocks

There are two interlocks which prevent certain unsafe operating conditions. They are the rating interlock and the trip-free interlock.

Trip Free Interlock

Figure 33 shows the devices providing the trip-free interlock function. The purpose of the trip-free interlock is to hold the circuit breaker operating mechanism mechanically and electrically trip free whenever the breaker is between the Test and Connected positions within the switchgear enclosure. This interlock ensures that the circuit breaker primary contacts can only be closed when in the Connect position, or the Test position, or out of the switchgear cell.

Rating Interlock

Figure 34 shows the rating interlock interference plates mounted on the circuit breaker frame. The breaker interference plates are complemented by matching plates located in the cubicle.

The interference plates (rating interlocks) test the breaker voltage, continuous current, interrupting, and momentary ratings and will not allow breaker insertion unless they match or exceed the cell rating.

Circuit Breaker Frame

The frame of the GMI circuit breaker contains several important devices and features deserving of special attention. These are the ground disconnect, the four racking wheels, and four handling wheels.

Ground Disconnect

Figure 35 shows the ground disconnect contact mounted at the bottom of the circuit breaker. The spring loaded fingers of the disconnect contact engage the ground bar, shown in **Figure 36**, at the bottom of the switchgear assembly. The ground bar is to the right of the racking mechanism, shown at the bottom center of the switchgear.

Circuit Breaker Handling Wheels

The GMI circuit breaker is designed for easy movement into and out of the Metal-Clad switchgear assembly. A section of indoor or Shelter-Clad switchgear does not require a transfer truck or lifting truck for handling of the breaker when all circuit breakers are located in the lower cells. Once the circuit breaker is racked out of the switchgear, the unit can be pulled using the handles shown in **Figure 37**. The breaker will roll on its bottom four wheels.

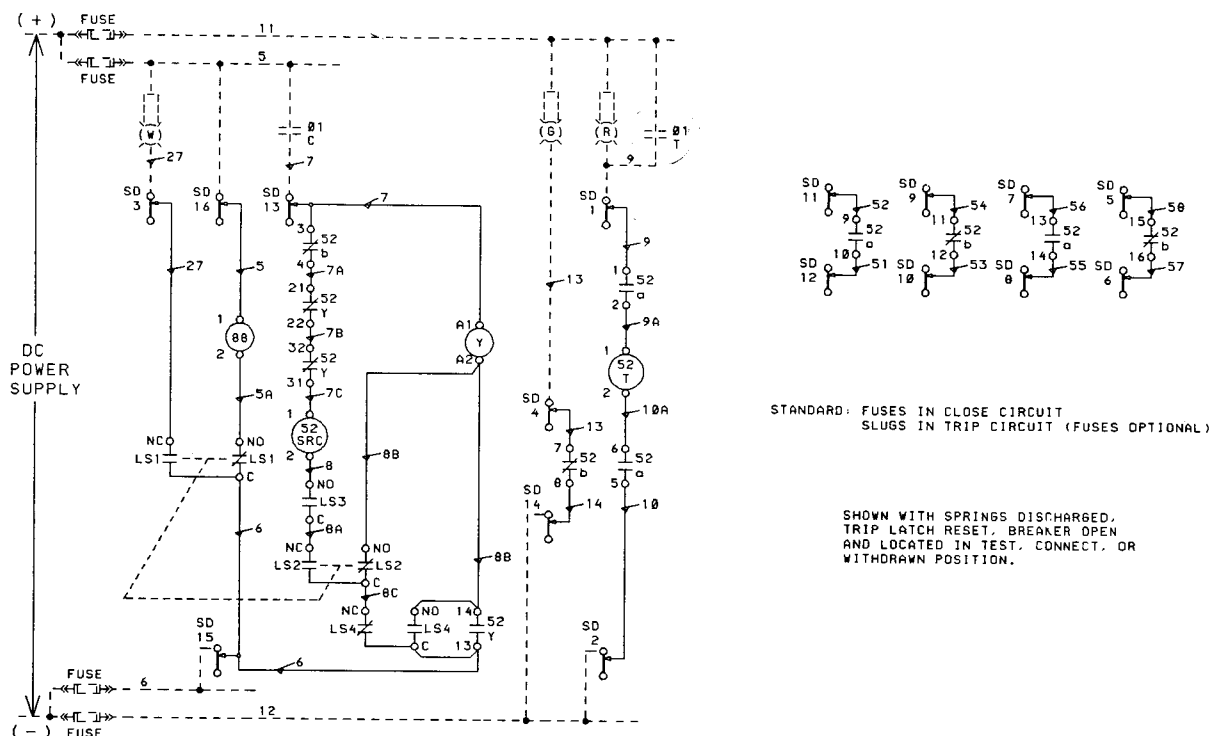
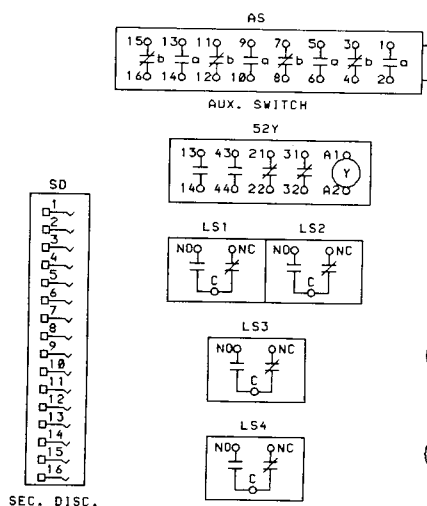


Figure 31. Schematic Diagram, Dc Control Power.

SYMBOLS

- LS1 — MOTOR CUTOFF SWITCH
 - LS2 — SPRING CHARGED SWITCH
 - LS3 — TRIP LATCH CHECK SWITCH
 - LS4 — RACKING POSITION SWITCH BLOCKS ELECTRIC
CLOSE WHILE RACKING "TEST" TO "CONNECT"
 - 52a — AUX. SWITCH, OPEN WHEN BRK IS OPEN
 - 52b — AUX. SWITCH, CLOSED WHEN BRK IS OPEN
 - 52Y — ANTI-PUMP RELAY
 - 52T — OPENING SOLENOID (TRIP)
 - 52SRC — SPRING RELEASE SOLENOID (CLOSE)
 - 88 — SPRING CHARGING MOTOR
 - SD — SECONDARY DISCONNECT
 - 01/C — CONTROL SWITCH CLOSE
 - 01/T — CONTROL SWITCH TRIP
 - R — RED INDICATING LAMP
 - G — GREEN INDICATING LAMP
 - W — WHITE INDICATING LAMP
- TYPICAL
REMOTE
DEVICES



WIRE CHART			
WIRE	TERMINALS		
5	SD16	88/1	LS4/C
5A	LS1/NO	88/2	
6	SD15	Y13	
6	SD15	LS1/C	
7	SD13	AS3	Y/A2
7	SD13	YA1	
7A	AS4	Y21	
7B	Y22	Y32	
7C	Y31	52SRC/1	
8	LS3/NO	52SRC/2	
8A	LS2/NC	LS3/C	
8B	LS4/NO	Y14	
8C	LS2/C	LS4/NC	
9	SD1	AS1	
9A	AS2	52T/1	
10	SD2	AS5	
10A	AS6	52T/2	
13	SD4	AS7	
14	SD14	AS8	
27	SD3	LS1/NC	
51	SD12	AS10	
52	SD11	AS9	
53	SD10	AS12	
54	SD9	AS11	
55	SD8	AS14	
56	SD7	AS13	
57	SD6	AS16	
58	SD5	AS15	

Figure 32. Wiring Diagram, Dc Control Power.

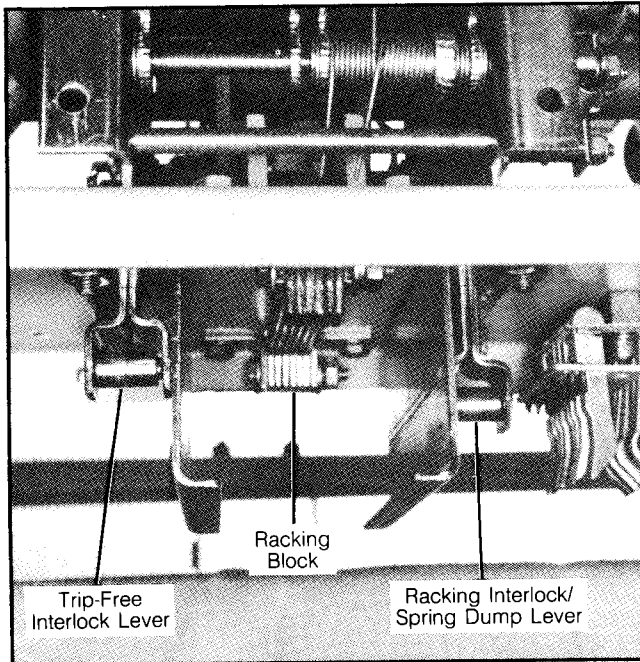


Figure 33. Typical Trip-Free Interlock.

On indoor and Shelter-Clad switchgear with circuit breakers located in the lower cell, the circuit breaker is easily rolled out of the switchgear by a single person. When circuit breakers are located in the upper cells, handling of the

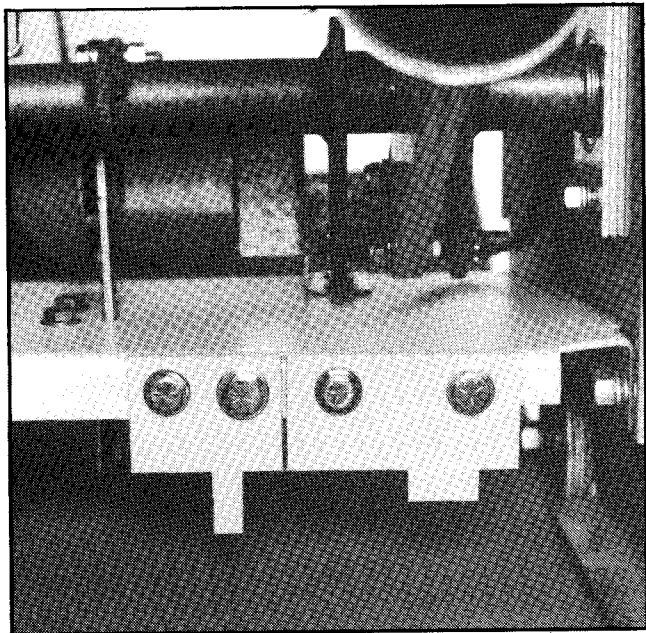


Figure 34. Rating Interlock Interference Plates.

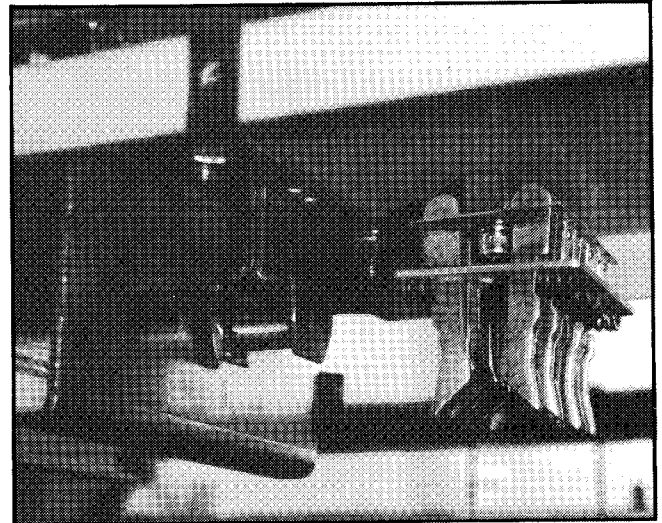


Figure 35. Ground Disconnect.

circuit breaker requires the use of a hoist or crane. These lifting devices are also required for removal of the lower circuit breaker of non walk-in type outdoor switchgear.

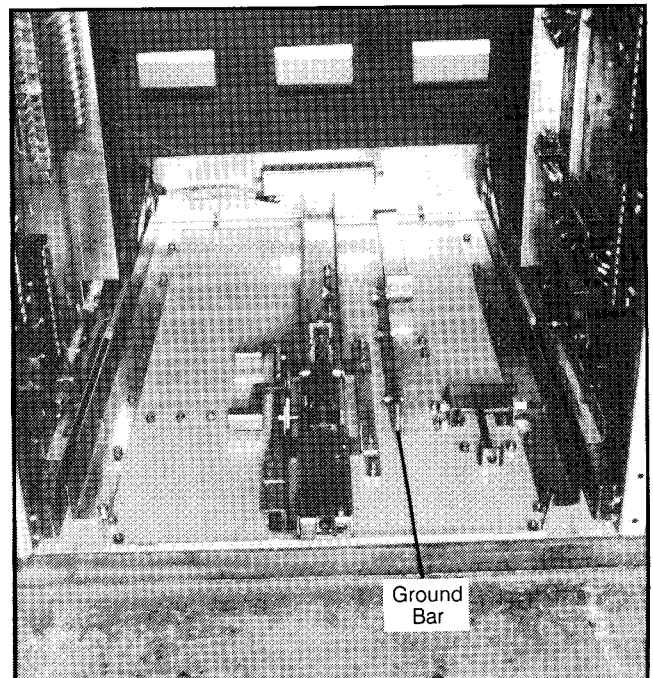


Figure 36. Ground Bar in Switchgear.

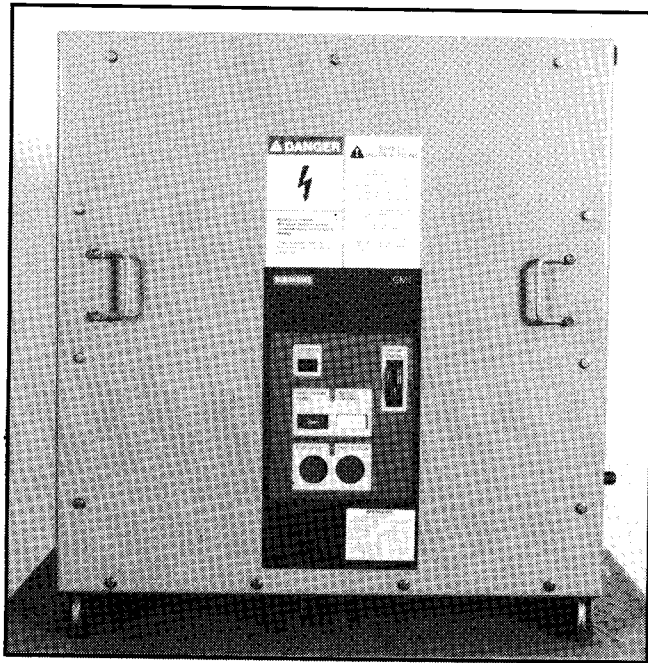


Figure 37. Front View of Breaker.

Racking Mechanism

Figure 38 shows the racking mechanism in the switchgear used to move the circuit breaker between the Disconnect, Test and Connected positions. This mechanism contains a set of interface blocks that mate with the bottom of the circuit breaker housing, and lock the breaker to the racking mechanism during in and out movement. A racking handle (not shown) mates with the threaded shaft of the racking mechanism. Clockwise rotation of the crank moves the breaker into the switchgear, and counterclockwise rotation removes it.

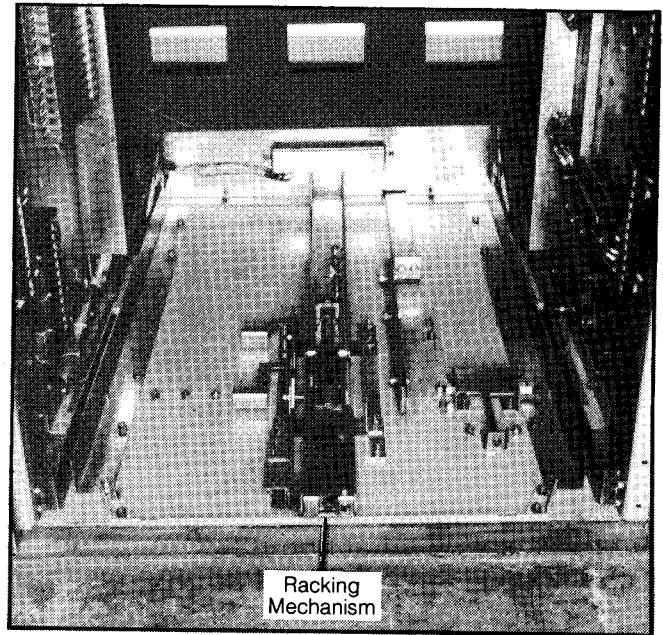


Figure 38. Racking Mechanism.

The racking and trip-free interlocks provide four essential functions.


1. They prevent racking a closed breaker into or out of the switchgear assembly.
2. They discharge the closing springs whenever the circuit breaker is inserted into, or withdrawn from, the switchgear.
3. They prevent insertion of a lower rated circuit breaker into a cubicle intended for a breaker of higher ratings.
4. They prevent closing of the circuit breaker unless it is in either the Test or Connect position.


Introduction

Periodic inspections and maintenance are essential to obtain safe and reliable operation of the GMI circuit breaker.

When the circuit breaker is infrequently operated (less than 20 times per week), and is located in a clean and dry indoor location, annual inspections are usually satisfactory. When the circuit breaker is operated more than 20 times per week, or when adverse environmental conditions exist, more frequent inspections may be necessary.

This part of the manual is designed to provide general guidance for maintenance. It will supplement, not replace individual maintenance programs based upon special experience and knowledge of specific installations and their actual operating conditions.



 **WARNING**

Hazardous voltages and high speed mechanical parts can cause death or severe personal injury and property damage.

Read instruction manual, observe safety instructions and limit use to qualified personnel.

Recommended Hand Tools

Type GMI breakers use both standard American and metric fasteners. Metric fasteners are used for the GMI vacuum interrupters. American fasteners are used in all other locations. This list of hand tools describes those normally used in disassembly and re-assembly procedures.

Metric (Vacuum Interrupter, Only)

- Deep Sockets: 18 and 24mm
- Torque Wrench, 0-150 Nm (0-100 lb-ft)

American (All Other Breaker Locations)

- Socket and Open-end Wrenches: 5/16, 3/8, 7/16, 1/2, 9/16, and 3/4 inch
- Hex Keys: 3/16 and 1/4 in
- Screw Drivers: 0.032 x 1/4 in wide and 0.55 x 7/16 in. wide

- Pliers
- Light Hammer
- Drift Pins: 1/8, 3/16 and 1/4 in. diameter

Recommended Annual Inspections

Periodic inspections occurring at annual, or more frequent, intervals should include all the tasks shown in **Table 1**. Recommended procedures for each of the listed tasks are provided in this section of the manual.

Table 1. Annual Inspection/Maintenance Tasks

- Checks of the Primary Power Path
- Checks of the Interrupter Operator Mechanism
- Electrical Control Checks
- High Potential Test
- Inspection and Cleaning of Breaker Insulation
- Functional Tests

For a "quick reference" to these tasks see "Annual Inspection Tasks" chart at the end of this section.

Removal from Switchgear

Prior to performing any inspection checks or tests, the circuit breaker must be removed from the switchgear. The Installation and Initial Functional Tests section describes the removal procedure in detail. Principal steps are repeated here for information and guidance, but without the details of the preceding section.

1. The first step in the annual inspection procedure is to de-energize the circuit breaker. **Figure 39** shows the outer door of a standard switchgear cubicle opened for access to the operator panel of the circuit breaker.

Figure 40 illustrates the location of the Trip control on the circuit breaker operator panel. Depressing the Trip pushbutton opens the breaker prior to removal from the switchgear.

2. The second step in the removal procedure is to de-energize control power to the circuit breaker. Open the control power disconnect device mounted above the lower breaker or below the upper breaker. Review **Figure 1**.
3. Rack the breaker to the Disconnect position.

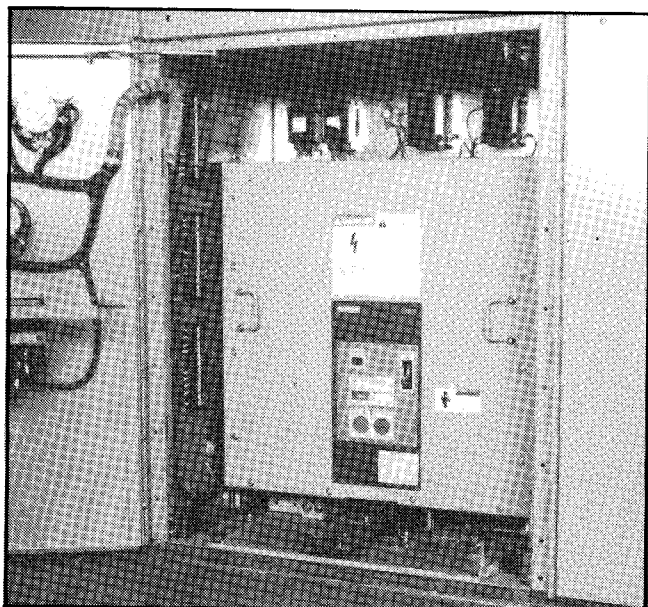


Figure 39. Outer Door of Switchgear Cubicle Open for Access to Breaker Controls.

4. Perform the spring discharge check. This is done by first depressing the red Trip pushbutton. Second, depress the green Close pushbutton. Third, depress the red Trip pushbutton again, and observe the spring condition indicator. It should read "Discharged."

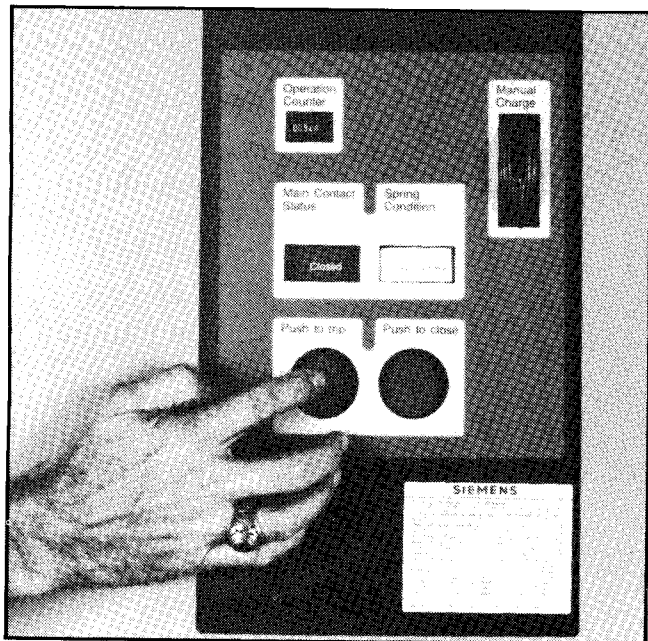


Figure 40. Tripping Breaker to be Inspected.

Figure 40 shows the breaker spring condition indicator in the Discharged position.

5. Remove the breaker from the switchgear. Refer to the preceding installation section of this manual for special instructions and precautions regarding removal of the upper breaker.
6. The breaker can be located either on the floor or an insulating pallet. Each breaker has four wheels and handles to allow one person to maneuver the unit on a level surface without assistance.

Checks of the Primary Power Path

The primary power path consists of the three vacuum interrupters, the three upper and the three lower primary disconnects. These components are checked for cleanliness and condition. The vacuum interrupters are also checked for vacuum integrity.

Some test engineers prefer to perform the contact erosion check during the manual spring charging check of the operator, since charging of the springs is necessary to place the contacts in the closed position.

Also, the vacuum integrity check is usually performed in conjunction with the High Potential tests.

These instructions follow the recommendation that these tests (contact erosion/manual spring charging check, and vacuum integrity/high potential tests) will be combined as described.

Cleanliness Check

Figure 41 is a side view of the GMI circuit breaker with one of the side insulating panels removed to show the vacuum interrupter, and the upper and lower primary disconnects.

All of these components must be cleaned and free of dirt or any foreign objects. Use a dry lint-free cloth.

Inspection of Primary Disconnects

Figures 42 and 43 show the primary disconnect contact fingers both in the engaged (**Figure 42**), and the disengaged positions (**Figure 43**). When the contacts are mated with the switchgear's primary stud assembly, there is forceful contact distributed over a wide area. This maintains low current flow per individual contact finger.

Inspect the contact fingers for any evidence of burning or pitting that would indicate weakness of the contact finger springs.

Inspect the primary disconnect arms for physical integrity and absence of mechanical damage.

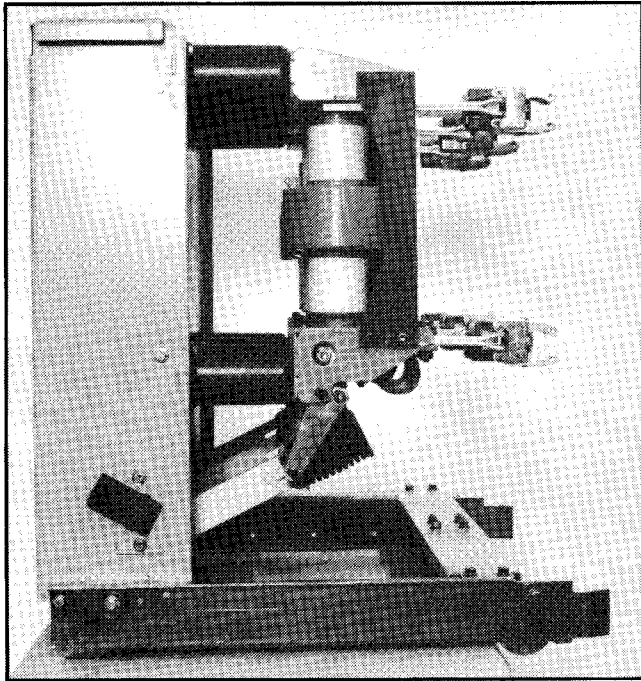


Figure 41. View of Breaker Showing Vacuum Interrupters and Primary Disconnects.

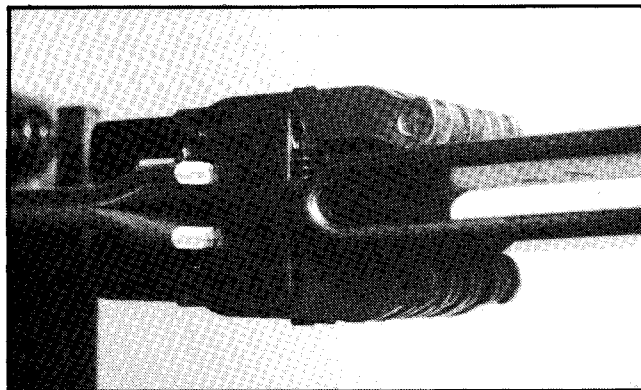


Figure 42. Primary Disconnect in Mated Position.

Inspect the flexible connectors that connect the bottom movable contacts of the vacuum interrupters to the lower

primary disconnect arms for tightness and absence of mechanical damage.

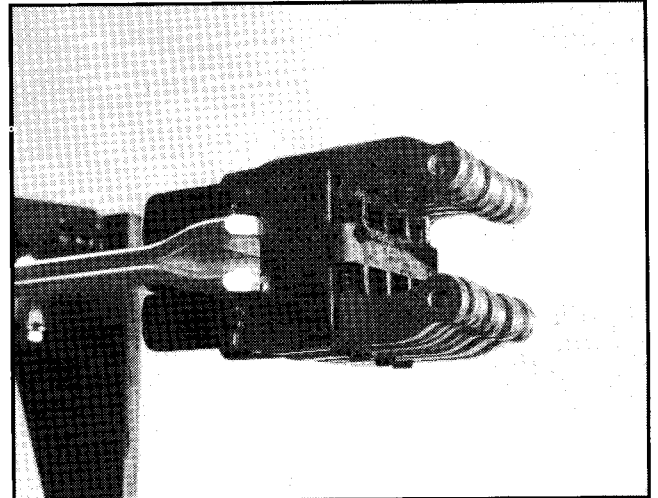


Figure 43. Primary Contact Fingers.

Checks of the Stored Energy Operator Mechanism

The stored energy operator checks are divided into mechanical and electrical checks for simplicity and better organization. This first series of checks determine if the basic mechanism is clean, lubricated and operates smoothly without control power. The contact erosion check of the vacuum interrupter is also performed during these tasks.

Cleaning and Lubrication

Table 2. Lubrication Schedule—ANSI C37.06 Table 8. Usual Service Conditions. Maintenance Based Upon Number of Breaker Closing Operations

Breaker Type	Number of Closing Operations
5-GMI-350 15-GMI-1000	1,000
All others	2,000

The interrupter operator mechanism is shown in **Figure 44** with the front cover and the operator control panel removed to show construction details. Both the tripping spring and the two closing springs are shown. The movable end of each closing spring is connected to a crank arm. The movable

end of tripping spring is connected to the jack shaft by a pull rod. The dashpot is connected to the jack shaft operating shaft by a pushrod linkage.

Clean the entire stored energy operator mechanism with a dry, lint-free cloth.

Check all components for evidence of excessive wear. Place special attention upon the closing spring cranks and the various pushrods and linkages.

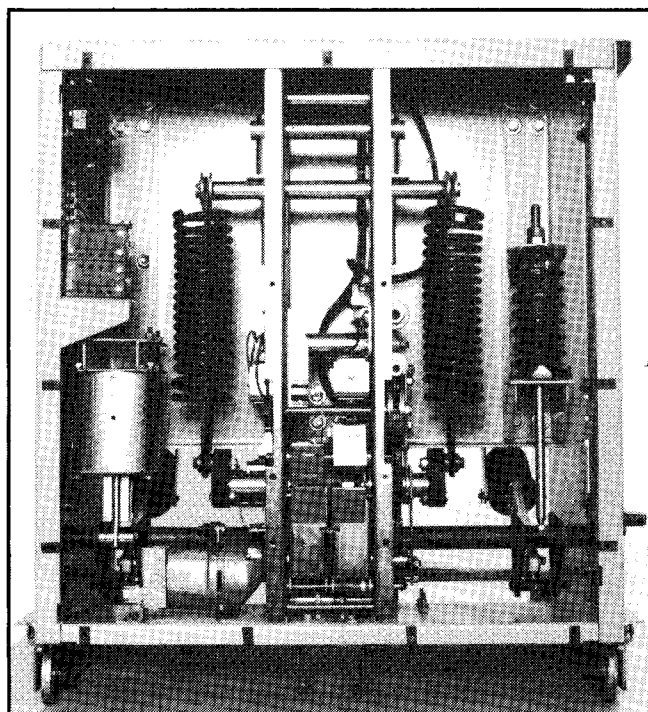


Figure 44. Front View of Operator Mechanism.

Lubricate all non-electrical moving or sliding surfaces with a light coat of machine oil containing a rust inhibitor.

Bearings and Sliding Surfaces

Use Beacon 325 or equivalent

Pivots and Articulated Joints

Use Tectyl 910 or SAE No.10 motor oil with rust inhibitors.

Do not lubricate the piston of the dashpot assembly.

Fastener Check

Inspect all fasteners for tightness. Both lock-nuts and retaining rings are used. Replace any fasteners that appear to have been frequently removed and replaced.

Manual Spring and Contact Erosion Checks

Perform the Manual Spring Check contained in the section describing the Installation Check and Initial Functional Tests. The key steps of this procedure are repeated here.

1. Insert the hand charging lever into the manual charge handle socket at the front of the operator control panel.

Figure 45 shows the lever inserted. Up and down motion of the lever charges the closing springs. Continue cranking until the Charged flag appears in the window of the spring indicator.

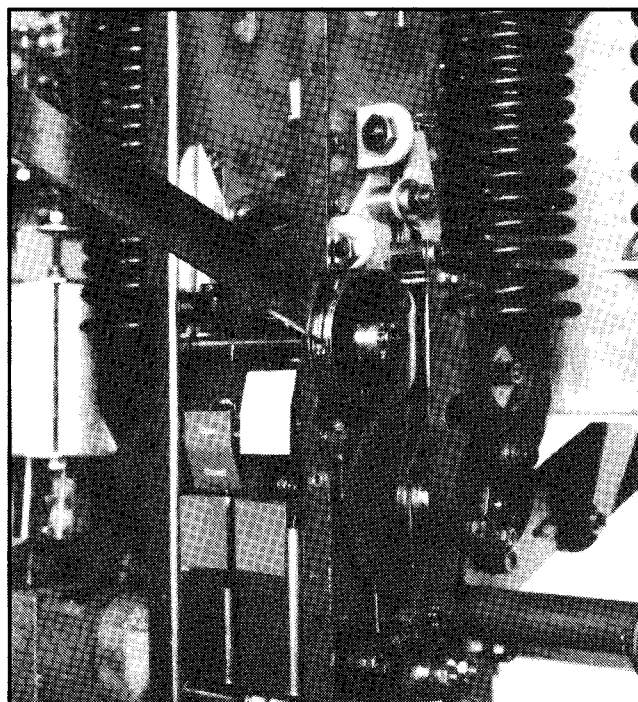


Figure 45. Manual Charging of Closing Springs.

2. Press the Close (green) pushbutton. The contact position indicator on the operator control panel should indicate that the breaker contacts are closed.
3. Perform the contact erosion check. Contact erosion occurs when high fault currents are interrupted or when the vacuum interrupter is nearing its contact life. Determina-

tion of acceptable contact condition is checked by the visibility of the erosion mark shown in **Figure 46**.

The contact erosion check procedure is:

- Be sure the breaker primary contacts are Closed.
- Observe the erosion mark (**Figure 46**) of each pole. When this mark is visible, contact wear is within acceptable limits.

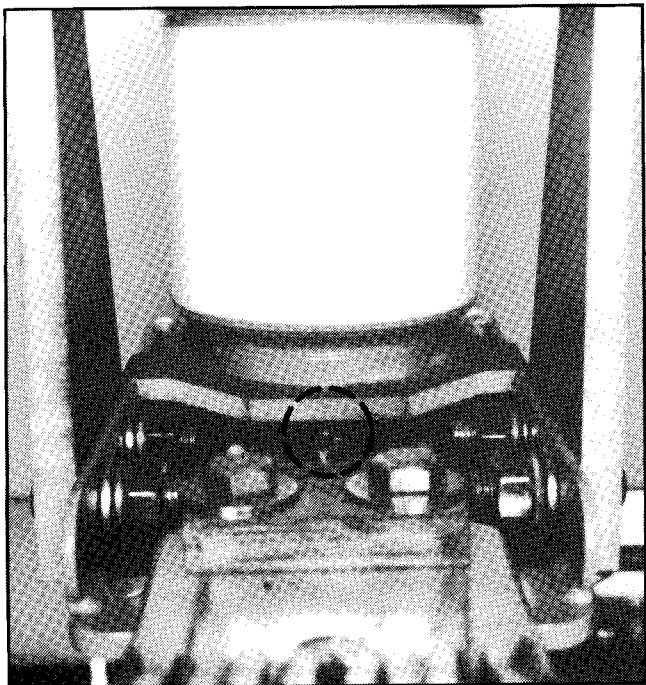




Figure 46. Contact Erosion Check Mark.

	 WARNING
	<p>The breaker tripping spring is charged.</p> <p>Observe precautions concerning physical contact with components of the breaker subjected to sudden, high speed movement.</p>

4. Press the red Trip pushbutton *after* completing the contact erosion check. Visually verify the Discharge condi-

tion of the closing springs and that the circuit breaker contacts are Open.

5. Press the green Close pushbutton. Nothing should happen. The manual spring check should demonstrate smooth operation of the operating mechanism.

Dashpot Assembly Check

GMI circuit breakers contain the pneumatic dashpot assembly shown in **Figure 47**. The internal piston of the dashpot is connected to the jack shaft by a push rod linkage.

While performing the manual spring check, a simple test of the dashpot is made by placing a cloth near the venting hole of the dashpot. If sharp, positive puffs of air exit from the venting hole when the breaker trips, the condition of the dashpot and its internal piston rings is acceptable.

Check the dashpot mechanical linkages for smooth operation at the same time.

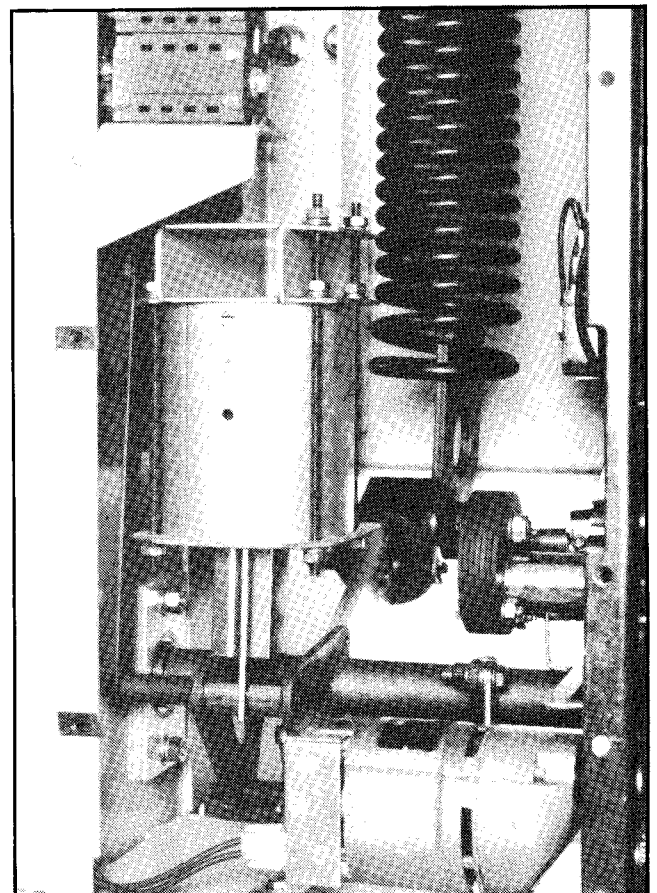


Figure 47. Dashpot Assembly.

Electrical Control Checks

The electrical controls of the GMI circuit breaker should be checked during annual inspections to verify absence of any mechanical damage, and proper operation of the automatic spring charging and Close and Trip circuits.

Unless otherwise noted, all of these tests are performed *without* any control power applied to the circuit breaker.

Check of the Wiring and Terminals

1. Physically check all of the breaker wiring for evidence of abrasion, cuts, burning or mechanical damage.
2. Check all terminals to be certain they are solidly attached to their respective device. **Figure 48** shows the terminals for the Close solenoid. The terminals of the trip solenoid and the spring charging motor are similar.

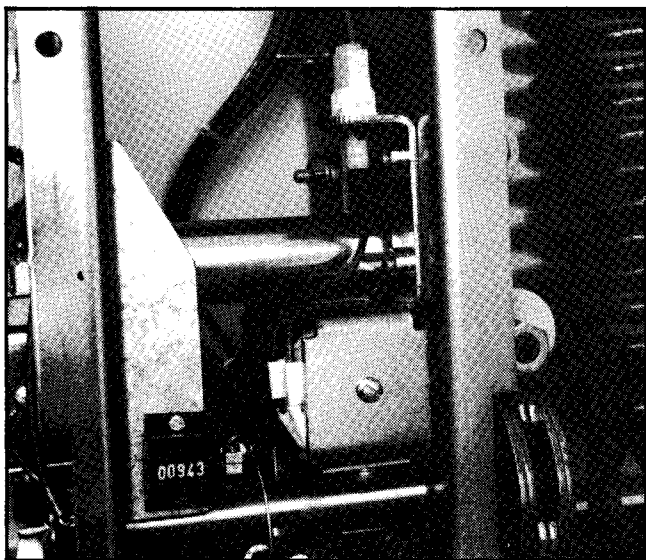


Figure 48. Terminals for Close Solenoid.

Check of the Secondary Disconnect

In addition to checking the terminals of the secondary disconnect, the contact fingers need to be free to move without binding.

Figure 49 shows the secondary disconnect fingers. Depress each finger, confirm presence of spring force (contact pressure), and verify freedom of motion.

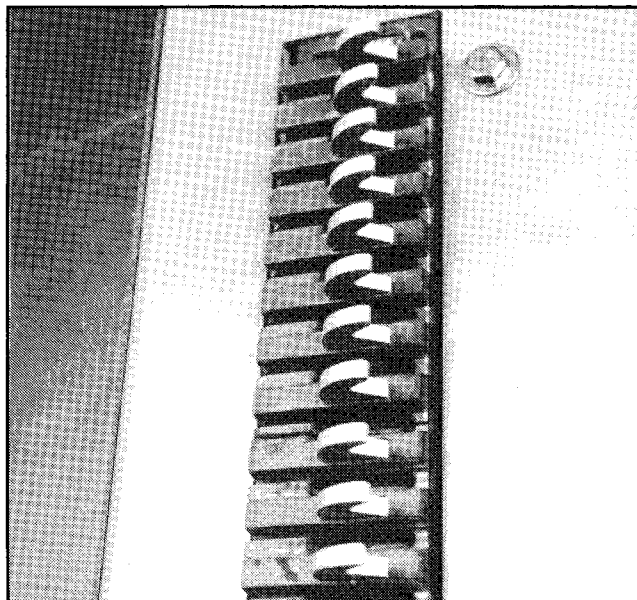


Figure 49. Secondary Disconnect Fingers.

Automatic Spring Charging Check— Control Power Required

Repeat the automatic spring charging check described in the section entitled Installation Checks & Initial Functional Tests.

Primary tasks of this check are:

1. The breaker is energized with control power for this check.
2. De-energize the source of control power. **Figure 1.**
3. Install the breaker end of the split plug jumper over the secondary disconnect of the circuit breaker. The split plug jumper has one male and one female connector and cannot be installed incorrectly. **Figure 7.**
4. Install the switchgear end of the plug jumper over the secondary disconnect block inside the switchgear. **Figure 8.**
5. Energize the control power source.
6. When control power is connected to the circuit breaker, the closing springs should automatically charge. Visually verify that the closing springs are charged.

NOTE

A temporary source of control power and test leads may be required if the control power source has not been connected to the switchgear. When control power is connected to the GMI circuit breaker, the closing springs should automatically charge.

Electrical Close and Trip Check—Control Power Required

A check of the breaker control circuits is performed while the unit is still connected to the switchgear by the plug jumper. This check is made with the breaker energized by control power from the switchgear.

1. Once the breaker springs are charged, move the switchgear Close/Trip switch to the Close position. There should be both the sound of the breaker closing and indication that the breaker contacts are closed by the main contact status indicator.
2. As soon as the breaker has tripped, the automatic spring charging process is repeated.
3. After a satisfactory close operation is verified, move the switchgear Close/Trip switch to the Trip position. Verify by both sound and contact position that the contacts are open. Completion of these checks demonstrates satis-

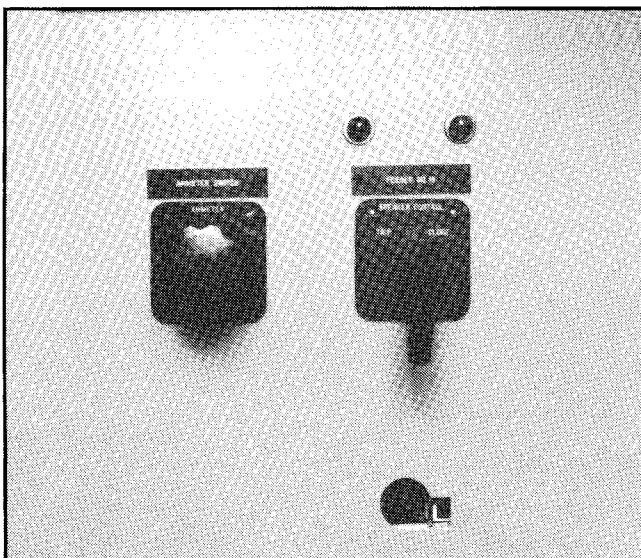


Figure 50. Close/Trip Control Switch of Standard Switchgear Assembly.

factory operation of auxiliary switches, internal relays and solenoids.

Checks of the Spring Charging Motor

No additional checks of the spring charging motor are necessary. Once every 10,000 operations, the motor brushes need replacement. Use the operation counter as the basis for establishing the operation frequency.

High-Potential Tests

The next series of tests involve use of high voltage test equipment. The breaker under test should be inside a suitable test barrier equipped with warning lights.

Electrical Vacuum Integrity Check

A high potential test is used to verify the vacuum integrity of the circuit breaker. This test is conducted on the circuit breaker with the its primary contacts in the Open position.




High Potential tests employ hazardous voltages which will cause severe personal injury and death.



Follow safe procedures, exclude unnecessary personnel and use safety barriers. Keep away from the breaker during application of test voltages. Disconnect the plug jumper from between the circuit breaker and switchgear before conducting high potential tests.

After test completion, ground both ends and the middle portion of the vacuum interrupter to dissipate any static charges.



CAUTION

Vacuum interrupters may emit X-ray radiation which can cause personal injury. X-rays can be produced when a high voltage is placed across two circuit elements in a vacuum.


Keep personnel more than six (6) feet away from a circuit breaker under test.

High Potential Test Voltages

The voltages for high potential tests are shown in **Table 3**.

Table 3. Hi Pot Test Voltages

Equipment kV Rating	Max Ac RMS	Max Dc Avg
4.76kV	14kV	20kV
8.25kV	27kV	38kV
15.0kV	27kV	38kV



CAUTION

Do not use Dc high potential testers incorporating half-wave rectification. These devices produce high peak voltages.

These high voltages will produce X-ray radiation. These devices also show erroneous readings of leakage current when testing vacuum circuit breakers.

Vacuum Integrity Test Procedure

1. Observe safety precautions listed in the danger and caution advisories. Construct the proper barrier and warning light system.
2. Ground each pole not under test.
3. Apply test voltage across each pole for one minute.
4. If the pole sustains the test voltage for that period, its vacuum integrity has been verified.

As-Found Insulation Tests

As-Found tests verify the integrity of the breaker insulation system. Megger or Doble tests conducted on equipment prior to installation provide a basis of future comparison to detect changes in the protection afforded by the insulation system. A permanent record of periodic As-Found tests enables the Maintenance organization to determine when corrective actions are required by watching for sudden deterioration in insulation resistance, or increases in contact resistance.

Test Equipment

In addition to the High Potential Test Equipment capable of test voltages as listed in **Table 3**, the following equipment is also required:

- Ac Hi-Pot tester with test voltage of 1125 volts, 60 Hz.
- Ductor for contact resistance tests.

As-Found Test Procedure

1. Observe safety precautions listed in the danger and caution advisories for the Vacuum Check tests.
2. Close the circuit breaker. Ground each pole not under test. Use manual charging, closing and tripping procedures
3. Apply the proper Ac (i.e., either 14 or 27 kV) or Dc (i.e., either 20 or 38 kV) high potential test voltage between a primary conductor of the pole and ground for one minute.
4. If no disruptive discharge occurs, the insulation system is satisfactory.
5. After test, ground both ends and the middle of each vacuum bottle to dissipate any static charge.
6. Disconnect the leads to the spring charging motor.
7. Connect all points of the secondary disconnect with a shorting wire. Connect the shorting wire to the high potential lead of the high voltage tester, and ground the breaker housing. Starting with zero volts, gradually increase the test voltage to 1125 volts, RMS, 60 Hz. Maintain test voltage for one minute.
8. If no disruptive discharge occurs, the secondary control insulation level is satisfactory.
9. Disconnect the shorting wire and re-attach the leads to the spring charging motor.

10. Perform contact resistance tests of the primary contacts using a ductor. Contact resistance should not exceed the values listed in **Table 4**.

Table 4. Maximum Contact Resistance

Current Rating (Amps)	Contact Resistance (Micro-Ohms)
1200	60
2000	40
3000	20

11. Make a permanent record of all tests performed.

Inspection and Cleaning of Breaker Insulation

1. Perform the Spring Discharge Check on the circuit breaker, *after* all control power is removed. The Spring Discharge Check consists of 1) depressing the red Trip pushbutton, 2) then depressing the green Close pushbutton, and 3) again depressing the red Trip pushbutton. All of these controls are on the breaker front panel. Visually verify the Discharge condition of the springs.
2. Remove any interphase and outer phase barriers as shown in **Figure 51**.
3. Clean barriers and post insulators using clean rags and one of the following cleaning solvents:
 - Soap and water
 - Either No.1 or No.2 denatured alcohol
 - White kerosene
 - Varsol No.2
 - VM & Naptha
 - Either isopropyl or isobutyl alcohol

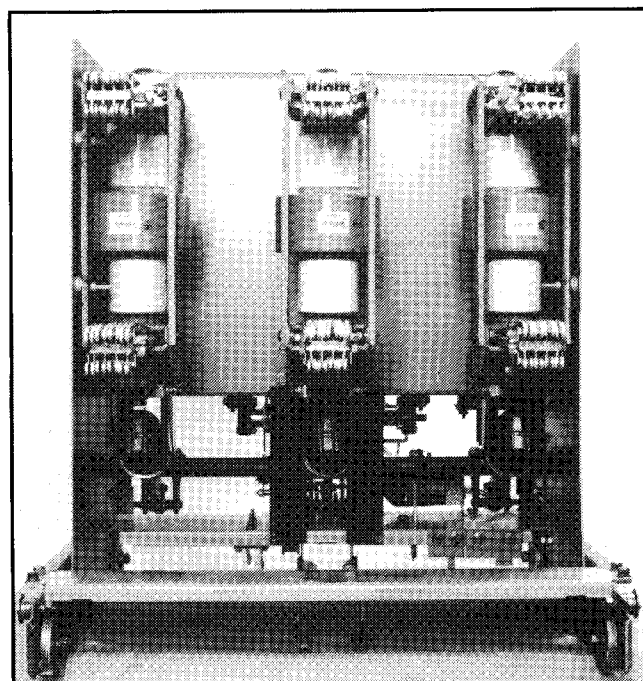



Figure 51. Rear View Showing Outer Phase Barriers.



⚠ CAUTION

Do not use any cleaning compounds containing chlorinated hydrocarbons such as trichlorethylene, perchlorethylene or carbon tetrachloride. These compounds will damage the phenylene ether copolymer material used in the barriers and other insulation on the circuit breaker.

4. Replace all barriers. Check all visible fasteners again for condition and tightness.


Functional Tests

Refer to the Installation Checklist in the Installation Checks & Initial Functional Tests section of this manual. Functional tests consist of performing at least three (3) Manual Spring Checks and three (3) Automatic Spring Charging Checks. After these tests are complete, and the springs fully dis-

charged, all fasteners and connections are checked again for tightness and condition before re-installing the breaker into the metal-clad switchgear.

Overhaul and Component Replacement

For following procedures along with the troubleshooting charts at the end of this section, provide maintenance personnel with a guide to identifying and correcting possible malfunctions of the GMI vacuum circuit breaker.



WARNING

All replacement of breaker components must be performed with the breaker completely de-energized, the springs discharged.

Circuit Breaker Overhaul

Table 5 lists the recommended overhaul schedule for GMI circuit breakers operating under ANSI usual conditions. When actual operating conditions are more severe, overhaul periods should occur more frequently. The counter on the front panel of the circuit breaker records the number of operations.

Table 5. Overhaul Schedule ANSI Usual Conditions. Maintenance Based Upon Number of Closing Operations.

Type Breaker	Number of Close Operations
5-GMI-350 15-GMI-1000	5,000
All others	10,000

Replacement at Overhaul

The following components are replaced during an overhaul of the circuit breaker, when required:

Vacuum interrupters as determined by contact erosion, or after 30,000 operations.

Spring charging motor brushes should be replaced after 10,000 operations.

Replacement of Closing Springs

Figure 52 shows the use of a 3/4 inch socket wrench to relieve spring tension on the closing springs. The top cover of the breaker has openings providing access to the tensioning bolts. Turning the left and right hand support bolts counterclockwise relieves spring tension. Once tension has been relieved, retaining ring pliers are needed to remove the top and bottom retaining rings attaching each spring to its cross-arm support shaft and its crank arm.

When one or both springs are reinstalled, be sure the support bolts are inserted inside their support bolt bushings. These bushings maintain the correct tension on the closing springs. Replace all retaining rings during the re-assembly. Re-tighten by turning the support bolts clockwise until the support bolt bushings firmly butt up against the support bolt attachment bracket and the cross arm support shaft.

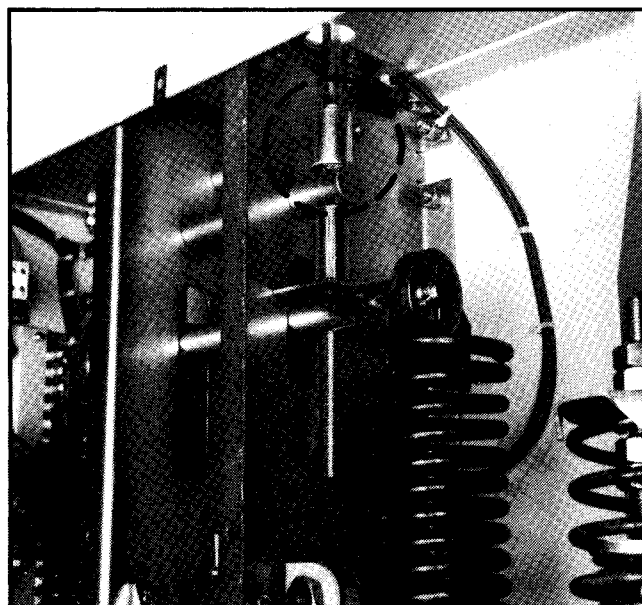


Figure 52. Use of Socket Wrench to Release Tension on Closing Springs.

Replacement of Opening Spring

The opening spring and "nested" kickoff spring (when used) may be removed without a spring keeper or compression aid. The opening spring pull rod has been provided sufficient thread length to allow the "jammed" nuts at the top of the assembly to be loosened and backed off to relieve opening spring precompression.

When used, the kickoff spring is installed with no precompression and may be dismantled by removing the jam nuts

and spring cap which become available after the opening spring is removed.

The opening spring pull rod is disassembled by unthreading the rod from the jackshaft pivot.

Reassembly requires the parts be assembled in reverse order.

If used, the kickoff spring is not to be assembled with precompression. Apply jam nuts and spring cap to bear firmly on the kickoff spring and jam the retaining nuts by opposite rotation.

The opening spring must be precompressed upon assembly by advancing the retaining nuts until the proper spring length is obtained. Jam the retaining nuts by opposite rotation.

Two different opening springs are used, depending on the circuit breaker ratings. One spring has a free length of 12 inches, and when installed should be compressed to 9.0 inches. The other has a free length of 7.5 inches, and when installed should be compressed to 6.88 inches.

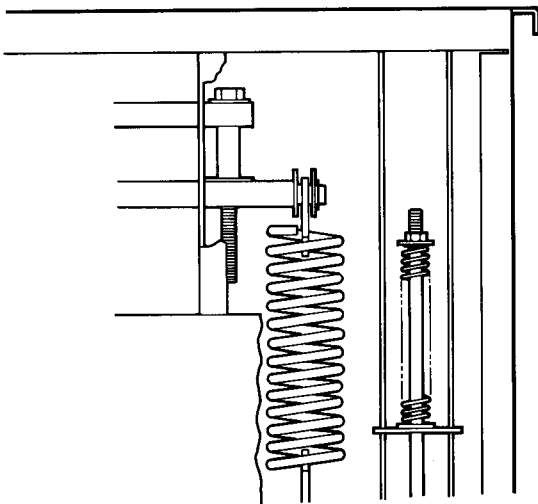


Figure 53. Removal of Opening Spring.

Replacement of Closing and Tripping Solenoids (Devices 52SRC and 52T)

Replacement of either the closing or tripping solenoids is straightforward. Each solenoid has two mounting screws and one quick disconnect terminal. Removing the mounting bolts and quick disconnect terminal of the solenoid permits it to be slid out and removed. Replacement requires careful insertion of the solenoid and re-attachment of the mounting bolts and quick disconnect. **Figure 54** shows the two

screws which attach the close coil and the quick disconnect terminal for control leads. The trip coil arrangement is similar.

Replacement of Anti-Pump Relay (Device 52Y)

Figure 55 helps illustrate the anti-pump relay removal procedure. The two nuts holding the relay and its mounting bracket are removed. The wires connected to the relay

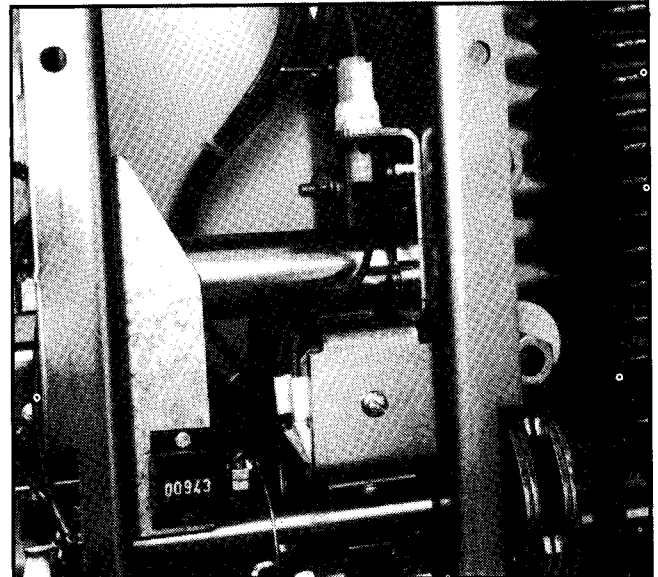


Figure 54. Replacement of Closing Solenoid.

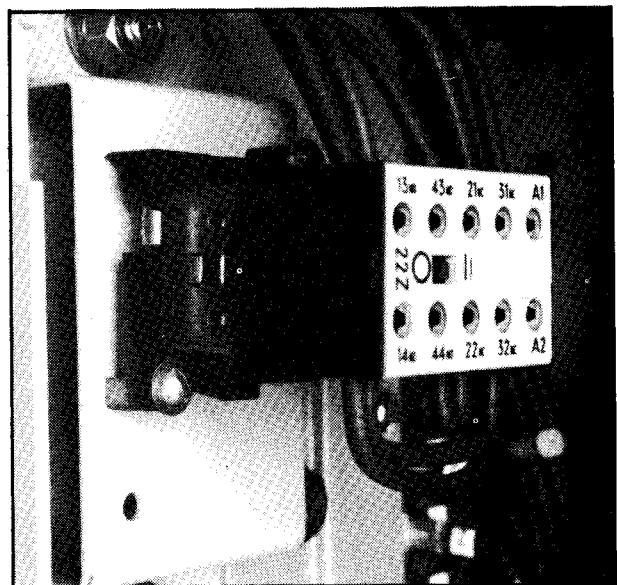


Figure 55. Replacement of Anti-Pump Relay.

should be tagged and disconnected, the relay and bracket can then be extracted and replaced.

Replacement of the Auxiliary Switch

Figure 56 shows the auxiliary switch and its key mounting components. Two mounting screws hold the switch to the mounting bracket. First remove the quick-disconnect terminals after marking their position. The screw, washers and nut connecting the switch's operating lever to the operating shaft is removed, and then the two mounting screws.

Re-assemble in reverse order.

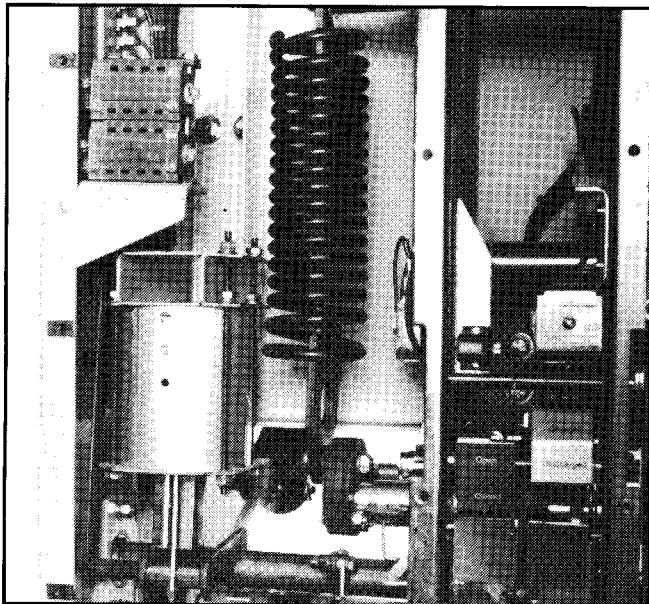


Figure 56. Replacement of Auxiliary Switch.

Replacement of Motor Cut-Off Switch (Device LS1) and Spring Charged Switch (LS2)

The motor cut-off switch (LS1) and spring charged switch (LS2) form a common assembly of two switches on one mounting bracket. Should either switch require replacement, it is recommended that both be replaced as a single assembly. The motor cut-off switch (LS1) is the "outboard" device with respect to the mounting bracket. Removal of the two mounting screws shown in **Figure 57** allows both switches to be brought out for convenient removal of the interconnecting wiring.

Next, mark all wires to both switches. Remove the wires. Then replace the switches, rewire, and reassemble the switches to their mounting bracket. Be sure to use the same

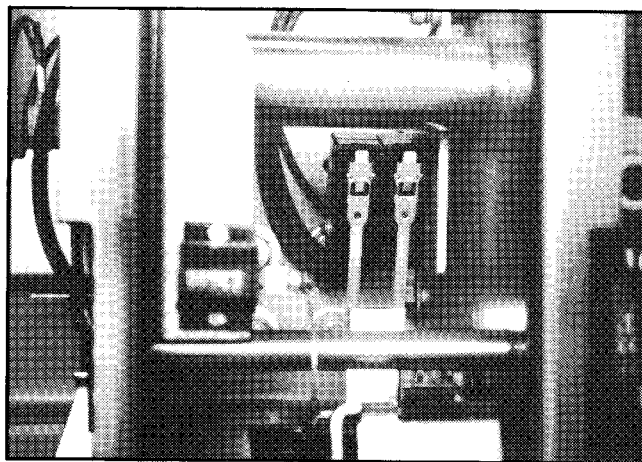


Figure 57. Motor Cutoff Switch (LS1) and Spring Charged Reset Switch (LS2).

flat washer, lock washer and nut configuration in reassembly as was present in the as-shipped condition.

Replacement of Trip Latch Reset Check Switch (Device LS3)

The trip latch reset check switch is mounted to the left (when facing the front of the breaker) vertical mechanism side sheet as shown in **Figure 58**. The switch is held in place by two screws. When replacement of the trip latch reset check switch is required, both screws need to be removed.

Next, mark both wires to the switch, and remove them. Then replace the switch, rewire and reassemble the switch to the left hand mechanism side sheet. Be sure to use the same washer and nut configuration as was present in the as-shipped condition.

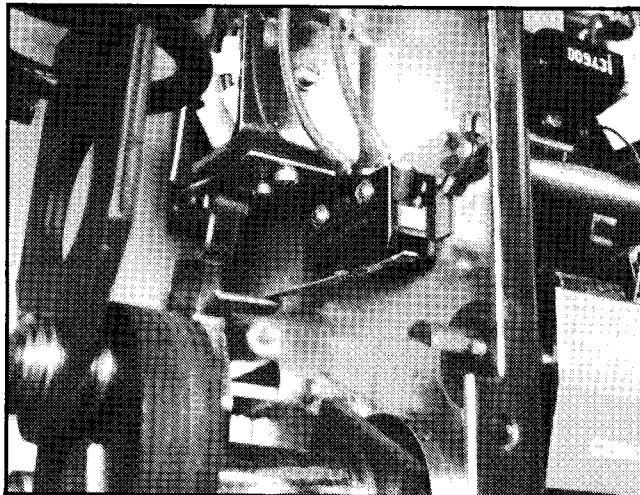


Figure 58. Trip Latch Reset Switch (LS3).

Replacement of Racking Position Switch (Device LS4) (Figure 59)

The racking position switch is mounted on the right (when facing the front of the breaker) vertical mechanism side sheet. The switch is actuated by a push rod, whose vertical position is a function of breaker racking position within its cell. Should difficulty be suspected with the racking position switch, be sure to eliminate all mechanical reasons for difficulty before replacing the switch.

The switch is held in place by two mounting screws. Remove the two screws. Mark the wires, and remove them. Next, replace the switch. Be sure to use the same configuration of flat washers, lock washers and nuts as was present in the as-shipped condition.

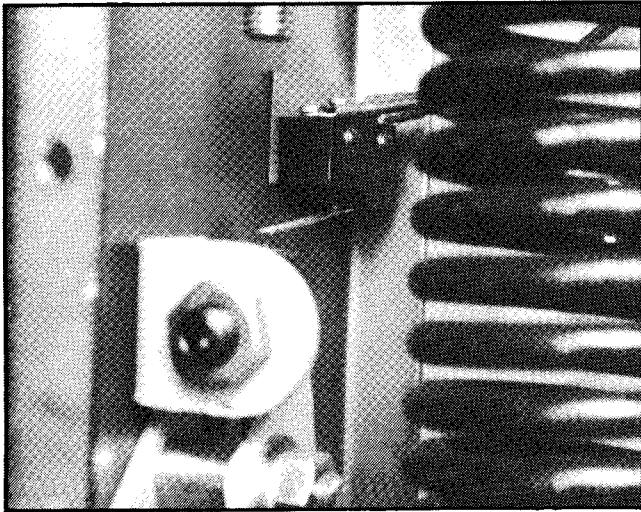


Figure 59. Racking Position Switch (LS4).

Replacement of Dashpot Assembly

The principal wear points of the dashpot assembly are the two piston rings, and the mating area between the push rod and crank shaft. **Figures 60** and **61** show the components involved in removal and replacement of this assembly.

First, remove the left and center retaining rings from pin 121. Next, push pin 121 to the right to free the pin from the dashpot linkage. Next, remove the four nuts holding the dashpot assembly to the mounting bracket.

Check the condition of the Teflon piston rings and replace as required.

Replacement of Spring Charging Motor (Device 88)

Remove the quick-disconnect terminals. Then remove the screws holding the motor mounting bracket to the breaker housing. The motor slips out as a complete assembly. Check and replace as required.

Replacement of Primary Disconnect Fingers

Figure 63 shows removal of the bolt which attaches the primary disconnect finger assembly to the primary disconnect. With this bolt removed, the finger assembly can be slid off the retaining arm as a unit. Replace burnt fingers or broken springs as necessary.

Replacement of Vacuum Interrupters

The following procedures are for the removal and replacement of the vacuum interrupters.

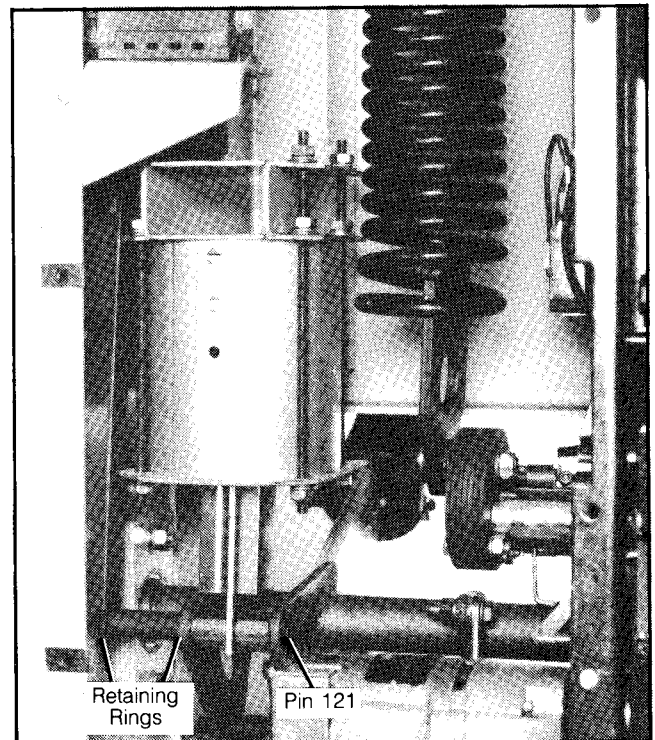


Figure 60. Dashpot Assembly.

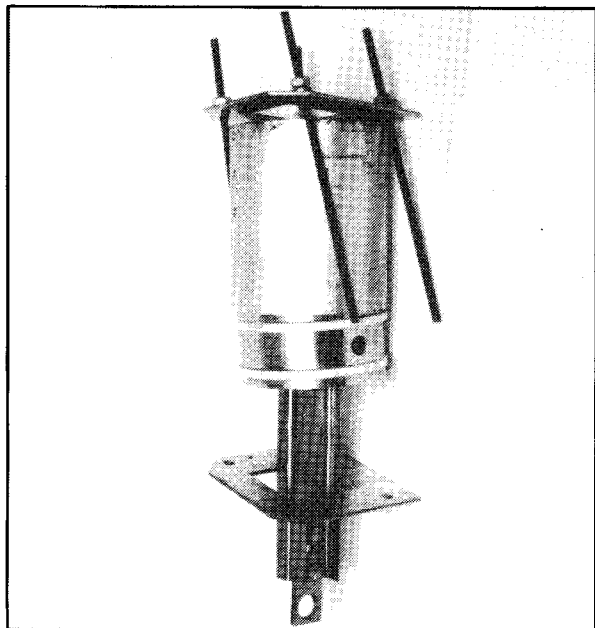


Figure 61. Piston Rings and Dashpot Piston.

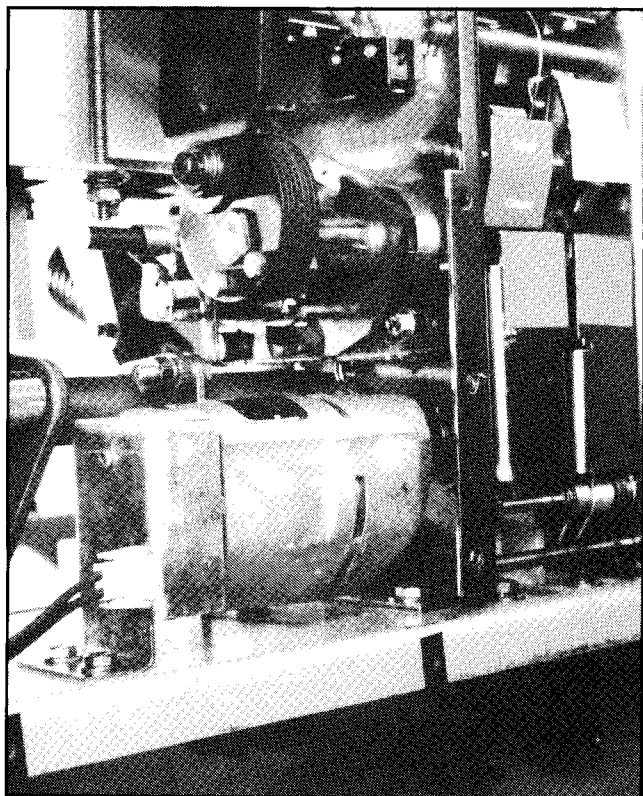


Figure 62. Replacement of Spring Charging Motor.

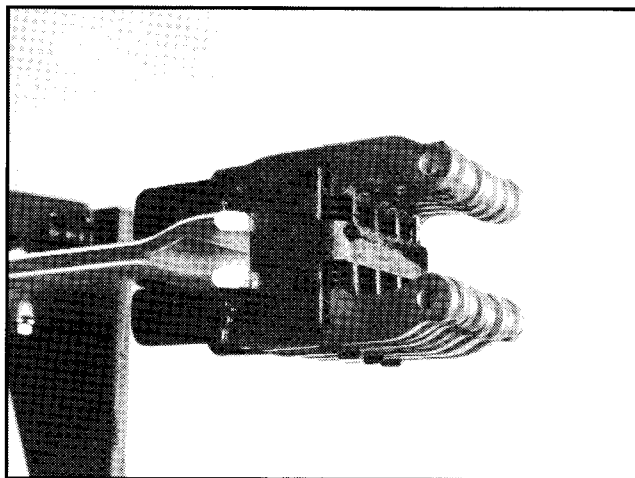


Figure 63. Replacement of Primary Disconnect Finger.

CAUTION



Special care needs to be exercised in removal of hardware around the bottom, or movable contact end, of the vacuum interrupter. The movable contact uses a metal bellows assembly to maintain the vacuum seal while still permitting up and down motion of the contact. This bellows assembly is rugged and reliable, and is designed to withstand years of vertical movement. However, caution should be exercised in subjecting the bellows to excessive torque during removal and replacement. Twisting the bellows through careless bolt removal or tightening may damage the vacuum interrupter.

Vacuum Interrupter Removal

Steps for removal of the vacuum interrupter are:

1. Remove the two "X-Clips" holding the bell crank to the push rod shown in **Figure 64**. These clips cannot be reused.
2. Spread the jaws of the bell crank and allow the push rod to drop down exposing the bottom connections to the movable contact.

3. Use two socket wrenches to hold both the head and nut end of the clamp that connects the flexible shunt to the movable contact. There are holes on both sides of the lower stab support to permit insertion of sockets that will prevent twisting of the movable contact bellows when removing the movable contact bolt.
4. While holding both socket wrenches in place at the clamp, another person can remove the movable contact bolt by rotating the bolt head counterclockwise.

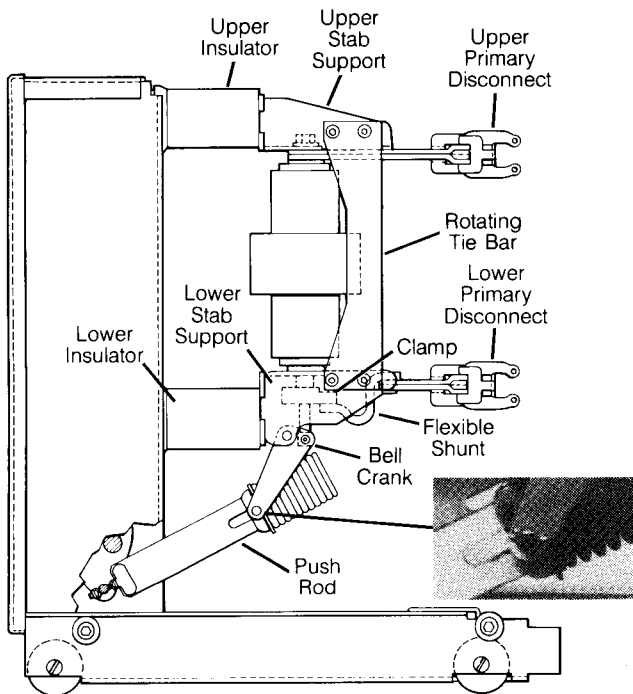


Figure 64. Removing X-Clips.

5. Using two wrenches (one holding, one torquing), loosen the nut holding the clamp (and flexible shunt) to the movable contact. Then remove the clamp, and the movable contact of the vacuum interrupter is now free.
6. **Figure 65** shows the mechanical connections to the fixed, or upper, contacts of the vacuum interrupter. Remove the bolt holding the upper stab support, the upper primary contact and the vacuum interrupter fixed contact together.
7. Remove the four bolts holding the upper end of the two insulating tie bars to the upper stab support.
8. Remove all of the bolts holding the upper stab support to the upper insulator. Have another person hold the vacuum interrupter and upper primary disconnect in place to prevent damage that might be caused by having these parts fall once they are no longer mechanically connected to the circuit breaker.
9. Remove the vacuum interrupter. Again, be sure to account for the location and sequence of each spacing and lock washer.

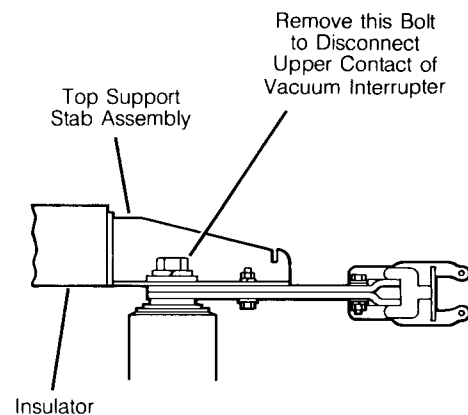


Figure 65. Disconnecting Top of Vacuum Interrupter.

	CAUTION
	<p>List the order and location of each flat and lock washer. It is critical that these spacing washers be replaced in their exact order upon reassembly to assure proper operation of the breaker.</p>

Vacuum Interrupter Replacement

1. Inspect all silver plated connection surfaces for cleanliness. Clean only with a soft cloth and solvent. Do not abrade any surface.
2. Insert the replacement vacuum interrupter into the lower stab support with the evacuation nipple shown in **Figure 66** facing the breaker mechanism housing.
3. Slip the flexible shunt clamp over the movable end of the interrupter. Replace clamp bolt, washers and nut. Finger tighten.
4. Position upper primary disconnect, upper stab support and all spacing washers over the fixed contact of the vacuum interrupter. Insert top bolt into fixed contact. Finger tighten.
5. Connect upper stab support to the upper insulator. Tighten all bolts holding the upper stab support to the upper insulator.

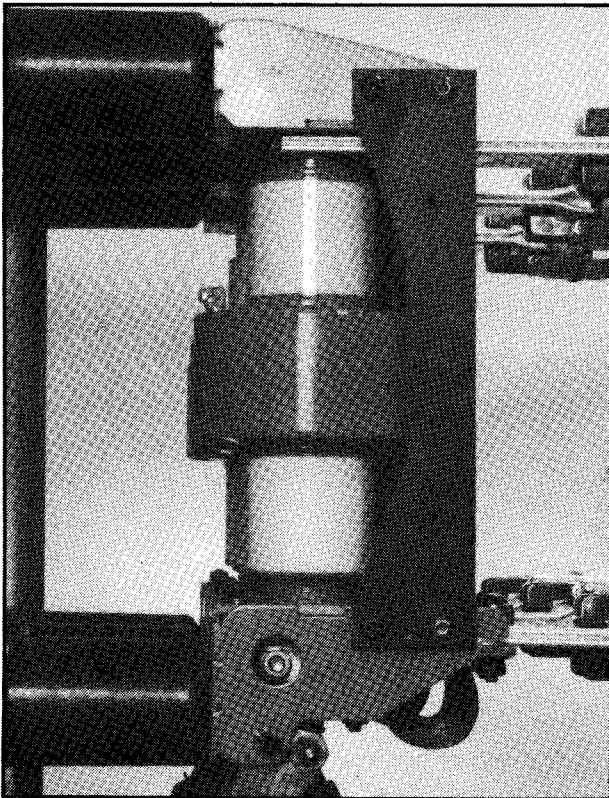


Figure 66. Inserting New Vacuum Interrupter.

6. Replace bolts and associated hardware connecting the two insulating tie bars to the upper stab support. Tighten.
7. Loosen the flexible shunt clamp bolt, be sure clamp is properly seated to the base of the interrupter's movable contact. Use two socket wrenches to tighten the clamp nut. Tighten the nut to produce a torque per **Table 6**. Use of holding and torquing wrenches will prevent twisting the movable contact bellows.
8. While maintaining use of the two wrenches at the flexible shunt, tighten the bottom bolt into the movable contact. Use the same torquing values listed in the preceding Step 7.
9. Tighten the top bolt holding the fixed contact and upper primary disconnect to the upper stab support. Use the torquing values listed for the top bolt in **Table 6**.
10. Replace the bell crank to jackshaft connection. Use new "X-Clips" to connect the jackshaft to the bell crank.
11. Perform a manual spring check. While the breaker primary contacts are Closed, check to be sure contact wear indicator is visible.

Table 6. Torque Limit Chart.

Breaker Type	Top Bolt	Flexible Shunt Clamp Bolt
05-GMI-250-1200-58 05-GMI-250-2000-58	30 ft.lb. \pm 4 ft.lb. (40Nm \pm 4Nm)	15 ft.lb. \pm 2 ft.lb. (20Nm \pm 2Nm)
All Others	60 ft.lb. \pm 8 ft.lb. (80Nm \pm 8Nm)	30 ft.lb. \pm 4 ft.lb. (40Nm \pm 4Nm)

Annual Inspection Tasks

Sub-Assembly	Item	Inspect For
Primary power path	Vacuum interrupter	<ol style="list-style-type: none"> 1. Cleanliness 2. Contact erosion Note: Perform with Manual Spring Checks 3. Vacuum integrity Note: Perform with High Potential Tests
	Primary disconnects Vacuum interrupter contact resistance	<ol style="list-style-type: none"> 1. Burnt or damaged fingers 1. Record contact resistance with contacts closed, and re-check each year to monitor condition.
Interrupter operator mechanism	Cleanliness	<ol style="list-style-type: none"> 1. Dirt or foreign material
	Fasteners	<ol style="list-style-type: none"> 1. Tightness of nuts and other locking devices
	Manual spring check	<ol style="list-style-type: none"> 1. Smooth operation of manual charging, and manual closing and tripping
Electrical controls	Lubrication	<ol style="list-style-type: none"> 1. Evidence of excessive wear 2. Lubrication of wear points
	Wiring	<ol style="list-style-type: none"> 1. Mechanical damage or abrasion
	Terminals and connectors	<ol style="list-style-type: none"> 1. Tightness and absence of mechanical damage
	Close and trip solenoids, anti-pump relay, auxiliary switches, secondary disconnect	<ol style="list-style-type: none"> 1. Automatic charging
High Potential Test	Spring charging motor(88)	<ol style="list-style-type: none"> 2. Close and trip with control power 1. Replace brushes after 10,000 operations
	Primary circuit to ground and between primary disconnects	<ol style="list-style-type: none"> 1. 60 second withstand, 14 or 27kV, 60Hz (20 or 38kV Dc) (depending upon voltage rating of breaker)
	Control circuit to ground	<ol style="list-style-type: none"> 1. 60 second withstand, 1125V, 60 Hz
Insulation	Barriers and all insulating components	<ol style="list-style-type: none"> 1. Cleanliness 2. Cracking

Troubleshooting

Problem	Symptoms	Possible Causes & Remedies
Breaker fails to close	<p>Closing springs will not automatically charge.</p> <p>Closing springs charge, but breaker does not close.</p> <ul style="list-style-type: none"> •Closing coil, or solenoid (52SRC) fails to energize. No sound of breaker closing. 	<ol style="list-style-type: none"> 1. Secondary control circuit is de-energized or control circuit fuses are blown. Check and energize or replace if necessary. 2. Secondary disconnect contacts 15 or 16 are not engaging. Check and replace if required. 3. Damage to wiring, terminals or connectors. Check and repair as necessary. 4. Failure of charging motor(88). Check brushes and replace if required. 5. Motor cut-off switch(LS1) fails to operate. Replace if necessary. 6. Mechanical failure of closing springs or tie-bar assembly. Check and replace as required. 7. Mechanical failure of operating mechanism. Refer to factory or authorized service shop. <ol style="list-style-type: none"> 1. Secondary control circuit de-energized, or control circuit fuses blown. Correct as indicated. 2. No closing signal to secondary disconnect pin 13. Check for continuity and correct relay logic. 3. Secondary disconnect contacts 13 or 15 are not engaging. Check and correct as required. 4. Failure of anti-pump relay(52Y) contacts 21-22 or 31-32 or 13-14. Check and replace as required. 5. Failure of close coil (solenoid) (52SRC). Check and replace as required.

Troubleshooting *Continued*

Problem	Symptoms	Possible Causes & Remedies
Nuisance or false close	<ul style="list-style-type: none"> •Closing coil energizes. Sound of breaker closing is heard, but breaker contacts do not close. <p>Electrical problem</p>	<p>6. Auxiliary switch NC contacts 3-4 are open when breaker contacts are open. Check linkage and switch. Replace or adjust as necessary.</p> <p>7. Spring charged switch(LS2) NO contact remains open after springs are charged. Check and replace as required.</p> <p>1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.</p> <p>1. Nuisance or false closing signal to secondary disconnect contact 13. Check relay logic. Correct as required.</p> <p>2. Closing coil(52SRC) terminal 2 is shorted to ground. Check to determine if problem is in wiring or coil. Correct as required.</p>
Circuit breaker will not trip	<p>Mechanical problem</p> <p>Tripping coil, or solenoid (52T) does not energize. There is no tripping sound.</p>	<p>1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.</p> <p>1. Secondary control power is de-energized or control power fuses are blown. Correct as indicated.</p> <p>2. Damage to wiring, terminals or connectors. Check and repair as necessary.</p> <p>3. No tripping signal to secondary disconnect contact 1. Check for continuity and correct relay logic.</p> <p>4. Secondary disconnect contacts 1 or 2 are not engaging. Check and replace if required.</p> <p>5. Failure of trip coil(52T). Check and replace if necessary.</p>

Troubleshooting *Continued*

Problem	Symptoms	Possible Causes & Remedies
Nuisance or false trip	Tripping coil(52T) energizes. No tripping sound is heard, and breaker contacts do not open (i.e., they remain closed).	<p>6. Auxiliary switch NO contacts 1-2 or 5-6 are open when breaker is closed. Check linkage and switch. Replace or adjust as necessary.</p> <p>1. Failure of tripping spring or its mechanical linkage. Check and replace if required.</p>
	Tripping coil(52T) energizes. Tripping sound is heard, but breaker contacts do not open.	<p>1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.</p> <p>2. One or more of the vacuum interrupters are held closed. Check and replace as necessary.</p>
	Electrical problem	<p>1. Tripping signal remains energized on secondary disconnect contact 1. Check for improper relay logic.</p>
	Mechanical problem	<p>1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.</p>

Table A-1. Type GMI Circuit Breaker Ratings

Identification			Rated Values								Rated Required Capabilities ^③							
Circuit Breaker Type	Nominal Voltage Class	Nominal 3-Phase MVA Class	Voltage		Insulation Level		Current				Current Values							
			Rated Max. Voltage ^②	Rated Voltage Range Factor ^③	Rated Withstand Test Voltage		Rated Cont. Current ^④	Rated Short Circuit Current (at rated Max.kV) ^{⑤ ⑥}	Rated Interrupting Time	Rated Permissible Tripping delay Y	Rated Max. Voltage Divided by K E/K kV rms	Max. Sym. Interrupting Capability ^⑦ K Times Rated Short-Circuit Current KI kA rms	3-Sec. Short Time Current Carrying Capability kA rms	Closing and Latching Capability (Momentary ^⑧)				
					Low Fre- quency									Im- pulse kV crest	1.6 K Times Rated Short Circuit Current ^⑨ kA rms	2.7 K Times Rated Short Circuit Current kA Crest		
					E kV rms	K											kV rms	kV crest
5-GMI-250 ^①	4.16	250	4.76	1.24	19	60	1200 2000	29	5	2	3.85	36	36	58&78 ^①	97&132 ^①			
5-GMI-350	4.16	350	4.76	1.19	19	60	1200 2000 3000	41	5	2	4.0	49	49	78	132			
7-GMI-500	7.2	500	8.25	1.25	36	95	1200 2000 3000	33	5	2	6.6	41	41	66	111			
15-GMI-500 ^①	13.8	500	15	1.30	36	95	1200 2000	18	5	2	11.5	23	23	37&58 ^①	62&97 ^①			
15-GMI-750	13.8	750	15	1.30	36	95	1200 2000 3000	28	5	2	11.5	36	36	58&77 ^①	97&130 ^①			
15-GMI-1000 ^①	13.8	1000	15	1.30	36	95	1200 2000 3000	37	5	2	11.5	48	48	77	130			

1 High close and latch (momentary) rating available for special application.

2 Maximum voltage for which the breaker is designed and the upper limit for operation.

3 K is the ratio of rated maximum voltage to the lower limit of the range of operating voltage in which the required symmetrical and asymmetrical interrupting capabilities vary in inverse proportion to the operating voltage.

4 3000 ampere units available with increased fan-cooled rating of 3750 amperes.

5 To obtain the required symmetrical interrupting capability of a circuit breaker at an operating voltage between 1/K times rated maximum voltage and rated maximum voltage, the following formula shall be used:

$$\text{Required Symmetrical Interrupting Capacity} = \text{Rated Short-Circuit Current} \times \frac{\text{Rated Maximum Voltage}}{\text{Operating Voltage}}$$

For operating voltages below 1/K times rated maximum voltage, the required symmetrical interrupting capability of the circuit breaker shall be equal to K times rated short-circuit current.

6 With the limitations stated in 5.10 of ANSI Standard C37.04-1979, all values apply for polyphase and line-to-line faults. For single phase-to-ground faults, the specific conditions stated in 5.10.2.3 of ANSI Standard C37.04-1979 apply.

7 Current values in this column are not to be exceeded even for operating voltages below 1/K times rated maximum voltage. For voltages between rated maximum voltage and 1/K times rated maximum voltage, follow 5 above.

8 Current values in this column are independent of operating voltage up to an including rated maximum voltage.

9 Included for reference only.

**Table A-2. 5kV, 7.2kV and 15kV Type GMI Circuit Breaker Control Data
Typical Spring Release (Close) Coil, Trip Coil, and Spring Charging Motor Characteristics**

Control Voltages, ANSI C37.06 Tbl. 10			Close Coil	Trip Coil	Spring Charging Motor		
Nominal	Range				Amperes		Charging
	Close	Trip			Amperes ^①	Amperes ^①	Run (Avg.)
48 VDC	38-56	28-56	13	13	13	—	10
125 VDC	100-140	70-140	6	6	5	—	10
250 VDC	200-280	140-280	3	3	3	—	10
120 VAC	104-127	104-127	10	10	6	28	10
240 VAC	208-254	208-254	6	6	3	14	10

① Current at nominal voltage.

Table A-3. Interrupting Capacity Auxiliary Switch Contacts

Type Auxiliary Switch	Continu- ous Current Amperes	Control Circuit Voltage				
		120 Ac	240 Ac	48 Dc	125 Dc	250 Dc
		Non-inductive circuit interrupting capacity in amperes				
Breaker Auxiliary Switch	20	20	20	20	10	2
TOC Auxiliary Switch	15	15	10	0.5	0.5	0.2
MOC Auxiliary Switch	20	15	10	10	10	5
		Inductive circuit interrupting capacity in amperes				
Breaker Auxiliary Switch	20	20	20	20	10	2
TOC Auxiliary Switch	15	15	10	0.5	0.5	0.2
MOC Auxiliary Switch	20	15	10	10	10	5

SIEMENS

Siemens Energy
& Automation, Inc.
Switchgear Division
P.O. Box 29503
Raleigh, NC 27626
(919) 365-6660

SIEMENS

5kV and 15kV Vacuum Circuit Breakers Type GMI

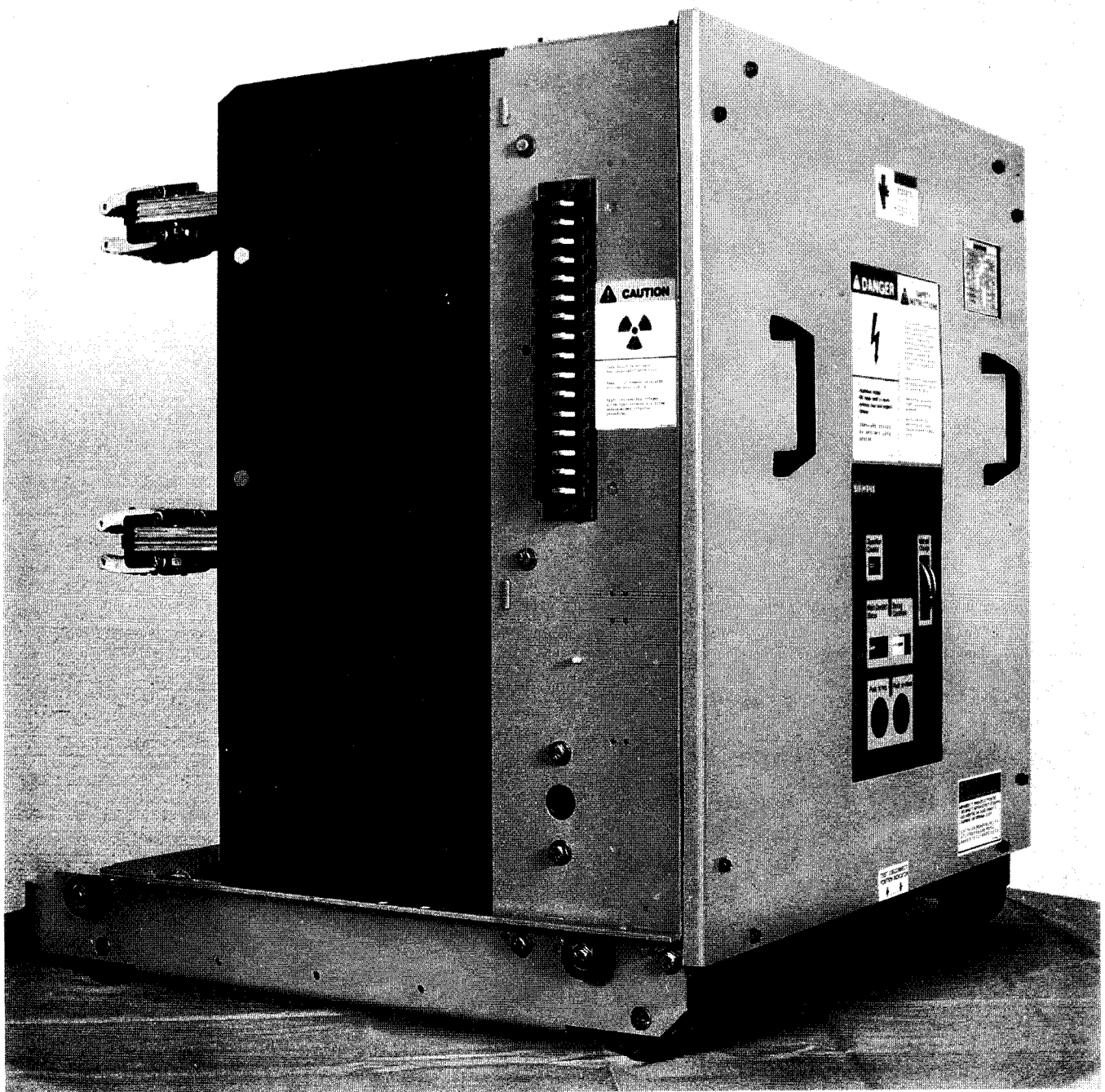
Instruction

Installation

Operation

Maintenance

SG-3268-02





DANGER

Hazardous voltages and high speed moving parts. Will cause death, serious personal injury or equipment damage.

Always de-energize and ground the equipment before maintenance. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which will cause severe personal injury or equipment damage. Follow all safety instructions contained herein.

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.

QUALIFIED PERSON

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

- (a) **is trained and authorized** to 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.

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 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 sales office.

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

5kV and 15kV Vacuum Circuit Breakers

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Introduction and Safety

Introduction

The GMI family of vacuum circuit breakers is designed to meet all the applicable ANSI, NEMA and IEEE standards. Successful application and operation of this equipment depends as much upon proper installation and maintenance by the user as it does upon the careful design and fabrication by Siemens.

The purpose of this Instruction Manual is to assist the user in developing safe and efficient procedures for the installation, maintenance and use of the equipment.

Contact the nearest Siemens representative if any additional information is desired.

	⚠ DANGER
	Power circuit breakers operate at high voltages and have spring-loaded mechanical parts which operate at high speed.
	When operated improperly, this equipment will cause death, personal injury and property damage.
	To avoid electrical shock, burns and entanglement in moving parts this equipment must be installed, operated and maintained only by qualified persons thoroughly familiar with the equipment, instruction manuals and drawings.

Qualified Person

For the purpose of this manual and product labels, a **"Qualified Person"** is one who is familiar with the installation, construction and operation of this equipment, and the hazards involved. In addition, this person has the following qualifications:

- Training and authorization to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.
- Training in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses, face shields, flash clothing, etc., in accordance with established safety procedures.
- Training in rendering first aid.

Signal Words

The signal words **"Danger"**, **"Warning"** and **"Caution"** used in this manual indicate the degree of hazard that may be encountered by the user. These words are defined as:

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.

Dangerous Procedures

In addition to other procedures described in this manual as dangerous, user personnel must adhere to the following:

1. Always work on a de-energized breaker. Always de-energize a breaker, and remove it from the metal-clad switchgear before performing any tests, maintenance or repair.
2. Always perform maintenance on the breaker after the spring-charged mechanisms are discharged (except for test of the charging mechanisms).
3. Always let an interlock device or safety mechanism perform its function without forcing or defeating the device.

Field Service Operation

Siemens can provide competent, well-trained Field Service Representatives to provide technical guidance and advisory assistance for the installation, overhaul, repair and maintenance of Siemens equipment, processes and systems. Contact regional service centers, sales offices or the factory for details.

Receiving, Handling and Storage

Introduction

Type GMI Vacuum Interrupter Circuit Breakers are normally installed in assembled metal-clad switchgear, and the Switchgear Instruction Manual (SG-3258) contains the Receiving, Handling and Storage instructions for assembled metal-clad switchgear.

This manual covers the Receiving, Handling and Storage instructions for Type GMI circuit breakers shipped separately from the switchgear. This section of the manual is intended to help the user identify, inspect and protect the circuit breaker prior to its installation.

Receiving Procedure

Make a physical inspection of the shipping container before removing or unpacking the circuit breaker. Check for shipment damage or indications of rough handling by the carrier. Check each item against the manifest to identify any shortages.


Accessories such as the manual charging lever, the racking crank and the plug jumper are shipped separately.

Shipping Damage Claims (When Applicable) - Follow normal shipment damage procedures, which should include:

1. Check for visible damage upon arrival.
2. Visible damage must be noted on delivery receipt, and acknowledged with driver's signature. Notation, "Possible internal damage, subject to inspection" must be on delivery receipt.
3. Notify Siemens Sales office immediately of any shipment damage.
4. Arrange for carrier's inspection. Do not move the unit from its unloading point.

Handling Procedure

1. Carefully remove the shipping carton from the circuit breaker. Keep the shipping pallet for later use if the breaker is to be stored prior to its installation.
2. Inspect for concealed damage. Notification to carrier must take place within 15 days to assure prompt resolution of claims.
3. Each circuit breaker should be appropriately lifted to avoid crushing the side panels of the breaker, or damaging the primary disconnect subassemblies.

	<p>⚠ WARNING</p> <p>Heavy Weight</p> <p>Can cause death, serious injury, or property damage.</p> <p>Obtain the services of a qualified rigger prior to hoisting the circuit breaker to assure adequate safety margins in the hoisting equipment and procedures to avoid damage.</p>
--	--

Type GMI circuit breakers weigh between 385 to 575 pounds (175 to 261 kg). See Table A-4, Technical Data in Appendix.

4. The palletted circuit breaker can also be moved using a properly rated fork-lift vehicle. The pallets are designed for movement by a standard fork-lift vehicle.

Storage Procedure

1. Whenever possible, install circuit breakers in their assigned switchgear enclosures for storage. Follow instructions contained in the Switchgear Instruction Manual.
2. When the breaker will be placed on its pallet for storage, be sure the unit is securely bolted to the pallet and covered with polyethylene film at least 10 mils thick.

Indoor Storage - Whenever possible, store the circuit breaker indoors. The storage environment must be clean, dry and free of such items as construction dust, corrosive atmosphere, mechanical abuse and rapid temperature variations.

Outdoor Storage - Outdoor storage is not recommended. When no other option is available, the circuit breaker must be completely covered and protected from rain, snow, dirt and all other contaminants.

Space Heating - Space heating must be used for *both indoor and outdoor* storage to prevent condensation and corrosion. When stored outdoors, between 150 to 200 watts per breaker of space heating is recommended. If the circuit breakers are stored inside the switchgear enclosures, and the switchgear is equipped with space heaters, energize the space heaters.

Installation Checks and Initial Functional Tests

Introduction

This section provides a description of the inspections, checks and tests to be performed on the circuit breaker prior to operation in the metal-clad switchgear.

Inspections, Checks and Tests without Control Power

Vacuum circuit breakers are normally shipped with their primary contacts open and their springs discharged. However, it is critical to *first* verify the discharged condition of the spring-loaded mechanisms after de-energizing control power.

De-Energizing Control Power in Switchgear - When the circuit breaker is mounted in switchgear, open the control power disconnect device in the metal-clad switchgear cubicle. **Figure 1** shows the location of this disconnect in a standard GM switchgear assembly.

The control power disconnect device is located on the device panel above the lower circuit breaker and below the upper circuit breaker. **Figure 1** shows a pullout type fuse holder. Removal of the fuse holder de-energizes control power to the circuit breaker in the respective switchgear cell. In some switchgear assemblies, a molded case circuit breaker is used in lieu of the pull out type fuse holder. Opening this circuit breaker accomplishes the same result: control power is disconnected.

Spring Discharge Check (Figure 2) - Perform the Spring Discharge Check *before* removing the circuit breaker from the pallet or removing it from the switchgear.

The spring discharge check consists of simply performing the following tasks in the order given. This check assures that both the tripping and closing springs are fully discharged.

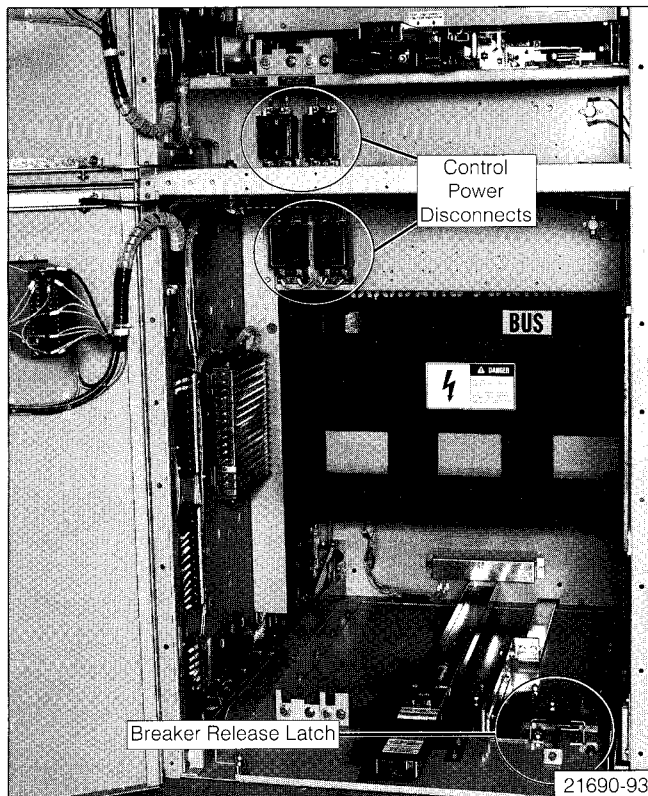



Figure 1: Control Power Disconnects in Switchgear.



⚠ DANGER

Hazardous voltages and high-speed mechanical parts.

Will cause death, severe personal injury, or property damage.

Read instruction manuals, observe safety instructions and use qualified personnel.

1. Press red Trip pushbutton.
2. Press black Close pushbutton.
3. Again press red Trip pushbutton.
4. Verify Spring Condition Indicator shows DISCHARGED.
5. Verify Main Contact Status Indicator shows OPEN.

Removal from Lower Cell in Indoor (if not on raised pad) and Shelter-Clad Outdoor Switchgear - After performing the Spring Discharge Check (with control power de-energized), remove the circuit breaker from its switchgear cubicle.

1. Insert the racking crank on the racking screw on the front of the breaker cell, and push in. This action operates the racking interlock latch. **Figure 3** shows racking of a circuit breaker in the upper cell - the process is similar for a breaker in the lower cell.
2. Rotate the racking crank *counterclockwise* until the breaker is in the Disconnect position. If the racking crank is not of the "Captive" type, constant inward pressure is required during racking to maintain engagement with the racking mechanism.
3. Move the breaker release latch to the left and pull the circuit breaker out from the Disconnect position. The breaker can now be removed from cubicle.

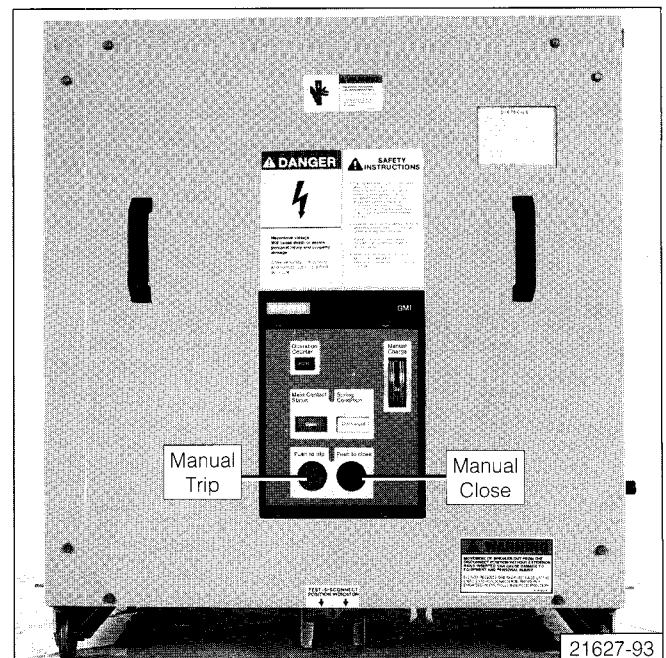


Figure 2: Front Panel of GMI Circuit Breaker.

Installation Checks and Initial Functional Tests

4. The circuit breaker is now free to be rolled out on the floor using the handles as shown in **Figure 4**. The wheels of the circuit breaker are virtually at floor level (unless the switchgear is installed on a raised pad), and one person can easily handle the unit.

Removal from Upper Cell (Indoor and Shelter-Clad Outdoor Switchgear) - Removal of the upper breaker in a two-high assembly is similar to removal of a breaker from a lower cell, with several additional steps.

Figure 5 shows one of the two breaker extension rails being inserted into the fixed rails within the upper cell of two-high switchgear equipment. The rails engage locking pins in the fixed rails to secure them in position.

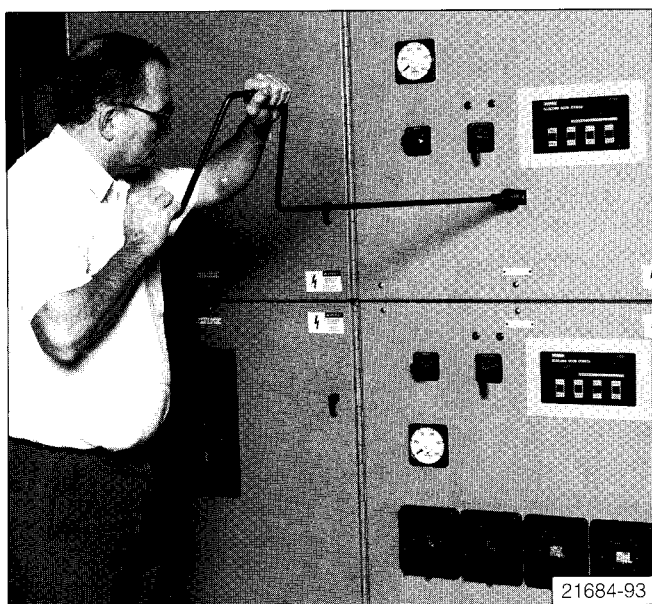


Figure 3: Racking Circuit Breaker in Switchgear.

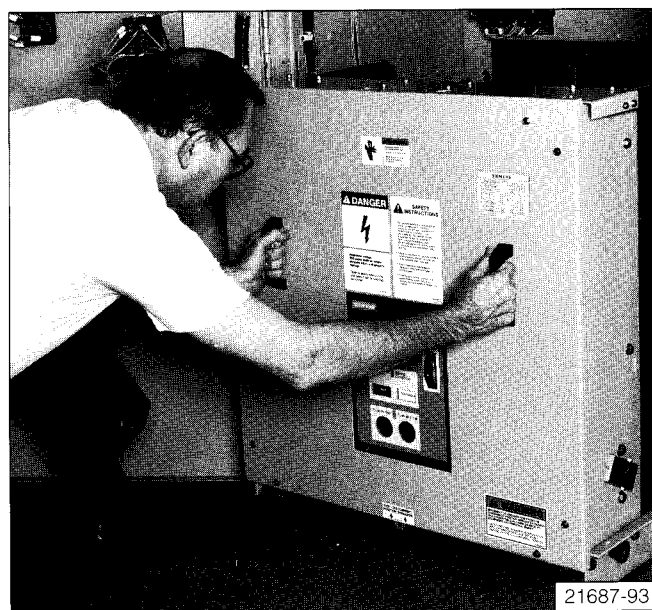



Figure 4: Removal of Circuit Breaker.

The procedure for removal of an upper circuit breaker is:

1. Insert the two extension rails into the fixed rails. Be sure the extension rails are properly secured in place. (This can be done at Step 4 if preferred.)
2. Insert the racking crank on the racking screw on the front of the breaker cell, and push in. This action operates the racking interlock latch. **Figure 3** shows racking of a circuit breaker in the upper cell.
3. Rotate the racking crank *counterclockwise* until the breaker is in the Disconnect position. If the racking crank is not of the "Captive" type, constant pressure is required during racking to maintain engagement with the racking mechanism.
4. If you have not yet installed the extension rails, do so now. Note that some difficulty may be experienced installing the extension rails if the circuit breaker is in the Disconnect position. If difficulty is encountered, rack the circuit breaker to the Test position, install the extension rails, and then rack the circuit breaker to the Disconnect position.

	
⚠ WARNING	
Heavy Weight	
Can cause death, serious injury, or property damage.	
Always use extension rails to remove or install circuit breaker in the upper cell or in cells not installed at floor level.	

5. Move the breaker release latch to the left and pull the circuit breaker out from the Disconnect position. The breaker is now free to be rolled out on the two extension rails using the handles on the front of the circuit breaker.
6. Remove the breaker from the two extension rails using the approved Siemens breaker lifting device.
7. Lift the two extension rails and withdraw them from the switchgear.

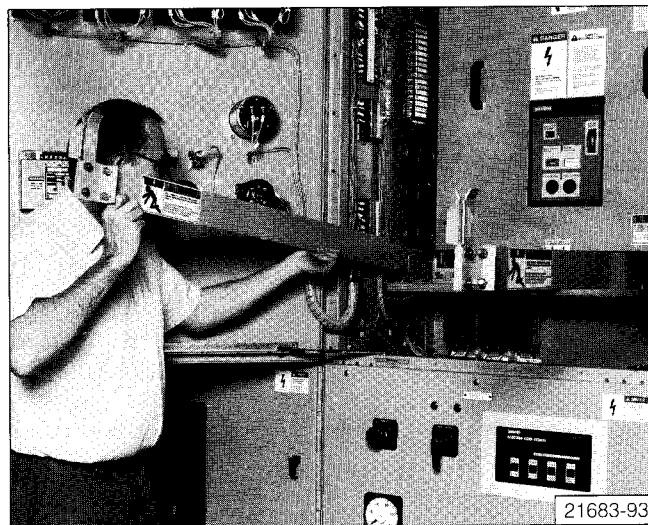


Figure 5: Use of Extension Rails for Upper Compartment.

Installation Checks and Initial Functional Tests

Removal from Upper and Lower Cell in Outdoor Non-Walk In Enclosures or for Indoor Switchgear Installed on a Raised Pad - Because the floor level in non-walk in outdoor enclosures is approximately 6 inches above grade (foundation) level, the lower breaker in either a one-high or two-high section of switchgear must be removed using the preceding procedure for upper breaker removal.

The approved breaker lifting device should be used for removal of both lower and upper breakers from the extension rails of outdoor non-walk in enclosures.

Physical Inspections

1. Verify that rating of the circuit breaker is compatible with both the system and the switchgear.
2. Perform a visual shipping damage check. Clean the breaker of all shipping dust, dirt and foreign material.

Manual Spring Charging Check

1. Insert the manual spring charging lever into the manual charge handle socket as shown in **Figure 6**. Operate the lever up and down until the spring condition indicator shows the closing spring is Charged.
2. Repeat the Spring Discharge Check.
3. Verify that the springs are discharged and the breaker primary contacts are open by indicator positions.

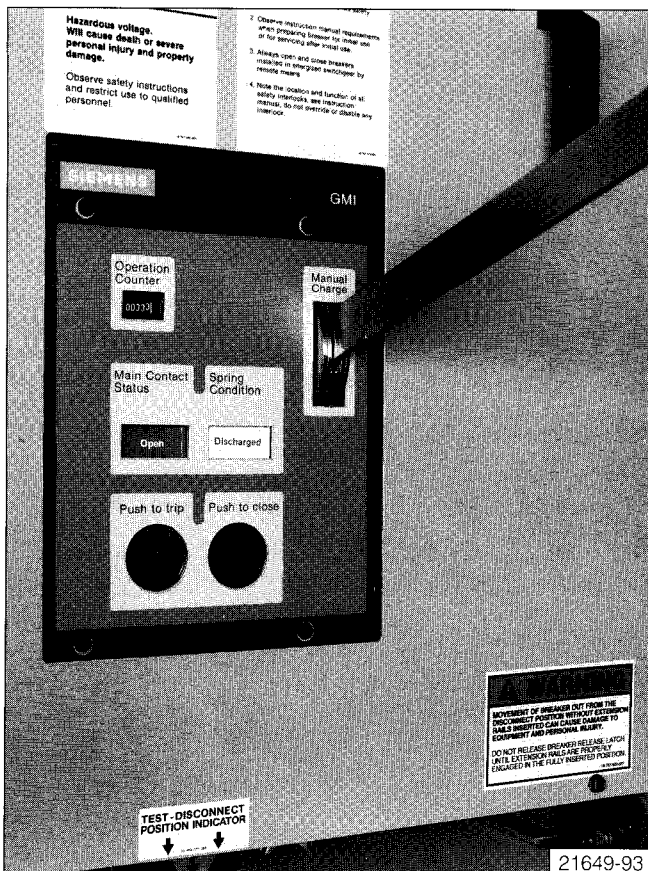


Figure 6: Manual Charging of Closing Springs.

As-Found and Vacuum Check Tests - Perform and record the results of both the As-Found insulation test and the vacuum check high-potential test. Procedures for these tests are described in the Maintenance Section of this manual.

Automatic Spring Charging Check

Note: A temporary source of control power and test leads may be required if the control power source has not been connected to the switchgear. (Refer to the specific wiring information and rating label for your circuit breaker to determine the voltage required and where the control voltage signal should be applied. Usually, spring charging power is connected to secondary disconnect fingers SD16 and SD15, closing control power to SD13 and SD15, and tripping power to SD1 and SD2.) When control power is connected to the GMI circuit breaker, the closing springs should automatically charge.

The automatic spring charging features of the circuit breaker must be checked. Control power is required for automatic spring charging to take place.

1. Open control power circuit by removing pullout fuse holder shown in **Figure 1**.
2. Install breaker end of split plug jumper (if furnished) shown in **Figure 7** to the circuit breaker. The plug jumper is secured by means of screws, over the circuit breaker's secondary contacts.

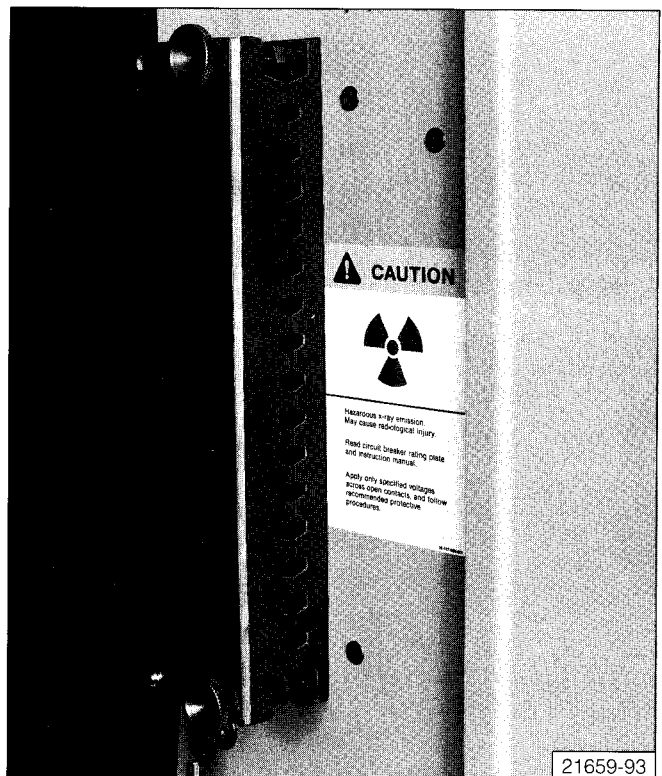


Figure 7: Split Plug Jumper Connected to Circuit Breaker.

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- ### Final Mechanical Inspections without Control Power

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7

Interrupter/Operator Description

Introduction

The Type GMI vacuum circuit breaker is of drawout construction designed for use in medium voltage, metal-clad switchgear. The GMI circuit breaker conforms to the requirements of ANSI standards C37.20.2, C37.04, C37.06, C37.09 and C37.010.

GMI circuit breakers consist of three vacuum interrupters, a stored energy operating mechanism, necessary electrical controls and interlock devices, disconnect devices to connect the breaker to both primary and control power and an operator housing. On some circuit breaker ratings insulating barriers are located between the vacuum interrupters or along the sides.

This section describes the operation of each major subassembly as an aid in the operation, installation, maintenance and repair of the GMI vacuum circuit breaker.

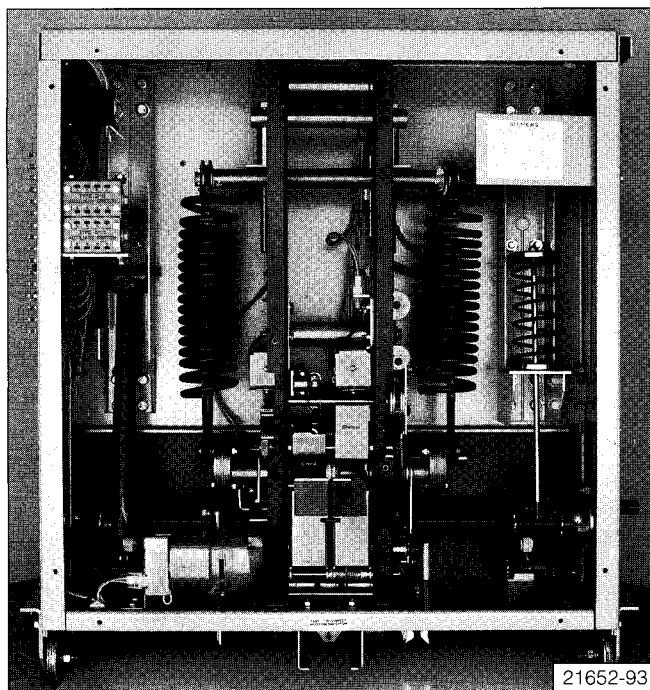


Figure 10: Front View of GMI Breaker.

Vacuum Interrupters and Primary Disconnects

The operating principle of the GMI vacuum interrupter is simple. **Figure 11** is a cutaway view of a typical vacuum interrupter. The entire assembly is sealed after a vacuum is established. The interrupter stationary contact is connected to the upper disconnect stud of the circuit breaker. The interrupter movable contact is connected to the lower disconnect stud and driving mechanism of the circuit breaker. The metal bellows assembly provides a secure seal around the movable contact, preventing loss of vacuum while permitting vertical motion of the movable contact.

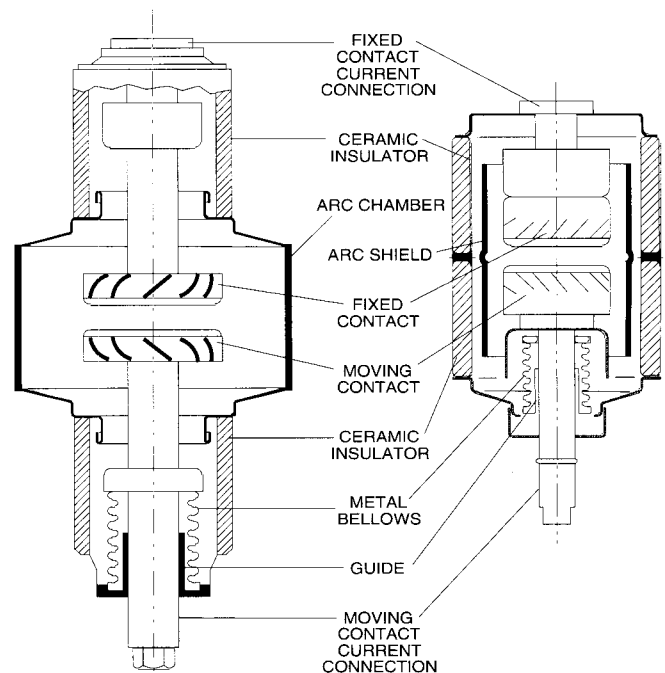


Figure 11: Cutaway View of GMI Vacuum Interrupters.

When the two contacts separate an arc is initiated which continues conduction up to the following current zero. At current zero, the arc extinguishes and any conductive metal vapor which has been created by and supported the arc condenses on the contacts and on the surrounding vapor shield. Contact materials and configuration are optimized to achieve arc motion and to minimize switching disturbances.

Interrupter/Operator Description

Primary Disconnects - Figure 12 is a side view of the circuit breaker with a side phase barrier removed to show details of the primary disconnects. Each circuit breaker has three upper and three lower primary disconnects. Upper primary disconnects are connected to the stationary contacts of the vacuum interrupters, and the lower primary disconnects to the movable contacts. Each disconnect arm has a set of multiple spring loaded fingers that mate with bus bars in the metal-clad switchgear. The number of fingers in the disconnect assembly varies with the continuous and/or momentary rating of the circuit breaker.

There are three insulating push rods. Each push rod connects the movable contact of one of the vacuum interrupters to the jack shaft driven by the closing and tripping mechanism. Flexible connectors ensure secure electrical connections between the movable contacts of each interrupter and its bottom primary disconnect.

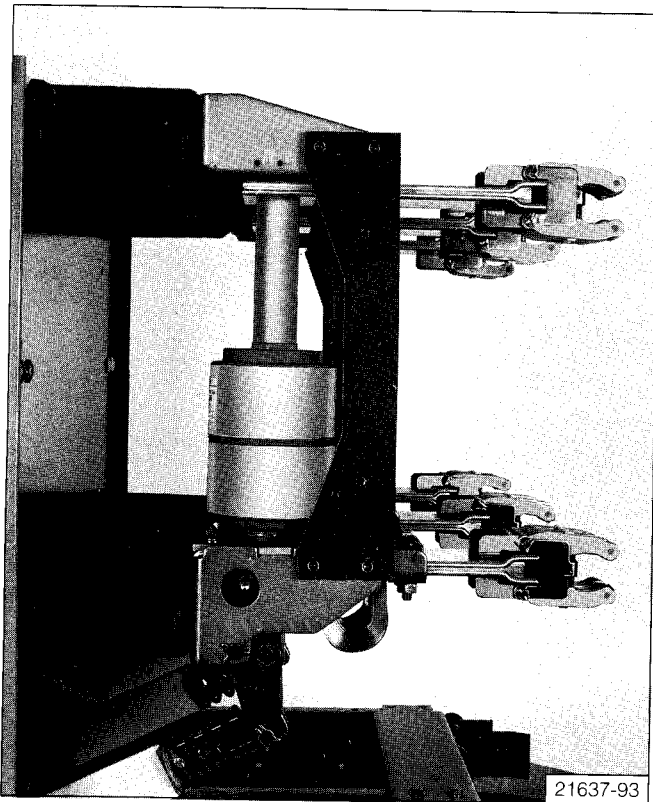


Figure 12: Upper and Lower Primary Disconnects.

Phase Barriers - Phase barrier configurations vary among GMI breakers depending on voltage and continuous current ratings.

Figure 13 is a rear view of a circuit breaker that shows the two outer (phase to ground) insulating barriers and two interphase barriers. The interphase barriers are not provided on all circuit breaker ratings. These four plates of glass polyester insulating material are attached to the circuit breaker and provide suitable electrical insulation between the vacuum interrupter primary circuits and the housing.

Stored Energy Operating Mechanism

The stored energy operating mechanism of the GMI circuit breaker is an integrated arrangement of springs, solenoids and mechanical devices designed to provide a number of critical functions. The energy necessary to close and open the contacts of the vacuum interrupters is stored in powerful tripping and closing springs. These springs are normally charged automatically, but there are provisions for manual charging. The operating mechanism that controls charging, closing and tripping functions is fully trip-free, i.e., spring charging does not automatically change the position of the primary contacts, and the closing function may be overridden by the tripping function at any time.

Note: Two different latch systems have been used in GMI circuit breakers, with changeover from one design to the other occurring in mid-1991. This instruction manual describes both designs.

Pages 10-11 describe the operation of the mechanism used beginning in approximately mid-1991.

Pages 12-13 describe the operation of the mechanism used from 1989 until approximately mid-1991.



Figure 13: Breaker with Interphase and Outerphase Barriers.

Interrupter/Operator Description

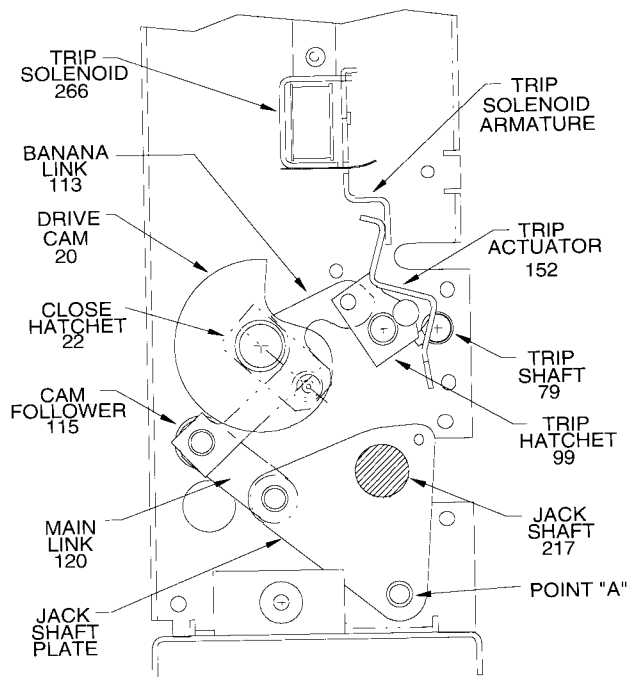


Figure 14a: Breaker Open—Closing Springs Discharged.

Modes of Operation - Mid-1991 and After

Pages 10-11 describe the operation of the mechanism used beginning in approximately mid-1991.

This mechanism can be identified by observing the close latch above the spring charging motor on the left side of the circuit breaker. Refer to **Figure 18a**. The close latch is installed on the close shaft assembly 72, and includes a hardened latch face. This face contacts a bearing which is part of the close hatchet assembly 105. If the mechanism has a close hatchet which bears directly on the close shaft, refer to pages 12-13 for the description of your mechanism.

Modes of Operation - Discussion

Some maintenance procedures are more easily understood when the operating mechanism modes of operation are described in detail. The next few paragraphs explain the five modes or status conditions (charging, closing, trip-free, opening and rapid auto-reclosing) of the stored energy operating mechanism.

Note: All discussion of modes of operation assumes that the reader is viewing the operator from the front, or from the right hand side.

Spring Charging Mode - Figures 14a and 15a show several key components of the operator mechanism in positions corresponding to the breaker open, with the closing springs discharged (**Figure 14a**) and charged (**Figure 15a**). **Figure 16a** shows portions of the operator mechanism that manually or electrically charge the closing springs. The drive cam (20), the closing spring crank arms (**Figure 19**) and spring condition indicator cam (18) are directly keyed to the main cam shaft (3). The main cam shaft rotates counterclockwise. The closing springs are attached to the crank arms, and are extended during the charging cycle.

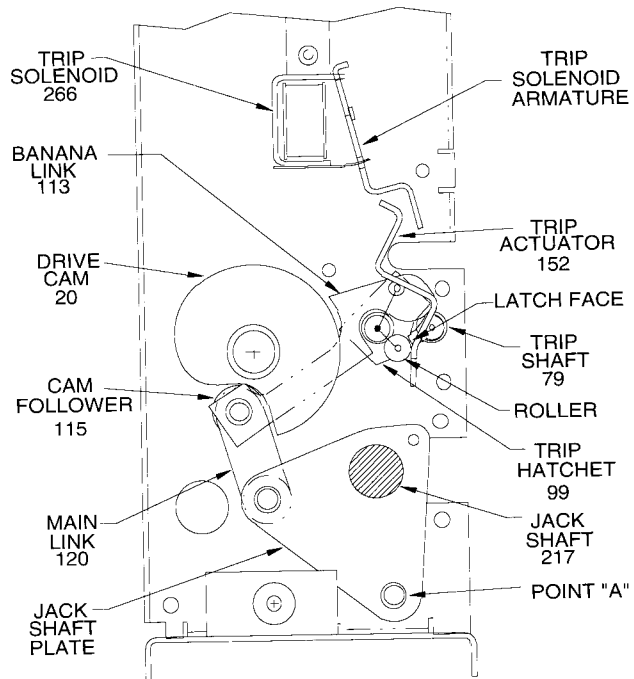


Figure 15a: Breaker Open—Closing Springs Charged.

Figure 16a shows the ratchet wheel (15) which is free to rotate about the main cam shaft (3). The ratchet wheel is driven by either the charging motor or the manual charge handle socket (52). When the springs are charged electrically, the motor eccentric (100) introduces a rocking motion into the drive plate (13). As this plate rocks back and forth, the lower pawl (24-1) (which is connected to the drive plate) imparts counterclockwise rotation of the ratchet wheel (15), one tooth at a time. The upper pawl (24-2) acts as a holding pawl during electrical charging.

When the springs are charged manually, up and down pumping action of the spring charging handle in the manual charge handle socket (52) causes the pawl plate (11) to rock back and forth through the movement of the manual charging link (48). The upper pawl (24-2) drives the ratchet plate counterclockwise during manual charging, and the lower pawl (24-1) becomes the holding device.

At the beginning of the charging cycle, ratchet pin (16) is at the 6 o'clock position. The ratchet pin is connected to the ratchet wheel. Upon being advanced by ratchet action to the 12 o'clock position, this pin engages the drive arms (8) which are keyed to the main cam shaft. Consequently, counterclockwise rotation of the ratchet wheel causes the ratchet pin to drive the main cam shaft counterclockwise. When the ratchet pin reaches the 6 o'clock position, the closing springs are fully charged. Driving pawl (24-1) is disengaged, the spring condition indicator cam (18) has rotated allowing the spring charged flag (132) to drop into the lower (charged) position, which also operates the motor cutoff switch (LS1) and spring charged switch (LS2) (258) (see **Figures 17a** and **27**). The closing springs are restrained fully charged by close hatchet (22) against close shaft (72).

Interrupter/Operator Description

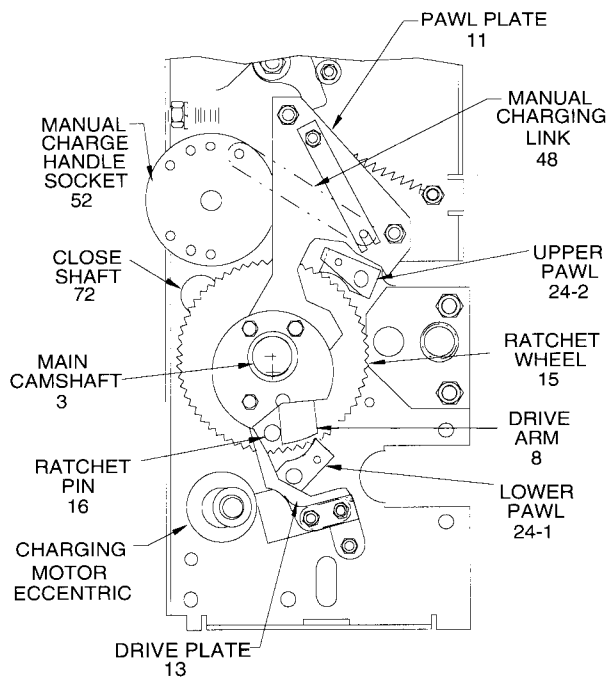


Figure 16a: Pawl and Ratchet Drive.

Closing Mode (Figure 17a) - Energizing the close solenoid (265) pulls the solenoid armature against the closing shaft actuator (75) and causes the close shaft (72) to rotate approximately 15°. If the closing springs are charged, the close hatchet (22) will be released by this rotation allowing the main cam shaft (3) to be driven by the closing springs. Depressing the manual close button on the operator panel causes the rotation of the close shaft (72) by the lower end of the close shaft actuator (75). Rotation of the main cam shaft (3) in a manual closing operation is identical to that of an electrical closing operation. As the main cam shaft (3) rotates, the cam follower (115) is driven by drive cam (20), and the main link (120) is forced outwards, and rotation of the jack shaft assembly (217) occurs. There are three drive links attached to Point "A" of each of the three jack shaft drive plates. Each drive link is connected to the movable contact of one vacuum interrupter. Closing rotation (counterclockwise) of the jack shaft assembly closes the contacts of the three vacuum interrupters. During closing operation, rotation of jack shaft assembly (217) forces the opening (i.e., tripping) spring into its charged position.

Trip Free Mode - If at any time during breaker closing, the trip shaft (79) (Figure 14a) operates as a result of either an electrical or mechanical trip, trip hatchet (99) is free to rotate. When the trip hatchet (99) rotates, cam follower (115) is displaced by drive cam (20) without motion of the jack shaft (217). Mechanical trip free operation is provided by manual tripping, electrical tripping and/or the mechanical interlocks.

Opening Mode - Opening or tripping the vacuum interrupter contacts is accomplished by rotation of the trip shaft (79). Rotation may be produced either electrically, by energizing the trip solenoid (266) (Figure 15a), or manually by pressing the trip button. Energizing the trip solenoid causes the upper arm of the trip actuator (152) to rotate counterclockwise. Pressing the trip button causes the trip actuator lower arm to move,

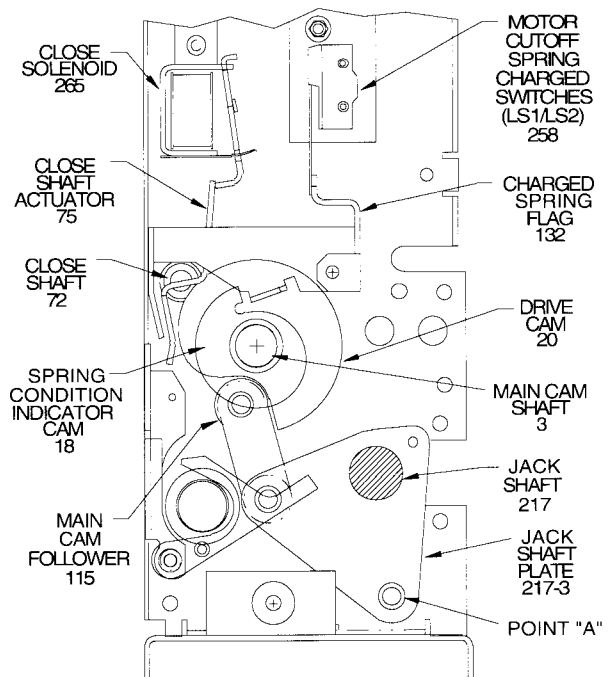


Figure 17a: Closing Mode

again producing rotation of the trip shaft. All of the linkages are trip free, and tripping or opening is unaffected by charging status of the closing springs or position of the drive cam (20).

Rapid Auto-Reclosing Mode (Optional) - The closing springs are automatically recharged by the motor driven operating mechanism when the breaker has closed. The operating mechanism is capable of the open-close-open duty cycle required for rapid auto-reclosing. A trip latch check switch and a relay (delay on dropout) prevent release of the closing spring energy if the trip hatchet (99) is not in its reset position. This ensures the mechanism does not operate trip free on an instantaneous reclosure.

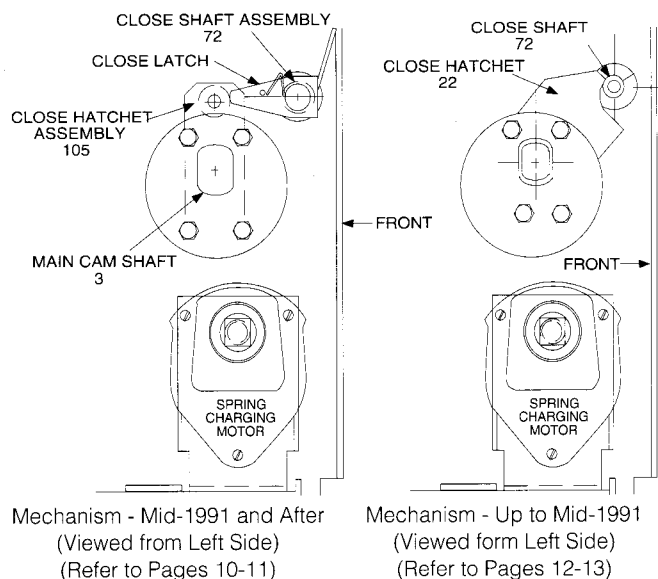


Figure 18a: Identification of Mechanism Vintage

Interrupter/Operator Description

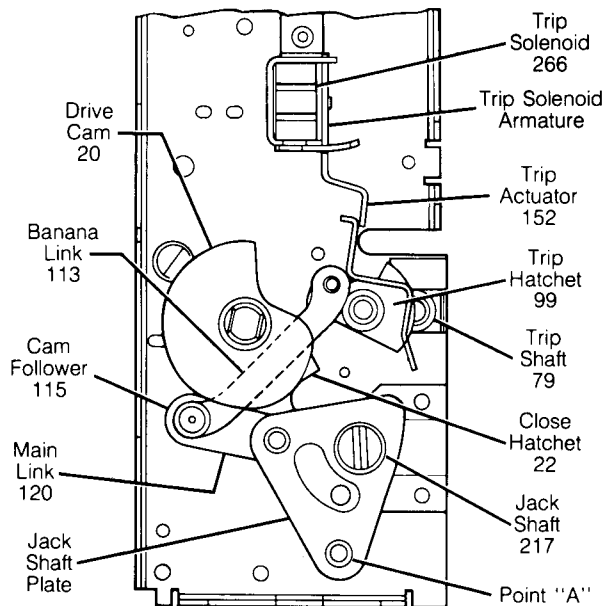


Figure 14b: Breaker Open—Closing Springs Discharged.

Modes of Operation - Up to Mid-1991

Pages 12-13 describe the operation of the mechanism used from 1989 until approximately mid-1991.

This mechanism can be identified by observing the close latch above the spring charging motor on the left side of the circuit breaker. Refer to **Figure 18b**. The close hatchet 22 has a latch face which bears directly on the close shaft 72. If the close hatchet includes a bearing which contacts a hardened latch installed on the close shaft, refer to pages 10-11 for the description of your mechanism.

Modes of Operation - Discussion

Some maintenance procedures are more easily understood when the operating mechanism modes of operation are described in detail. The next few paragraphs explain the five modes or status conditions (charging, closing, trip-free, opening and rapid auto-reclosing) of the stored energy operating mechanism.

Note: All discussion of modes of operation assumes that the reader is viewing the operator from the front, or from the right hand side.

Spring Charging Mode - Figures 14b and 15b show several key components of the operator mechanism in positions corresponding to the breaker open, with the closing springs discharged (**Figure 14b**) and charged (**Figure 15b**). **Figure 16b** shows portions of the operator mechanism that manually or electrically charge the closing springs. The drive cam (20), the closing spring crank arms (**Figure 19**) and spring condition indicator cam (18) are directly keyed to the main cam shaft (3). The main cam shaft rotates counterclockwise. The closing springs are attached to the crank arms, and are extended during the charging cycle.

Figure 16b shows the ratchet wheel (15) which is free to rotate about the main cam shaft (3). The ratchet wheel is driven by

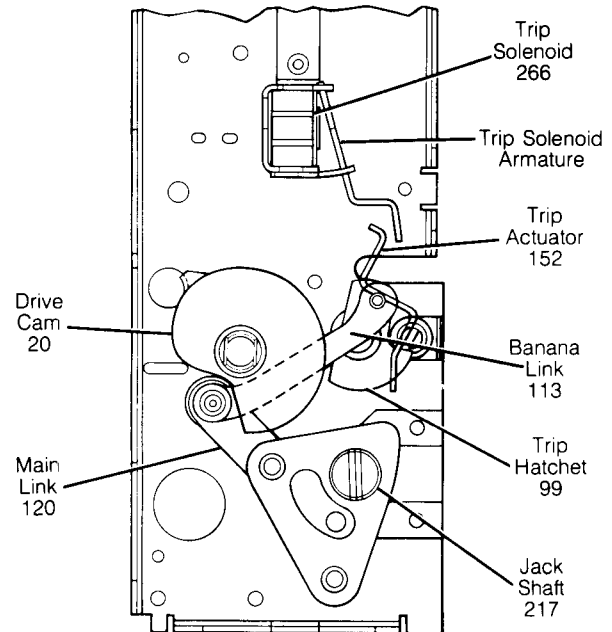


Figure 15b: Breaker Open—Closing Springs Charged.

either the charging motor or the manual charge handle socket (52). When the springs are charged electrically, the motor eccentric (100) introduces a rocking motion into the drive plate (13). As this plate rocks back and forth, the lower pawl (24-1) (which is connected to the drive plate) imparts counterclockwise rotation of the ratchet wheel (15), one tooth at a time. The upper pawl (24-2) acts as a holding pawl during electrical charging.

When the springs are charged manually, up and down pumping action of the spring charging handle in the manual charge handle socket (52) causes the pawl plate (11) to rock back and forth through the movement of the manual charging link (48). The upper pawl (24-2) drives the ratchet plate counterclockwise during manual charging, and the lower pawl (24-1) becomes the holding device.

At the beginning of the charging cycle, ratchet pin (16) is at the 6 o'clock position. The ratchet pin is connected to the ratchet wheel. Upon being advanced by ratchet action to the 12 o'clock position, this pin engages the drive arms (8) which are keyed to the main cam shaft. Consequently, counterclockwise rotation of the ratchet wheel causes the ratchet pin to drive the main cam shaft counterclockwise. When the ratchet pin reaches the 6 o'clock position, the closing springs are fully charged. Driving pawl (24-1) is disengaged, the spring condition indicator cam (18) has rotated allowing the spring charged flag (132) to drop into the lower (charged) position, which also operates the motor cutoff switch (LS1) and spring charged switch (LS2) (258) (see **Figures 17b** and **27**). The closing springs are restrained fully charged by close hatchet (22) against close shaft (72).

Closing Mode (Figure 17b) - Energizing the close solenoid (265) pulls the solenoid armature against the closing shaft actuator (75) and causes the close shaft (72) to rotate approximately 15°. If the closing springs are charged, the close

Interrupter/Operator Description

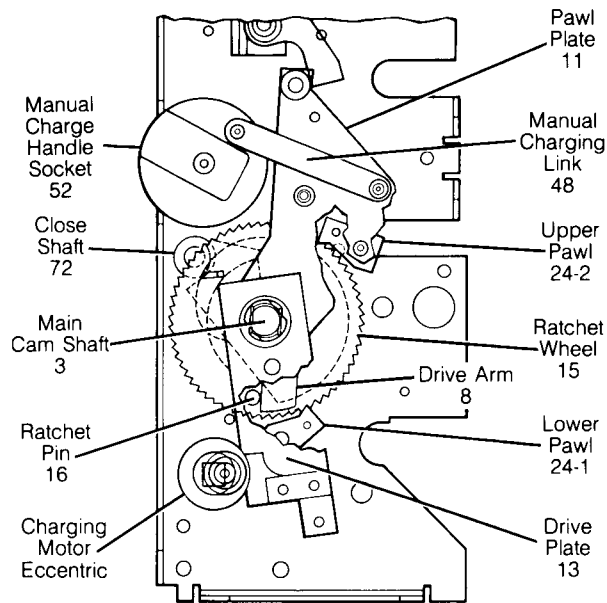


Figure 16b: Pawl and Ratchet Drive.

hatchet (22) will be released by this rotation allowing the main cam shaft (3) to be driven by the closing springs. Depressing the manual close button on the operator panel causes the rotation of the close shaft (72) by the lower end of the close shaft actuator (75). Rotation of the main cam shaft (3) in a manual closing operation is identical to that of an electrical closing operation. As the main cam shaft (3) rotates, the cam follower (115) is driven by drive cam (20), and the main link (120) is forced outwards, and rotation of the jack shaft assembly (217) occurs. There are three drive links attached to Point "A" of each of the three jack shaft drive plates. Each drive link is connected to the movable contact of one vacuum interrupter. Closing rotation (counterclockwise) of the jack shaft assembly closes the contacts of the three vacuum interrupters. During closing operation, rotation of jack shaft assembly (217) forces the opening (i.e., tripping) spring into its charged position.

Trip Free Mode - If at any time during breaker closing, the trip shaft (79) (**Figure 14b**) operates as a result of either an electrical or mechanical trip, trip hatchet (99) is free to rotate. When the trip hatchet (99) rotates, cam follower (115) is displaced by drive cam (20) without motion of the jack shaft (217). Mechanical trip free operation is provided by manual tripping, electrical tripping and/or the mechanical interlocks.

Opening Mode - Opening or tripping the vacuum interrupter contacts is accomplished by rotation of the trip shaft (79). Rotation may be produced either electrically, by energizing the trip solenoid (266) (**Figure 15b**), or manually by pressing the trip button. Energizing the trip solenoid causes the upper arm of the trip actuator (152) to rotate counterclockwise. Pressing the trip button causes the trip actuator lower arm to move, again producing rotation of the trip shaft. All of the linkages are trip free, and tripping or opening is unaffected by charging status of the closing springs or position of the drive cam (20).

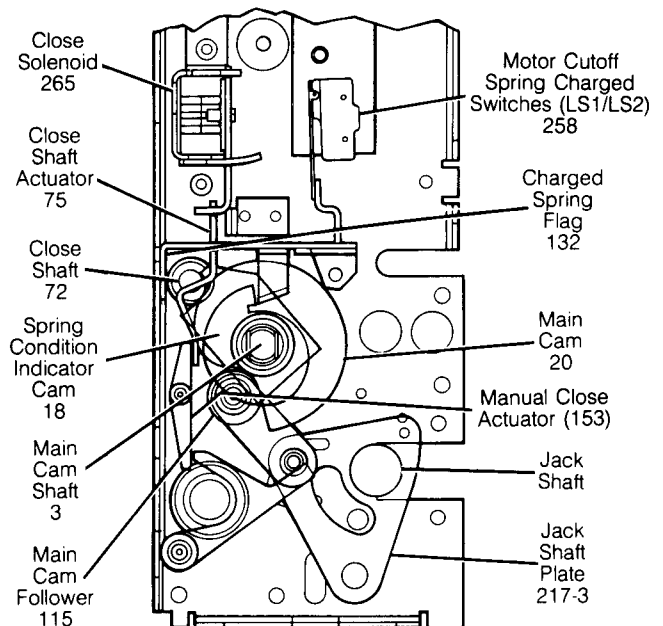


Figure 17b: Closing Mode

Rapid Auto-Reclosing Mode (Optional) - The closing springs are automatically recharged by the motor driven operating mechanism when the breaker has closed. The operating mechanism is capable of the open-close-open duty cycle required for rapid auto-reclosing. A trip latch check switch and a relay (delay on dropout) prevent release of the closing spring energy if the trip hatchet (99) is not in its reset position. This ensures the mechanism does not operate trip free on an instantaneous reclosure.

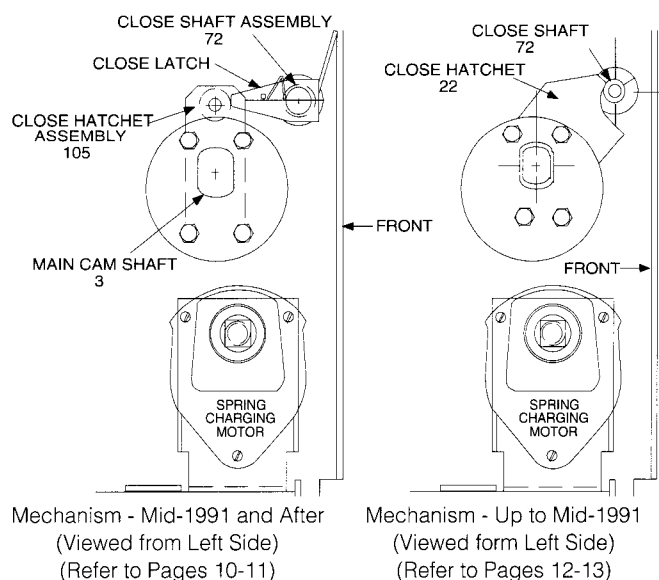


Figure 18b: Identification of Mechanism Vintage

Interrupter/Operator Description

Closing and Opening Springs - The stored energy assembly consists of two dual closing springs and a single opening spring. **Figure 19** shows the three springs and their linkages to the charging devices. The two closing springs are connected to crank arms mounted on the rotating main cam shaft. The closing springs are extended, and charged, by rotation of the crank arms connected to the movable ends of the springs. The fixed ends of these springs are attached to a support arm, which in turn is bolted to the structure of the circuit breaker.

The opening spring is connected to the jack shaft. When the circuit breaker closes, rotation of the jack shaft causes the opening spring push rod to compress and charge the opening spring. Consequently, the opening spring is automatically charged whenever breaker contacts are closed.

Trip Free Operation - The GMI circuit breaker is mechanically and electrically trip free. This important function enables the breaker to be tripped before, after or during a closing operation. Whenever the circuit breaker trip shaft is moved as the result of manual or electrical signals or mechanical interlocks, a) a closed breaker will open, b) a breaker in the process of closing will not complete the close operation and will remain open, or c) an open breaker will not be able to be closed.

Damper - GMI circuit breakers are equipped with a sealed, oil-filled, viscous damper, or shock absorber (**Figure 19**). The purpose of this damper is to limit overtravel and rebound of the vacuum interrupters' movable contacts during the conclusion of an opening operation. The damper action affects only the end of an opening operation.

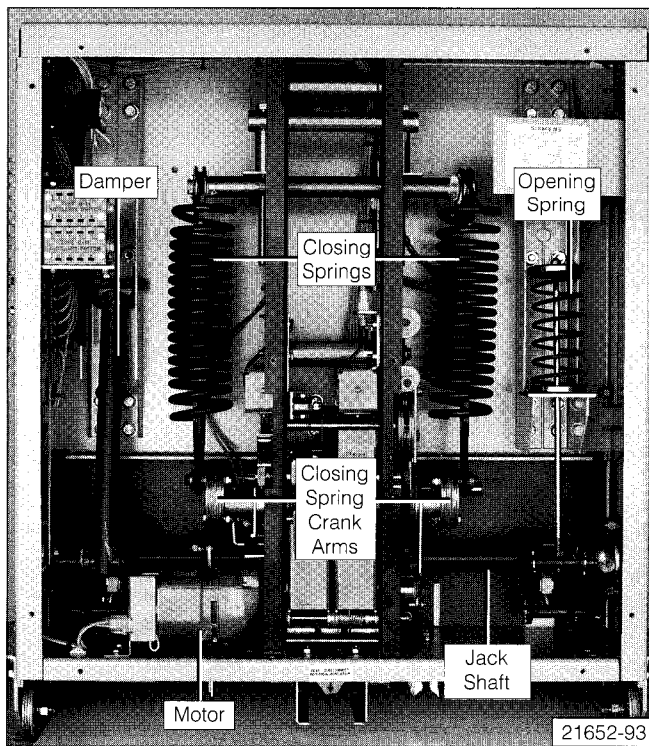


Figure 19: Closing and Opening Springs, Spring Charging Motor and Damper.

The cylindrical body of the damper is secured to the breaker frame, with a yoke. The damper's piston and striker tip protrude from the opposite end of this cylinder (the lower end as installed on the breaker). A striker block is fixed within an outer tube, which is guided by the cylindrical body of the damper. The end of the outer tube is attached to the breaker jack shaft.

The outer tube and (inner) damper remain uncoupled until the end of the opening operation is reached. At this time, the tube's striker block contacts the damper piston, to begin control of movable contact dynamics.

Manual Spring Charging - Manual charging of the closing springs is accomplished using a lever in lieu of the spring charging motor. **Figure 20** shows the principal components of the manual spring charging mechanism.

The manual spring charging lever is inserted into a rectangular socket in the hand operator. This socket is accessible through the front panel of the circuit breaker. Moving the lever up and down in a cranking or pumping motion causes rotation of the internal spring charging components.

Note: Manual spring charging components will be damaged by overcharging.

Manual charging action must be suspended when the operator sees the "Charged" status indicator appear on the front panel of the circuit breaker and hears the sound of impact against the internal closing latch.

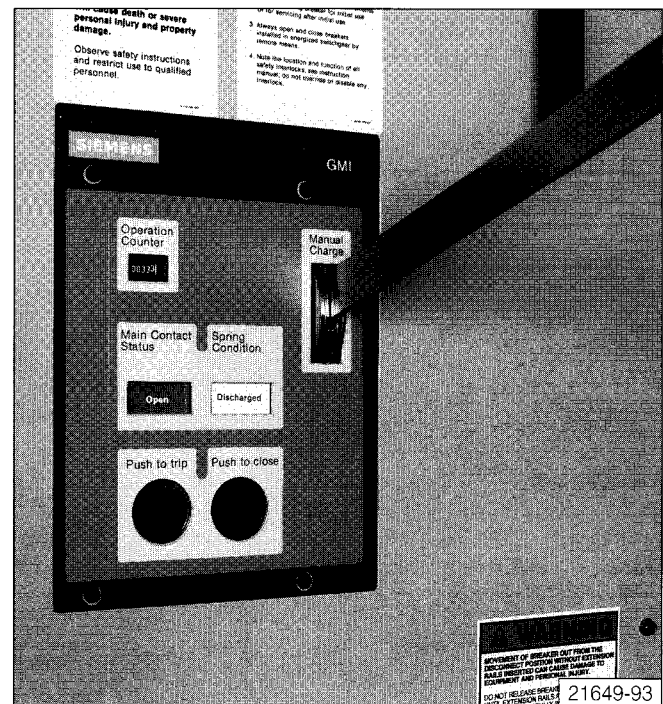


Figure 20: Manual Charging of the Closing Springs.

Interrupter/Operator Description

Spring Charging Motor - Figure 19 shows the spring charging motor mounted at the bottom of the left side of the circuit breaker housing. A mounting bracket holds the motor firmly in place. A universal motor is used to permit operation on either AC or DC control power.

The motor control circuits call for automatic charging of the springs by the motor whenever control power is available and the springs are discharged. The springs automatically recharge following a closing operation.

Electrical connections to the motor utilize quick disconnect terminations for easy inspections or removal.

Close Solenoid, Trip Solenoid and Anti-Pump Relay - Figure 21 shows the two solenoids controlling operation of the circuit breaker by external electrical signals.

When the close solenoid is energized it causes the two closing springs to be released from their extended or charged state. This forces the three insulating push rods to move the movable vacuum interrupter contacts vertically upwards, and close the circuit breaker.

The anti-pump relay (Figure 41) electrically isolates signals to the close solenoid such that only one releasing action by the close solenoid can occur during each application of the close command. The circuit breaker must be tripped, the springs recharged and the closing signal removed (interrupted) before the close solenoid can be energized the second time.

When the trip solenoid is energized, it allows rotation of the jack shaft by the tripping spring. This rotation pulls the insulating push rods attached to the movable contacts of the three vacuum interrupters, and the circuit breaker contacts are opened.

Electrical connections to the close solenoid and trip solenoid are made through quick disconnect terminations.

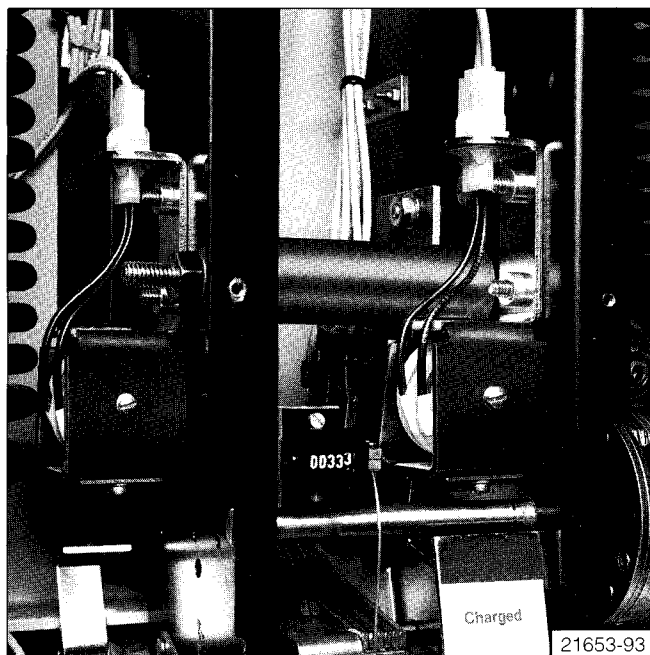


Figure 21: Close (Right) and Trip (Left) Solenoids.

Secondary Disconnect - Signal and control power is delivered to the internal circuits of the breaker by an arrangement of movable contact fingers mounted on the left side of the circuit breaker. These fingers are shown in Figure 22.

When the circuit breaker is racked into the Test or Connected positions in the metal-clad switchgear, these disconnect fingers engage a mating disconnect block on the inside of the switchgear shown in Figure 23. These electrical connections automatically disengage when the circuit breaker is racked from the Test to the Disconnect position.

All of the control power necessary to operate the circuit breaker is connected to this disconnect block inside the switchgear. The external trip and close circuits and status indicators are also connected to this same disconnect block.



Figure 22: Secondary Disconnects on Circuit Breaker.

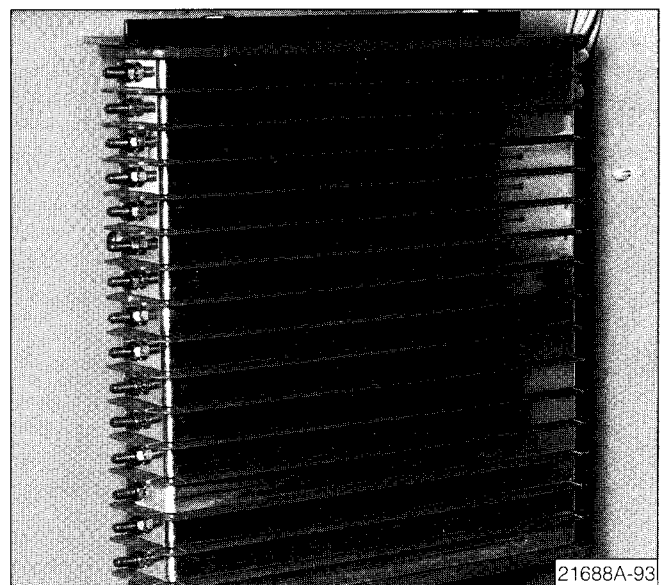


Figure 23: Secondary Disconnect Inside Switchgear.

Interrupter/Operator Description

Auxiliary Switch - Figure 24 shows the breaker mounted auxiliary switch. This switch provides auxiliary contacts for control of circuit breaker closing and tripping functions. Contacts are available for use in relaying and external logic circuits. This switch is driven by linkages connected to the jack shaft. The auxiliary switch contains both 'b' (Normally Closed) and 'a' (Normally Open) contacts. When the circuit breaker is open, the 'b' switches are closed and the 'a' switches are open.

MOC (Mechanism Operated Cell) Switch - Figures 25 and 26 show the principal components that provide optional control flexibility when operating the circuit breaker in the Test and Connected positions.

Figure 25 shows the MOC switch operating arm that projects from the right side of the circuit breaker, just above the bottom rail structure. The MOC switch operating arm is part of the jack

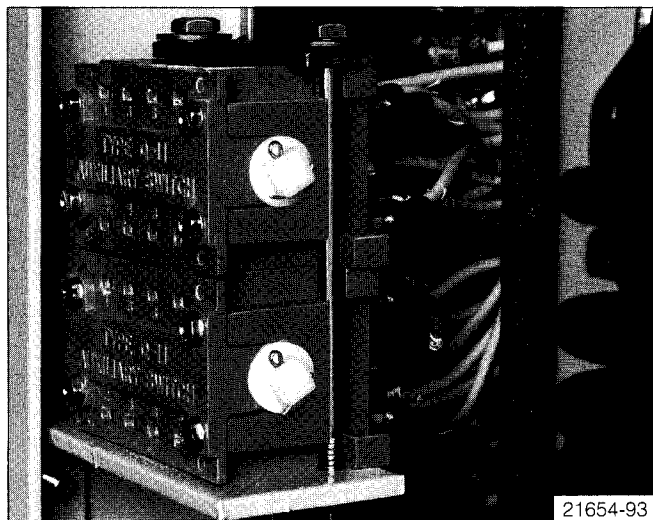


Figure 24: Auxiliary Switch.

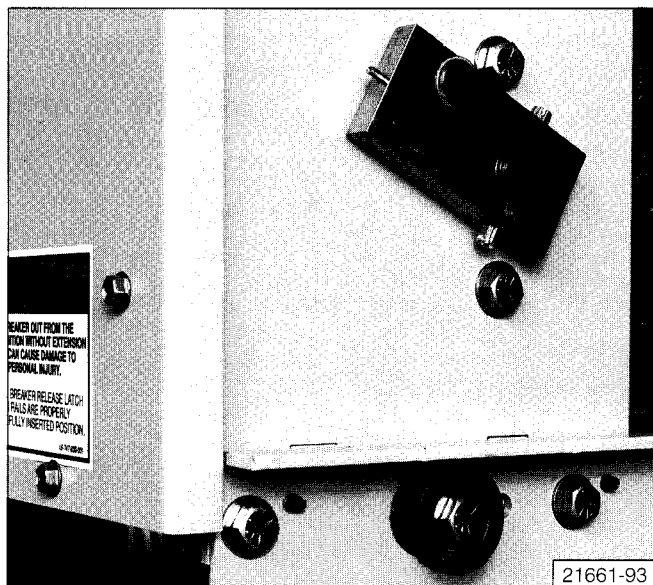


Figure 25: MOC Switch Operating Arm on Circuit Breaker.

shaft assembly, and directly reflects the open or closed position of the breaker primary contacts.

As the circuit breaker is racked into the appropriate position inside the switchgear, the MOC switch operating arm passes a wiring protective cover plate, and engages the pantograph linkage shown in **Figure 26**. Operation of the circuit breaker causes the pantograph linkage to transfer motion to the MOC switches located above the pantograph. The 'a' and 'b' contacts can be used in relaying and control logic schemes.

All circuit breakers contain the MOC switch operating arm. However, MOC switches are provided in the switchgear only when specified.

The breaker engages the MOC auxiliary switch only in the connected (operating) position unless an optional test position pickup is specified in the contract. If a test position pickup is included, the breaker will engage the auxiliary switch in both positions (**Figure 26**). Up to 24 stages may be provided.

TOC (Truck Operated Cell) Switch - Figure 26 shows the optional TOC cell switch. This switch is operated by the circuit breaker as it is racked into the Connect position.

Various combinations of 'a' and 'b' contacts may be optionally specified. These switches provide control and logic indication that a breaker in the cell has achieved the Connect (ready to operate) position.

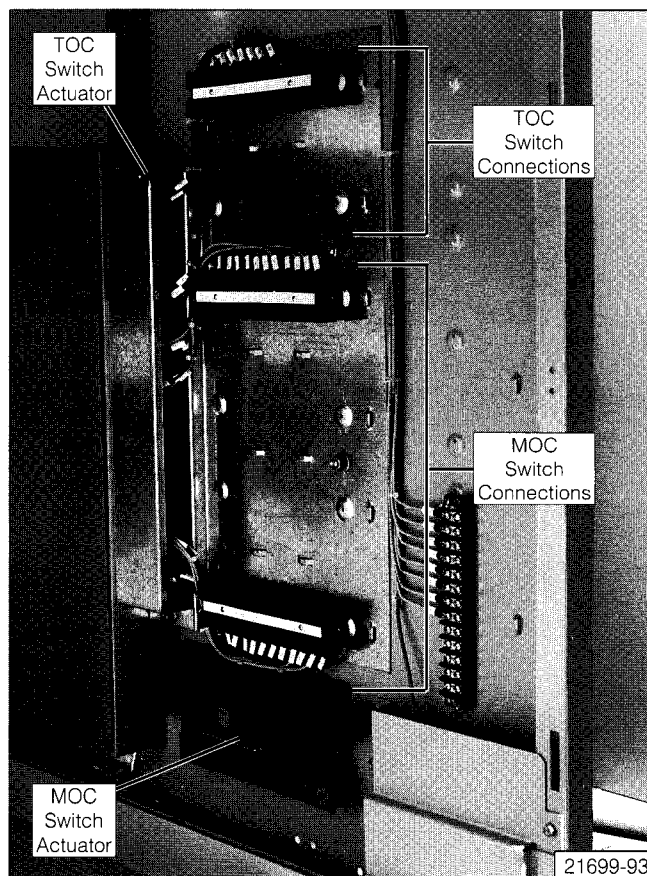


Figure 26: MOC and TOC Switches Inside Switchgear.

Interrupter/Operator Description

Limit Switches (Figure 27) - The motor cutoff switch (LS1) is used to sense the position of the driven mechanisms. This switch de-energizes the charging motor when the Charged position of the closing springs is reached. When the closing springs are discharged, this switch energizes the control circuit powering the spring charging motor.

Spring charged switch (LS2) operates simultaneously with motor switch (LS1). The spring charged switch allows the close solenoid to be energized only when the springs are charged, and also is part of the anti-pump circuitry.

The trip latch check switch (LS3) operates when the trip latch linkage is in the reset position. It also is driven by operating bars that sense when the breaker is in either the Test or Connected position inside the switchgear. Control circuitry prevents an electrical release of the closing springs unless the breaker is either in the Test or Connected position, or is out of the compartment.

The spring dump switch (LS4) operates when the circuit breaker is removed from, or is being inserted into, the cubicle.

Standard Schematic Diagrams

Note: Figure 28a shows a typical schematic for a circuit breaker which is not specifically intended for reclosing application, while Figure 28b shows a breaker for reclosing service. Figure 28c shows a breaker with capacitor tripping. These are typical — refer to the specific drawing for your project.

Inspection of the schematic diagrams shown in Figures 28a-28c provides a clear picture of the logic states of the various devices for the three basic control functions.

These are: 1) automatic charging of the closing springs; 2) electrical closing of the primary contacts and 3) electrical tripping of the primary contacts.

Automatic spring charging by charging motor occurs when secondary control power is available, and motor cutoff switch LS1 has not operated. The springs are automatically re-charged after each closing operation.

Electrical closing occurs with closing control power applied and when *all* of the following conditions exist: 1) External control switch CS/C is closed; 2) Anti-pump relay 52Y is not energized; 3) Auxiliary switch 52b indicates the breaker is in open position; 4) Limit switch LS3 shows that the trip latch has been reset and the circuit breaker is in the Test or Connected position, or is out of the compartment; and 5) Limit switch LS2 indicates that the closing springs are charged. Electrical tripping occurs with tripping control power applied and when the auxiliary switch 52a shows the breaker is closed, and a trip signal is provided by the control switch CS/T or the protective relays. While external control power is required for either electrical closing or tripping, the circuit breaker can be manually charged, closed and tripped without external control power.

Capacitor Trip Device (Optional)

The capacitor trip device is an auxiliary tripping option providing a short term means of storing adequate electrical energy to ensure breaker tripping.

This device is applied in breaker installations lacking independent auxiliary control power or station battery. In such installations, control power is usually derived from the primary source. In the event of a primary source fault, or disturbance with attendant depression of the primary source voltage, the capacitor trip device will provide short term tripping energy for breaker opening due to relay operation.

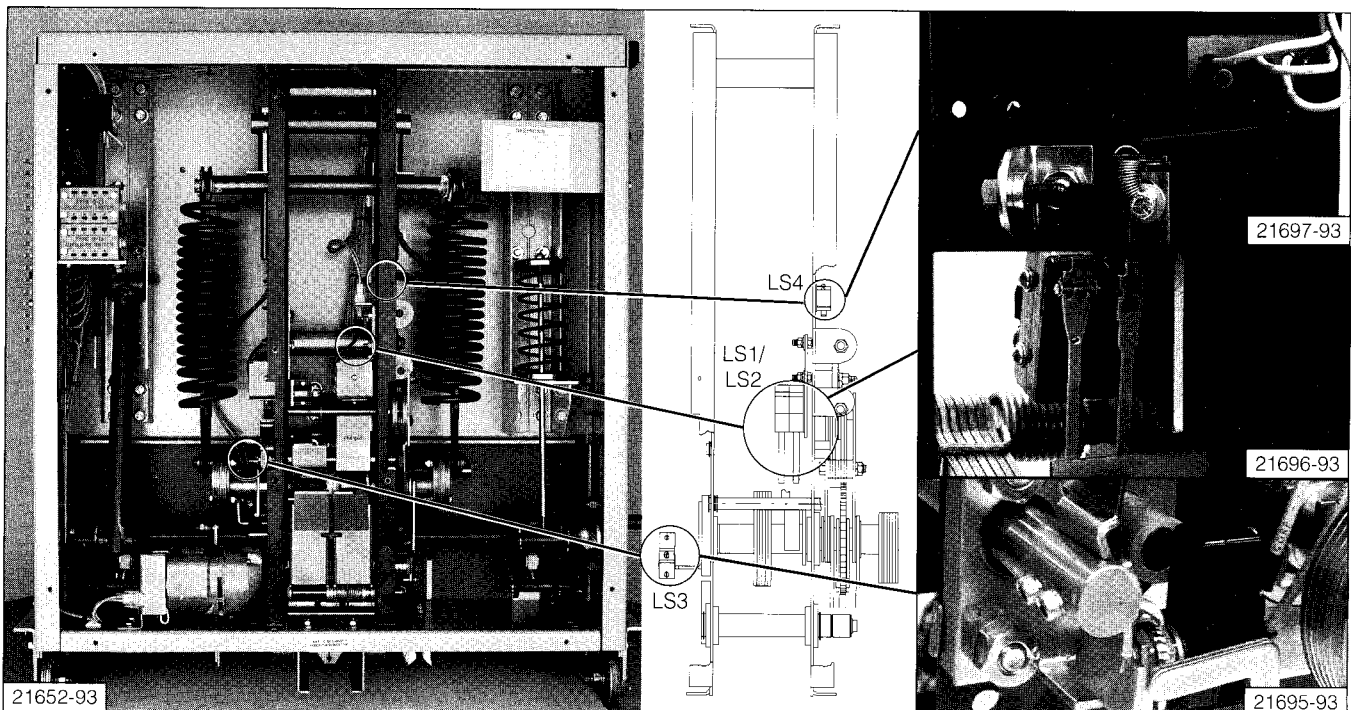


Figure 27: Circuit Breaker Limit Switches.

Interrupter/Operator Description

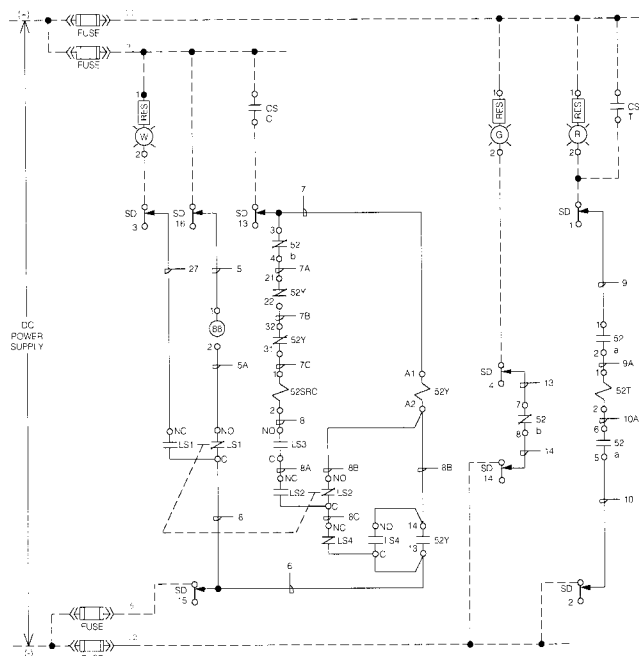


Figure 28a: DC Control Power (Non-Reclosing).

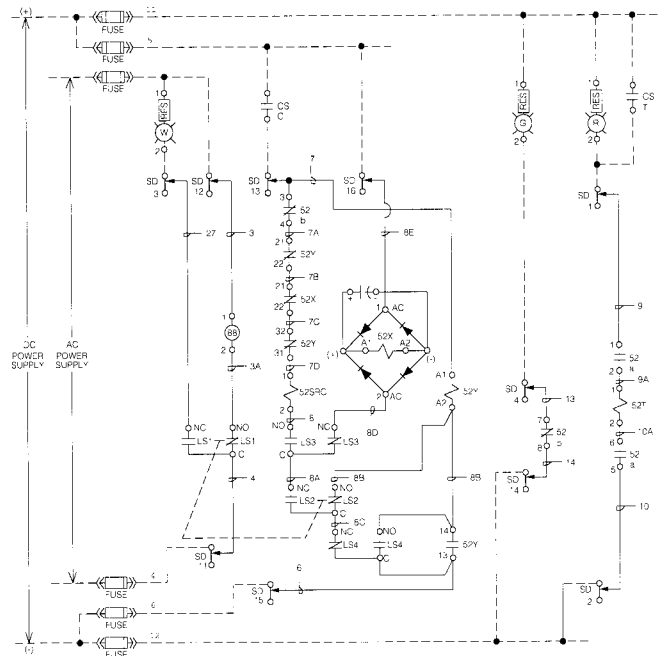


Figure 28b: AC and DC Control Power (Reclosing).

Symbols

- LS1 • Motor Cutoff Switch
- LS2 • Spring Charged Switch
- LS3 • Checks Trip Latch Reset and Blocks Electric Close while Racking "Test" to "Connect"
- LS4 • Spring Dump Switch

- 52/a • Aux. Switch, Open when Brk. is Open
- 52/b • Aux. Switch, Closed when Brk. is Open
- 52Y • Anti-Pump Relay
- 52T • Opening Solenoid (Trip)
- 52SRC • Spring Release Solenoid (Close)
- 52X • Reclosing Control Relay

- 88 • Spring Charging Motor
 - SD • Secondary Disconnect
 - CS/C • Control Switch Close
 - CS/T • Control Switch Trip
 - R • Red Indicating Lamp
 - G • Green Indicating Lamp
 - W • White Indicating Lamp
- } Typical Remote Devices

Notes on Schematic Arrangement

- Schematics are shown with:
1. Closing Springs Discharged
 2. Breaker Open
 3. Breaker Located in Test, Connect or Withdrawn Position

Note that, in this condition, the trip latch is free to reset, but is temporarily blocked until the closing springs are partially recharged. Prior to full spring charge, LS3 (NO) closes, and LS3 (NC) opens.

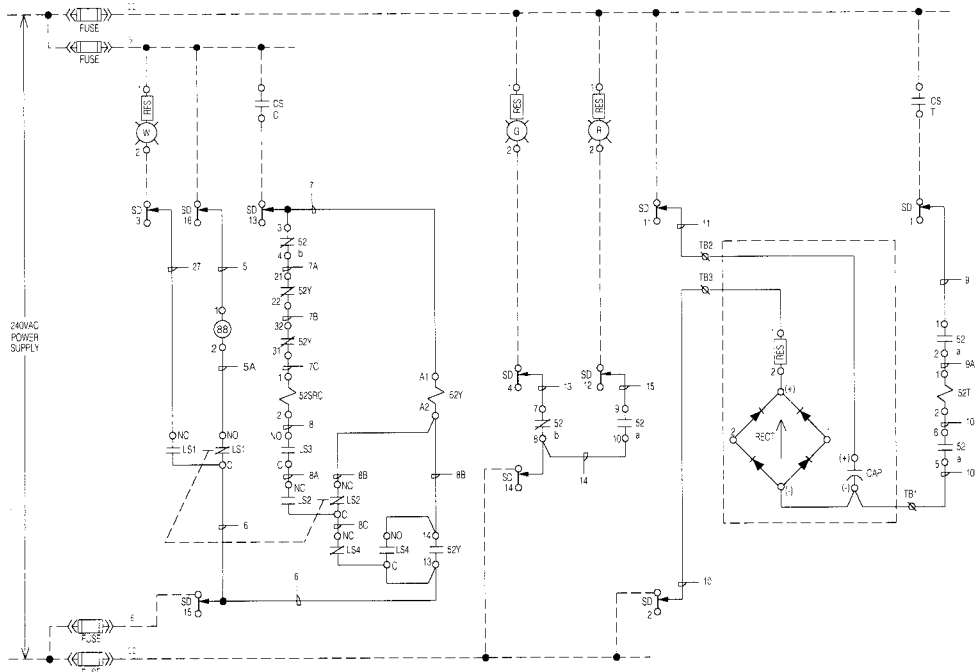


Figure 28c: AC Control Power (with Capacitor Trip).

Interrupter/Operator Description

Refer to **Figure 28c**. An electrolytic capacitor resides across the tripping supply voltage connected through a half wave rectifier and resistor. The rectifier allows the capacitor to assume a charge approximating the peak voltage of the AC tripping supply voltage. The series resistor limits the magnitude of charge current flowing into the capacitor.

The charged capacitor is then connected across the breaker trip coil circuit through an external contact which closes upon trip command.

The capacitor size and charge current magnitude are tuned to the inductance and resistance of the tripping solenoid, an RLC series circuit, to produce a discharge current through the solenoid which emulates the magnitude of current and current duration which the solenoid would experience if operated from a DC tripping supply voltage.

Undervoltage Release (Optional)

The undervoltage release is used for continuous monitoring of the tripping supply voltage. If the trip supply voltage falls significantly, the undervoltage release will provide for automatic tripping of the breaker.

Description of Operation - The undervoltage release consists of a spring stored energy mechanism, a latching device and an electromagnet. These elements are accommodated in a single assembly as shown in **Figure 29**.

The stored energy spring (1), spring charging arm (2) and latch face are arranged in a cylindrical assembly concentric with the trip latch shaft (3). The cylindrical assembly is retained by the support bracket (4), yet remains free to rotate. The cylindrical assembly is supported by the trip latch shaft which rotates freely on the trip shaft supported by needle bearings.

The stored energy torsion spring (1) has one tail bearing on a lug fixed to the cylindrical assembly, and an opposite tail fixed

on a lug of the support bracket. Thus, the torsional tension of the spring will cause the cylindrical assembly (5) to be forcibly rotated relative to the support bracket.

The cylindrical assembly is notched at the end nearest the mechanism side sheet with the notch engaging a spring pin (6) driven into the trip latch shaft. The notch has sufficient arc width to permit the trip latch shaft to rotate normally in response to the breaker receiving a trip command.

The breaker jackshaft (7) is fitted with an arm and track roller (8) which bears on the charging arm (2) of the cylindrical assembly. Whenever the breaker is opened, the arm and roller cause the charging arm to be rotated charging or winding up the stored energy torsion spring.

A spring loaded latch arm (9) rises to engage the latch face which is an integral feature of the cylindrical assembly. The latch arm (9) is held in this position by the vertical lever (10) which is pulled to the supporting position by the electromagnet. The vertical lever is pivoted (11) by the electromagnet (12) against the force developed by an extension spring (13) which constantly attempts to pull the vertical lever (10) into a position which releases the stored energy torsion spring.

The latch arm supported by the vertical lever retained in position by the electromagnet will retain the stored energy state until the electromagnet senses a loss of trip supply voltage. When the supply voltage falls to a level 30 to 60 percent of nominal, the electromagnet releases the vertical lever, the latch arm descends and the cylindrical assembly rotates displacing the trip shaft. Latching is established at 85% nominal voltage.

Interlocks

There are two interlocks which prevent certain unsafe operating conditions. They are the rating interlock and the trip-free interlock.

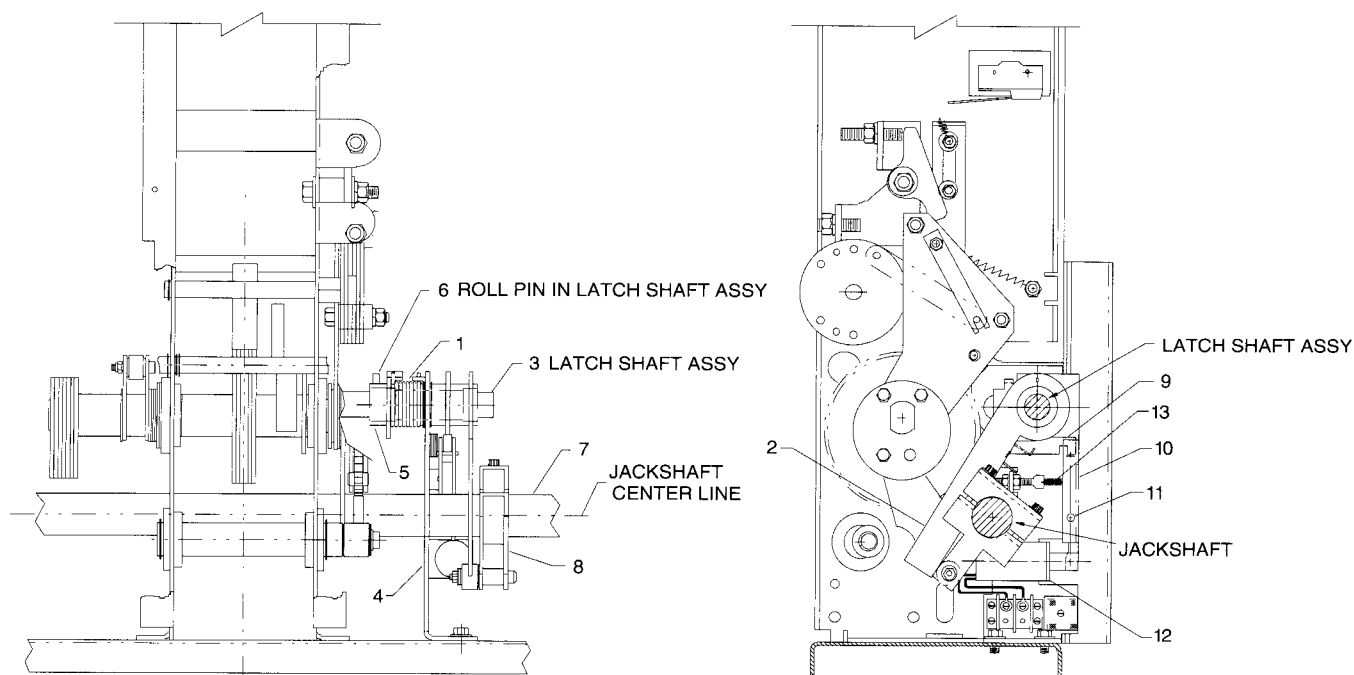


Figure 29: Undervoltage Trip Option.

Interrupter/Operator Description

Trip Free Interlock - Figure 30 shows the devices providing the trip-free interlock function. The purpose of the trip-free interlock is to hold the circuit breaker operating mechanism mechanically and electrically trip free whenever the breaker is between the Test and Connected positions within the switchgear enclosure. This interlock ensures that the circuit breaker primary contacts can only be closed when in the Connect position, or the Test position, or out of the switchgear cell.

Rating Interlock - Figure 30 shows the rating interlock interference plates mounted on the circuit breaker frame. The breaker interference plates are complemented by matching plates located in the cubicle.

The interference plates (rating interlocks) test the breaker voltage, continuous current, interrupting and momentary ratings and will not allow breaker insertion unless they match or exceed the cell rating.

Circuit Breaker Frame

The frame of the GMI circuit breaker contains several important devices and features deserving of special attention. These are the ground disconnect, the four racking wheels and four handling wheels.

Ground Disconnect - Figure 30 shows the ground disconnect contact mounted at the bottom of the circuit breaker. The spring loaded fingers of the disconnect contact engage the ground bar (**Figure 31**) at the bottom of the switchgear assembly. The ground bar is to the right of the racking mechanism, shown at the bottom center of the switchgear.

Circuit Breaker Handling Wheels - The GMI circuit breaker is designed for easy movement into and out of the metal-clad switchgear assembly. A section of indoor or Shelter-Clad switchgear does not require a transfer truck or lifting truck for

handling of the breaker when all circuit breakers are located in the lower cells. Once the circuit breaker is racked out of the switchgear, the unit can be pulled using the handles on the front of the breaker. The breaker will roll on its bottom four wheels.

On indoor and Shelter-Clad switchgear with circuit breakers located in the lower cell, the circuit breaker is easily rolled out of the switchgear by a single person. When circuit breakers are located in the upper cells, handling of the circuit breakers requires the use of a hoist or crane. These lifting devices are also required for removal of the lower circuit breaker of non walk-in type outdoor switchgear.

Racking Mechanism

Figure 31 shows the racking mechanism in the switchgear used to move the circuit breaker between the Disconnect, Test and Connected positions. This mechanism contains a set of interface blocks that mate with the bottom of the circuit breaker housing, and lock the breaker to the racking mechanism during in and out movement. A racking handle (not shown) mates with the threaded shaft of the racking mechanism. Clockwise rotation of the crank moves the breaker into the switchgear, and counterclockwise rotation removes it.

The racking and trip-free interlocks provide several essential functions.

1. They prevent racking a closed breaker into or out of the switchgear assembly.
2. They discharge the closing springs whenever the circuit breaker is inserted into, or withdrawn from, the switchgear.
3. They prevent closing of the circuit breaker unless it is in either the Test or Connect positions.

The rating interlock prevents insertion of a lower rated circuit breaker into a cubicle intended for a breaker of higher ratings.

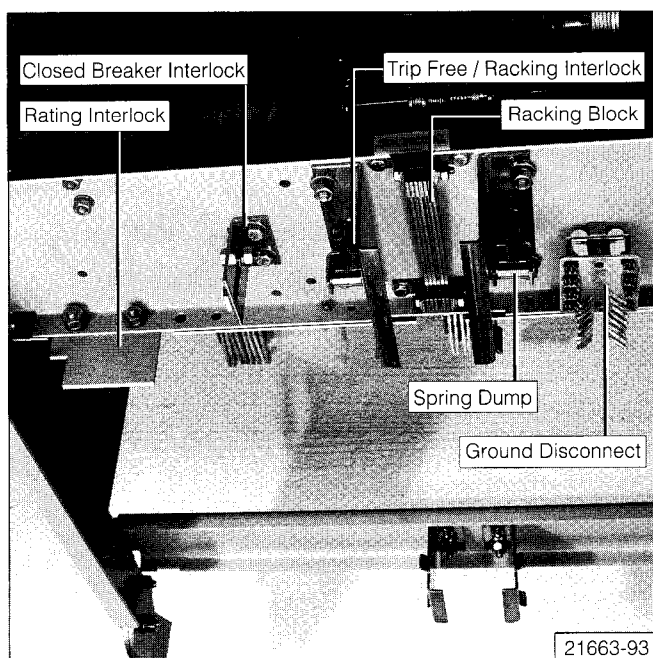


Figure 30: Breaker Interlocks and Ground Disconnect.

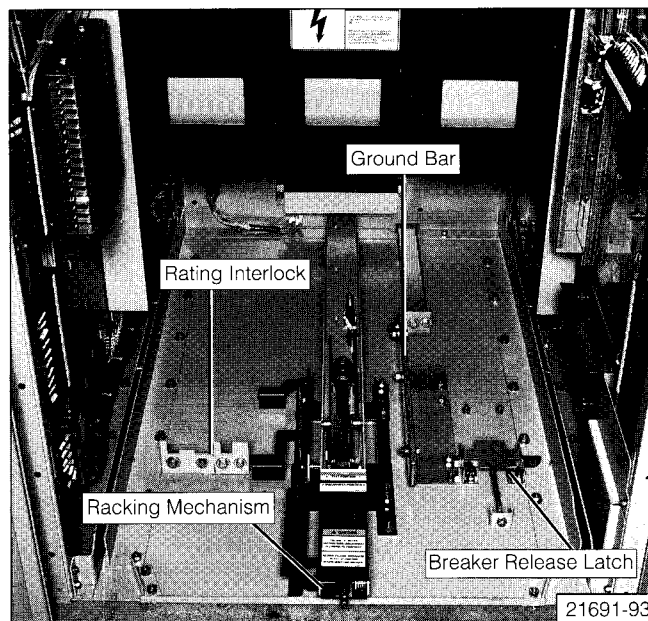


Figure 31: Racking Mechanism and Floor Interlocks.

Maintenance


Introduction and Maintenance Intervals

Periodic inspections and maintenance are essential to obtain safe and reliable operation of the GMI circuit breaker.

When GMI circuit breakers (manufactured beginning January, 1992) are operated under "Usual Service Conditions", maintenance and lubrication is recommended at five year (one year if manufactured before January, 1992) intervals or at the number of operations indicated in Table 2. "Usual" and "Unusual" service conditions for Medium Voltage Metal-Clad Switchgear are defined in ANSI C37.20.1, sections 3 and 7.1. Generally, "usual service conditions" are defined as an environment in which the equipment is not exposed to excessive dust, acid fumes, damaging chemicals, salt air, rapid or frequent changes in temperature, vibration, high humidity, and extremes of temperature.

The definition of "usual service conditions" is subject to a variety of interpretations. Because of this, you are best served by adjusting maintenance and lubrication intervals based on your experience with the equipment in the actual service environment.

Regardless of the length of the maintenance and lubrication interval, Siemens recommends that circuit breakers should be inspected and exercised annually.

	⚠ DANGER
	Hazardous voltages and high-speed mechanical parts.
	Will cause death, severe personal injury, or property damage. Read instruction manuals, observe safety instructions and limit use to qualified personnel.

For the safety of maintenance personnel as well as others who might be exposed to hazards associated with maintenance activities, the safety related work practices of NFPA 70E, parts II and III, should always be followed when working on electrical equipment. Maintenance personnel should be trained in the safety practices, procedures and requirements that pertain to their respective job assignments. This manual should be reviewed and retained in a location readily accessible for reference during maintenance of this equipment.

The user must establish a periodic maintenance program to ensure trouble-free and safe operation. The frequency of inspection, periodic cleaning, and preventive maintenance schedule will depend upon the operation conditions. NFPA Publication 70B, "Electrical Equipment Maintenance" may be used as a guide to establish such a program. **A preventive maintenance program is not intended to cover reconditioning or major repair, but should be designed to reveal, if possible, the need for such actions in time to prevent malfunctions during operation.**

Recommended Hand Tools

Type GMI breakers use both standard American and metric fasteners. Metric fasteners are used for the GMI vacuum interrupters. American fasteners are used in all other locations. This list of hand tools describes those normally used in disassembly and re-assembly procedures.

Metric (Vacuum Interrupter Only)

- Deep Sockets: 19 and 24mm
- Torque Wrench: 0-150 Nm (0-100 ft-lbs.)
- Allen Wrenches: 8 and 10mm

American (All Other Breaker Locations)

- Socket and Open-End Wrenches: 5/16, 3/8, 7/16, 1/2, 9/16 and 3/4 in.
- Hex Keys: 3/16 and 1/4 in.
- Screwdrivers: 0.032 x 1/4 in. wide and 0.55 x 7/16 in. wide
- Pliers
- Light Hammer
- Dental Mirror

Recommended Maintenance and Lubrication

Periodic maintenance and lubrication should include all the tasks shown in **Table 1**. Recommended procedures for each of the listed tasks are provided in this section of the manual.

⚠ WARNING

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

The instructions contained herein should be carefully reviewed, understood, and followed.

The maintenance tasks in Table 1 must be performed regularly.

Table 1: Maintenance Tasks

- Checks of the Primary Power Path
- Checks of the Interrupter Operator Mechanism
- Electrical Control Checks
- High Potential Test
- Inspection and Cleaning of Breaker Insulation
- Functional Tests

For a "quick reference" to these tasks see "Periodic Maintenance and Lubrication Tasks" chart on page 36.

The list of tasks in Table 1 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.

⚠ DANGER

THE USE OF UNAUTHORIZED PARTS IN THE REPAIR OF THE EQUIPMENT, OR TAMPERING BY UNQUALIFIED PERSONNEL WILL RESULT IN DANGEROUS CONDITIONS WHICH CAN CAUSE DEATH, SERIOUS INJURY OR EQUIPMENT DAMAGE. FOLLOW ALL SAFETY INSTRUCTIONS CONTAINED HEREIN.

Removal from Switchgear

Prior to performing any inspection or maintenance checks or tests, the circuit breaker must be removed from the switchgear. The Installation and Initial Functional Tests section describes the removal procedure in detail. Principal steps are repeated here for information and guidance, but without the details of the preceding section.

Maintenance

1. The first step is to de-energize the circuit breaker. **Figure 32** illustrates the location of the trip control on the circuit breaker operator panel. Depressing the Trip pushbutton opens the breaker prior to removal from the switchgear.
2. The second step in the removal procedure is to de-energize control power to the circuit breaker. Open the control power disconnect device mounted above the lower breaker or below the upper breaker. Review **Figure 1**.
3. Rack the breaker to the Disconnect position.
4. Perform the spring discharge check. This is done by first depressing the red Trip pushbutton. Second, depress the black Close pushbutton. Third, depress the red Trip pushbutton again, and observe the spring condition indicator. It should read Discharged.

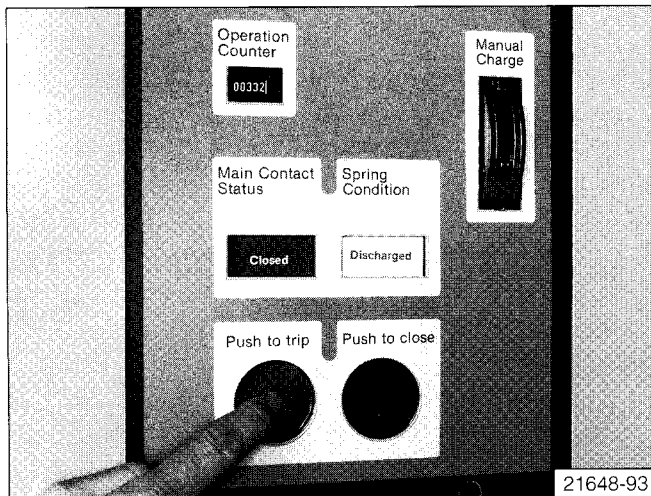


Figure 32: Manual Tripping of Circuit Breaker.

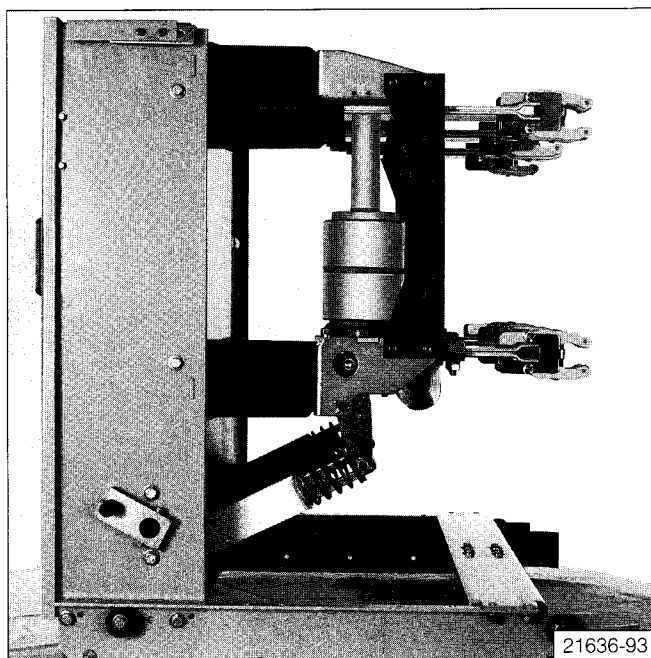


Figure 33: GMI Breaker Showing Vacuum Interrupters and Primary Disconnects

Figure 32 shows the breaker spring condition indicator in the Discharged position.

5. Remove the breaker from the switchgear. Refer to the preceding installation section of this manual for special instructions and precautions regarding removal of the upper breaker.
6. The breaker can be located either on the floor or on a pallet. Each breaker has four wheels and handles to allow one person to maneuver the unit on a level surface without assistance.

Checks of the Primary Power Path

The primary power path consists of the three vacuum interrupters, the three upper and the three lower primary disconnects. These components are checked for cleanliness and condition. The vacuum interrupters are also checked for vacuum integrity.

Some test engineers prefer to perform the contact erosion check during the manual spring charging check of the operator, since charging of the springs is necessary to place the contacts in the closed position.

Also, the vacuum integrity check is usually performed in conjunction with the High Potential tests.

These instructions follow the recommendation that these tests (contact erosion/manual spring charging check, and vacuum integrity/high potential tests) will be combined as described.

Cleanliness Check - Figure 33 is a side view of the GMI circuit breaker with the outer insulating barriers removed to show the vacuum interrupter, and the upper and lower primary disconnects.

All of these components must be cleaned and free of dirt or any foreign objects. Use a dry lint-free cloth. For stubborn dirt, use a clean cloth saturated with denatured alcohol.

Inspection of Primary Disconnects - Figure 34 shows the primary disconnect contact fingers engaged. When the contacts are mated with the switchgear's primary stud assembly, there is forceful contact distributed over a wide area. This maintains low current flow per individual contact finger.

Inspect the contact fingers for any evidence of burning or pitting that would indicate weakness of the contact finger springs.

Inspect the primary disconnect arms for physical integrity and absence of mechanical damage.

Inspect the flexible connectors that connect the bottom movable contacts of the vacuum interrupters to the lower primary disconnect arms for tightness and absence of mechanical damage, burning, or pitting.

Using a clean cloth saturated with denatured alcohol, clean old lubricant from primary disconnects, and apply Siemens contact lubricant (reference 15-171-370-002) in a very thin layer.

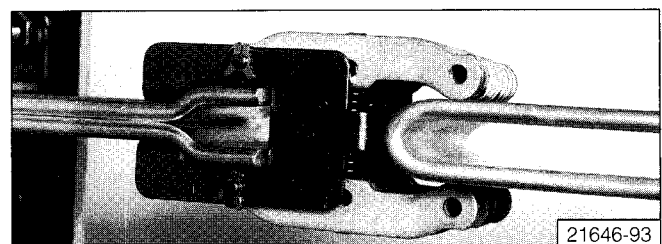


Figure 34: Primary Disconnect in Mated Position.

Maintenance

Checks of the Stored Energy Operator Mechanism

The stored energy operator checks are divided into mechanical and electrical checks for simplicity and better organization. This first series of checks determine if the basic mechanism is clean, lubricated and operates smoothly without control power. The contact erosion check of the vacuum interrupter is also performed during these tasks.

Maintenance and Lubrication

Table 2: Maintenance and Lubrication Intervals

ANSI C37.06 Table 8 - Usual Service Conditions

Maintenance Based Upon Number of Breaker Closing Operations

Breaker Type	Number of Years/Closing Operations
5-GMI-350 15-GMI-1000	5 years ¹ /1,000 operations
All others	5 years ¹ /2,000 operations

¹ Five year interval for GMI breakers manufactured January, 1992 or later. One year interval for units manufactured earlier.

The interrupter operator mechanism is shown in **Figure 35** with the front cover and the operator control panel removed to show construction details. Both the tripping spring and the two closing springs are shown. The movable end of each closing spring is connected to a crank arm. The movable end of the opening spring is connected to the jack shaft by a pull rod. The dashpot is connected to the jack shaft operating shaft by a pushrod linkage.

Clean the entire stored energy operator mechanism with a dry, lint-free cloth.

Check all components for evidence of excessive wear. Place special attention upon the closing spring cranks and the various pushrods and linkages.

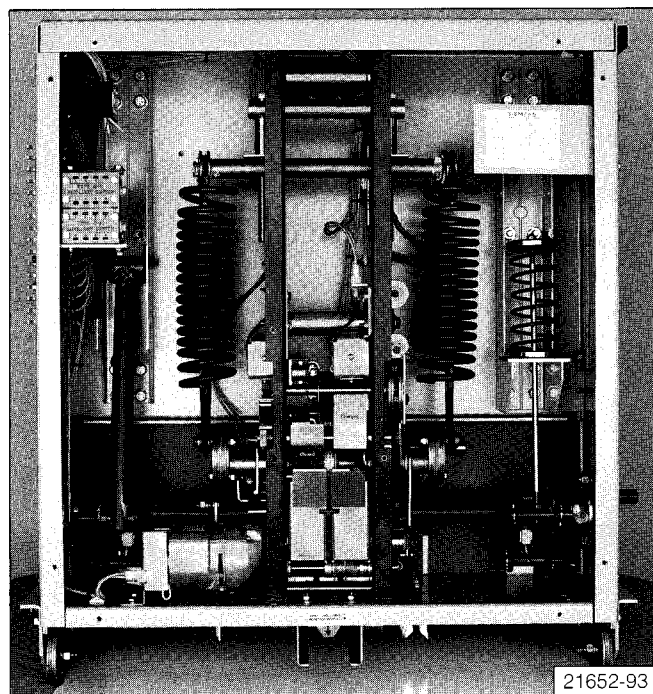


Figure 34: Front View of Operator Mechanism.

Lubricate all non-electrical moving or sliding surfaces with a light coat of synthetic grease or oil. Lubricants composed of diester oils and lithium thickeners will be compatible.

Shell (drawn cup) needle bearings: Use either Beacon (Exxon) 325 (reference 18-658-676-422 and part number 15-337-131-001), or Supermil (Amoco) A-72832 (reference 18-758-676-423), or Anderol 732.

Pivots, sliding, and/or rolling surfaces and general lubrication: Use Anderol 732 aerosol synthetic fluid grease (reference part number 15-172-816-058).

In addition to lubricating the stored energy operating mechanism, use Anderol 732 to lubricate both the OD of the bushing and the ID of the wheel for the four floor wheels.

Fastener Check - Inspect all fasteners for tightness. Both lock-nuts and retaining rings are used. Replace any fasteners that appear to have been frequently removed and replaced.

Manual Spring Charging and Contact Erosion Checks - Perform the Manual Spring Charging Check contained in the section describing the Installation Check and Initial Functional Tests. The key steps of this procedure are repeated here.

1. Insert the hand charging lever into the manual charge handle socket at the front of the operator control panel.

Figure 20 shows the lever inserted. Up and down motion of the lever charges the closing springs. Continue cranking until the Charged flag appears in the window of the spring indicator.

2. Press the Close (black) pushbutton. The contact position indicator on the operator control panel should indicate that the breaker contacts are closed.

3. Perform the contact erosion check. Contact erosion occurs when high fault currents are interrupted or when the vacuum interrupter is nearing the limit of its contact life. Determination

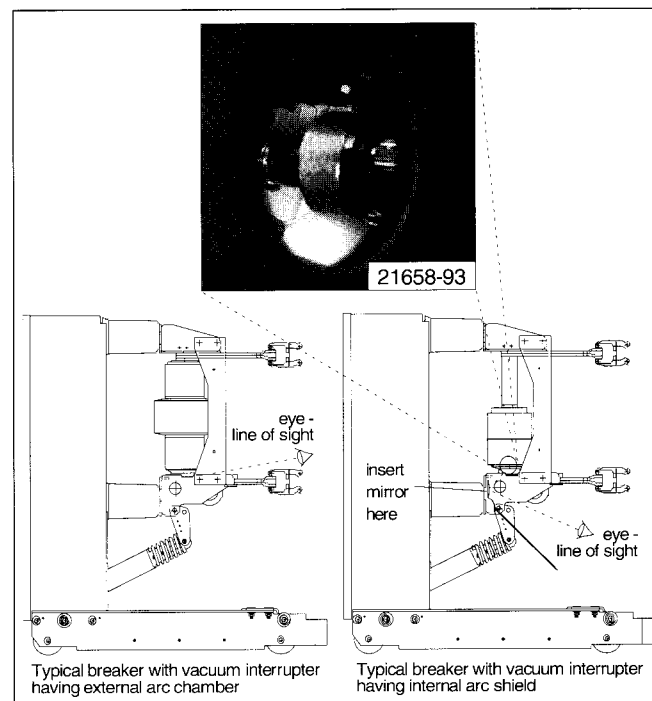



Figure 36: Contact Erosion Check Mark.

Maintenance

of acceptable contact condition is checked by the visibility of the white erosion mark shown in **Figure 36**. The white erosion mark is located in the keyway (or slot) on the movable stem of the vacuum interrupter, near the plastic guide bushing.

The contact erosion check procedure is:

- Be sure the breaker primary contacts are Closed.
- Observe the white erosion mark (**Figure 36**) of each pole. When this mark is visible, contact wear is within acceptable limits. For some circuit breakers (with a vacuum interrupter having an internal arc shield), a flashlight and dental mirror will be needed to observe the white erosion mark.



⚠ WARNING

Tripping spring is charged.

If trip latch is moved, high-speed movement of components can cause serious injury.

Observe precautions concerning physical contact with components of the circuit breaker subjected to sudden, high speed movement.

4. Press the red Trip pushbutton *after* completing the contact erosion check. Visually verify the Discharge condition of the closing springs and that the circuit breaker contacts are Open.
5. Press the black Close pushbutton. Nothing should happen. The manual spring check should demonstrate smooth operation of the operating mechanism.

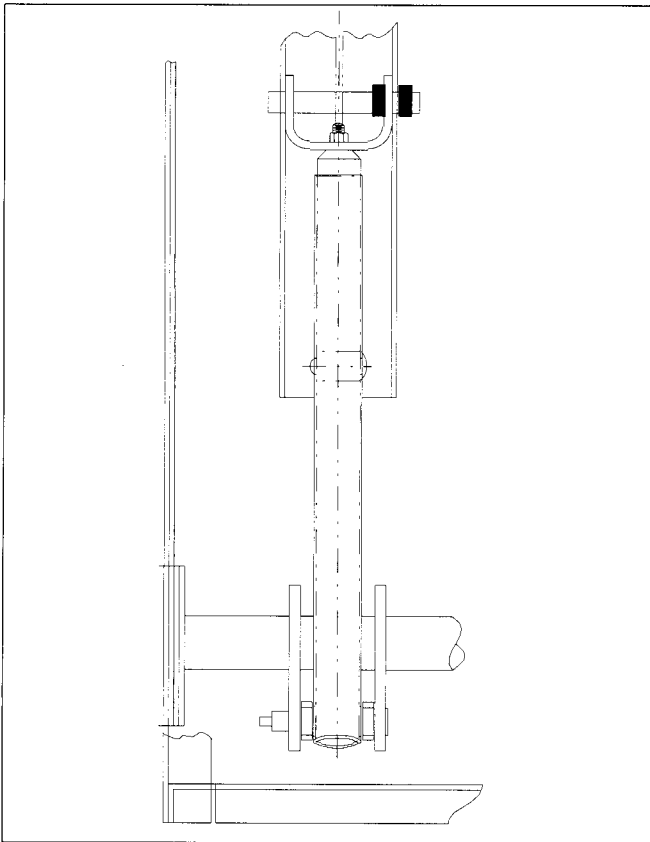


Figure 37: Damper Assembly.

Damper Assembly Check - GMI circuit breakers contain a viscous damper assembly, shown in **Figure 37**, and described in some detail on page 14, and in **Figure 19**.

While performing the manual spring charging check, a simple check of the damper mounting yoke, pin, retaining rings, and the nut for tightness should be completed.

The cylindrical surface of the damper and telescoping tube should be well greased. The full periphery of the tube and cylinder should be coated with Beacon 325.

Electrical Control Checks


The electrical controls of the GMI circuit breaker should be checked during inspections to verify absence of any mechanical damage, and proper operation of the automatic spring charging and Close and Trip circuits.

Unless otherwise noted, all of these tests are performed *without* any control power applied to the circuit breaker.

Check of the Wiring and Terminals -

1. Physically check all of the breaker wiring for evidence of abrasion, cuts, burning or mechanical damage.
2. Check all terminals to be certain they are solidly attached to their respective device.

Check of the Secondary Disconnect - In addition to checking the terminals of the secondary disconnect, the secondary contact fingers need to be free to move without binding. Depress each finger, confirm presence of spring force (contact pressure), and verify freedom of motion.



⚠ WARNING

Hazardous voltages and high-speed mechanical parts.

Will cause death, severe personal injury, or property damage.

Read instruction manuals, observe safety instructions and limit use to qualified personnel.

Automatic Spring Charging Check—Control Power Required - Repeat the automatic spring charging check described in the section entitled Installation Checks and Initial Functional Tests.

Primary tasks of this check are:

1. The breaker is energized with control power for this check.
2. De-energize the source of control power (**Figure 1**).
3. Install the breaker end of the split plug jumper over the secondary disconnect of the circuit breaker. The split plug jumper has one male and one female connector and cannot be installed incorrectly (**Figure 7**).
4. Install the switchgear end of the plug jumper over the secondary disconnect block inside the switchgear (**Figure 8**).
5. Energize the control power source.
6. When control power is connected to the circuit breaker, the closing springs should automatically charge. Visually verify that the closing springs are charged.

Maintenance

Note: A temporary source of control power and test leads may be required if the control power source has not been connected to the switchgear. When control power is connected to the GMI circuit breaker, the closing springs should automatically charge.

Electrical Close and Trip Check—Control Power Required

- A check of the breaker control circuits is performed while the unit is still connected to the switchgear by the plug jumper. This check is made with the breaker energized by control power from the switchgear.


1. Once the breaker springs are charged, move the switchgear Close/Trip switch to the Close position. There should be both the sound of the breaker closing and indication that the breaker contacts are closed by the main contact status indicator.
2. As soon as the breaker has closed, the automatic spring charging process is repeated.
3. After a satisfactory close operation is verified, move the switchgear Close/Trip switch to the Trip position. Verify by both sound and contact position that the contacts are open. Completion of these checks demonstrates satisfactory operation of auxiliary switches, internal relays and solenoids.

Checks of the Spring Charging Motor - No additional checks of the spring charging motor are necessary. Once every 10,000 operations, the motor brushes need replacement (reference kit 18-658-612-886). Use the operation counter as the basis for establishing the operation frequency.

High-Potential Tests

The next series of tests (Vacuum Integrity Test and Insulation Tests) involve use of high voltage test equipment. The breaker under test should be inside a suitable test barrier equipped with warning lights.

Vacuum Integrity Check - A high potential test is used to verify the vacuum integrity of the circuit breaker. This test is conducted on the circuit breaker with its primary contacts in the Open position.




⚠ DANGER

High Potential tests employ hazardous voltages.

Will cause severe personal injury and death.

Follow safe procedures, exclude unnecessary personnel and use safety barriers. Keep away from the breaker during application of test voltages. Disconnect the plug jumper from between the circuit breaker and switchgear before conducting high potential tests.

After test completion, ground both ends and the middle portion of the vacuum interrupter to dissipate any static charges.



⚠ WARNING

Vacuum interrupters may emit X-ray radiation. Can cause personal injury.

X-rays can be produced when a high voltage is placed across two circuit elements in a vacuum.

Keep personnel more than six (6) feet away from a circuit breaker under test.

High Potential Test Voltages - The voltages for high potential tests are shown in **Table 3**.

Table 3 High Potential Test Voltages

Equipment kV Rating	Max AC RMS	Max DC Avg
4.76kV	14kV	20kV
8.25kV	27kV	38kV
15.0kV	27kV	38kV

Note: Do not use DC high potential testers incorporating half-wave rectification. These devices produce high peak voltages.

These high voltages will produce X-ray radiation. These devices also show erroneous readings of leakage current when testing vacuum circuit breakers.

Vacuum Integrity Test Procedure

1. Observe safety precautions listed in the danger and caution advisories. Construct the proper barrier and warning light system.
2. Ground each pole not under test.
3. Apply test voltage across each pole for one minute.
4. If the pole sustains the test voltage for that period, its vacuum integrity has been verified.

Note: This test includes not only the vacuum interrupter, but also the other insulation components in parallel with the interrupter. These include the standoff insulators and the insulated drive links, as well as the insulating (tension) struts between the upper and lower vacuum interrupter supports. If these insulation components are contaminated or defective, the test voltage will not be sustained. If so, clean or replace the affected components, and retest.

As-Found Insulation and Contact Resistance Tests - As-Found tests verify the integrity of the breaker insulation system. Megger or insulation resistance tests conducted on equipment prior to installation provide a basis of future comparison to detect changes in the protection afforded by the insulation system. A permanent record of periodic As-Found tests enables the Maintenance organization to determine when corrective actions are required by watching for significant deterioration in insulation resistance, or increases in contact resistance.

Insulation and Contact Resistance Test Equipment - In addition to the High Potential Test Equipment capable of test voltages as listed in Table 3, the following equipment is also required:

- AC High Potential tester with test voltage of 1500 volts, 60 Hz.
- Ductor for contact resistance tests.

Insulation and Contact Resistance Test Procedure

1. Observe safety precaution listed in the danger and caution advisories for the Vacuum Integrity Check tests.
2. Close the circuit breaker. Ground each pole not under test. Use manual charging, closing and tripping procedures.

Maintenance

3. Apply the proper AC (i.e., either 14 or 27 kV) or DC (i.e., either 20 or 38 kV) high potential test voltage between a primary conductor of the pole and ground for one minute.
 4. If no disruptive discharge occurs, the insulation system is satisfactory.
 5. After test, ground both ends and the middle of each vacuum bottle to dissipate any static charge.
 6. Disconnect the leads to the spring charging motor.
 7. Connect all points of the secondary disconnect with a shorting wire. Connect the shorting wire to the high potential lead of the high voltage tester, and ground the breaker housing. Starting with zero volts, gradually increase the test voltage to 1500 volts, RMS, 60 Hz. Maintain test voltage for one minute.
 8. If no disruptive discharge occurs, the secondary control insulation level is satisfactory.
 9. Disconnect the shorting wire and re-attach the leads to the spring charging motor.
 10. Perform contact resistance tests of the primary contacts using a ductor. Contact resistance should not exceed the values listed in **Table 4**.
- Table 4 Maximum Contact Resistance**
- | Current Rating
(Amps) | Contact Resistance
(Micro-Ohms) |
|--------------------------|------------------------------------|
| 1200 | 60 |
| 2000 | 40 |
| 3000 | 20 |
11. Make a permanent record of all tests performed.

Inspection and Cleaning of Breaker Insulation

1. Perform the Spring Discharge Check on the circuit breaker, *after* all control power is removed. The Spring Discharge Check consists of 1) depressing the red Trip pushbutton, 2) then depressing the black Close pushbutton, and 3) again depressing the red Trip pushbutton. All of these controls are on the breaker front panel. Visually verify the Discharge condition of the springs.
2. Remove any interphase and outer phase barriers as shown in **Figure 13**.
3. Clean barriers and post insulators using clean cloth and one of the following cleaning solvents:
 - No. 1 or No. 2 denatured alcohol
 - Isopropyl or isobutyl alcohol
4. Replace all barriers. Check all visible fasteners again for condition and tightness.

Note: Do not use any cleaning compounds containing chlorinated hydrocarbons such as trichlorethylene, perchlorethylene or carbon tetrachloride.

These compounds will damage the phenylene ether copolymer material used in the barriers and other insulation on the circuit breaker.


Functional Tests

Refer to the Installation Checklist in the Installation Checks and Initial Functional Tests section of this manual. Functional tests consist of performing at least three (3) Manual Spring Charging Checks and three (3) Automatic Spring Charging Checks. After these tests are complete, and the springs fully discharged, all fasteners and connections are checked again for tightness and condition before re-installing the breaker into the metal-clad switchgear.

Overhaul

Introduction

For following procedures along with the troubleshooting charts at the end of this section, provide maintenance personnel with a guide to identifying and correcting possible malfunctions of the GMI vacuum circuit breaker.



WARNING

Hazardous voltages and high speed mechanical parts.

Can cause death, severe personal injury, or property damage.

All replacement of breaker components must be performed with the breaker completely de-energized and the springs discharged.

Circuit Breaker Overhaul - Table 5 lists the recommended overhaul schedule for GMI circuit breakers operating under ANSI usual conditions. When actual operating conditions are more severe, overhaul periods should occur more frequently. The counter on the front panel of the circuit breaker records the number of operations.

Table 5 Overhaul Schedule
ANSI Usual Conditions
Maintenance Based Upon Number of Closing Operations

Breaker Type	Number of Closing Operations
5-GMI-350 15-GMI-1000	5,000
All others	10,000

Replacement at Overhaul - The following components are replaced during an overhaul of the circuit breaker, when required:

- Vacuum interrupters as determined by vacuum integrity test, contact erosion, or after 30,000 operations.
- Spring charging motor brushes should be replaced after 10,000 operations (reference kit 18-658-612-886).

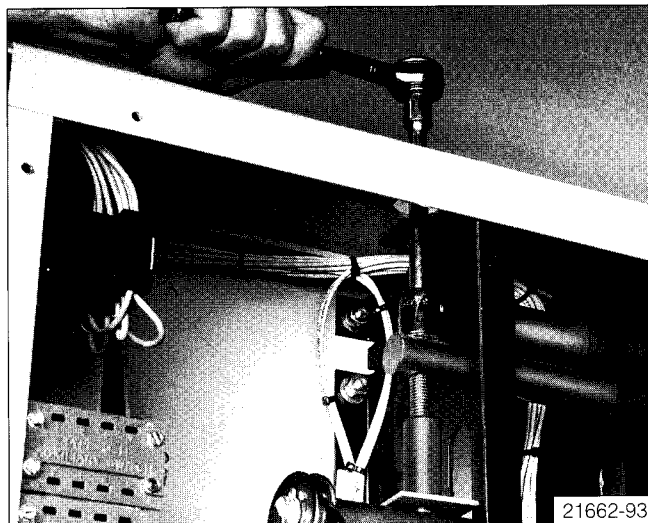


Figure 38: Use of Socket Wrench to Release Tension on Closing Springs.

Replacement of Closing Springs - Figure 38 shows the use of a 3/4 inch socket wrench to relieve spring tension on the closing springs. The top cover of the breaker has openings providing access to the tensioning bolts. Turning the left and right hand support bolts counterclockwise relieves spring tension.

For early models of the GMI breaker, once tension has been relieved, retaining ring pliers are needed to remove the top and bottom retaining rings attaching each spring to its cross-arm support shaft and its crank arm.

For later models of the GMI breaker, the lower spring hangers are fastened to the crank arms using hex socket shoulder bolt and nut. The nut is applied using thread locking adhesive, Loctite 271, with Loctite type T primer.

When one or both springs are reinstalled, be sure the support bolts are inserted inside their support bolt bushings. These bushings maintain the correct tension on the closing springs. Replace all retaining rings during the re-assembly. Re-tighten by turning the support bolts clockwise until the support bolt bushings firmly butt up against the support bolt attachment bracket and the cross arm support shaft.

Replacement of Opening Spring - The opening spring may be removed and replaced without the need to use a spring keeper or compression aid.

The opening spring assembly consists of the top and bottom spring caps, threaded coupling rod with nuts, and a supporting shelf. The shelf features location holes and tabs which work in concert with supports in the breaker frame to secure the shelf.

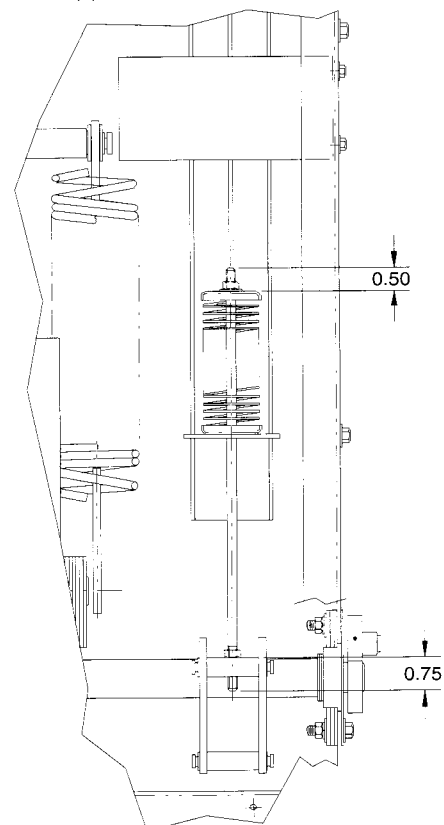


Figure 39: Removal of Opening Spring.

Overhaul

An adjustable crescent wrench allows an easy means of grasping the shelf and lifting it slightly to disengage the tabs in the shelf locating holes. With the tabs disengaged, and grasping the top of the spring, the whole assembly can be pulled forward.

A reversal of this procedure allows re-assembly. Note that the jam jut at the lower end of the threaded coupling rod is located so that there is 0.75" thread engagement of the jack shaft. The top nut above the upper spring cap is located so that the top surface of the spring cap is 0.50" from the end of coupling rod.

When re-assembling, apply upward pressure to the shelf over stationary support and to engage the shelf tab guides. The shelf may then be guided into place.

Replacement of Closing and Tripping Solenoids (Devices 52SRC and 52T) - Replacement of either the closing or tripping solenoids is straightforward. Each solenoid has two mounting screws and one quick disconnect terminal. Removing the mounting bolts and quick disconnect terminal of the solenoid permits it to slide out and to be removed. Replacement requires careful insertion of the solenoid and re-attachment of the mounting bolts and quick disconnect. **Figure 40** shows the two screws which attach the close coil and the quick disconnect terminal for control leads. The trip coil arrangement is similar.

Replacement of Anti-Pump Relay (Device 52Y) - Figure 41 helps illustrate the anti-pump relay removal procedure. The two nuts holding the relay and its mounting bracket are removed. The wires connected to the relay should be tagged and disconnected, the relay and bracket can then be extracted and replaced.

Replacement of the Auxiliary Switch - Figure 41 shows the auxiliary switch and its key mounting components. Two mounting screws hold the switch to the mounting bracket. First remove the quick disconnect terminals after marking their position. The screw, washers and nut connecting the switch's operating lever to the operating shaft is removed, and then the two mounting screws. Re-assemble in reverse order.

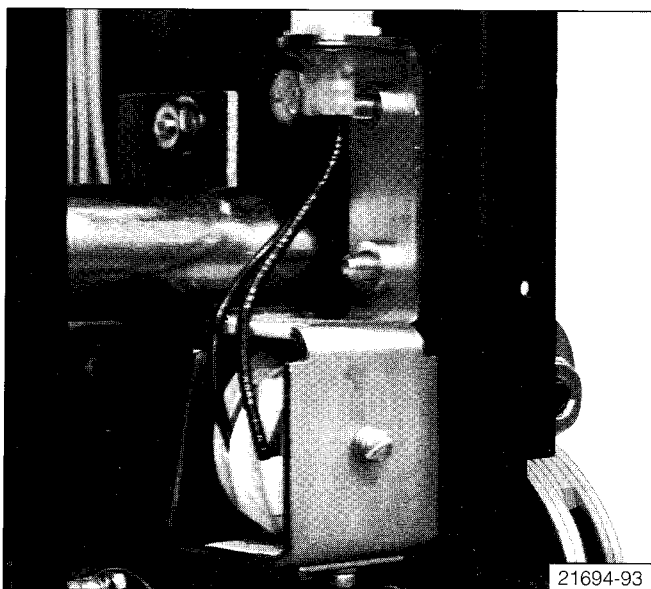


Figure 40: Replacement of Closing Solenoid.

Replacement of Motor Cut-Off Switch (Device LS1) and Spring Charged Switch (LS2) - The motor cut-off switch (LS1) and spring charged switch (LS2) form a common assembly of two switches on one mounting bracket. Should either switch require replacement, it is recommended that both be replaced as a single assembly. The motor cut-off switch (LS1) is the "outboard" device with respect to the mounting bracket. Removal of the two mounting screws shown in **Figure 42** allows both switches to be brought out for convenient removal of the interconnecting wiring.

Next, mark all wires to both switches. Remove the wires. Then replace the switches, rewire, and reassemble the switches to their mounting bracket. Be sure to use the same flat washer, lock washer and nut configuration in reassembly as was present in the as-shipped condition.

Replacement of Trip Latch Reset Check Switch (Device LS3) - Note: Two different latch systems have been used in GMI circuit breakers, with changeover from one design to the other occurring in mid-1991. This instruction manual describes both designs.

Pages 10-11 describe the operation of the mechanism used beginning in approximately mid-1991.

Pages 12-13 describe the operation of the mechanism used from 1989 until approximately mid-1991.

Replacement of LS3 - Mid-1991 and After

The following paragraphs describe replacement of the trip latch reset switch for the mechanism used beginning in approximately mid-1991.

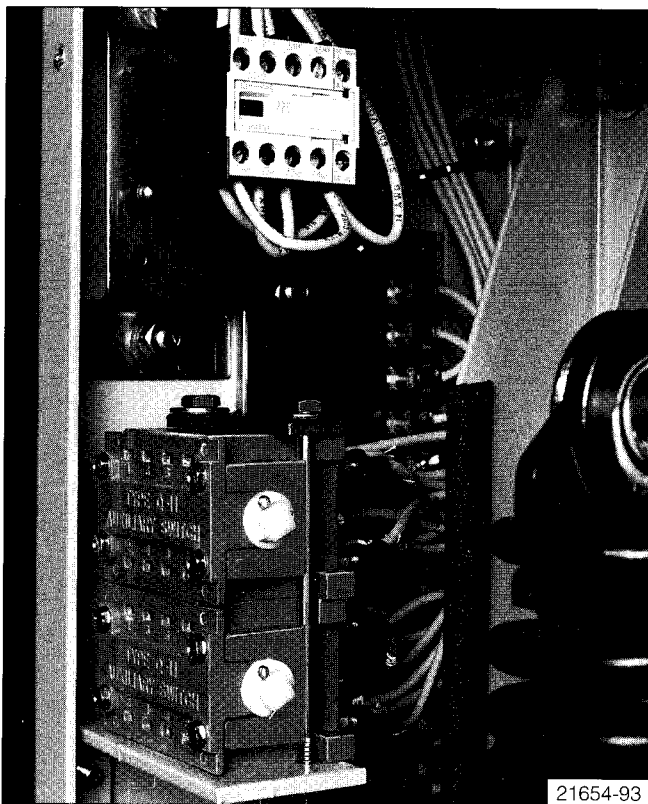


Figure 41: Replacement of Anti-Pump Relay or Auxiliary Switch.

Overhaul

This mechanism can be identified by observing the close latch above the spring charging motor on the left side of the circuit breaker. Refer to **Figure 18a**. The close latch is installed on the close shaft assembly 72, and includes a hardened latch face. This face contacts a bearing which is part of the close hatchet assembly 105. If the mechanism has a close hatchet which bears directly on the close shaft, refer to the next section for replacement of the trip latch reset switch for your mechanism.

The trip latch reset check switch (LS3) is mounted on the trip shaft actuator stop plate, as shown in **Figure 43a**. To replace this switch, the trip shaft actuator must be removed by backing out two #10-32 hex socket screws, and then removing two 3/8" nuts which secure the trip shaft actuator stop plate to the mechanism.

Wires to the switch must be marked and removed. The stop plate and switch may then be removed as a subassembly. The switch is a bushing type, for panel mounting, and threads into the stop bracket. After adjustment, it is secured by a jam nut and locking nut.

Adjustment requires the trip of the switch plunger to be set 0.06-0.09" ahead of the stop bracket tab, as illustrated in **Figure 43a**. Secure the switch, position the stop bracket assembly, and reattach the wires. Install the 3/8" nuts to secure the trip shaft actuator stop plate to the mechanism. Remount the trip shaft actuator.

Confirm that the switch is vertically aligned to ensure that it will not be struck by the closing hatchet or the trip shaft actuator.

Replacement of LS3 - Up to Mid-1991

The following paragraphs describe replacement of the trip latch reset switch for the mechanism used beginning in approximately mid-1991.

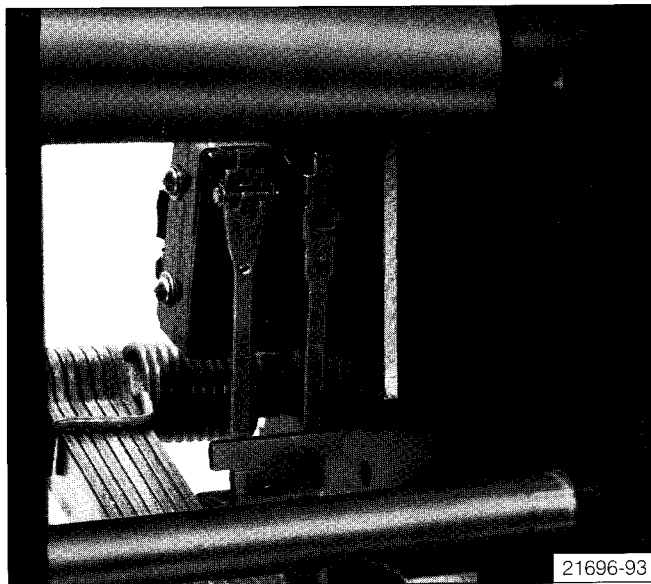


Figure 42: Motor Cut-Off Switch (LS1) and Spring Charged Switch (LS2).

This mechanism can be identified by observing the close latch above the spring charging motor on the left side of the circuit breaker. Refer to **Figure 18b**. The close hatchet 22 has a latch face which bears directly on the close shaft 72. If the close hatchet includes a bearing which contacts a hardened latch installed on the close shaft, refer to the preceding section for replacement of the trip latch reset switch for your mechanism.

The trip latch reset check switch is mounted to the left (when facing the front of the beaker) vertical mechanism side sheet as shown in **Figure 43b**. The switch is held in place by two screws. When replacement of the trip latch reset check switch is required, both screws need to be removed.

Next, mark both wires to the switch, and remove them. Then replace the switch, rewire and reassemble the switch to the left hand mechanism side sheet. Be sure to use the same washer and nut configuration as was present in the as-shipped condition.

Replacement of Spring Dump Switch (Device LS4) (Figure

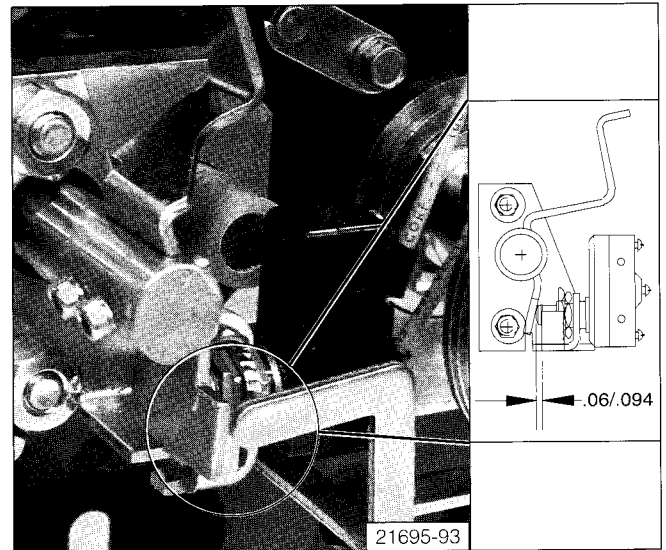


Figure 43a: Trip Latch Reset Switch (LS3) (From mid-1991 to present).

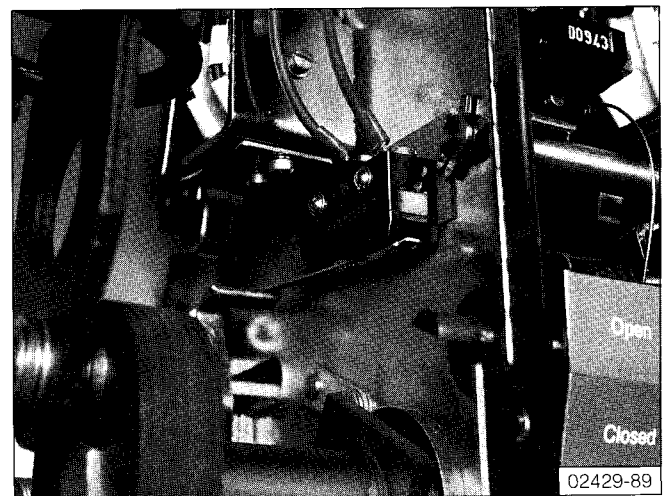


Figure 43b: Trip Latch Reset Switch (LS3) (From 1989 to mid-1991).

Overhaul

44) - The spring dump switch is mounted on the right (when facing the front of the breaker) vertical mechanism side sheet. The switch is actuated by a push rod which is actuated whenever the circuit breaker is inserted into or withdrawn from, the cubicle. Should difficulty be suspected with the spring dump switch, be sure to eliminate all mechanical reasons for difficulty before replacing the switch.

The switch is held in place by two mounting screws. Remove the two screws. Mark the wires, and remove them. Next, replace the switch. Be sure to use the same configuration of flat washers, lock washers and nuts as was present in the as-shipped condition.

Replacement of Damper Assembly - Damper replacement will require the removal of a pin which ties the damper mounting yoke to the circuit breaker frame. Refer to **Figure 45**.

The damper is attached to the mounting yoke with a lock washer and 5/8-18 jam nut. For added security, the jam nut is treated with a thread locking adhesive (Loctite 271 with Loctite type T primer), and then torqued to a value of 17-20 ft-lbs.

Check all associated parts, damper body and telescoping tube, for wear. Replace as necessary.

The telescoping tube and internal striker block employ slugs in variable thicknesses and quantity to control movable contact motion. If the telescoping tube is replaced, the tube must be replaced with the correct tube to assure that the correct type and number of slugs are present.

Replacement of Spring Charging Motor (Device 88) - Remove the quick-disconnect terminals. Then remove the screws holding the motor mounting bracket to the breaker housing. The motor slips out as a complete assembly. Check and replace as required.

Replacement of Primary Disconnect Fingers - The primary disconnect finger assembly is secured with standard hardware. With the bolt removed, the finger assembly can be slid off the retaining arm as a unit. Replace burnt fingers or broken springs as necessary.

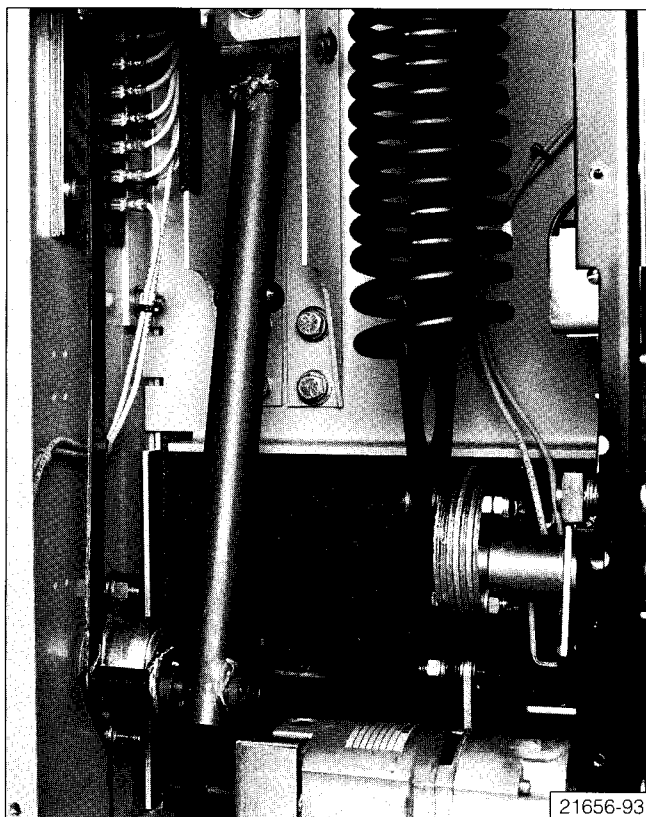


Figure 45: Damper Assembly.

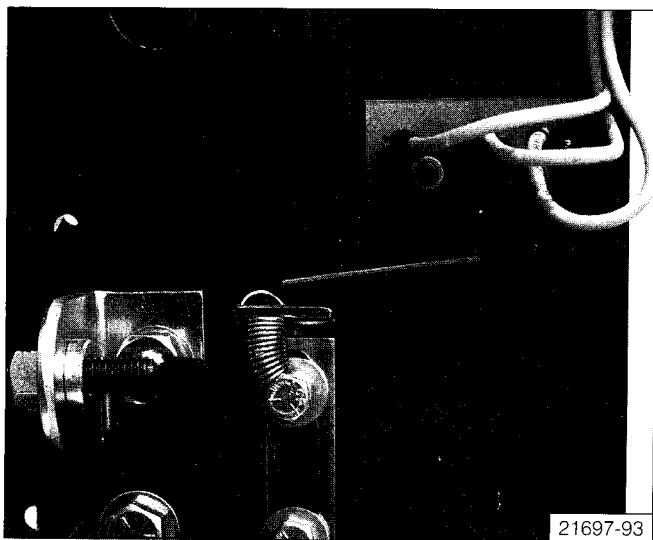


Figure 44: Spring Dump Switch (LS4).

Overhaul

Replacement of Vacuum Interrupters

The following procedures are for the removal and replacement of the vacuum interrupters.

Note: Special care needs to be exercised in removal of hardware around the bottom, or movable contact end, of the vacuum interrupter.

The movable contact uses a metal bellows assembly to maintain the vacuum seal while still permitting up and down motion of the contact. This bellows assembly is rugged and reliable, and is designed to withstand years of vertical movement. However, care should be exercised in subjecting the bellows to excessive torque during removal and replacement. Twisting the bellows through careless bolt removal or tightening may damage the vacuum interrupter.

Index of Figures and Tables

Vacuum Tube Family	Continuous Current	Figure
Pole Unit Assembly		
VS12015	1200 and 2000 Amp	48
VS10006	1200 Amp	47
VS10006	2000 Amp	50
VS25002	1200 and 2000 Amp	48
VS10028	1200 Amp	47
VS10028	2000 and 3000 Amp	49
Breaker Side Elevation (Typical)		46
Tube Clamp Fastening Procedure		51
Gaging Procedure and Stroke Adjustments		52

Reference Tables and Lists

Recommended Tools	Table 6
Fastener Torque Limits	Table 7

Preparation

Identify tube family and breaker continuous current rating. The tube will have an identifying nameplate showing the family designation and the continuous current requirement can be taken from the breaker's rating label.

Check the "Index of Figures" to find the appropriate side elevation picture of the breaker pole unit assembly. Confirm that the figure applies by comparing the figure carefully to the breaker.

Read through the replacement procedures, noting recommended tools, gaging requirements and torquing limits, etc.

Vacuum Tube Removal

1. Make provision to save and retain hardware. Rejoin fastener parts (bolts, nuts, washers, lockwashers, etc.) as they are removed. Save in an appropriate container.
2. Remove interphase and outer barriers as required.

3. Loosen, but do not remove, bolt fastening trunnion to the movable contact stem of the vacuum tube. An 8mm or a 10mm Allen wrench is required.
4. Disconnect insulating pushrod at bell cranks. Remove and discard two 0.25" X-washers. Spread the bell crank elements and allow the push rod to drop down.
5. Refer to **Figure 51**, and using the procedure shown to secure head and nut proceed to loosen the bolts which fasten the flexible shunt clamp to the movable contact of the tube.
6. Remove the two X-washers (discard) fastening the bell cranks to the trunnion.
7. Loosen, but do not remove insulating centering devices near the movable contact end of the vacuum tube.
8. Remove the bolt fastening the trunnion to the end of the tube. Be certain to save the washers, spacer, trunnion and hardware for later use.

Note: List the order and location of each flat and lock washer.

It is critical that these spacing washers be replaced in their exact order upon reassembly to assure proper operation of the breaker.

9. Vacuum Tube Stationary Contact Disassembly and Tube Removal.

- 9.1 Circuit breakers rated 1200 amp using the VS12015 or VS25002 Interrupters (**Figure 48**).

Using an 19mm socket and extension remove bolt fastening vacuum tube stationary contact to the upper primary connectors and upper stab support. Save bolt washer and lockwasher.

Carefully remove and set aside the heavy copper spacer connecting the tube to the upper primary bars. Handle with care to maintain flat ends on the cylindrical spacer.

- 9.2 Circuit breakers rated 1200 amp using the VS10006 or VS10028 Interrupters (**Figure 47**).

Using 9/16 (and 11/16) socket and backup wrench remove two 3/8 fasteners joining upper primary extensions to the stab support. Rejoin hardware and save with primary extensions for reuse.

Using a 24mm socket and extension loosen and remove hex bolt joining the tubes stationary contact to the bus extensions and stab support. Remove primary extensions and save.

- 9.3 Circuit breakers rated 2000 amp using the VS10006 Interrupter (**Figure 50**).

Using a 24mm socket and extension loosen and remove hex bolt joining the tubes stationary contact to the primary extensions and stab support.

After removing the bolt carefully remove a 3/8 copper spacer, handle carefully and save protecting the flat contact surfaces.

Overhaul

- 9.4 Circuit breakers rated 2000 and 3000 amp using the VS10028 Interrupter (**Figure 49**).

Remove four hex socket flat head screws joining the insulating support plate to the upper primary stab support. A 5/32 (0.156) hex key and 7/16 back up wrench will be required (hex key socket preferred). These screws have been secured with a thread locking adhesive. Preheating the fasteners to 350°F using a hot air gun prior to breaking them free is recommended. Remove, rejoin and save fasteners for future use.

Using a 24mm socket and extension, loosen and remove the hex bolt joining the tubes stationary contact to the primary extensions.

Using 9/16 socket and extension, remove four 3/8 hex bolts fastening the upper primary stab support to the red post insulator. Lift and remove, set aside with care. This item is heavy, and two people may be required to safely remove.

10. Check the clamp on the movable contact to ensure that it will slide freely from the tubes movable stem. The clamp may have to be wedged or worked open in order to slide freely from the tube.

With the clamp free, the vacuum tube may be lifted clear of the clamp and pole unit structure.

Vacuum Tube Replacement

11. Inspect all silver plated surfaces for cleanliness. Wipe clean with solvent and clean rag. Do not abrade.
12. Insert vacuum tube replacements into the lower stab support with the evacuation nipple or tubulation oriented as follows:
- | | |
|---------|-------------------------------------|
| VS12015 | Tubulation toward primary fingers |
| VS25002 | Tubulation toward primary fingers |
| VS10006 | Tubulation toward mechanism housing |
| VS10028 | Tubulation toward mechanism housing |
13. Slip the flexible shunt clamp over the movable contact stem of the interrupter. Replace clamp hardware; bolt(s), washer(s), and nut(s). Raise clamp until it bears on step or retaining ring 33 to 48mm up from the end of the stem.

Note: Finger tighten only! Excessive clamping force at this time may deform movable contact stem.

Later in this procedure a trunnion bolt will be inserted and secured. After this bolts insertion and adjustment the clamp may then be tightened.

14. Stationary Contact Assembly.

- 14.1 VS12015 and VS25002 Interrupters.
Align copper spacer bar with large hole in stab support. Insert long M12 bolt through lockwasher, washer, stab support and copper spacer. Align tube stationary contact and (by hand) engage the M12 bolt (**Figure 48**).

Note: Stationary contact is annealed copper.

Thread damage will occur if threads are crossed. Be sure the bolt can be fully engaged with light manual torque.

- 14.2 VS10006 and VS10028 Interrupters in breakers rated 1200 amp (**Figure 47**).

With the tube in alignment under stab support, place the primary extension into the gap between stab support and tubes stationary contact. Make sure contact surfaces are wiped clean.

Replace, finger tight, two 3/8 fasteners joining the primary extension to the stab support.

Insert an M16 hex bolt through lockwasher, washer, stab support and primary extension. Align tube stationary contact, and (by hand) engage the M16 bolt.

Note: Stationary contact is annealed copper.

Thread damage will occur if threads are crossed. Be sure the bolt can be fully engaged with light manual torque.

Fasten two 3/8 fasteners securing the primary extensions (26-36 ft-lbs.)

- 14.3 VS10006 Interrupter in 2000 Amp Breakers (**Figure 50**).

With tube aligned under the primary stab, place the 3/8" copper spacer between primary extensions and stationary contact of the vacuum tube.

Insert the M16 hex bolt through a lockwasher, washer, stab support, primary extension and 3/8" copper spacer. Align vacuum tube stationary contact, and (by hand) engage the M16 bolt.

Note: Stationary contact is annealed copper.

Thread damage will occur if threads are crossed. Be sure the bolt can be fully engaged with light manual torque.

- 14.4 VS10028 Vacuum Interrupter Applied in Breakers Rated 2000 and 3000 Amperes (**Figure 49**).

Allow tube to rest on the lower stab support.

Replace upper primary stab support with primary bus extensions. Fasten with four 3/8" hex bolts to the primary insulator. Use 3/8 bolt, lockwasher and washer torqued 20-25 ft-lbs.

Align vacuum tube stationary contact. Insert M16 hex bolt through lockwasher, washer, upper stab support and primary bus extensions. Manually engage bolt into tube by applying hand torque only.

Overhaul

Note: Stationary contact is annealed copper.

Thread damage will occur if threads are crossed. Be sure the bolt can be fully engaged with light manual torque.

Fasten the insulating support plate to the upper primary stab support. Use four hex socket flat head screws. Clean external and internal threads. Apply "Loctite" Primer T to the external and internal threads. Apply "Loctite" threadlocker 262 to the external threads. Engage and torque 8-10 ft-lbs.

15. Trunnion and Movable Contact Adjustment

- 15.1 The trunnion is fitted to the tube's movable stem in concert with spacer and shim washers. A special tool consisting of a threaded shaft and gage block is to be used to determine the correct number of shimming washers. Gaging tool consists of:

Note: VS10028 Interrupter will not require a spacer.

Threaded Shaft	M12	18-658-137-105
Threaded Shaft	M10	18-658-137-102
Gage Block	6mm:	18-750-171-001
Gage Block	8mm:	18-750-171-002
Gage Block	11mm:	18-750-171-003

VS12015 requires 6mm gage and stroke.

VS25002 requires 8mm gage and stroke.

VS10028 requires 8mm gage and stroke.

VS10006 requires 11mm gage and stroke.

The gage will set the trunnion center at one half the stroke magnitude above the center of the bell cranks major pivot. The gage block includes allowances for trunnion thickness, 1/2 the stroke and radius of the major bell crank pivot (**Figure 52**).

- 15.2 Torque fastener at the tube's stationary contact to firm the tube stationary contact against the primary extensions, using torque shown in **Table 7**. The companion lock washer is to be fully collapsed. Hold tube in the alignment required under Article 12 of the vacuum tube replacement procedure while tightening this fastener.
- 15.3 Thread gaging shaft, by hand, into movable stem of the vacuum tube.

M10 thread for VS12015 and VS25002.

M12 thread for VS10006 and VS10028.

Thread by hand until fully and firmly seated.

- 15.4 Apply shim washers, approximately 7, spacer and correct gage block over the shaft. Raise the gage block until the gage foot just bears or comes within one washer thickness of bearing upon the lower surface of the bell crank shaft. Washers may have to be removed or added to achieve these conditions. The spacer and washers above the gage block must be packed against the vacuum interrupter movable stem when observation of the gage foot to bell crank clearance is made. The gage foot must just touch the shaft or be within one shim washer thickness of doing so.

Note: The VS10028 tube will not require a spacer.

- 15.5 Having determined the required number of washers, insert hex bolt through lockwasher, trunnion, spacer and shim washers. Engage bolt into the vacuum tube stem and tighten by hand to snugness. Engage trunnion to bell crank (both sides) and tighten hex bolt further until lockwasher is just collapsed.

- 15.6 Manually exercise bell cranks, opening tube approximately 1/4 to 3/8 of an inch. Release bell cranks, tube should snap freely to the closed position. The main contacts should be clearly heard as they meet upon closing.

Check to make certain the insulating centering blocks or rings at the base of the tube are loose to permit tube alignment. It may be necessary to repeatedly free the tube's stationary fastener, shift the tube slightly, retighten and recheck bell crank snap action closing until full movable contact freedom is assured.

- 15.7 Once free movement of the movable contact is achieved, the tube centering blocks or ring may be fastened. Select two X-washers from parts kit and crimp into grooves at each end of the trunnion.

16. Open Stroke Adjustment

The open position is established by the insulating coupler which when adjusted to the proper length, and attached to the bell cranks, will hold the tube open at the proper contact gap or separation.

In Article 15, the trunnion shaft center was set at one half the required vacuum tube stroke *above* the bell crank shaft horizontal center line. The open position will be established with the trunnion shaft center one half the required vacuum tube stroke *below* the bell crank shaft horizontal centerline.

The adjustment requires the insulating pushrod length be varied by turning the threaded pushrod end into or out of the pin coupling the pushrod to the breaker jack shaft.

Required trunnion center below bell crank shaft center:

VS12015	3mm	(0.118 in)
VS25002	4mm	(0.157 in)
VS10006	5.5mm	(0.217 in)
VS10028	4mm	(0.157 in)

Engage pushrod to bell cranks and gage trunnion shaft center distance below bell crank shaft center. If less than required, the pushrod must be shortened, screwed into the jackshaft pin. If greater than required, the pushrod must be lengthened by screwing it out of the jackshaft pin.

By interactively engaging the trunnion shaft center, disconnecting the coupler, adjusting the coupler, reattaching the coupler to the bell cranks, and again gaging the trunnion center, the required trunnion center position relative to the bell crank shaft center will be achieved.

The gage block (18-750-171-001, -002, or -003 as appropriate), when held firmly on the trunnion will just contact the lower surface of the bell crank shaft at the correct open position (**Figure 52**).

Overhaul

17. Concluding Operations

- 17.1 Torque vacuum tube stationary and movable contact fasteners to values indicated in **Table 7**.
- 17.2 Using procedure shown in **Figure 51** and torque limits established in **Table 7** secure tube clamp hardware.

Note: Check to be certain the tube clamp has been raised into firm bearing against the movable stem step or retaining ring before securing the clamp.

- 17.3 Replace all barriers.
- 17.4 Perform High Potential Test across open vacuum tube and from each primary extension to ground (See **Table 3** on page 25).

Table 6: Recommended Tools

Open End or Box End Wrenches

7/16, 1/2, 9/16, 5/8, 11/16

Socket Wrenches: (1/2" drive preferred)

7/16, 1/2, 9/16, 5/8, 11/16

19mm, 24mm

Ratchet

2 Extensions (6" maximum)

Torque Wrench (0-150 ft-lbs.)

Hex Socket Keys:

5/16 (0.156) socket type preferred

Miscellaneous:

Pliers

Hot Air Gun

"Loctite" Threadlocker 262

"Loctite" Primer T

Allen Wrenches - 8mm, 10mm

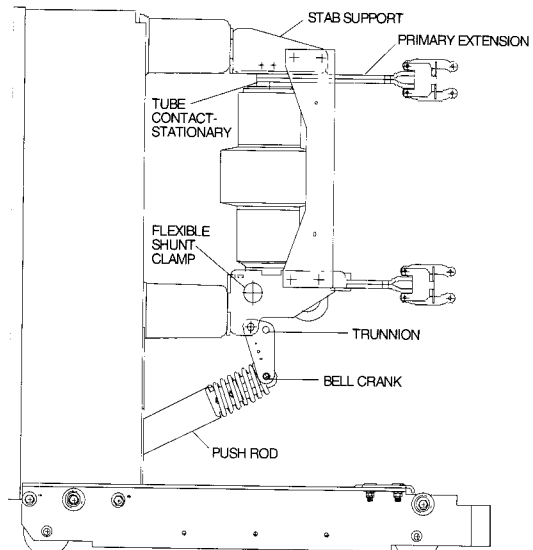


Figure 46: GMI Breaker Side Elevation (Typical).

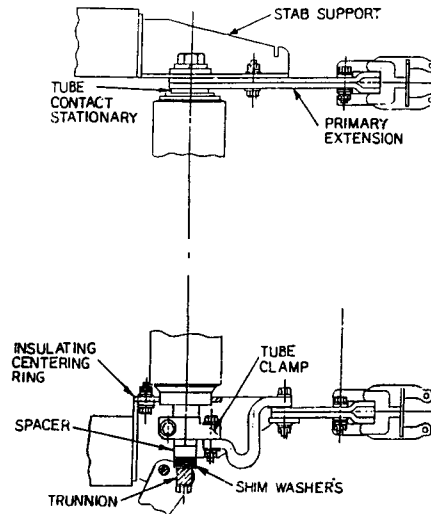


Figure 47: VS10006 and VS10028 1200 Amp.

Table 7: Critical Fasteners and Torque Limits

Tube Family	Stationary Contact		Movable Contact		Tube Clamp		
	Size	Torque	Size	Torque	Size		Torque
All Current Ratings					1200	2000 & 3000	
VS12015	M12 x 1.75	60-65 ft-lbs.	M10 x 1.5	15-20 ft-lbs.	1-3/8-16	2-3/8-16	26-36 ft-lbs.
VS25002	M12 x 1.75	60-65 ft-lbs.	M10 x 1.5	15-20 ft-lbs.	1-3/8-16	2-3/8-16	26-36 ft-lbs.
VS10006	M16 x 2	60-65 ft-lbs.	M12 x 1.75	30-35 ft-lbs.	1-3/8-16	2-3/8-16	26-36 ft-lbs.
VS10028	M16 x 2	60-65 ft-lbs.	M12 x 1.75	30-35 ft-lbs.	1-3/8-16	2-3/8-16	26-36 ft-lbs.

Overhaul

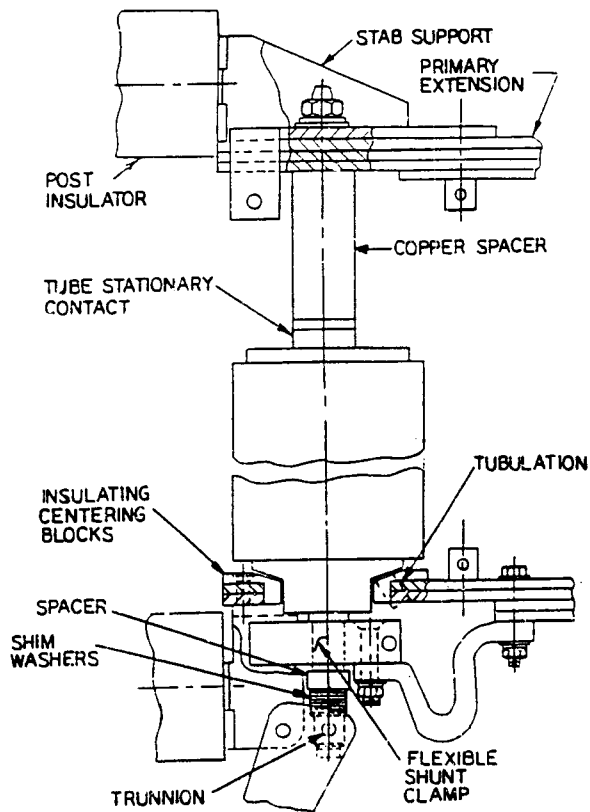


Figure 48: VS12015 and VS25002 1200 and 2000 Amp.

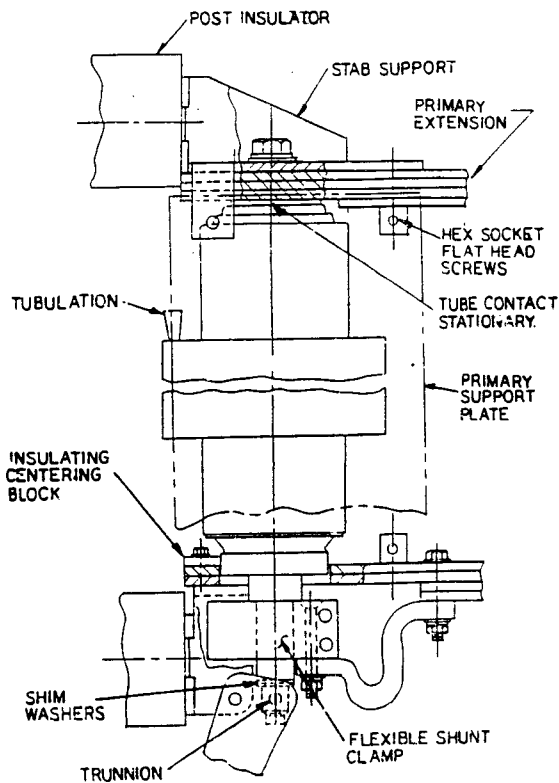


Figure 49: VS10028 2000 and 3000 Amp.

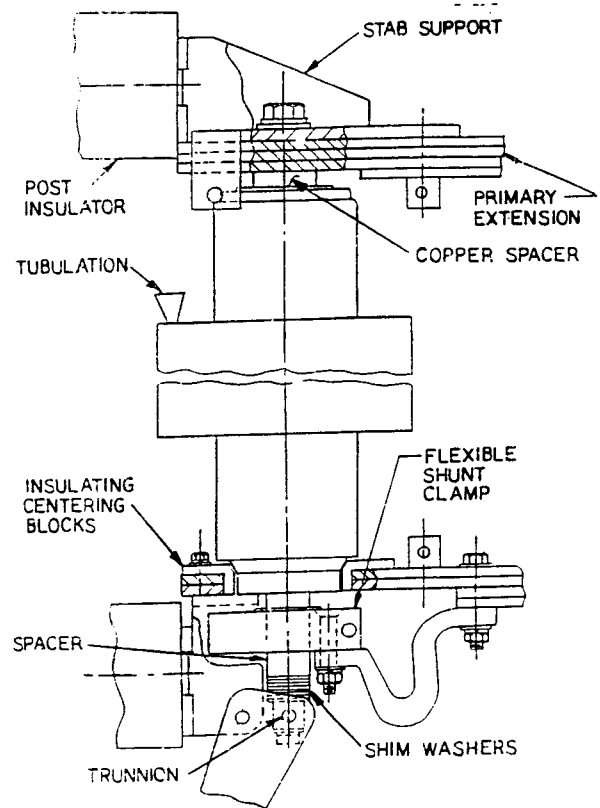


Figure 50: VS10006 2000 Amp.

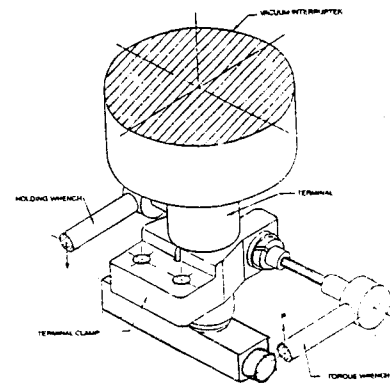


Figure 51: Tube Clamp Fastening Procedure.

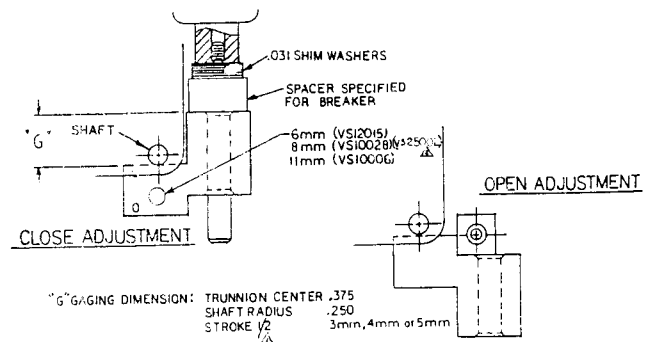


Figure 52: Gaging Procedure and Stroke Adjustments.

Overhaul

Periodic Maintenance and Lubrication Tasks

Sub-Assembly	Item	Inspect For
Primary Power Path	Vacuum Interrupter	<ol style="list-style-type: none"> 1. Cleanliness 2. Contact erosion Note: Perform with Manual Spring Checks 3. Vacuum integrity Note: Perform with High Potential Tests
	Primary Disconnects	<ol style="list-style-type: none"> 1. Burnt or damaged fingers 2. Lubrication of contact surfaces
	Vacuum Interrupter Contact Resistance	<ol style="list-style-type: none"> 1. Record contact resistance with contacts closed, and re-check each year to monitor condition.
Interrupter Operator Mechanism	Cleanliness	<ol style="list-style-type: none"> 1. Dirt or foreign material
	Fasteners	<ol style="list-style-type: none"> 1. Tightness of nuts and other locking devices
	Manual Spring Check	<ol style="list-style-type: none"> 1. Smooth operation of manual charging, and manual closing and tripping.
Electrical Controls	Lubrication	<ol style="list-style-type: none"> 1. Evidence of excessive wear 2. Lubrication of wear points
	Wiring	<ol style="list-style-type: none"> 1. Mechanical damage or abrasion
	Terminals and Connectors	<ol style="list-style-type: none"> 1. Tightness and absence of mechanical damage
High Potential Test	Close and Trip Solenoids, Anti-Pump Relay, Auxiliary Switches, Secondary Disconnect	<ol style="list-style-type: none"> 1. Automatic charging
	Spring Charging Motor (88	<ol style="list-style-type: none"> 2. Close and trip with control power 1. Replace brushes after 10,000 operations
	Primary Circuit to Ground and between Primary Disconnects	<ol style="list-style-type: none"> 1. 60 second withstand, 14 or 27kV, 60 Hz (20 or 38kV DC) (depending upon voltage rating of breaker)
Insulation	Control Circuit to Ground	<ol style="list-style-type: none"> 1. 60 second withstand, 1500V, 60 Hz
	Barriers and all Insulating Components	<ol style="list-style-type: none"> 1. Cleanliness
		<ol style="list-style-type: none"> 2. Cracking

Overhaul

Troubleshooting

Problem	Symptoms	Possible Causes and Remedies
Breaker fails to close	Closing springs will not automatically charge.	<ol style="list-style-type: none"> 1. Secondary control circuit is de-energized or control circuit fuses are blown. Check and energize or replace if necessary. 2. Secondary disconnect contacts 15 or 16 are not engaging. Check and replace if required. 3. Damage to wiring, terminals or connectors. Check and repair as necessary. 4. Failure of charging motor (88). Check brushes and replace if required. 5. Motor cut-off switch (LS1) fails to operate. Replace if necessary. 6. Mechanical failure of operating mechanism. Refer to factory or authorized service shop.
	<p>Closing springs charge, but breaker does not close</p> <ul style="list-style-type: none"> • Closing coil, or solenoid (52SRC) fails to energize. No sound of breaker closing. 	<ol style="list-style-type: none"> 1. Secondary control circuit de-energized, or control circuit fuses blown. Correct as indicated. 2. No closing signal to secondary disconnect pin 13. Check for continuity and correct relay logic. 3. Secondary disconnect contacts 13 or 15 are not engaging. Check and correct as required. 4. Failure of anti-pump relay (52Y) contacts 21-22 or 31-32 or 13-14. Check and replace as required. 5. Failure of close coil (solenoid) (52SRC). Check and replace as required. 6. Auxiliary switch NC contacts 3-4 are open when breaker contacts are open. Check linkage and switch. Replace or adjust as necessary. 7. Spring charged switch (LS2) NO contact remains open after springs are charged. Check and replace as required.
	<ul style="list-style-type: none"> • Closing coil energizes. Sound of breaker closing is heard, but breaker contacts do not close. 	<ol style="list-style-type: none"> 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.

Overhaul

Troubleshooting (continued)

Problem	Symptoms	Possible Causes and Remedies
Nuisance or false close	Electrical problem	<ol style="list-style-type: none"> 1. Nuisance or false closing signal to secondary disconnect contact 13. Check relay logic. Correct as required. 2. Closing coil (52SRC) terminal 2 is shorted to ground. Check to determine if problem is in wiring or coil. Correct as required.
	Mechanical problem	<ol style="list-style-type: none"> 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.
Circuit breaker will not trip	Tripping coil, or solenoid (52T) does not energize. There is no tripping sound.	<ol style="list-style-type: none"> 1. Secondary control power is de-energized or control power fuses are blown. Correct as indicated. 2. Damage to wiring, terminals or connectors. Check and repair as necessary. 3. No tripping signal to secondary disconnect contact 1. Check for continuity and correct relay logic. 4. Secondary disconnect contacts 1 or 2 are not engaging. Check and replace if required. 5. Failure of trip coil (52T). Check and replace if necessary. 6. Auxiliary switch NO contacts 1-2 or 5-6 are open when breaker is closed. Check linkage and switch. Replace or adjust as necessary.
	Tripping coil (52T) energizes. No tripping sound is heard, and breaker contacts do not open (i.e., they remain closed).	<ol style="list-style-type: none"> 1. Failure of tripping spring or its mechanical linkage. Check and replace if required.
	Tripping coil (52T) energizes. Tripping sound is heard, but breaker contacts do not open.	<ol style="list-style-type: none"> 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop. 2. One or more of the vacuum interrupters are held closed. Check and replace as necessary.
Nuisance or false trip	Electrical problem	<ol style="list-style-type: none"> 1. Tripping signal remains energized on secondary disconnect contact 1. Check for improper relay logic.
	Mechanical problem	<ol style="list-style-type: none"> 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.

Appendix

Table A-1
Type GMI Circuit Breaker Ratings

Identification			Rated Values								Rated Required Capabilities						
Circuit Breaker Type	Nominal Voltage Class	Nominal 3-Phase MVA Class	Voltage		Insulation Level		Current				Current Values						
	kV Class	MVA Class	Rated Max. Voltage ②	Rated Voltage Range Factor ③	Rated Withstand Test Voltage		Rated Cont. Current ④	Rated Short Circuit Current (at rated Max kV) ⑤ ⑥	Rated Interrupting Time	Rated Permissible Tripping delay Y	Rated Max. Voltage Divided by K E/K	Max. Sym. Interrupting Capability ⑦	3-Sec. Short Time Current Carrying Capability	Closing and Latching Capability (Momentary) ⑧			
					Low Frequency	Impulse								K Times Rated Short Circuit Current KI		1.6 K Times Rated Short Circuit Current ⑨	2.7 K Times Rated Short Circuit Current
														E kV rms	K	kV rms	kV Crest
5-GMI-250 ^①	4.16	250	4.76	1.24	19	60	1200 2000	29	5	2	3.85	36	36	58 & 78 ^①	97 & 132 ^①		
5-GMI-350	4.16	350	4.76	1.19	19	60	1200 2000 3000	41	5	2	4.0	49	49	78	132		
7-GMI-500	7.2	500	8.25	1.25	36	95	1200 2000 3000	33	5	2	6.6	41	41	66	111		
15-GMI-500 ^①	13.8	500	15	1.30	36	95	1200 2000	18	5	2	11.5	23	23	37 & 58 ^①	62 & 97 ^①		
15-GMI-750	13.8	750	15	1.30	36	95	1200 2000 3000	28	5	2	11.5	36	36	58 & 77 ^①	97 & 130 ^①		
15-GMI-1000 ^①	13.8	1000	15	1.30	36	95	1200 2000 3000	37	5	2	11.5	48	48	77	130		

- High close and latch (momentary) rating available for special application.
- Maximum voltage for which the breaker is designed and the upper limit for operation.
- K is the ratio of rated maximum voltage to the lower limit of the range of operating voltage in which the required symmetrical and asymmetrical interrupting capabilities vary in inverse proportion to the operating voltage.
- 3000 ampere units available with increased fan-cooled rating of 4000 amperes.
- To obtain the required symmetrical interrupting capability of a circuit breaker at an operating voltage between 1/K times rated maximum voltage and rated maximum voltage, the following formula shall be used:

$$\text{Required Symmetrical Interrupting Capacity} = \text{Rated Short Circuit Current} \times \frac{\text{Rated Maximum Voltage}}{\text{Operating Voltage}}$$

For operating voltages below 1/K times rated maximum voltage, the required symmetrical interrupting capability of the circuit breaker shall be equal to K times rated short circuit current.
- With the limitations stated in 5.10 of ANSI Standard C37.04-1979, all values apply for polyphase and line-to-line faults. For single phase-to-ground faults, the specific conditions stated in 5.10.2.3 of ANSI Standard C37.04-1979 apply.
- Current values in this column are not to be exceeded even for operating voltages below 1/K times rated maximum voltage. For voltages between rated maximum voltage and 1/K times rated maximum voltage, follow 5 above.
- Current values in this column are independent of operating voltage up to and including rated maximum voltage.
- Included for reference only.

Appendix

Table A-2

5kV, 7.2kV and 15kV Type GMI Circuit Breaker Control Data
Typical Spring Release (Close Coil), Trip Coil and Spring Charging Motor Characteristics

Control Voltages, ANSI C37.06 Table 10			Close Coil	Trip Coil	Spring Charging Motor		
Nominal	Range				Amperes		Charging
	Close	Trip			Run (Avg.) ^①	Inrush (Peak) ^①	
48 VDC	38-56	28-56	10 ^②	10 ^②	8.5	15	10
125 VDC	100-140	70-140	4	4	2.7	10.2	8
250 VDC	200-280	140-280	3	3	1.3	2.4	8
120 VAC	104-127	104-127	4	--	3.3	10.6	8
240 VAC	208-254	208-254	3	--	1.7	7.1	8

① Current at nominal voltage. ② 10A for coils supplied mid-1993 and later. For coils supplied up to mid-1993, current is 23A.

Table A-3

Interrupting Capacity Auxiliary Switch Contacts

Type Auxiliary Switch	Continuous Current Amperes	Control Circuit Voltage				
		120 VAC	240 VAC	48 VDC	125 VDC	250 VDC
		Non-Inductive Circuit Interrupting Capacity in Amperes				
Breaker Auxiliary Switch	20	20	20	20	10	2
TOC Auxiliary Switch	15	15	10	0.5	0.5	0.2
MOC Auxiliary Switch	20	15	10	10	10	5
		Inductive Circuit Interrupting Capacity in Amperes				
Breaker Auxiliary Switch	20	20	20	20	10	2
TOC Auxiliary Switch	15	15	10	0.5	0.5	0.2
MOC Auxiliary Switch	20	15	10	10	10	5

Table A-4

Circuit Breaker Weights

Breaker Type	Weight, Lbs.		
	Continuous Current, Amperes		
	1200 A	2000 A	3000 A
5-GMI-250	385	425	--
5-GMI-350	440	480	575
7-GMI-500	425	465	560
15-GMI-500	415	455	--
15-GMI-750	425	465	560
15-GMI-1000	440	480	575

SIEMENS

Siemens Energy
& Automation, Inc.
Electrical Apparatus
Division
P.O. Box 29503
Raleigh, NC 27626-0503

SIEMENS

5kV and 15kV Vacuum Circuit Breakers Type GMI

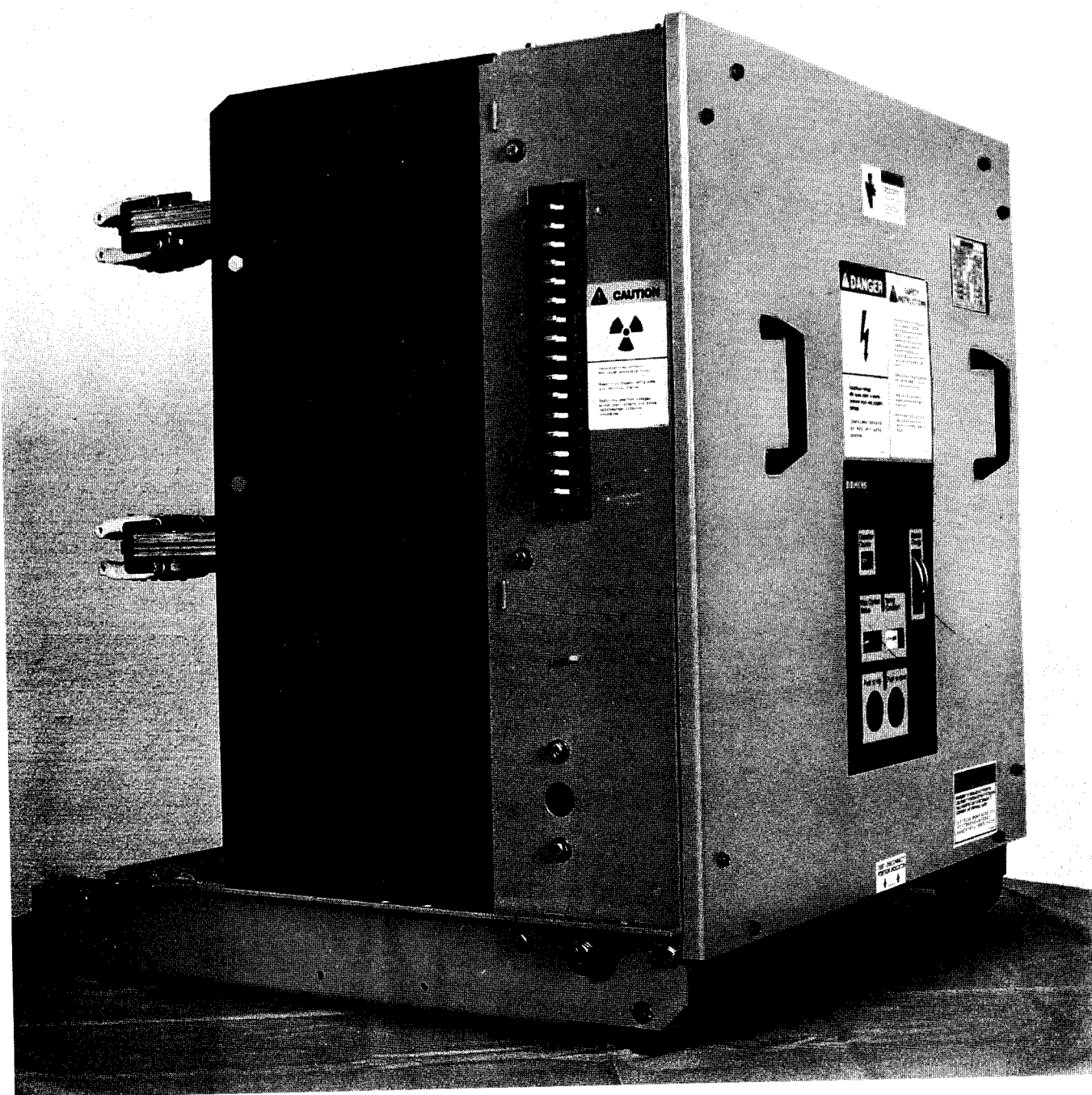
Instruction

Installation

Operation

Maintenance

SG-3268-03





DANGER

Hazardous voltages.

Will cause death, serious personal injury or equipment damage.

Always de-energize and ground the equipment before maintenance.

Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which will cause severe personal injury or equipment damage. Follow all safety instructions contained herein.

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.

QUALIFIED PERSON

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

- (a) **is trained and authorized** to 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.

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 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 sales office, listed on back of this instruction guide.

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

5kV and 15kV Vacuum Circuit Breakers

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Introduction and Safety

Introduction

The GMI family of vacuum circuit breakers is designed to meet all the applicable ANSI, NEMA and IEEE standards. Successful application and operation of this equipment depends as much upon proper installation and maintenance by the user as it does upon the careful design and fabrication by Siemens.

The purpose of this Instruction Manual is to assist the user in developing safe and efficient procedures for the installation, maintenance and use of the equipment.

Contact the nearest Siemens representative if any additional information is desired.

 ⚠ DANGER	
	<p>Power circuit breakers operate at high voltages and have spring-loaded mechanical parts which operate at high speed.</p> <p>When operated improperly, this equipment will cause death, personal injury and property damage.</p> <p>To avoid electrical shock, burns and entanglement in moving parts this equipment must be installed, operated and maintained only by qualified persons thoroughly familiar with the equipment, instruction manuals and drawings.</p>

Qualified Person

For the purpose of this manual and product labels, a "**Qualified Person**" is one who is familiar with the installation, construction and operation of this equipment, and the hazards involved. In addition, this person has the following qualifications:

- Training and authorization to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.
- Training in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses, face shields, flash clothing, etc., in accordance with established safety procedures.
- Training in rendering first aid.

Signal Words

The signal words "**Danger**", "**Warning**" and "**Caution**" used in this manual indicate the degree of hazard that may be encountered by the user. These words are defined as:

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.

Dangerous Procedures

In addition to other procedures described in this manual as dangerous, user personnel must adhere to the following:

1. Always work on a de-energized breaker. Always de-energize a breaker, and remove it from the metal-clad switchgear before performing any tests, maintenance or repair.
2. Always perform maintenance on the breaker after the spring-charged mechanisms are discharged (except for test of the charging mechanisms).
3. Always let an interlock device or safety mechanism perform its function without forcing or defeating the device.

Field Service Operation

Siemens can provide competent, well-trained Field Service Representatives to provide technical guidance and advisory assistance for the installation, overhaul, repair and maintenance of Siemens equipment, processes and systems. Contact regional service centers, sales offices or the factory for details.

Receiving, Handling and Storage

Introduction

Type GMI Vacuum Interrupter Circuit Breakers are normally installed in assembled metal-clad switchgear, and the Switchgear Instruction Manual (SG-3258) contains the Receiving, Handling and Storage instructions for assembled metal-clad switchgear.

This manual covers the Receiving, Handling and Storage instructions for Type GMI circuit breakers shipped separately from the switchgear. This section of the manual is intended to help the user identify, inspect and protect the circuit breaker prior to its installation.

Receiving Procedure

Make a physical inspection of the shipping container before removing or unpacking the circuit breaker. Check for shipment damage or indications of rough handling by the carrier. Check each item against the manifest to identify any shortages.

Accessories such as the manual charging lever, the racking crank and the plug jumper are shipped separately.

Shipping Damage Claims (When Applicable) - Follow normal shipment damage procedures, which should include:

1. Check for visible damage upon arrival.
2. Visible damage must be noted on delivery receipt, and acknowledged with driver's signature. Notation, "Possible internal damage, subject to inspection" must be on delivery receipt.
3. Notify Siemens Sales office immediately of any shipment damage.
4. Arrange for carrier's inspection. Do not move the unit from its unloading point.

Handling Procedure

1. Carefully remove the shipping carton from the circuit breaker. Keep the shipping pallet for later use if the breaker is to be stored prior to its installation.
2. Inspect for concealed damage. Notification to carrier must take place within 15 days to assure prompt resolution of claims.
3. Each circuit breaker should be appropriately lifted to avoid crushing the side panels of the breaker, or damaging the primary disconnect subassemblies.

⚠ WARNING



Heavy Weight

Can cause death, serious injury, or property damage.

Obtain the services of a qualified rigger prior to hoisting the circuit breaker to assure adequate safety margins in the hoisting equipment and procedures to avoid damage.

Type GMI circuit breakers weigh between 385 to 575 pounds (175 to 261 kg). See Table A-4, Technical Data in Appendix.

4. The palletted circuit breaker can also be moved using a properly rated fork-lift vehicle. The pallets are designed for movement by a standard fork-lift vehicle.

Storage Procedure

1. Whenever possible, install circuit breakers in their assigned switchgear enclosures for storage. Follow instructions contained in the Switchgear Instruction Manual.
2. When the breaker will be placed on its pallet for storage, be sure the unit is securely bolted to the pallet and covered with polyethylene film at least 10 mils thick.

Indoor Storage - Whenever possible, store the circuit breaker indoors. The storage environment must be clean, dry and free of such items as construction dust, corrosive atmosphere, mechanical abuse and rapid temperature variations.

Outdoor Storage - Outdoor storage is not recommended. When no other option is available, the circuit breaker must be completely covered and protected from rain, snow, dirt and all other contaminants.

Space Heating - Space heating must be used for *both indoor and outdoor* storage to prevent condensation and corrosion. When stored outdoors, between 150 to 200 watts per breaker of space heating is recommended. If the circuit breakers are stored inside the switchgear enclosures, and the switchgear is equipped with space heaters, energize the space heaters.

Installation Checks and Initial Functional Tests

Introduction

This section provides a description of the inspections, checks and tests to be performed on the circuit breaker prior to operation in the metal-clad switchgear.

Inspections, Checks and Tests without Control Power

Vacuum circuit breakers are normally shipped with their primary contacts open and their springs discharged. However, it is critical to *first* verify the discharged condition of the spring-loaded mechanisms after de-energizing control power.

De-Energizing Control Power in Switchgear - When the circuit breaker is mounted in switchgear, open the control power disconnect device in the metal-clad switchgear cubicle. **Figure 1** shows the location of this disconnect in a standard GM switchgear assembly.

The control power disconnect device is located on the device panel above the lower circuit breaker and below the upper circuit breaker. **Figure 1** shows a pullout type fuse holder. Removal of the fuse holder de-energizes control power to the circuit breaker in the respective switchgear cell. In some switchgear assemblies, a molded case circuit breaker is used in lieu of the pull out type fuse holder. Opening this circuit breaker accomplishes the same result: control power is disconnected.

Spring Discharge Check (Figure 2) - Perform the Spring Discharge Check *before* removing the circuit breaker from the pallet or removing it from the switchgear.

The spring discharge check consists of simply performing the following tasks in the order given. This check assures that both the tripping and closing springs are fully discharged.

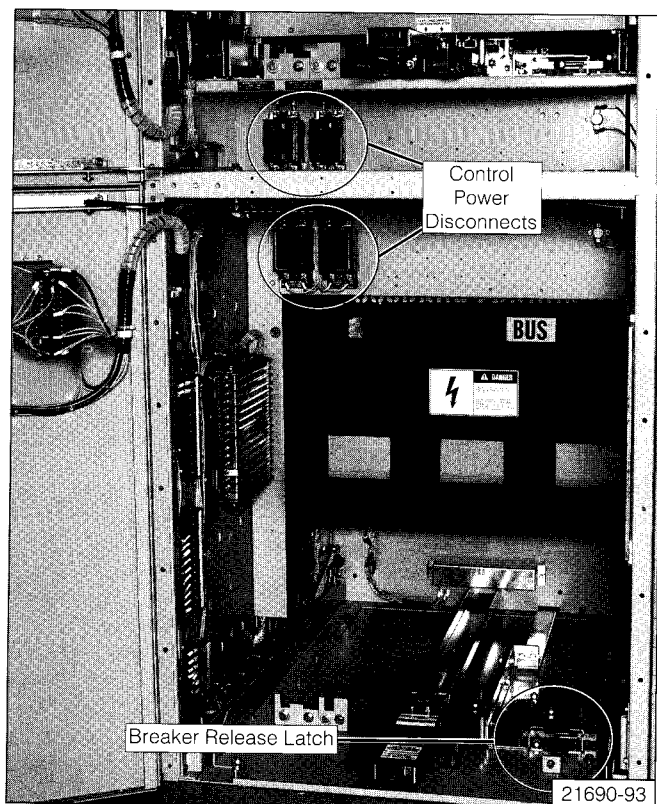
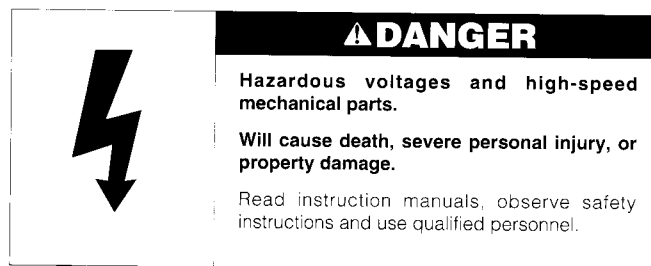


Figure 1: Control Power Disconnects in Switchgear.



1. Press red Trip pushbutton.
2. Press black Close pushbutton.
3. Again press red Trip pushbutton.
4. Verify Spring Condition Indicator shows DISCHARGED.
5. Verify Main Contact Status Indicator shows OPEN.

Removal from Lower Cell in Indoor (if not on raised pad) and Shelter-Clad Outdoor Switchgear -

1. Open the circuit breaker.
2. If the circuit breaker is in the Connect position, insert the racking crank on the racking screw on the front of the breaker cell, and push in. This action operates the racking interlock latch. **Figure 3** shows racking of a circuit breaker in the upper cell - the process is similar for a breaker in the lower cell. Rotate the racking crank *counterclockwise* until the breaker is in the Test position. (If the circuit breaker is in the Disconnect position, turn the racking crank *clockwise* to rack the circuit breaker from the Disconnect position to the Test position). If the racking crank is not of the "Captive" type, constant inward pressure is required during racking to maintain engagement with the racking mechanism.
3. With the circuit breaker in the Test position and OPEN, de-energize control power to the circuit breaker. **Figure 1** shows the location of control power disconnects in a normal unit.

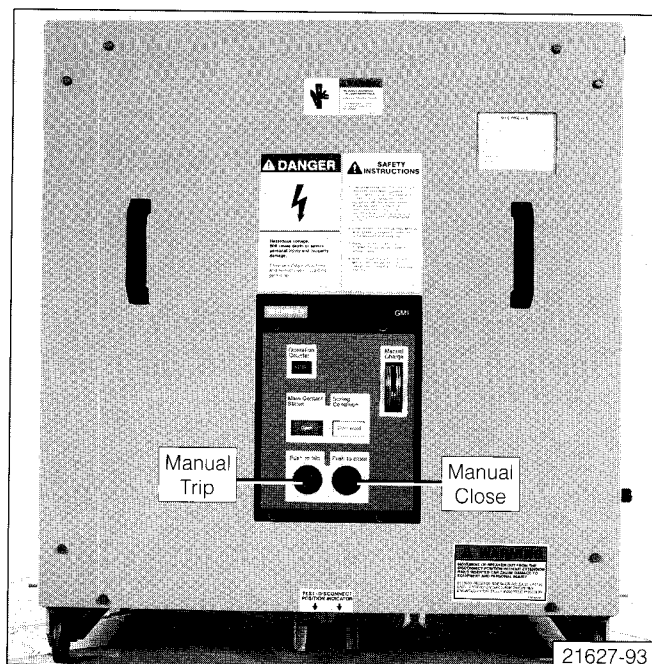


Figure 2: Front Panel of GMI Circuit Breaker.

Installation Checks and Initial Functional Tests

4. Perform the Spring Discharge Check, and verify that the circuit breaker is OPEN and the closing spring indicator shows DISCHARGED.
5. Insert the racking crank on the racking screw on the front of the breaker cell, and push in, as described in step 2. Rotate the racking crank *counterclockwise* until the breaker is in the Disconnect position. The breaker can now be removed from the cubicle.
6. The circuit breaker is now free to be rolled out on the floor using the handles as shown in **Figure 4**. The wheels of the circuit breaker are virtually at floor level (unless the switchgear is installed on a raised pad), and one person can easily handle the unit.

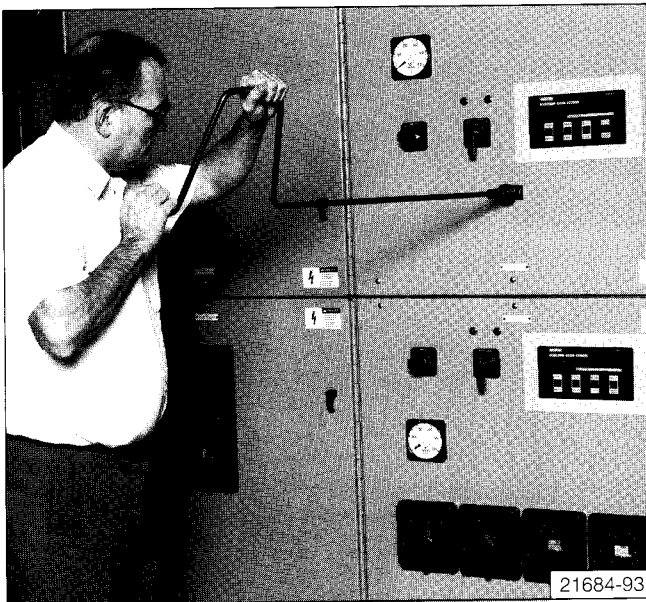


Figure 3: Racking Circuit Breaker in Switchgear.

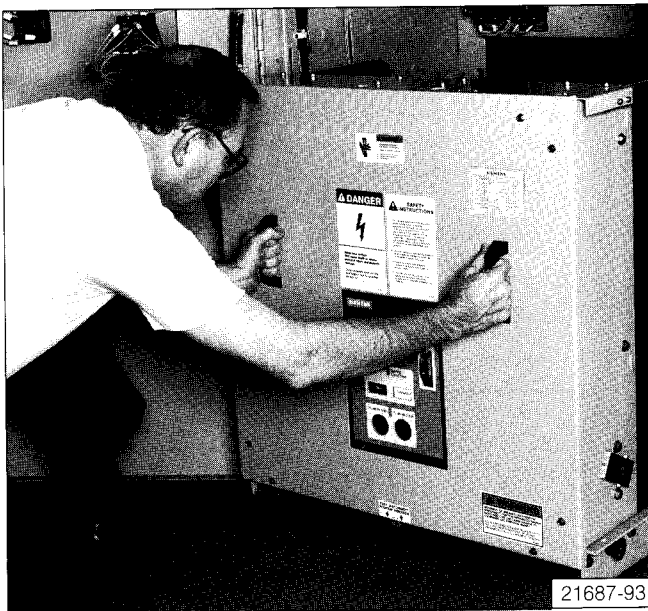


Figure 4: Removal of Circuit Breaker.

Removal from Upper Cell (Indoor and Shelter-Clad Outdoor Switchgear) - Removal of the upper breaker in a two-high assembly is similar to removal of a breaker from a lower cell, with several additional steps.

Figure 5 shows one of the two breaker extension rails being inserted into the fixed rails within the upper cell of two-high switchgear equipment. The rails engage locking pins in the fixed rails to secure them in position.

The procedure for removal of an upper circuit breaker is:

1. Open the circuit breaker.
2. If the circuit breaker is in the Connect position, insert the racking crank on the racking screw on the front of the breaker cell, and push in. This action operates the racking interlock latch. **Figure 3** shows racking of a circuit breaker in the upper cell - the process is similar for a breaker in the lower cell. Rotate the racking crank *counterclockwise* until the breaker is in the Test position. (If the circuit breaker is in the Disconnect position, turn the racking crank *clockwise* to rack the circuit breaker from the Disconnect position to the Test position). If the racking crank is not of the "Captive" type, constant inward pressure is required during racking to maintain engagement with the racking mechanism.
3. With the circuit breaker in the Test position and OPEN, de-energize control power to the circuit breaker. **Figure 1** shows the location of control power disconnects in a normal unit.
4. Perform the Spring Discharge Check, and verify that the circuit breaker is OPEN and the closing spring indicator shows DISCHARGED.
5. Insert the two extension rails into the fixed rails. Be sure the extension rails are properly secured in place. (This can be done at step 7 if preferred.)
6. Insert the racking crank on the racking screw on the front of the breaker cell, and push in, as described in step 2. Rotate the racking crank *counterclockwise* until the breaker is in the Disconnect position.
7. If you have not yet installed the extension rails, do so now. Note that some difficulty may be experienced installing the extension rails if the circuit breaker is in the Disconnect

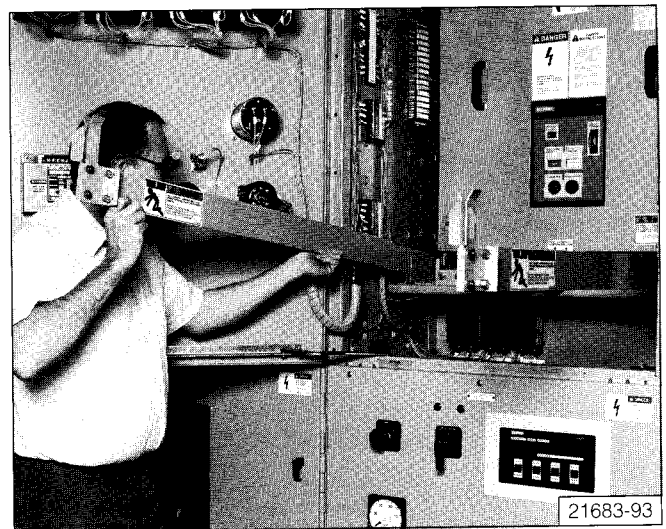
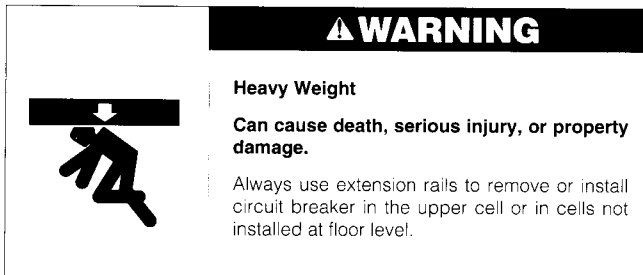


Figure 5: Use of Extension Rails for Upper Compartment.

Installation Checks and Initial Functional Tests

position. If difficulty is encountered, rack the circuit breaker to the Test position, install the extension rails, and then rack the circuit breaker to the Disconnect position.



8. Move the breaker release latch to the left and pull the circuit breaker out from the Disconnect position. The breaker is now free to be rolled out on the two extension rails using the handles on the front of the circuit breaker.
9. Remove the breaker from the two extension rails using the approved Siemens breaker lifting device.
10. Lift the two extension rails and withdraw them from the switchgear.

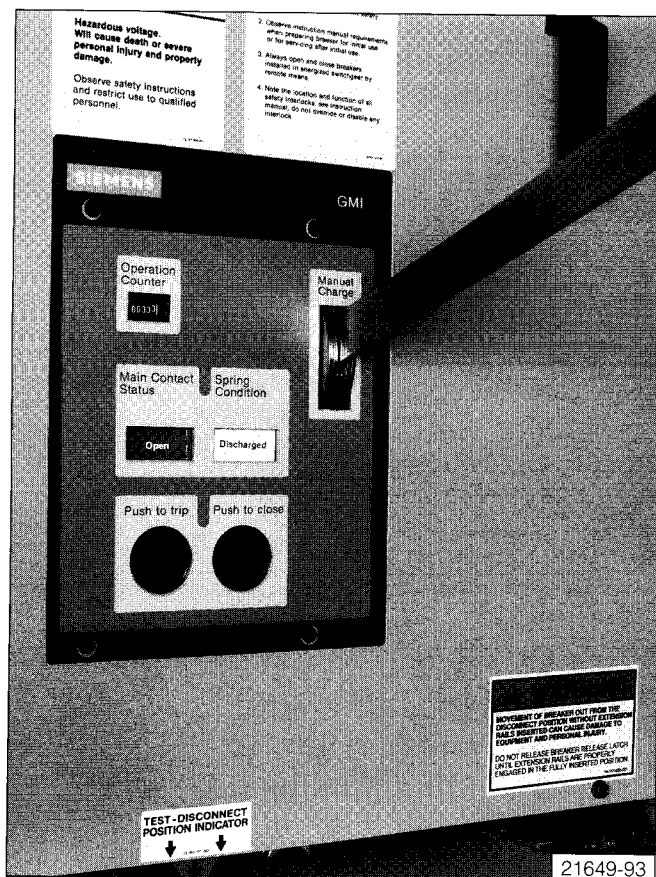


Figure 6: Manual Charging of Closing Springs.

Removal from Upper and Lower Cell in Outdoor Non-Walk In Enclosures or for Indoor Switchgear Installed on a Raised Pad - Because the floor level in non-walk in outdoor enclosures is approximately 6 inches above grade (foundation) level, the lower breaker in either a one-high or two-high section of switchgear must be removed using the preceding procedure for upper breaker removal.

The approved breaker lifting device should be used for removal of both lower and upper breakers from the extension rails of outdoor non-walk in enclosures.

Physical Inspections

1. Verify that rating of the circuit breaker is compatible with both the system and the switchgear.
2. Perform a visual shipping damage check. Clean the breaker of all shipping dust, dirt and foreign material.

Manual Spring Charging Check

1. Insert the manual spring charging lever into the manual charge handle socket as shown in **Figure 6**. Operate the lever up and down until the spring condition indicator shows the closing spring is Charged.
2. Repeat the Spring Discharge Check.
3. Verify that the springs are discharged and the breaker primary contacts are open by indicator positions.



Figure 7: Split Plug Jumper Connected to Circuit Breaker.

Installation Checks and Initial Functional Tests

As-Found and Vacuum Check Tests - Perform and record the results of both the As-Found insulation test and the vacuum check high-potential test. Procedures for these tests are described in the Maintenance Section of this manual.

Automatic Spring Charging Check

Note: A temporary source of control power and test leads may be required if the control power source has not been connected to the switchgear. (Refer to the specific wiring information and rating label for your circuit breaker to determine the voltage required and where the control voltage signal should be applied. Usually, spring charging power is connected to secondary disconnect fingers SD16 and SD15, closing control power to SD13 and SD15, and tripping power to SD1 and SD2.) When control power is connected to the GMI circuit breaker, the closing springs should automatically charge.

The automatic spring charging features of the circuit breaker must be checked. Control power is required for automatic spring charging to take place.

1. Open control power circuit by removing pullout fuse holder shown in **Figure 1**.
2. Install breaker end of split plug jumper (if furnished) shown in **Figure 7** to the circuit breaker. The plug jumper is secured by means of screws, over the circuit breaker's secondary contacts.
3. Install the switchgear end of the plug jumper shown in **Figure 8** to the secondary disconnect block inside the switchgear cubicle. The jumper slides into place. The plug jumper interconnects all control power and signal leads (e.g., remote trip and close contacts) between the switchgear and the circuit breaker.
4. Energize (close) the control power circuit disconnect (**Figure 1**).

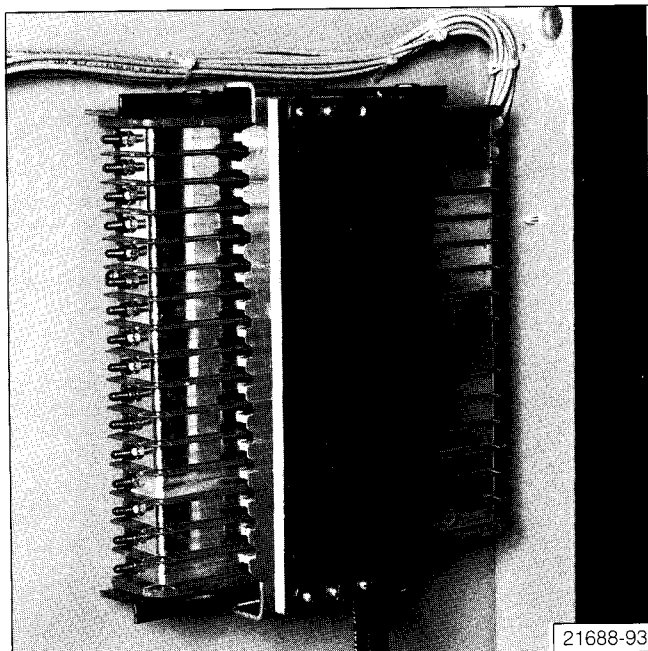


Figure 8: Split Plug Jumper Connected to Switchgear.

5. Use the Close and Trip controls (**Figure 2**) to first Close and then Open the circuit breaker contacts. Verify contact positions visually by observing the Open/Closed indicator on the circuit breaker.
6. De-energize control power by repeating Step 1. Disconnect the plug jumper from the switchgear first and next from the circuit breaker.
7. Perform the Spring Discharge Check again. Verify that the closing springs are discharged and the primary contacts of the GMI circuit breaker are open.

Final Mechanical Inspections without Control Power

1. Make a final mechanical inspection of the circuit breaker. Verify that the contacts are in the Open position, and the closing springs are Discharged.
2. Check the upper and lower primary studs and contact fingers shown in **Figure 9**. Verify mechanical condition of finger springs and the disconnect studs.
3. Coat movable primary contact fingers (**Figure 9**) and the secondary disconnect contacts (**Figure 9** and **22**) with a light film of Siemens Contact Lubricant No. 15-171-370-002.
4. The GMI vacuum circuit breaker is ready for installation into its assigned cubicle of the metal-clad switchgear. Refer to removal procedures and re-install the circuit breaker into the switchgear.
5. Refer to the Switchgear Instruction Manual for functional tests of an installed circuit breaker.

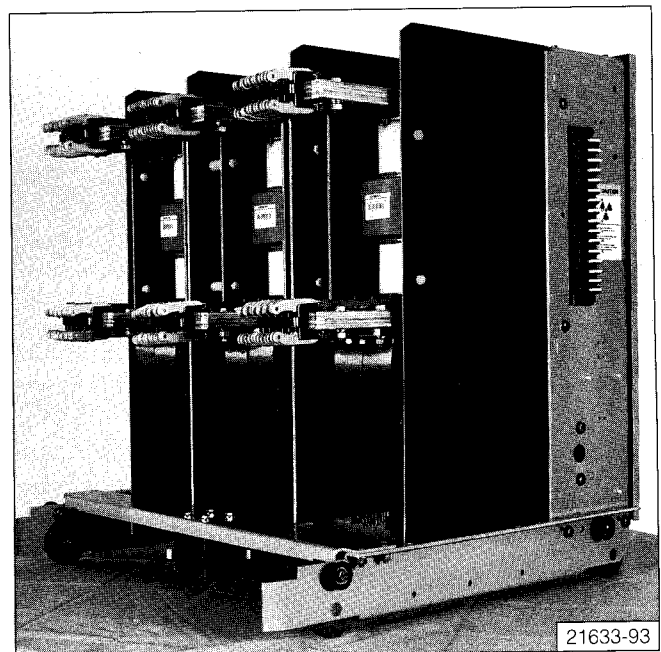


Figure 9: Rear of GMI Breaker with Primary Disconnects.

Interrupter/Operator Description

Introduction

The Type GMI vacuum circuit breaker is of drawout construction designed for use in medium voltage, metal-clad switchgear. The GMI circuit breaker conforms to the requirements of ANSI standards C37.20.2, C37.04, C37.06, C37.09 and C37.010.

GMI circuit breakers consist of three vacuum interrupters, a stored energy operating mechanism, necessary electrical controls and interlock devices, disconnect devices to connect the breaker to both primary and control power and an operator housing. On some circuit breaker ratings insulating barriers are located between the vacuum interrupters or along the sides.

This section describes the operation of each major subassembly as an aid in the operation, installation, maintenance and repair of the GMI vacuum circuit breaker.

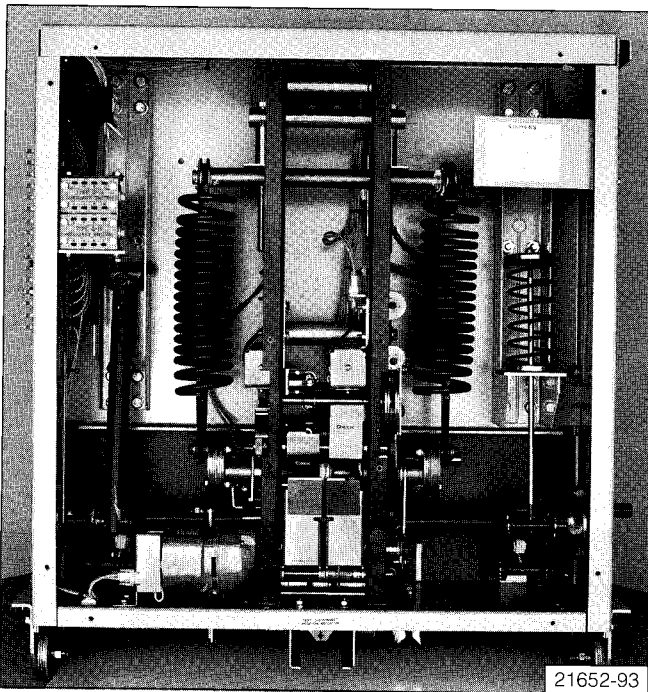


Figure 10: Front View of GMI Breaker.

Vacuum Interrupters and Primary Disconnects

The operating principle of the GMI vacuum interrupter is simple. **Figure 11** is a cutaway view of a typical vacuum interrupter. The entire assembly is sealed after a vacuum is established. The interrupter stationary contact is connected to the upper disconnect stud of the circuit breaker. The interrupter movable contact is connected to the lower disconnect stud and driving mechanism of the circuit breaker. The metal bellows assembly provides a secure seal around the movable contact, preventing loss of vacuum while permitting vertical motion of the movable contact.

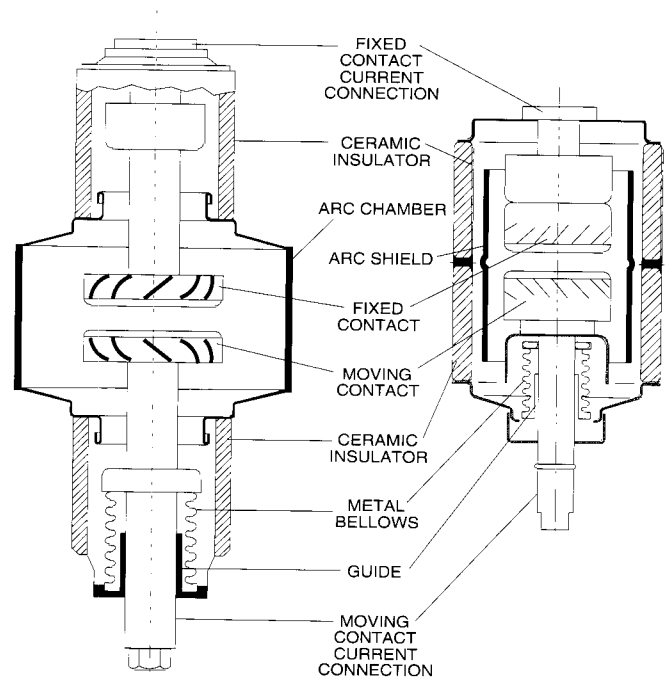


Figure 11: Cutaway View of GMI Vacuum Interrupters.

When the two contacts separate an arc is initiated which continues conduction up to the following current zero. At current zero, the arc extinguishes and any conductive metal vapor which has been created by and supported the arc condenses on the contacts and on the surrounding vapor shield. Contact materials and configuration are optimized to achieve arc motion and to minimize switching disturbances.

Interrupter/Operator Description

Primary Disconnects - Figure 12 is a side view of the circuit breaker with a side phase barrier removed to show details of the primary disconnects. Each circuit breaker has three upper and three lower primary disconnects. Upper primary disconnects are connected to the stationary contacts of the vacuum interrupters, and the lower primary disconnects to the movable contacts. Each disconnect arm has a set of multiple spring loaded fingers that mate with bus bars in the metal-clad switchgear. The number of fingers in the disconnect assembly varies with the continuous and/or momentary rating of the circuit breaker.

There are three insulating push rods. Each push rod connects the movable contact of one of the vacuum interrupters to the jack shaft driven by the closing and tripping mechanism. Flexible connectors ensure secure electrical connections between the movable contacts of each interrupter and its bottom primary disconnect.

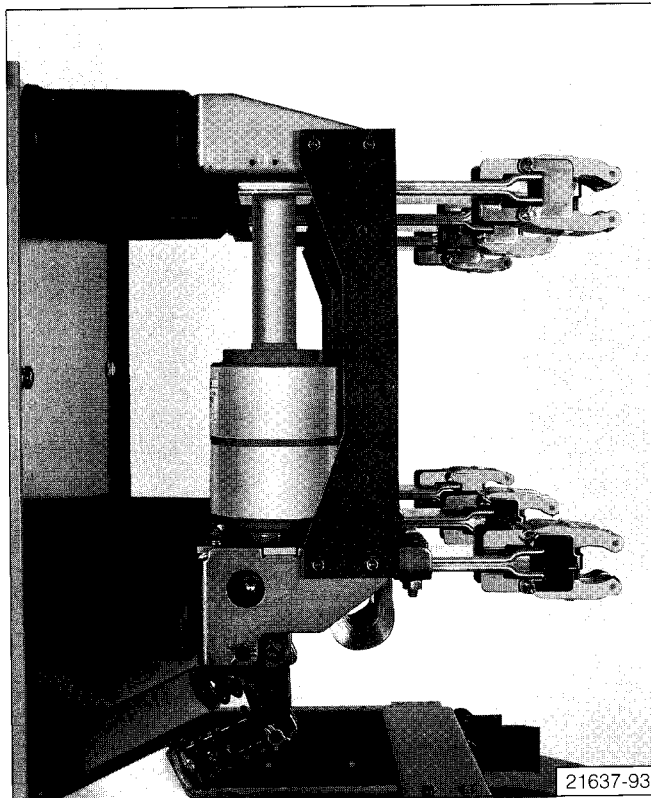


Figure 12: Upper and Lower Primary Disconnects.

Phase Barriers - Phase barrier configurations vary among GMI breakers depending on voltage and continuous current ratings.

Figure 13 is a rear view of a circuit breaker that shows the two outer (phase to ground) insulating barriers and two interphase barriers. The interphase barriers are not provided on all circuit breaker ratings. These four plates of glass polyester insulating material are attached to the circuit breaker and provide suitable electrical insulation between the vacuum interrupter primary circuits and the housing.

Stored Energy Operating Mechanism

The stored energy operating mechanism of the GMI circuit breaker is an integrated arrangement of springs, solenoids and mechanical devices designed to provide a number of critical functions. The energy necessary to close and open the contacts of the vacuum interrupters is stored in powerful tripping and closing springs. These springs are normally charged automatically, but there are provisions for manual charging. The operating mechanism that controls charging, closing and tripping functions is fully trip-free, i.e., spring charging does not automatically change the position of the primary contacts, and the closing function may be overridden by the tripping function at any time.

Note: Two different latch systems have been used in GMI circuit breakers, with changeover from one design to the other occurring in mid-1991. This instruction manual describes both designs.

Pages 10-11 describe the operation of the mechanism used beginning in approximately mid-1991.

Pages 12-13 describe the operation of the mechanism used from 1989 until approximately mid-1991.

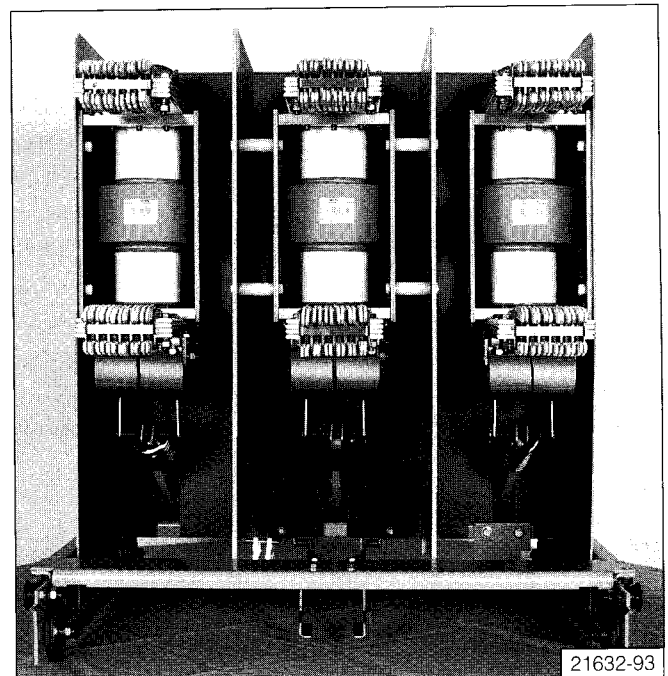


Figure 13: Breaker with Interphase and Outerphase Barriers.

Interrupter/Operator Description

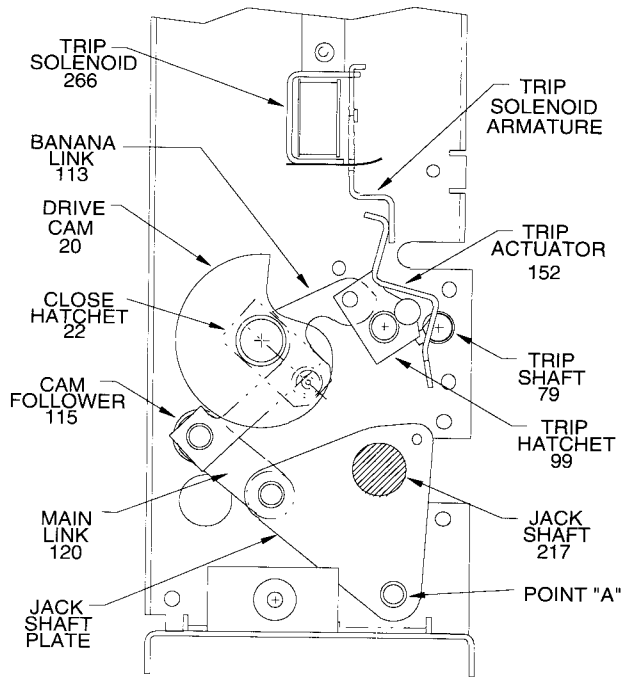


Figure 14a: Breaker Open—Closing Springs Discharged.

Modes of Operation - Mid-1991 and After

Pages 10-11 describe the operation of the mechanism used beginning in approximately mid-1991.

This mechanism can be identified by observing the close latch above the spring charging motor on the left side of the circuit breaker. Refer to **Figure 18a**. The close latch is installed on the close shaft assembly 72, and includes a hardened latch face. This face contacts a bearing which is part of the close hatchet assembly 105. If the mechanism has a close hatchet which bears directly on the close shaft, refer to pages 12-13 for the description of your mechanism.

Modes of Operation - Discussion

Some maintenance procedures are more easily understood when the operating mechanism modes of operation are described in detail. The next few paragraphs explain the five modes or status conditions (charging, closing, trip-free, opening and rapid auto-reclosing) of the stored energy operating mechanism.

Note: All discussion of modes of operation assumes that the reader is viewing the operator from the front, or from the right hand side.

Spring Charging Mode - Figures 14a and 15a show several key components of the operator mechanism in positions corresponding to the breaker open, with the closing springs discharged (**Figure 14a**) and charged (**Figure 15a**). **Figure 16a** shows portions of the operator mechanism that manually or electrically charge the closing springs. The drive cam (20), the closing spring crank arms (**Figure 19**) and spring condition indicator cam (18) are directly keyed to the main cam shaft (3). The main cam shaft rotates counterclockwise. The closing springs are attached to the crank arms, and are extended during the charging cycle.

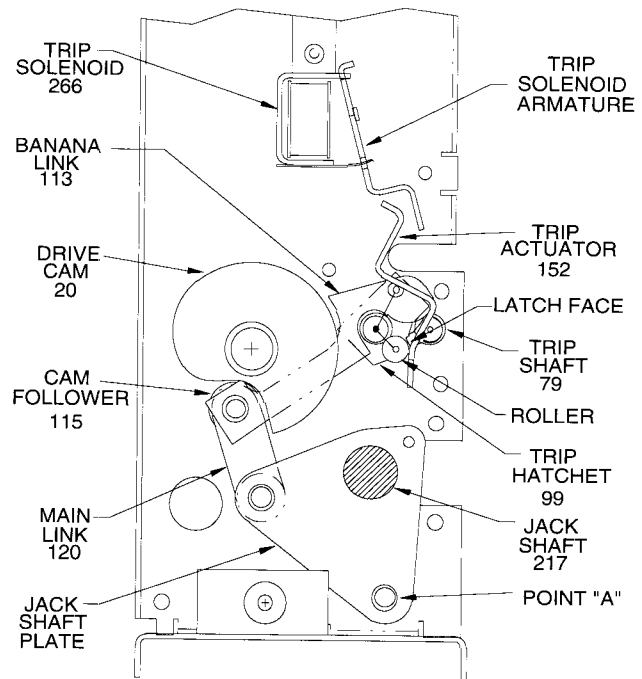


Figure 15a: Breaker Open—Closing Springs Charged.

Figure 16a shows the ratchet wheel (15) which is free to rotate about the main cam shaft (3). The ratchet wheel is driven by either the charging motor or the manual charge handle socket (52). When the springs are charged electrically, the motor eccentric (100) introduces a rocking motion into the drive plate (13). As this plate rocks back and forth, the lower pawl (24-1) (which is connected to the drive plate) imparts counterclockwise rotation of the ratchet wheel (15), one tooth at a time. The upper pawl (24-2) acts as a holding pawl during electrical charging.

When the springs are charged manually, up and down pumping action of the spring charging handle in the manual charge handle socket (52) causes the pawl plate (11) to rock back and forth through the movement of the manual charging link (48). The upper pawl (24-2) drives the ratchet plate counterclockwise during manual charging, and the lower pawl (24-1) becomes the holding device.

At the beginning of the charging cycle, ratchet pin (16) is at the 6 o'clock position. The ratchet pin is connected to the ratchet wheel. Upon being advanced by ratchet action to the 12 o'clock position, this pin engages the drive arms (8) which are keyed to the main cam shaft. Consequently, counterclockwise rotation of the ratchet wheel causes the ratchet pin to drive the main cam shaft counterclockwise. When the ratchet pin reaches the 6 o'clock position, the closing springs are fully charged. Driving pawl (24-1) is disengaged, the spring condition indicator cam (18) has rotated allowing the spring charged flag (132) to drop into the lower (charged) position, which also operates the motor cutoff switch (LS1) and spring charged switch (LS2) (258) (see **Figures 17a and 27**). The closing springs are restrained fully charged by close hatchet (22) against close shaft (72).

Interrupter/Operator Description

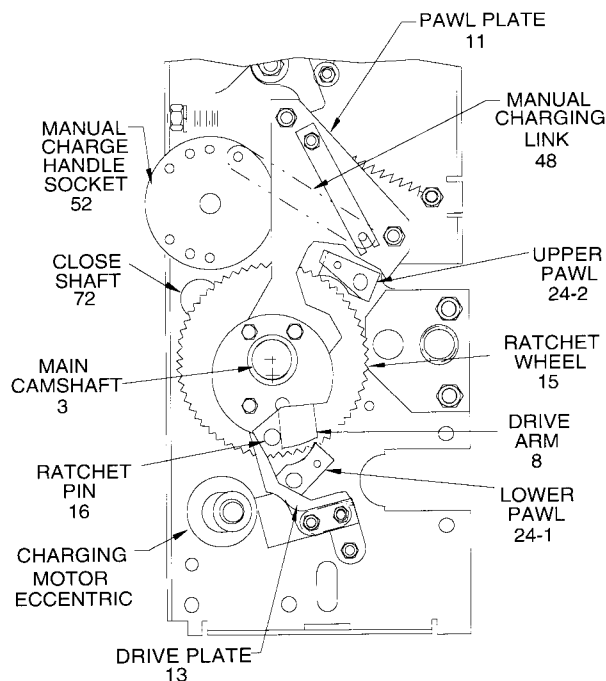


Figure 16a: Pawl and Ratchet Drive.

Closing Mode (Figure 17a) - Energizing the close solenoid (265) pulls the solenoid armature against the closing shaft actuator (75) and causes the close shaft (72) to rotate approximately 15°. If the closing springs are charged, the close hatchet (22) will be released by this rotation allowing the main cam shaft (3) to be driven by the closing springs. Depressing the manual close button on the operator panel causes the rotation of the close shaft (72) by the lower end of the close shaft actuator (75). Rotation of the main cam shaft (3) in a manual closing operation is identical to that of an electrical closing operation. As the main cam shaft (3) rotates, the cam follower (115) is driven by drive cam (20), and the main link (120) is forced outwards, and rotation of the jack shaft assembly (217) occurs. There are three drive links attached to Point "A" of each of the three jack shaft drive plates. Each drive link is connected to the movable contact of one vacuum interrupter. Closing rotation (counterclockwise) of the jack shaft assembly closes the contacts of the three vacuum interrupters. During closing operation, rotation of jack shaft assembly (217) forces the opening (i.e., tripping) spring into its charged position.

Trip Free Mode - If at any time during breaker closing, the trip shaft (79) (Figure 14a) operates as a result of either an electrical or mechanical trip, trip hatchet (99) is free to rotate. When the trip hatchet (99) rotates, cam follower (115) is displaced by drive cam (20) without motion of the jack shaft (217). Mechanical trip free operation is provided by manual tripping, electrical tripping and/or the mechanical interlocks.

Opening Mode - Opening or tripping the vacuum interrupter contacts is accomplished by rotation of the trip shaft (79). Rotation may be produced either electrically, by energizing the trip solenoid (266) (Figure 15a), or manually by pressing the trip button. Energizing the trip solenoid causes the upper arm of the trip actuator (152) to rotate counterclockwise. Pressing the trip button causes the trip actuator lower arm to move,

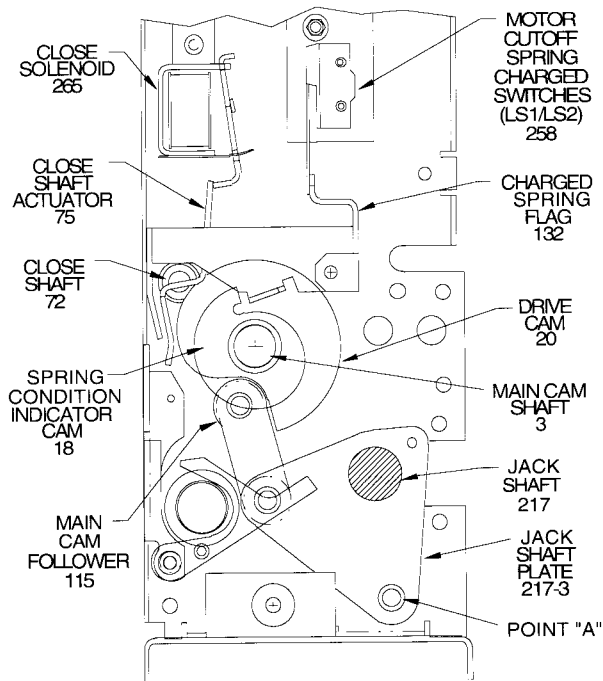


Figure 17a: Closing Mode

again producing rotation of the trip shaft. All of the linkages are trip free, and tripping or opening is unaffected by charging status of the closing springs or position of the drive cam (20).

Rapid Auto-Reclosing Mode (Optional) - The closing springs are automatically recharged by the motor driven operating mechanism when the breaker has closed. The operating mechanism is capable of the open-close-open duty cycle required for rapid auto-reclosing. A trip latch check switch and a relay (delay on dropout) prevent release of the closing spring energy if the trip hatchet (99) is not in its reset position. This ensures the mechanism does not operate trip free on an instantaneous reclosure.

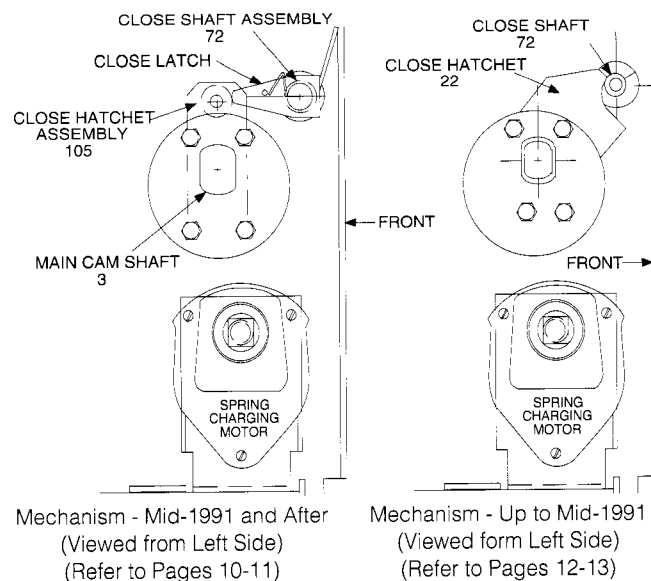


Figure 18a: Identification of Mechanism Vintage

Interrupter/Operator Description

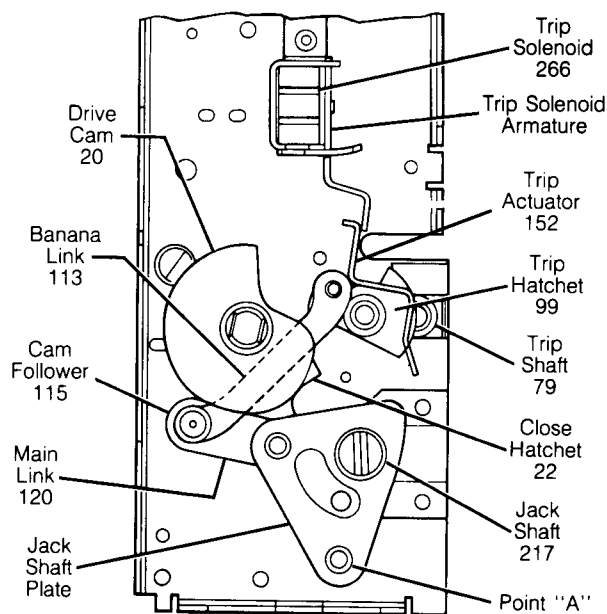


Figure 14b: Breaker Open—Closing Springs Discharged.

Modes of Operation - Up to Mid-1991

Pages 12-13 describe the operation of the mechanism used from 1989 until approximately mid-1991.

This mechanism can be identified by observing the close latch above the spring charging motor on the left side of the circuit breaker. Refer to **Figure 18b**. The close hatchet 22 has a latch face which bears directly on the close shaft 72. If the close hatchet includes a bearing which contacts a hardened latch installed on the close shaft, refer to pages 10-11 for the description of your mechanism.

Modes of Operation - Discussion

Some maintenance procedures are more easily understood when the operating mechanism modes of operation are described in detail. The next few paragraphs explain the five modes or status conditions (charging, closing, trip-free, opening and rapid auto-reclosing) of the stored energy operating mechanism.

Note: All discussion of modes of operation assumes that the reader is viewing the operator from the front, or from the right hand side.

Spring Charging Mode - Figures 14b and 15b show several key components of the operator mechanism in positions corresponding to the breaker open, with the closing springs discharged (**Figure 14b**) and charged (**Figure 15b**). **Figure 16b** shows portions of the operator mechanism that manually or electrically charge the closing springs. The drive cam (20), the closing spring crank arms (**Figure 19**) and spring condition indicator cam (18) are directly keyed to the main cam shaft (3). The main cam shaft rotates counterclockwise. The closing springs are attached to the crank arms, and are extended during the charging cycle.

Figure 16b shows the ratchet wheel (15) which is free to rotate about the main cam shaft (3). The ratchet wheel is driven by

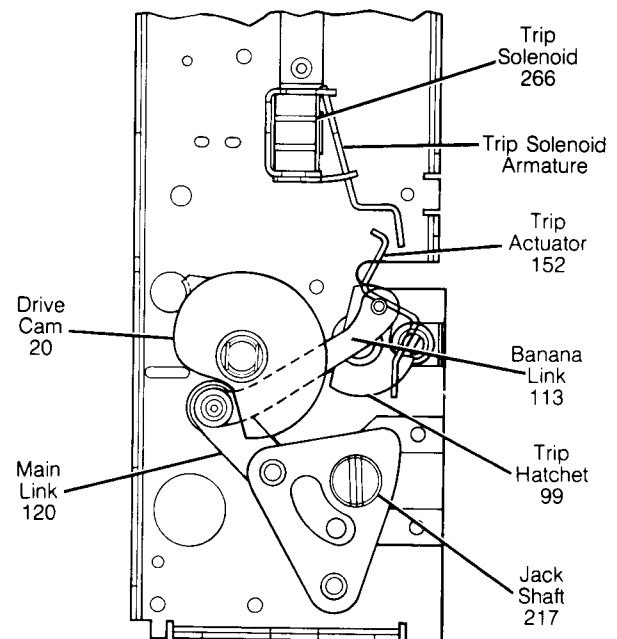


Figure 15b: Breaker Open—Closing Springs Charged.

either the charging motor or the manual charge handle socket (52). When the springs are charged electrically, the motor eccentric (100) introduces a rocking motion into the drive plate (13). As this plate rocks back and forth, the lower pawl (24-1) (which is connected to the drive plate) imparts counterclockwise rotation of the ratchet wheel (15), one tooth at a time. The upper pawl (24-2) acts as a holding pawl during electrical charging.

When the springs are charged manually, up and down pumping action of the spring charging handle in the manual charge handle socket (52) causes the pawl plate (11) to rock back and forth through the movement of the manual charging link (48). The upper pawl (24-2) drives the ratchet plate counterclockwise during manual charging, and the lower pawl (24-1) becomes the holding device.

At the beginning of the charging cycle, ratchet pin (16) is at the 6 o'clock position. The ratchet pin is connected to the ratchet wheel. Upon being advanced by ratchet action to the 12 o'clock position, this pin engages the drive arms (8) which are keyed to the main cam shaft. Consequently, counterclockwise rotation of the ratchet wheel causes the ratchet pin to drive the main cam shaft counterclockwise. When the ratchet pin reaches the 6 o'clock position, the closing springs are fully charged. Driving pawl (24-1) is disengaged, the spring condition indicator cam (18) has rotated allowing the spring charged flag (132) to drop into the lower (charged) position, which also operates the motor cutoff switch (LS1) and spring charged switch (LS2) (258) (see **Figures 17b and 27**). The closing springs are restrained fully charged by close hatchet (22) against close shaft (72).

Closing Mode (Figure 17b) - Energizing the close solenoid (265) pulls the solenoid armature against the closing shaft actuator (75) and causes the close shaft (72) to rotate approximately 15°. If the closing springs are charged, the close

Interrupter/Operator Description

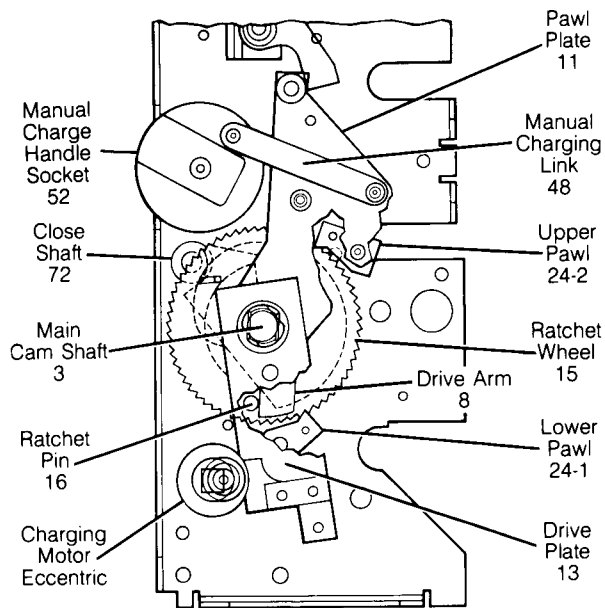


Figure 16b: Pawl and Ratchet Drive.

hatchet (22) will be released by this rotation allowing the main cam shaft (3) to be driven by the closing springs. Depressing the manual close button on the operator panel causes the rotation of the close shaft (72) by the lower end of the close shaft actuator (75). Rotation of the main cam shaft (3) in a manual closing operation is identical to that of an electrical closing operation. As the main cam shaft (3) rotates, the cam follower (115) is driven by drive cam (20), and the main link (120) is forced outwards, and rotation of the jack shaft assembly (217) occurs. There are three drive links attached to Point "A" of each of the three jack shaft drive plates. Each drive link is connected to the movable contact of one vacuum interrupter. Closing rotation (counterclockwise) of the jack shaft assembly closes the contacts of the three vacuum interrupters. During closing operation, rotation of jack shaft assembly (217) forces the opening (i.e., tripping) spring into its charged position.

Trip Free Mode - If at any time during breaker closing, the trip shaft (79) (**Figure 14b**) operates as a result of either an electrical or mechanical trip, trip hatchet (99) is free to rotate. When the trip hatchet (99) rotates, cam follower (115) is displaced by drive cam (20) without motion of the jack shaft (217). Mechanical trip free operation is provided by manual tripping, electrical tripping and/or the mechanical interlocks.

Opening Mode - Opening or tripping the vacuum interrupter contacts is accomplished by rotation of the trip shaft (79). Rotation may be produced either electrically, by energizing the trip solenoid (266) (**Figure 15b**), or manually by pressing the trip button. Energizing the trip solenoid causes the upper arm of the trip actuator (152) to rotate counterclockwise. Pressing the trip button causes the trip actuator lower arm to move, again producing rotation of the trip shaft. All of the linkages are trip free, and tripping or opening is unaffected by charging status of the closing springs or position of the drive cam (20).

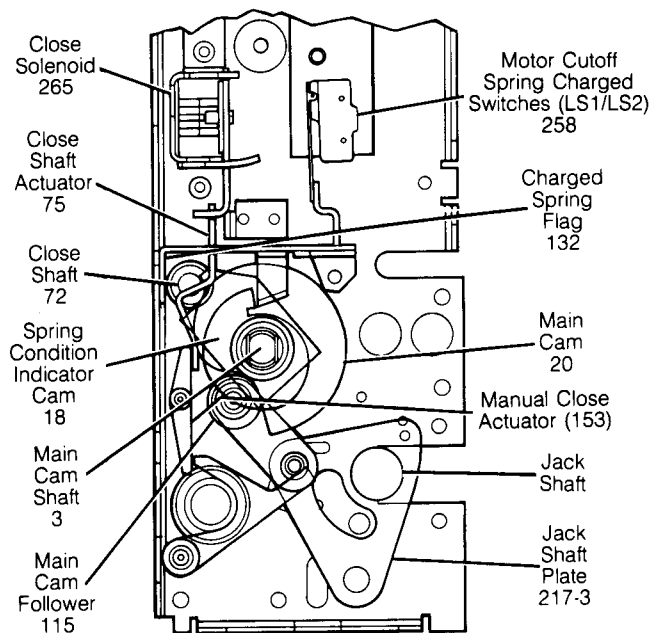


Figure 17b: Closing Mode

Rapid Auto-Reclosing Mode (Optional) - The closing springs are automatically recharged by the motor driven operating mechanism when the breaker has closed. The operating mechanism is capable of the open-close-open duty cycle required for rapid auto-reclosing. A trip latch check switch and a relay (delay on dropout) prevent release of the closing spring energy if the trip hatchet (99) is not in its reset position. This ensures the mechanism does not operate trip free on an instantaneous reclosure.

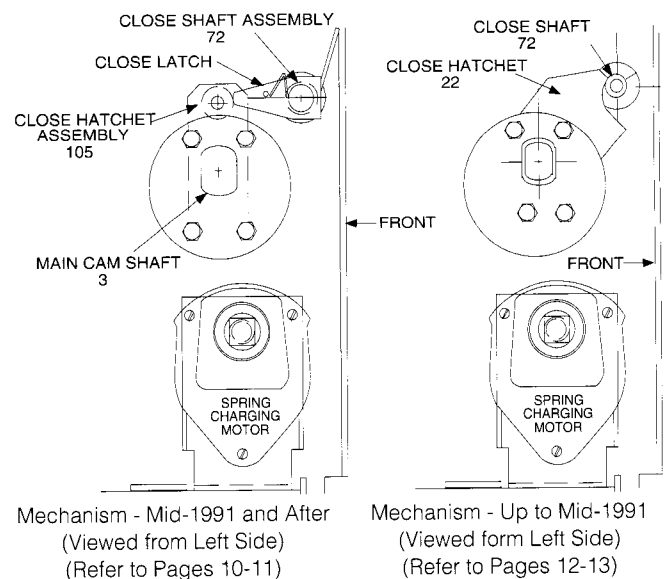


Figure 18b: Identification of Mechanism Vintage

Interrupter/Operator Description

Closing and Opening Springs - The stored energy assembly consists of two dual closing springs and a single opening spring. **Figure 19** shows the three springs and their linkages to the charging devices. The two closing springs are connected to crank arms mounted on the rotating main cam shaft. The closing springs are extended, and charged, by rotation of the crank arms connected to the movable ends of the springs. The fixed ends of these springs are attached to a support arm, which in turn is bolted to the structure of the circuit breaker.

The opening spring is connected to the jack shaft. When the circuit breaker closes, rotation of the jack shaft causes the opening spring push rod to compress and charge the opening spring. Consequently, the opening spring is automatically charged whenever breaker contacts are closed.

Trip Free Operation - The GMI circuit breaker is mechanically and electrically trip free. This important function enables the breaker to be tripped before, after or during a closing operation. Whenever the circuit breaker trip shaft is moved as the result of manual or electrical signals or mechanical interlocks, a) a closed breaker will open, b) a breaker in the process of closing will not complete the close operation and will remain open, or c) an open breaker will not be able to be closed.

Damper - GMI circuit breakers are equipped with a sealed, oil-filled, viscous damper, or shock absorber (**Figure 19**). The purpose of this damper is to limit overtravel and rebound of the vacuum interrupters' movable contacts during the conclusion of an opening operation. The damper action affects only the end of an opening operation.

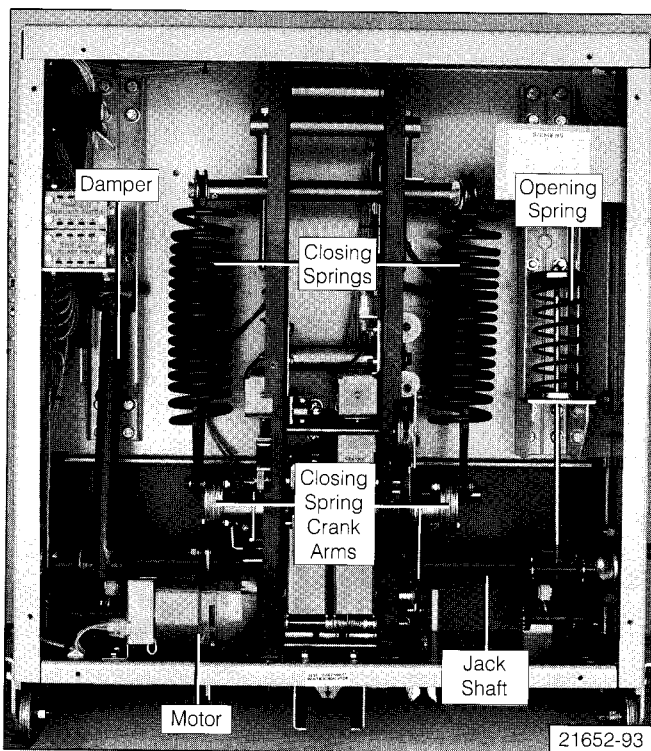


Figure 19: Closing and Opening Springs, Spring Charging Motor and Damper.

The cylindrical body of the damper is secured to the breaker frame, with a yoke. The damper's piston and striker tip protrude from the opposite end of this cylinder (the lower end as installed on the breaker). A striker block is fixed within an outer tube, which is guided by the cylindrical body of the damper. The end of the outer tube is attached to the breaker jack shaft.

The outer tube and (inner) damper remain uncoupled until the end of the opening operation is reached. At this time, the tube's striker block contacts the damper piston, to begin control of movable contact dynamics.

Manual Spring Charging - Manual charging of the closing springs is accomplished using a lever in lieu of the spring charging motor. **Figure 20** shows the principal components of the manual spring charging mechanism.

The manual spring charging lever is inserted into a rectangular socket in the hand operator. This socket is accessible through the front panel of the circuit breaker. Moving the lever up and down in a cranking or pumping motion causes rotation of the internal spring charging components.

Note: Manual spring charging components will be damaged by overcharging.

Manual charging action must be suspended when the operator sees the "Charged" status indicator appear on the front panel of the circuit breaker and hears the sound of impact against the internal closing latch.

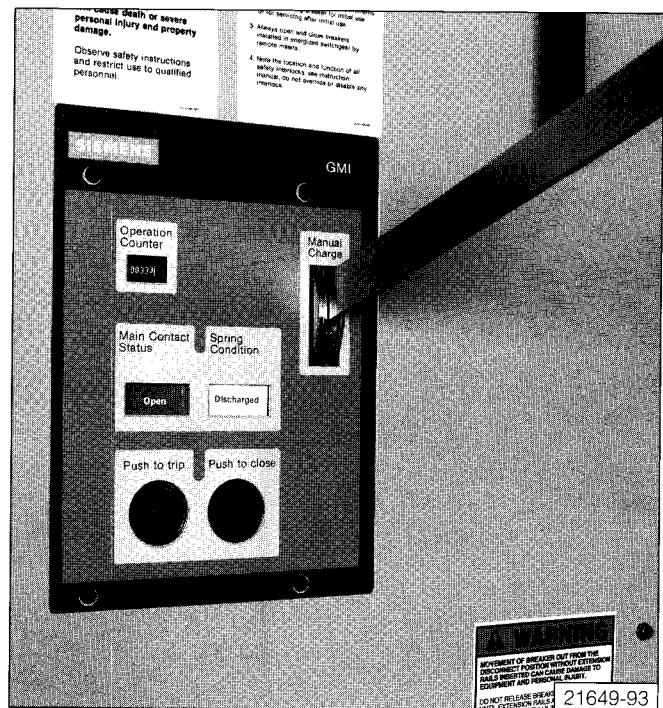


Figure 20: Manual Charging of the Closing Springs.

Interrupter/Operator Description

Spring Charging Motor - Figure 19 shows the spring charging motor mounted at the bottom of the left side of the circuit breaker housing. A mounting bracket holds the motor firmly in place. A universal motor is used to permit operation on either AC or DC control power.

The motor control circuits call for automatic charging of the springs by the motor whenever control power is available and the springs are discharged. The springs automatically recharge following a closing operation.

Electrical connections to the motor utilize quick disconnect terminations for easy inspections or removal.

Close Solenoid, Trip Solenoid and Anti-Pump Relay - Figure 21 shows the two solenoids controlling operation of the circuit breaker by external electrical signals.

When the close solenoid is energized it causes the two closing springs to be released from their extended or charged state. This forces the three insulating push rods to move the movable vacuum interrupter contacts vertically upwards, and close the circuit breaker.

The anti-pump relay (Figure 41) electrically isolates signals to the close solenoid such that only one releasing action by the close solenoid can occur during each application of the close command. The circuit breaker must be tripped, the springs recharged and the closing signal removed (interrupted) before the close solenoid can be energized the second time.

When the trip solenoid is energized, it allows rotation of the jack shaft by the tripping spring. This rotation pulls the insulating push rods attached to the movable contacts of the three vacuum interrupters, and the circuit breaker contacts are opened.

Electrical connections to the close solenoid and trip solenoid are made through quick disconnect terminations.

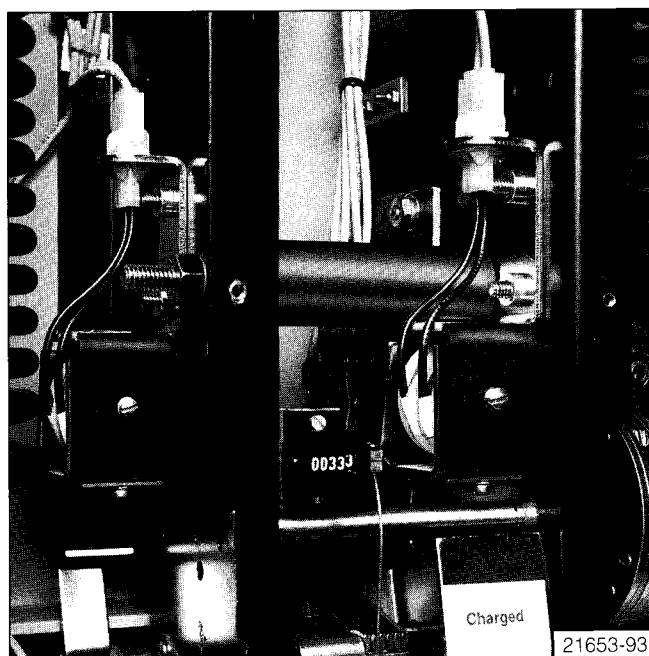


Figure 21: Close (Right) and Trip (Left) Solenoids.

Secondary Disconnect - Signal and control power is delivered to the internal circuits of the breaker by an arrangement of movable contact fingers mounted on the left side of the circuit breaker. These fingers are shown in Figure 22.

When the circuit breaker is racked into the Test or Connected positions in the metal-clad switchgear, these disconnect fingers engage a mating disconnect block on the inside of the switchgear shown in Figure 23. These electrical connections automatically disengage when the circuit breaker is racked from the Test to the Disconnect position.

All of the control power necessary to operate the circuit breaker is connected to this disconnect block inside the switchgear. The external trip and close circuits and status indicators are also connected to this same disconnect block.

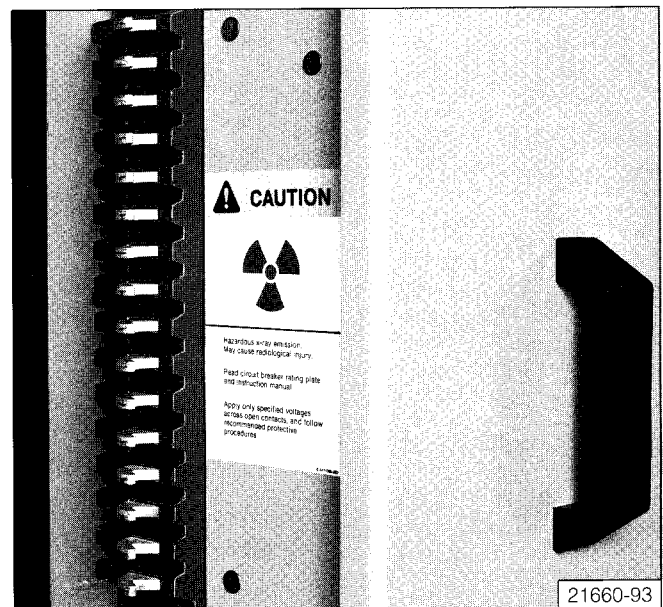


Figure 22: Secondary Disconnects on Circuit Breaker.

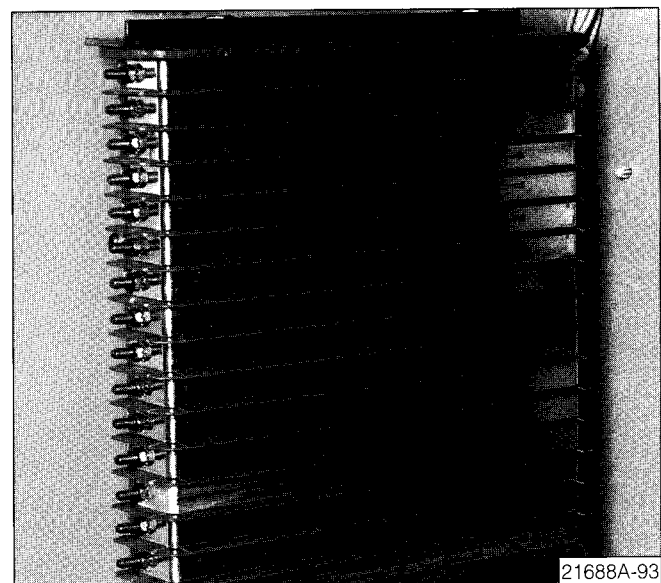


Figure 23: Secondary Disconnect Inside Switchgear.

Interrupter/Operator Description

Auxiliary Switch - Figure 24 shows the breaker mounted auxiliary switch. This switch provides auxiliary contacts for control of circuit breaker closing and tripping functions. Contacts are available for use in relaying and external logic circuits. This switch is driven by linkages connected to the jack shaft. The auxiliary switch contains both 'b' (Normally Closed) and 'a' (Normally Open) contacts. When the circuit breaker is open, the 'b' switches are closed and the 'a' switches are open.

MOC (Mechanism Operated Cell) Switch - Figures 25 and 26 show the principal components that provide optional control flexibility when operating the circuit breaker in the Test and Connected positions.

Figure 25 shows the MOC switch operating arm that projects from the right side of the circuit breaker, just above the bottom rail structure. The MOC switch operating arm is part of the jack

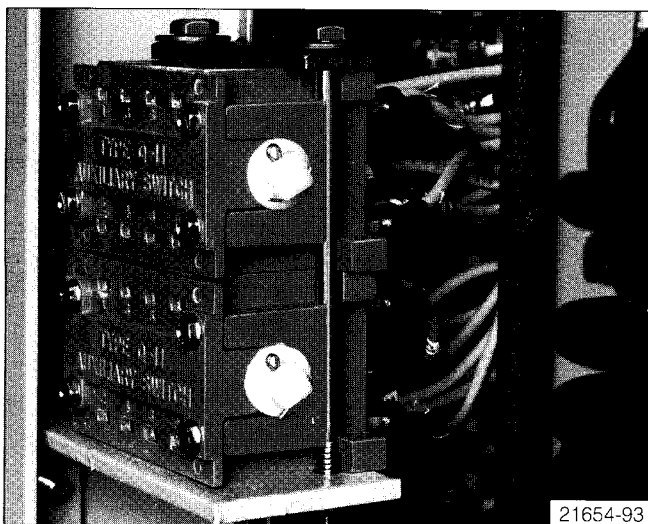


Figure 24: Auxiliary Switch.

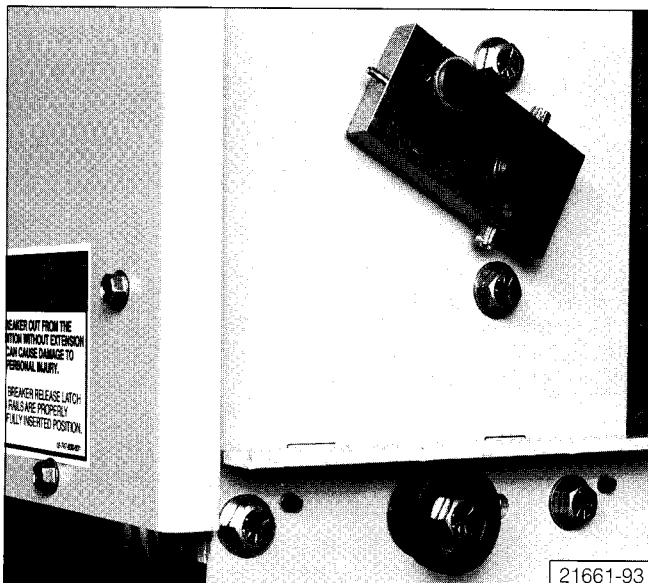


Figure 25: MOC Switch Operating Arm on Circuit Breaker.

shaft assembly, and directly reflects the open or closed position of the breaker primary contacts.

As the circuit breaker is racked into the appropriate position inside the switchgear, the MOC switch operating arm passes a wiring protective cover plate, and engages the pantograph linkage shown in **Figure 26**. Operation of the circuit breaker causes the pantograph linkage to transfer motion to the MOC switches located above the pantograph. The 'a' and 'b' contacts can be used in relaying and control logic schemes.

All circuit breakers contain the MOC switch operating arm. However, MOC switches are provided in the switchgear only when specified.

The breaker engages the MOC auxiliary switch only in the connected (operating) position unless an optional test position pickup is specified in the contract. If a test position pickup is included, the breaker will engage the auxiliary switch in both positions (**Figure 26**). Up to 24 stages may be provided.

TOC (Truck Operated Cell) Switch - Figure 26 shows the optional TOC cell switch. This switch is operated by the circuit breaker as it is racked into the Connect position.

Various combinations of 'a' and 'b' contacts may be optionally specified. These switches provide control and logic indication that a breaker in the cell has achieved the Connect (ready to operate) position.

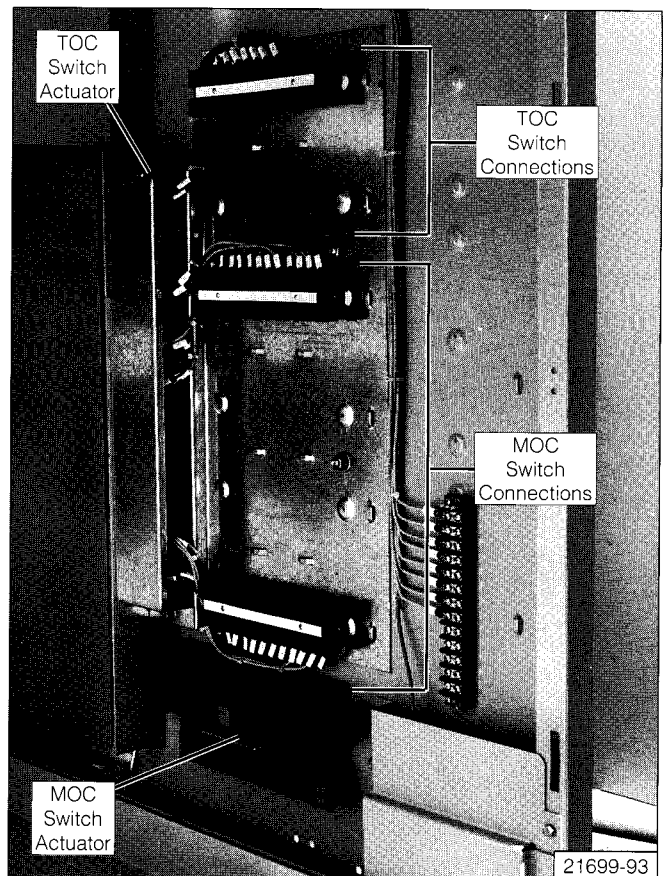


Figure 26: MOC and TOC Switches Inside Switchgear.

Interrupter/Operator Description

Limit Switches (Figure 27) - The motor cutoff switch (LS1) is used to sense the position of the driven mechanisms. This switch de-energizes the charging motor when the Charged position of the closing springs is reached. When the closing springs are discharged, this switch energizes the control circuit powering the spring charging motor.

Spring charged switch (LS2) operates simultaneously with motor switch (LS1). The spring charged switch allows the close solenoid to be energized only when the springs are charged, and also is part of the anti-pump circuitry.

The trip latch check switch (LS3) operates when the trip latch linkage is in the reset position. It also is driven by operating bars that sense when the breaker is in either the Test or Connected position inside the switchgear. Control circuitry prevents an electrical release of the closing springs unless the breaker is either in the Test or Connected position, or is out of the compartment.

The spring dump switch (LS4) operates when the circuit breaker is removed from, or is being inserted into, the cubicle.

Standard Schematic Diagrams

Note: Figure 28a shows a typical schematic for a circuit breaker which is not specifically intended for reclosing application, while Figure 28b shows a breaker for reclosing service. Figure 28c shows a breaker with capacitor tripping. These are typical — refer to the specific drawing for your project.

Inspection of the schematic diagrams shown in Figures 28a-28c provides a clear picture of the logic states of the various devices for the three basic control functions.

These are: 1) automatic charging of the closing springs; 2) electrical closing of the primary contacts and 3) electrical tripping of the primary contacts.

Automatic spring charging by charging motor occurs when secondary control power is available, and motor cutoff switch LS1 has not operated. The springs are automatically re-charged after each closing operation.

Electrical closing occurs with closing control power applied and when *all* of the following conditions exist: 1) External control switch CS/C is closed; 2) Anti-pump relay 52Y is not energized; 3) Auxiliary switch 52b indicates the breaker is in open position; 4) Limit switch LS3 shows that the trip latch has been reset and the circuit breaker is in the Test or Connected position, or is out of the compartment; and 5) Limit switch LS2 indicates that the closing springs are charged. Electrical tripping occurs with tripping control power applied and when the auxiliary switch 52a shows the breaker is closed, and a trip signal is provided by the control switch CS/T or the protective relays. While external control power is required for either electrical closing or tripping, the circuit breaker can be manually charged, closed and tripped without external control power.

Capacitor Trip Device (Optional)

The capacitor trip device is an auxiliary tripping option providing a short term means of storing adequate electrical energy to ensure breaker tripping.

This device is applied in breaker installations lacking independent auxiliary control power or station battery. In such installations, control power is usually derived from the primary source. In the event of a primary source fault, or disturbance with attendant depression of the primary source voltage, the capacitor trip device will provide short term tripping energy for breaker opening due to relay operation.

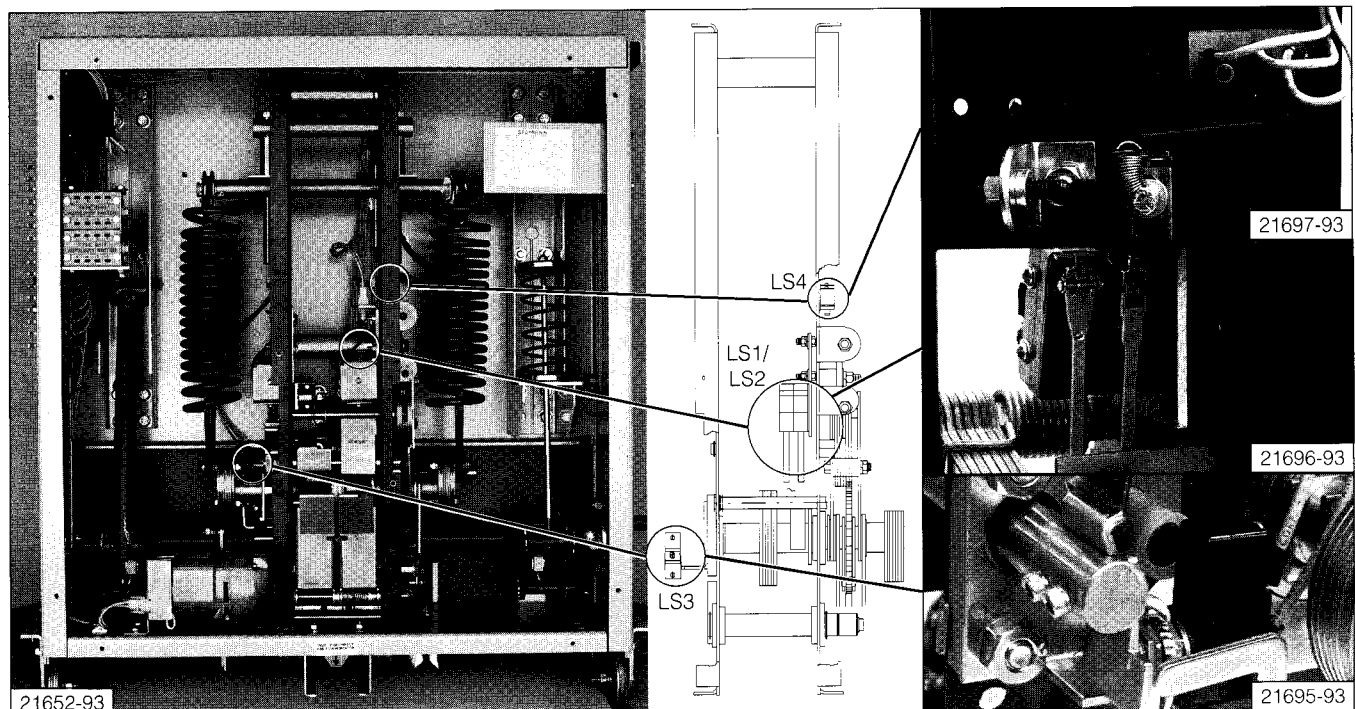


Figure 27: Circuit Breaker Limit Switches.

Interrupter/Operator Description

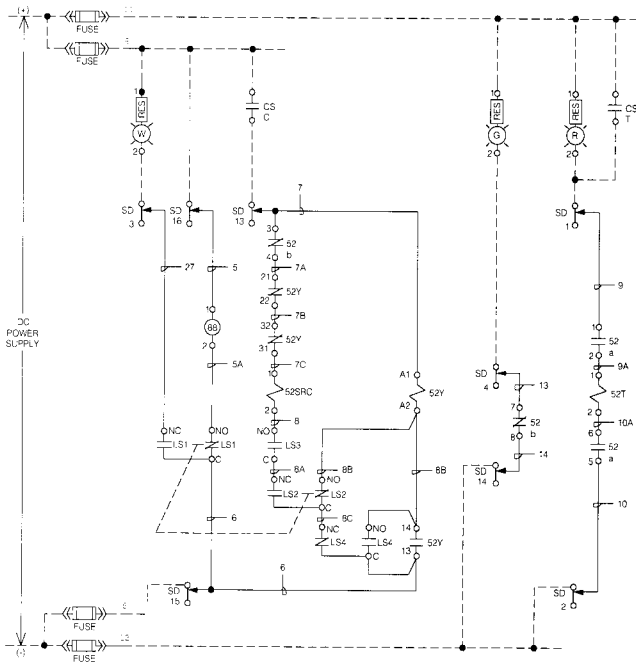


Figure 28a: DC Control Power (Non-Reclosing).

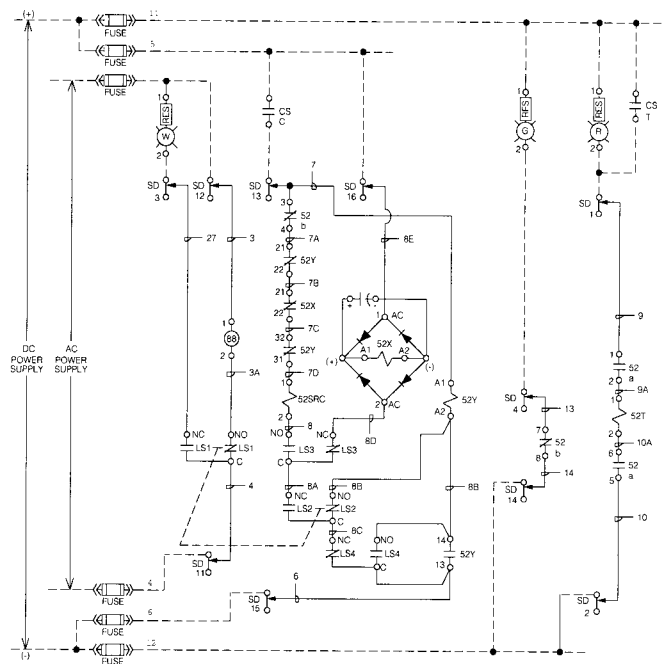


Figure 28b: AC and DC Control Power (Reclosing).

Symbols

- LS1 • Motor Cutoff Switch
- LS2 • Spring Charged Switch
- LS3 • Checks Trip Latch Reset and Blocks Electric Close while Racking "Test" to "Connect"
- LS4 • Spring Dump Switch

- 52/a • Aux. Switch, Open when Brk. is Open
- 52/b • Aux. Switch, Closed when Brk. is Open
- 52Y • Anti-Pump Relay
- 52T • Opening Solenoid (Trip)
- 52SRC • Spring Release Solenoid (Close)
- 52X • Reclosing Control Relay

- 88 • Spring Charging Motor
 - SD • Secondary Disconnect
 - CS/C • Control Switch Close
 - CS/T • Control Switch Trip
 - R • Red Indicating Lamp
 - G • Green Indicating Lamp
 - W • White Indicating Lamp
- } Typical Remote Devices

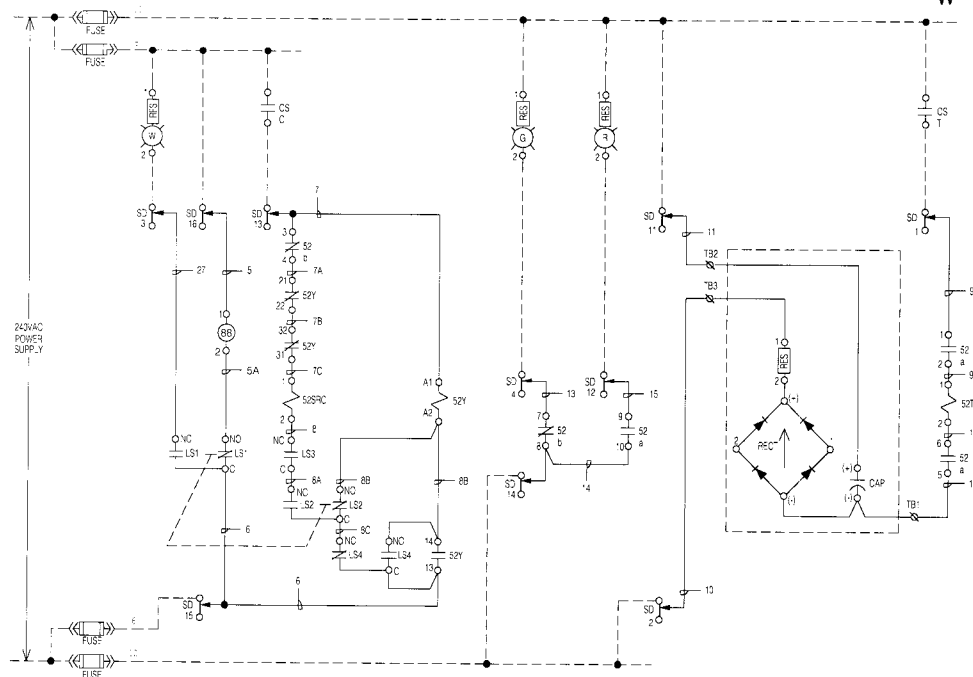


Figure 28c: AC Control Power (with Capacitor Trip).

Notes on Schematic Arrangement

Schematics are shown with:

1. Closing Springs Discharged
2. Breaker Open
3. Breaker Located in Test, Connect or Withdrawn Position

Note that, in this condition, the trip latch is free to reset, but is temporarily blocked until the closing springs are partially recharged. Prior to full spring charge, LS3 (NO) closes, and LS3 (NC) opens.

Interrupter/Operator Description

Refer to **Figure 28c**. An electrolytic capacitor resides across the tripping supply voltage connected through a half wave rectifier and resistor. The rectifier allows the capacitor to assume a charge approximating the peak voltage of the AC tripping supply voltage. The series resistor limits the magnitude of charge current flowing into the capacitor.

The charged capacitor is then connected across the breaker trip coil circuit through an external contact which closes upon trip command.

The capacitor size and charge current magnitude are tuned to the inductance and resistance of the tripping solenoid, an RLC series circuit, to produce a discharge current through the solenoid which emulates the magnitude of current and current duration which the solenoid would experience if operated from a DC tripping supply voltage.

Undervoltage Release (Optional)

The undervoltage release is used for continuous monitoring of the tripping supply voltage. If the trip supply voltage falls significantly, the undervoltage release will provide for automatic tripping of the breaker.

Description of Operation - The undervoltage release consists of a spring stored energy mechanism, a latching device and an electromagnet. These elements are accommodated in a single assembly as shown in **Figure 29**.

The stored energy spring (1), spring charging arm (2) and latch face are arranged in a cylindrical assembly concentric with the trip latch shaft (3). The cylindrical assembly is retained by the support bracket (4), yet remains free to rotate. The cylindrical assembly is supported by the trip latch shaft which rotates freely on the trip shaft supported by needle bearings.

The stored energy torsion spring (1) has one tail bearing on a lug fixed to the cylindrical assembly, and an opposite tail fixed

on a lug of the support bracket. Thus, the torsional tension of the spring will cause the cylindrical assembly (5) to be forcibly rotated relative to the support bracket.

The cylindrical assembly is notched at the end nearest the mechanism side sheet with the notch engaging a spring pin (6) driven into the trip latch shaft. The notch has sufficient arc width to permit the trip latch shaft to rotate normally in response to the breaker receiving a trip command.

The breaker jackshaft (7) is fitted with an arm and track roller (8) which bears on the charging arm (2) of the cylindrical assembly. Whenever the breaker is opened, the arm and roller cause the charging arm to be rotated charging or winding up the stored energy torsion spring.

A spring loaded latch arm (9) rises to engage the latch face which is an integral feature of the cylindrical assembly. The latch arm (9) is held in this position by the vertical lever (10) which is pulled to the supporting position by the electromagnet. The vertical lever is pivoted (11) by the electromagnet (12) against the force developed by an extension spring (13) which constantly attempts to pull the vertical lever (10) into a position which releases the stored energy torsion spring.

The latch arm supported by the vertical lever retained in position by the electromagnet will retain the stored energy state until the electromagnet senses a loss of trip supply voltage. When the supply voltage falls to a level 30 to 60 percent of nominal, the electromagnet releases the vertical lever, the latch arm descends and the cylindrical assembly rotates displacing the trip shaft. Latching is established at 85% nominal voltage.

Interlocks

There are two interlocks which prevent certain unsafe operating conditions. They are the rating interlock and the trip-free interlock.

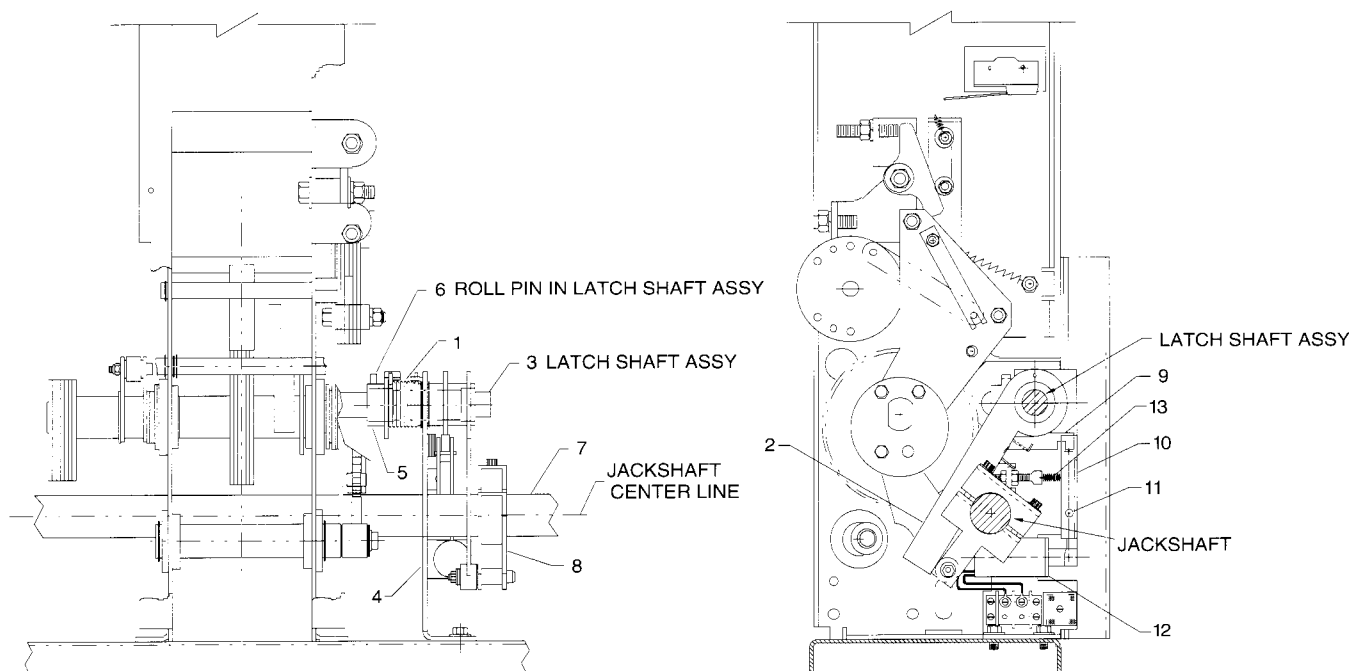


Figure 29: Undervoltage Trip Option.

Interrupter/Operator Description

Trip Free Interlock - Figure 30 shows the devices providing the trip-free interlock function. The purpose of the trip-free interlock is to hold the circuit breaker operating mechanism mechanically and electrically trip free whenever the breaker is between the Test and Connected positions within the switchgear enclosure. This interlock ensures that the circuit breaker primary contacts can only be closed when in the Connect position, or the Test position, or out of the switchgear cell.

Rating Interlock - Figure 30 shows the rating interlock interference plates mounted on the circuit breaker frame. The breaker interference plates are complemented by matching plates located in the cubicle.

The interference plates (rating interlocks) test the breaker voltage, continuous current, interrupting and momentary ratings and will not allow breaker insertion unless they match or exceed the cell rating.

Circuit Breaker Frame

The frame of the GMI circuit breaker contains several important devices and features deserving of special attention. These are the ground disconnect, the four racking wheels and four handling wheels.

Ground Disconnect - Figure 30 shows the ground disconnect contact mounted at the bottom of the circuit breaker. The spring loaded fingers of the disconnect contact engage the ground bar (**Figure 31**) at the bottom of the switchgear assembly. The ground bar is to the right of the racking mechanism, shown at the bottom center of the switchgear.

Circuit Breaker Handling Wheels - The GMI circuit breaker is designed for easy movement into and out of the metal-clad switchgear assembly. A section of indoor or Shelter-Clad switchgear does not require a transfer truck or lifting truck for

handling of the breaker when all circuit breakers are located in the lower cells. Once the circuit breaker is racked out of the switchgear, the unit can be pulled using the handles on the front of the breaker. The breaker will roll on its bottom four wheels.

On indoor and Shelter-Clad switchgear with circuit breakers located in the lower cell, the circuit breaker is easily rolled out of the switchgear by a single person. When circuit breakers are located in the upper cells, handling of the circuit breakers requires the use of a hoist or crane. These lifting devices are also required for removal of the lower circuit breaker of non walk-in type outdoor switchgear.

Racking Mechanism

Figure 31 shows the racking mechanism in the switchgear used to move the circuit breaker between the Disconnect, Test and Connected positions. This mechanism contains a set of interface blocks that mate with the bottom of the circuit breaker housing, and lock the breaker to the racking mechanism during in and out movement. A racking handle (not shown) mates with the threaded shaft of the racking mechanism. Clockwise rotation of the crank moves the breaker into the switchgear, and counterclockwise rotation removes it.

The racking and trip-free interlocks provide several essential functions.

1. They prevent racking a closed breaker into or out of the switchgear assembly.
2. They discharge the closing springs whenever the circuit breaker is inserted into, or withdrawn from, the switchgear.
3. They prevent closing of the circuit breaker unless it is in either the Test or Connect positions.

The rating interlock prevents insertion of a lower rated circuit breaker into a cubicle intended for a breaker of higher ratings.

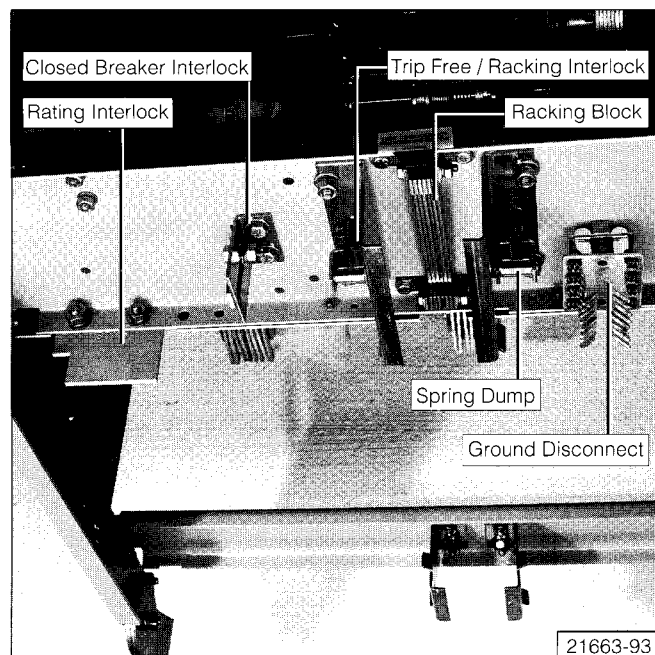


Figure 30: Breaker Interlocks and Ground Disconnect.

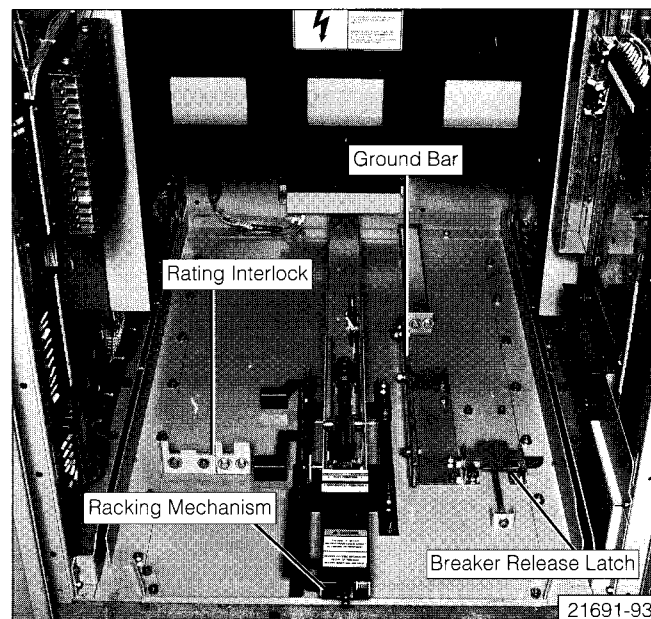


Figure 31: Racking Mechanism and Floor Interlocks.

Maintenance


Introduction and Maintenance Intervals

Periodic inspections and maintenance are essential to obtain safe and reliable operation of the GMI circuit breaker.

When GMI circuit breakers (manufactured beginning January, 1992) are operated under "Usual Service Conditions", maintenance and lubrication is recommended at five year (one year if manufactured before January, 1992) intervals or at the number of operations indicated in Table 2. "Usual" and "Unusual" service conditions for Medium Voltage Metal-Clad Switchgear are defined in ANSI C37.20.1, sections 3 and 7.1. Generally, "usual service conditions" are defined as an environment in which the equipment is not exposed to excessive dust, acid fumes, damaging chemicals, salt air, rapid or frequent changes in temperature, vibration, high humidity, and extremes of temperature.

The definition of "usual service conditions" is subject to a variety of interpretations. Because of this, you are best served by adjusting maintenance and lubrication intervals based on your experience with the equipment in the actual service environment.

Regardless of the length of the maintenance and lubrication interval, Siemens recommends that circuit breakers should be inspected and exercised annually.



⚠ DANGER

Hazardous voltages and high-speed mechanical parts.

Will cause death, severe personal injury, or property damage.

Read instruction manuals, observe safety instructions and limit use to qualified personnel.

For the safety of maintenance personnel as well as others who might be exposed to hazards associated with maintenance activities, the safety related work practices of NFPA 70E, parts II and III, should always be followed when working on electrical equipment. Maintenance personnel should be trained in the safety practices, procedures and requirements that pertain to their respective job assignments. This manual should be reviewed and retained in a location readily accessible for reference during maintenance of this equipment.

The user must establish a periodic maintenance program to ensure trouble-free and safe operation. The frequency of inspection, periodic cleaning, and preventive maintenance schedule will depend upon the operation conditions. NFPA Publication 70B, "Electrical Equipment Maintenance" may be used as a guide to establish such a program. **A preventive maintenance program is not intended to cover reconditioning or major repair, but should be designed to reveal, if possible, the need for such actions in time to prevent malfunctions during operation.**

Recommended Hand Tools

Type GMI breakers use both standard American and metric fasteners. Metric fasteners are used for the GMI vacuum interrupters. American fasteners are used in all other locations. This list of hand tools describes those normally used in disassembly and re-assembly procedures.

Metric (Vacuum Interrupter Only)

- Deep Sockets: 19 and 24mm
- Torque Wrench: 0-150 Nm (0-100 ft-lbs.)
- Allen Wrenches: 8 and 10mm

American (All Other Breaker Locations)

- Socket and Open-End Wrenches: 5/16, 3/8, 7/16, 1/2, 9/16 and 3/4 in.
- Hex Keys: 3/16 and 1/4 in.
- Screwdrivers: 0.032 x 1/4 in. wide and 0.55 x 7/16 in. wide
- Pliers
- Light Hammer
- Dental Mirror

Recommended Maintenance and Lubrication

Periodic maintenance and lubrication should include all the tasks shown in **Table 1**. Recommended procedures for each of the listed tasks are provided in this section of the manual.

⚠ WARNING

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

The instructions contained herein should be carefully reviewed, understood, and followed.

The maintenance tasks in Table 1 must be performed regularly.

Table 1: Maintenance Tasks

- Checks of the Primary Power Path
- Checks of the Interrupter Operator Mechanism
- Electrical Control Checks
- High Potential Test
- Inspection and Cleaning of Breaker Insulation
- Functional Tests

For a "quick reference" to these tasks see "Periodic Maintenance and Lubrication Tasks" chart on page 36.

The list of tasks in Table 1 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.

⚠ DANGER

THE USE OF UNAUTHORIZED PARTS IN THE REPAIR OF THE EQUIPMENT, OR TAMPERING BY UNQUALIFIED PERSONNEL WILL RESULT IN DANGEROUS CONDITIONS WHICH CAN CAUSE DEATH, SERIOUS INJURY OR EQUIPMENT DAMAGE. FOLLOW ALL SAFETY INSTRUCTIONS CONTAINED HEREIN.

Removal from Switchgear

Prior to performing any inspection or maintenance checks or tests, the circuit breaker must be removed from the switchgear. The Installation and Initial Functional Tests section describes the removal procedure in detail. Principal steps are repeated here for information and guidance, but without the details of the preceding section.

Maintenance

1. Open the circuit breaker.
2. Rack the circuit breaker to the test position. Review instructions for removal of a circuit breaker from the upper or lower cell, as appropriate, for information on racking.
3. With the circuit breaker in the Test position and OPEN, de-energize control power to the circuit breaker. Review **Figure 1**.
4. Perform the Spring Discharge Check, by first pushing the red Trip pushbutton, then the black Close pushbutton, and finally the red Trip pushbutton again. Verify that the circuit breaker is OPEN and the closing spring indicator shows DISCHARGED. See **Figure 32**, which shows the breaker condition preceding the second operation of the red Trip pushbutton.

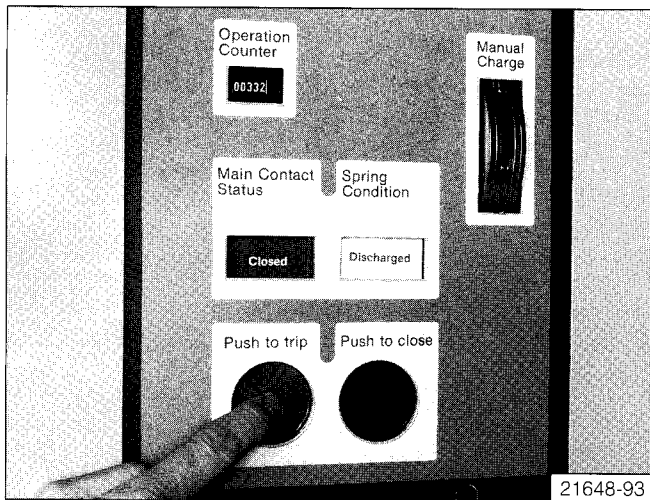


Figure 32: Manual Tripping of Circuit Breaker.

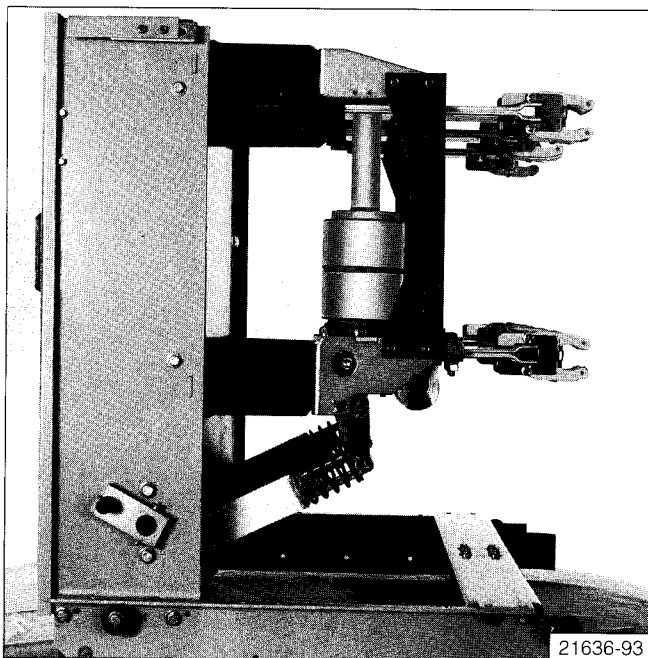


Figure 33: GMI Breaker Showing Vacuum Interrupters and Primary Disconnects

5. Rack the circuit breaker to the Disconnect position, and remove the circuit breaker from the switchgear. Refer to the instructions for removal of a circuit breaker from the upper cell for special instructions and precautions regarding removal of the upper breaker.
6. The breaker can be located either on the floor or on a pallet. Each breaker has handles and four wheels to allow one person to maneuver the unit on a level surface without assistance.

Checks of the Primary Power Path

The primary power path consists of the three vacuum interrupters, the three upper and the three lower primary disconnects. These components are checked for cleanliness and condition. The vacuum interrupters are also checked for vacuum integrity.

Some test engineers prefer to perform the contact erosion check during the manual spring charging check of the operator, since charging of the springs is necessary to place the contacts in the closed position.

Also, the vacuum integrity check is usually performed in conjunction with the High Potential tests.

These instructions follow the recommendation that these tests (contact erosion/manual spring charging check, and vacuum integrity/high potential tests) will be combined as described.

Cleanliness Check - Figure 33 is a side view of the GMI circuit breaker with the outer insulating barriers removed to show the vacuum interrupter, and the upper and lower primary disconnects.

All of these components must be cleaned and free of dirt or any foreign objects. Use a dry lint-free cloth. For stubborn dirt, use a clean cloth saturated with denatured alcohol.

Inspection of Primary Disconnects - Figure 34 shows the primary disconnect contact fingers engaged. When the contacts are mated with the switchgear's primary stud assembly, there is forceful contact distributed over a wide area. This maintains low current flow per individual contact finger.

Inspect the contact fingers for any evidence of burning or pitting that would indicate weakness of the contact finger springs.

Inspect the primary disconnect arms for physical integrity and absence of mechanical damage.

Inspect the flexible connectors that connect the bottom movable contacts of the vacuum interrupters to the lower primary disconnect arms for tightness and absence of mechanical damage, burning, or pitting.

Using a clean cloth saturated with denatured alcohol, clean old lubricant from primary disconnects, and apply Siemens contact lubricant (reference 15-171-370-002) in a very thin layer.

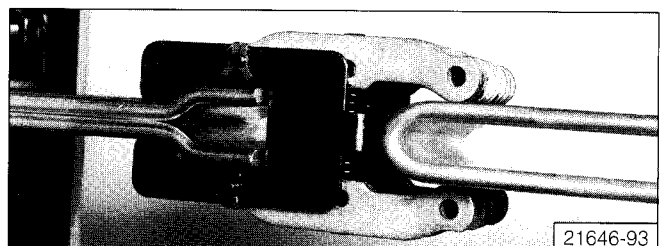


Figure 34: Primary Disconnect in Mated Position.

Maintenance

Checks of the Stored Energy Operator Mechanism

The stored energy operator checks are divided into mechanical and electrical checks for simplicity and better organization. This first series of checks determine if the basic mechanism is clean, lubricated and operates smoothly without control power. The contact erosion check of the vacuum interrupter is also performed during these tasks.

Maintenance and Lubrication

Table 2: Maintenance and Lubrication Intervals

ANSI C37.06 Table 8 - Usual Service Conditions

Maintenance Based Upon Number of Breaker Closing Operations

Breaker Type	Number of Years/Closing Operations
5-GMI-350 15-GMI-1000	5 years ¹ /1,000 operations
All others	5 years ¹ /2,000 operations

¹ Five year interval for GMI breakers manufactured January, 1992 or later. One year interval for units manufactured earlier.

The interrupter operator mechanism is shown in **Figure 35** with the front cover and the operator control panel removed to show construction details. Both the tripping spring and the two closing springs are shown. The movable end of each closing spring is connected to a crank arm. The movable end of the opening spring is connected to the jack shaft by a pull rod. The dashpot is connected to the jack shaft operating shaft by a pushrod linkage.

Clean the entire stored energy operator mechanism with a dry, lint-free cloth.

Check all components for evidence of excessive wear. Place special attention upon the closing spring cranks and the various pushrods and linkages.

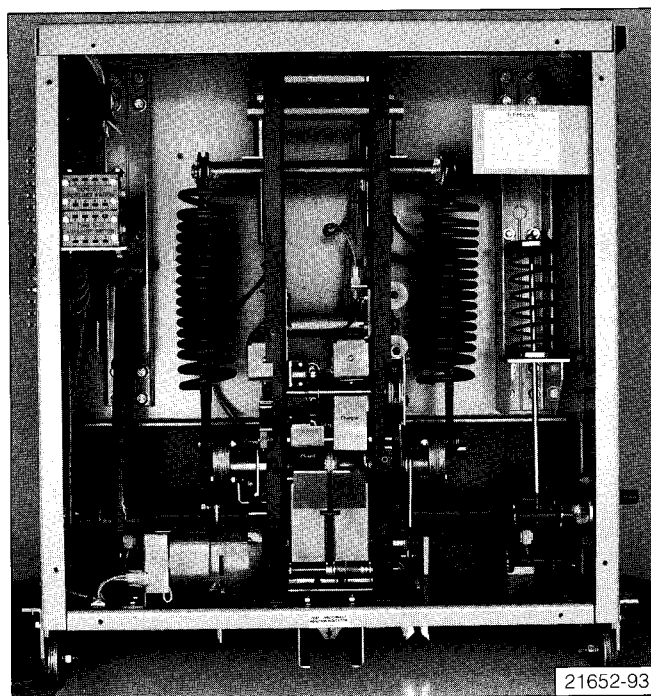


Figure 34: Front View of Operator Mechanism.

Lubricate all non-electrical moving or sliding surfaces with a light coat of synthetic grease or oil. Lubricants composed of diester oils and lithium thickeners will be compatible.

Shell (drawn cup) needle bearings: Use either Beacon (Exxon) 325 (reference 18-658-676-422 and part number 15-337-131-001), or Supermil (Amoco) A-72832 (reference 18-758-676-423), or Anderol 732.

Pivots, sliding, and/or rolling surfaces and general lubrication: Use Anderol 732 aerosol synthetic fluid grease (reference part number 15-172-816-058).

In addition to lubricating the stored energy operating mechanism, use Anderol 732 to lubricate both the OD of the bushing and the ID of the wheel for the four floor wheels.

Fastener Check - Inspect all fasteners for tightness. Both lock-nuts and retaining rings are used. Replace any fasteners that appear to have been frequently removed and replaced.

Manual Spring Charging and Contact Erosion Checks - Perform the Manual Spring Charging Check contained in the section describing the Installation Check and Initial Functional Tests. The key steps of this procedure are repeated here.

1. Insert the hand charging lever into the manual charge handle socket at the front of the operator control panel. **Figure 20** shows the lever inserted. Up and down motion of the lever charges the closing springs. Continue cranking until the Charged flag appears in the window of the spring indicator.
2. Press the Close (black) pushbutton. The contact position indicator on the operator control panel should indicate that the breaker contacts are closed.
3. Perform the contact erosion check. Contact erosion occurs when high fault currents are interrupted or when the vacuum interrupter is nearing the limit of its contact life. Determination

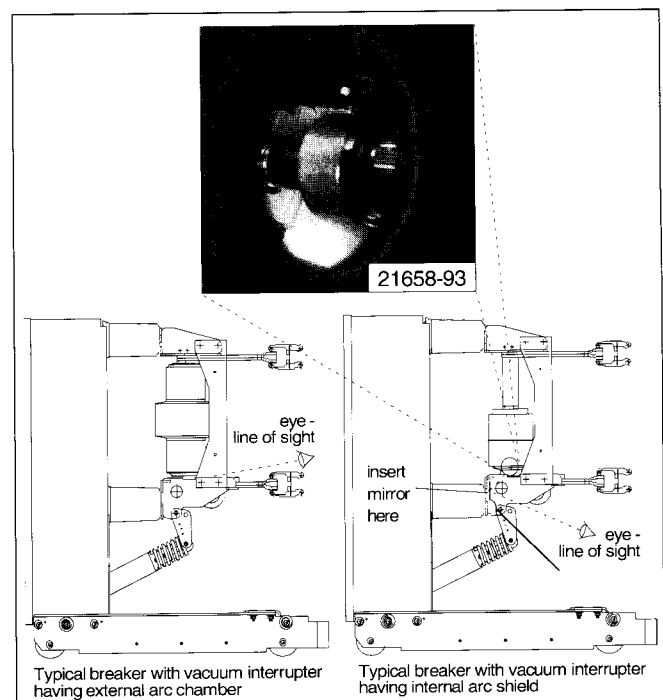



Figure 36: Contact Erosion Check Mark.

Maintenance

of acceptable contact condition is checked by the visibility of the white erosion mark shown in **Figure 36**. The white erosion mark is located in the keyway (or slot) on the movable stem of the vacuum interrupter, near the plastic guide bushing.

The contact erosion check procedure is:

- Be sure the breaker primary contacts are Closed.
- Observe the white erosion mark (**Figure 36**) of each pole. When this mark is visible, contact wear is within acceptable limits. For some circuit breakers (with a vacuum interrupter having an internal arc shield), a flashlight and dental mirror will be needed to observe the white erosion mark.



⚠ WARNING

Tripping spring is charged.

If trip latch is moved, high-speed movement of components can cause serious injury.

Observe precautions concerning physical contact with components of the circuit breaker subjected to sudden, high speed movement.

4. Press the red Trip pushbutton *after* completing the contact erosion check. Visually verify the Discharge condition of the closing springs and that the circuit breaker contacts are Open.
5. Press the black Close pushbutton. Nothing should happen. The manual spring check should demonstrate smooth operation of the operating mechanism.

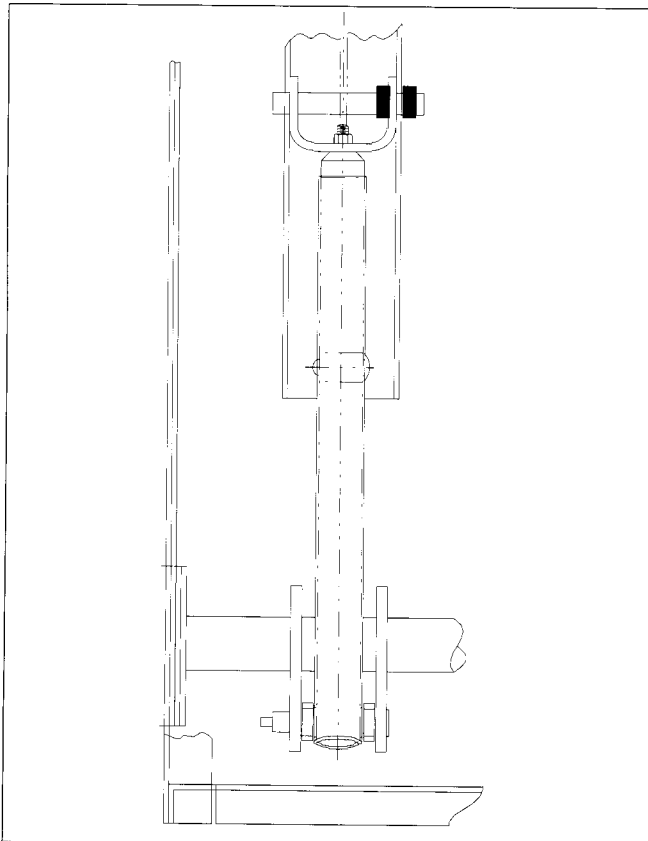


Figure 37: Dampener Assembly.

Dampener Assembly Check - GMI circuit breakers contain a viscous damper assembly, shown in **Figure 37**, and described in some detail on page 14, and in **Figure 19**.

While performing the manual spring charging check, a simple check of the damper mounting yoke, pin, retaining rings, and the nut for tightness should be completed.

The cylindrical surface of the damper and telescoping tube should be well greased. The full periphery of the tube and cylinder should be coated with Beacon 325.

Electrical Control Checks


The electrical controls of the GMI circuit breaker should be checked during inspections to verify absence of any mechanical damage, and proper operation of the automatic spring charging and Close and Trip circuits.

Unless otherwise noted, all of these tests are performed *without* any control power applied to the circuit breaker.

Check of the Wiring and Terminals -

1. Physically check all of the breaker wiring for evidence of abrasion, cuts, burning or mechanical damage.
2. Check all terminals to be certain they are solidly attached to their respective device.

Check of the Secondary Disconnect - In addition to checking the terminals of the secondary disconnect, the secondary contact fingers need to be free to move without binding. Depress each finger, confirm presence of spring force (contact pressure), and verify freedom of motion.



⚠ WARNING

Hazardous voltages and high-speed mechanical parts.

Will cause death, severe personal injury, or property damage.

Read instruction manuals, observe safety instructions and limit use to qualified personnel.

Automatic Spring Charging Check—Control Power Required - Repeat the automatic spring charging check described in the section entitled Installation Checks and Initial Functional Tests.

Primary tasks of this check are:

1. The breaker is energized with control power for this check.
2. De-energize the source of control power (**Figure 1**).
3. Install the breaker end of the split plug jumper over the secondary disconnect of the circuit breaker. The split plug jumper has one male and one female connector and cannot be installed incorrectly (**Figure 7**).
4. Install the switchgear end of the plug jumper over the secondary disconnect block inside the switchgear (**Figure 8**).
5. Energize the control power source.
6. When control power is connected to the circuit breaker, the closing springs should automatically charge. Visually verify that the closing springs are charged.

Maintenance

Note: A temporary source of control power and test leads may be required if the control power source has not been connected to the switchgear. When control power is connected to the GMI circuit breaker, the closing springs should automatically charge.

Electrical Close and Trip Check—Control Power Required

- A check of the breaker control circuits is performed while the unit is still connected to the switchgear by the plug jumper. This check is made with the breaker energized by control power from the switchgear.

1. Once the breaker springs are charged, move the switchgear Close/Trip switch to the Close position. There should be both the sound of the breaker closing and indication that the breaker contacts are closed by the main contact status indicator.
2. As soon as the breaker has closed, the automatic spring charging process is repeated.
3. After a satisfactory close operation is verified, move the switchgear Close/Trip switch to the Trip position. Verify by both sound and contact position that the contacts are open. Completion of these checks demonstrates satisfactory operation of auxiliary switches, internal relays and solenoids.

Checks of the Spring Charging Motor - No additional checks of the spring charging motor are necessary. Once every 10,000 operations, the motor brushes need replacement (reference kit 18-658-612-886). Use the operation counter as the basis for establishing the operation frequency.

High-Potential Tests

The next series of tests (Vacuum Integrity Test and Insulation Tests) involve use of high voltage test equipment. The breaker under test should be inside a suitable test barrier equipped with warning lights.

Vacuum Integrity Check - A high potential test is used to verify the vacuum integrity of the circuit breaker. This test is conducted on the circuit breaker with its primary contacts in the Open position.

⚠ DANGER



High Potential tests employ hazardous voltages.

Will cause severe personal injury and death.

Follow safe procedures, exclude unnecessary personnel and use safety barriers. Keep away from the breaker during application of test voltages. Disconnect the plug jumper from between the circuit breaker and switchgear before conducting high potential tests.

After test completion, ground both ends and the middle portion of the vacuum interrupter to dissipate any static charges.

⚠ WARNING



Vacuum interrupters may emit X-ray radiation. Can cause personal injury.

X-rays can be produced when a high voltage is placed across two circuit elements in a vacuum.

Keep personnel more than six (6) feet away from a circuit breaker under test.

High Potential Test Voltages - The voltages for high potential tests are shown in **Table 3**.

Table 3 High Potential Test Voltages

Equipment kV Rating	Max AC RMS	Max DC Avg
4.76kV	14kV	20kV
8.25kV	27kV	38kV
15.0kV	27kV	38kV

Note: Do not use DC high potential testers incorporating half-wave rectification. These devices produce high peak voltages.

These high voltages will produce X-ray radiation. These devices also show erroneous readings of leakage current when testing vacuum circuit breakers.

Vacuum Integrity Test Procedure

1. Observe safety precautions listed in the danger and caution advisories. Construct the proper barrier and warning light system.
2. Ground each pole not under test.
3. Apply test voltage across each pole for one minute.
4. If the pole sustains the test voltage for that period, its vacuum integrity has been verified.

Note: This test includes not only the vacuum interrupter, but also the other insulation components in parallel with the interrupter. These include the standoff insulators and the insulated drive links, as well as the insulating (tension) struts between the upper and lower vacuum interrupter supports. If these insulation components are contaminated or defective, the test voltage will not be sustained. If so, clean or replace the affected components, and retest.

As-Found Insulation and Contact Resistance Tests - As-Found tests verify the integrity of the breaker insulation system. Megger or insulation resistance tests conducted on equipment prior to installation provide a basis of future comparison to detect changes in the protection afforded by the insulation system. A permanent record of periodic As-Found tests enables the Maintenance organization to determine when corrective actions are required by watching for significant deterioration in insulation resistance, or increases in contact resistance.

Insulation and Contact Resistance Test Equipment - In addition to the High Potential Test Equipment capable of test voltages as listed in Table 3, the following equipment is also required:

- AC High Potential tester with test voltage of 1500 volts, 60 Hz.
- Ductor for contact resistance tests.

Insulation and Contact Resistance Test Procedure

1. Observe safety precaution listed in the danger and caution advisories for the Vacuum Integrity Check tests.
2. Close the circuit breaker. Ground each pole not under test. Use manual charging, closing and tripping procedures.

Maintenance

3. Apply the proper AC (i.e., either 14 or 27 kV) or DC (i.e., either 20 or 38 kV) high potential test voltage between a primary conductor of the pole and ground for one minute.
4. If no disruptive discharge occurs, the insulation system is satisfactory.
5. After test, ground both ends and the middle of each vacuum bottle to dissipate any static charge.
6. Disconnect the leads to the spring charging motor.
7. Connect all points of the secondary disconnect with a shorting wire. Connect the shorting wire to the high potential lead of the high voltage tester, and ground the breaker housing. Starting with zero volts, gradually increase the test voltage to 1500 volts, RMS, 60 Hz. Maintain test voltage for one minute.
8. If no disruptive discharge occurs, the secondary control insulation level is satisfactory.
9. Disconnect the shorting wire and re-attach the leads to the spring charging motor.
10. Perform contact resistance tests of the primary contacts using a ductor. Contact resistance should not exceed the values listed in **Table 4**.

Table 4 Maximum Contact Resistance

Current Rating (Amps)	Contact Resistance (Micro-Ohms)
1200	60
2000	40
3000	20

11. Make a permanent record of all tests performed.

Inspection and Cleaning of Breaker Insulation

1. Perform the Spring Discharge Check on the circuit breaker, *after* all control power is removed. The Spring Discharge Check consists of 1) depressing the red Trip pushbutton, 2) then depressing the black Close pushbutton, and 3) again depressing the red Trip pushbutton. All of these controls are on the breaker front panel. Visually verify the Discharge condition of the springs.
2. Remove any interphase and outer phase barriers as shown in **Figure 13**.
3. Clean barriers and post insulators using clean cloth and one of the following cleaning solvents:
 - No. 1 or No. 2 denatured alcohol
 - Isopropyl or isobutyl alcohol
4. Replace all barriers. Check all visible fasteners again for condition and tightness.

Note: Do not use any cleaning compounds containing chlorinated hydrocarbons such as trichlorethylene, perchlorethylene or carbon tetrachloride.

These compounds will damage the phenylene ether copolymer material used in the barriers and other insulation on the circuit breaker.

Functional Tests

Refer to the Installation Checklist in the Installation Checks and Initial Functional Tests section of this manual. Functional tests consist of performing at least three (3) Manual Spring Charging Checks and three (3) Automatic Spring Charging Checks. After these tests are complete, and the springs fully discharged, all fasteners and connections are checked again for tightness and condition before re-installing the breaker into the metal-clad switchgear.

Overhaul

Introduction

For following procedures along with the troubleshooting charts at the end of this section, provide maintenance personnel with a guide to identifying and correcting possible malfunctions of the GMI vacuum circuit breaker.

WARNING



Hazardous voltages and high speed mechanical parts.

Can cause death, severe personal injury, or property damage.

All replacement of breaker components must be performed with the breaker completely de-energized and the springs discharged.

Circuit Breaker Overhaul - Table 5 lists the recommended overhaul schedule for GMI circuit breakers operating under ANSI usual conditions. When actual operating conditions are more severe, overhaul periods should occur more frequently. The counter on the front panel of the circuit breaker records the number of operations.

Table 5 Overhaul Schedule
ANSI Usual Conditions
Maintenance Based Upon Number of Closing Operations

Breaker Type	Number of Closing Operations
5-GMI-350 15-GMI-1000	5,000
All others	10,000

Replacement at Overhaul - The following components are replaced during an overhaul of the circuit breaker, when required:

- Vacuum interrupters as determined by vacuum integrity test, contact erosion, or after 30,000 operations.
- Spring charging motor brushes should be replaced after 10,000 operations (reference kit 18-658-612-886).

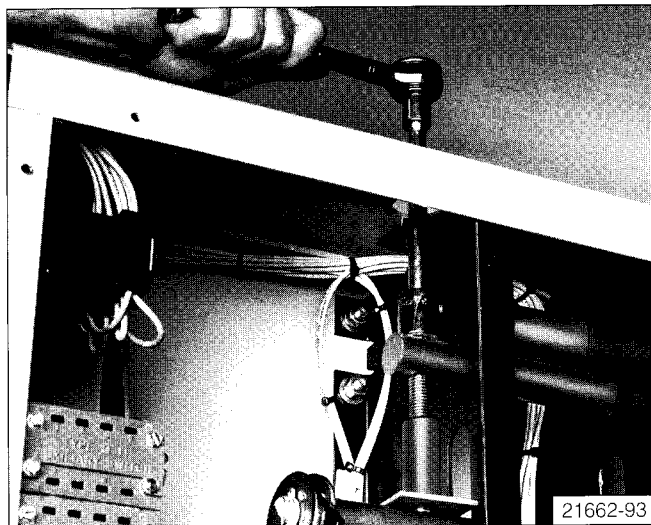


Figure 38: Use of Socket Wrench to Release Tension on Closing Springs.

Replacement of Closing Springs - Figure 38 shows the use of a 3/4 inch socket wrench to relieve spring tension on the closing springs. The top cover of the breaker has openings providing access to the tensioning bolts. Turning the left and right hand support bolts counterclockwise relieves spring tension.

For early models of the GMI breaker, once tension has been relieved, retaining ring pliers are needed to remove the top and bottom retaining rings attaching each spring to its cross-arm support shaft and its crank arm.

For later models of the GMI breaker, the lower spring hangers are fastened to the crank arms using hex socket shoulder bolt and nut. The nut is applied using thread locking adhesive, Loctite 271, with Loctite type T primer.

When one or both springs are reinstalled, be sure the support bolts are inserted inside their support bolt bushings. These bushings maintain the correct tension on the closing springs. Replace all retaining rings during the re-assembly. Re-tighten by turning the support bolts clockwise until the support bolt bushings firmly butt up against the support bolt attachment bracket and the cross arm support shaft.

Replacement of Opening Spring - The opening spring may be removed and replaced without the need to use a spring keeper or compression aid.

The opening spring assembly consists of the top and bottom spring caps, threaded coupling rod with nuts, and a supporting shelf. The shelf features location holes and tabs which work in concert with supports in the breaker frame to secure the shelf.

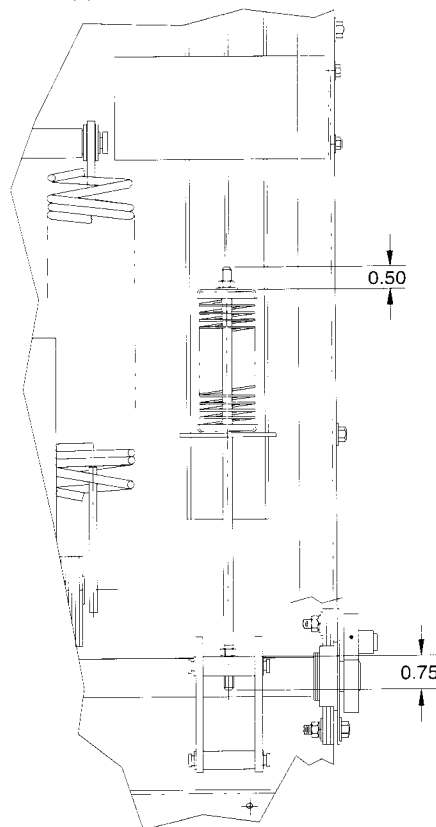


Figure 39: Removal of Opening Spring.

Overhaul

An adjustable crescent wrench allows an easy means of grasping the shelf and lifting it slightly to disengage the tabs in the shelf locating holes. With the tabs disengaged, and grasping the top of the spring, the whole assembly can be pulled forward.

A reversal of this procedure allows re-assembly. Note that the jam nut at the lower end of the threaded coupling rod is located so that there is 0.75" thread engagement of the jack shaft. The top nut above the upper spring cap is located so that the top surface of the spring cap is 0.50" from the end of coupling rod.

When re-assembling, apply upward pressure to the shelf over stationary support and to engage the shelf tab guides. The shelf may then be guided into place.

Replacement of Closing and Tripping Solenoids (Devices 52SRC and 52T) - Replacement of either the closing or tripping solenoids is straightforward. Each solenoid has two mounting screws and one quick disconnect terminal. Removing the mounting bolts and quick disconnect terminal of the solenoid permits it to slide out and to be removed. Replacement requires careful insertion of the solenoid and re-attachment of the mounting bolts and quick disconnect. **Figure 40** shows the two screws which attach the close coil and the quick disconnect terminal for control leads. The trip coil arrangement is similar.

Replacement of Anti-Pump Relay (Device 52Y) - Figure 41 helps illustrate the anti-pump relay removal procedure. The two nuts holding the relay and its mounting bracket are removed. The wires connected to the relay should be tagged and disconnected, the relay and bracket can then be extracted and replaced.

Replacement of the Auxiliary Switch - Figure 41 shows the auxiliary switch and its key mounting components. Two mounting screws hold the switch to the mounting bracket. First remove the quick disconnect terminals after marking their position. The screw, washers and nut connecting the switch's operating lever to the operating shaft is removed, and then the two mounting screws. Re-assemble in reverse order.

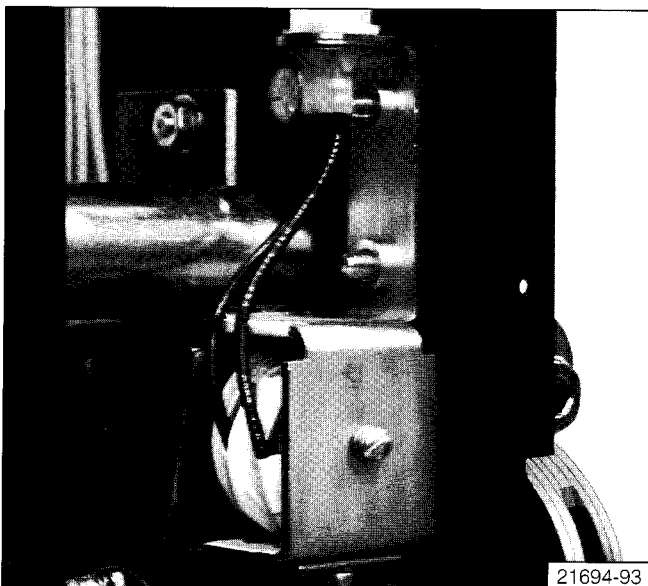


Figure 40: Replacement of Closing Solenoid.

Replacement of Motor Cut-Off Switch (Device LS1) and Spring Charged Switch (LS2) - The motor cut-off switch (LS1) and spring charged switch (LS2) form a common assembly of two switches on one mounting bracket. Should either switch require replacement, it is recommended that both be replaced as a single assembly. The motor cut-off switch (LS1) is the "outboard" device with respect to the mounting bracket. Removal of the two mounting screws shown in **Figure 42** allows both switches to be brought out for convenient removal of the interconnecting wiring.

Next, mark all wires to both switches. Remove the wires. Then replace the switches, rewire, and reassemble the switches to their mounting bracket. Be sure to use the same flat washer, lock washer and nut configuration in reassembly as was present in the as-shipped condition.

Replacement of Trip Latch Reset Check Switch (Device LS3) - Note: Two different latch systems have been used in GMI circuit breakers, with changeover from one design to the other occurring in mid-1991. This instruction manual describes both designs.

Pages 10-11 describe the operation of the mechanism used beginning in approximately mid-1991.

Pages 12-13 describe the operation of the mechanism used from 1989 until approximately mid-1991.

Replacement of LS3 - Mid-1991 and After

The following paragraphs describe replacement of the trip latch reset switch for the mechanism used beginning in approximately mid-1991.

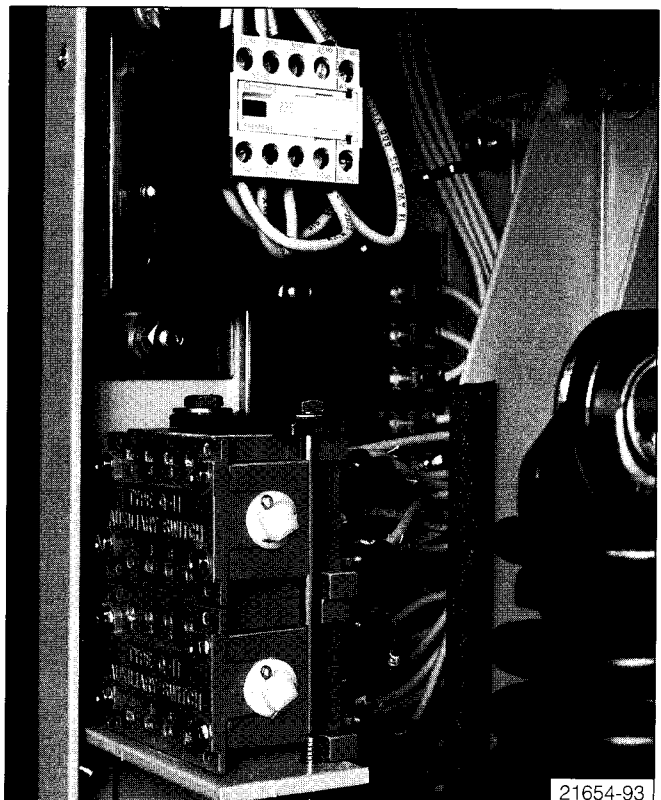


Figure 41: Replacement of Anti-Pump Relay or Auxiliary Switch.

Overhaul

This mechanism can be identified by observing the close latch above the spring charging motor on the left side of the circuit breaker. Refer to **Figure 18a**. The close latch is installed on the close shaft assembly 72, and includes a hardened latch face. This face contacts a bearing which is part of the close hatchet assembly 105. If the mechanism has a close hatchet which bears directly on the close shaft, refer to the next section for replacement of the trip latch reset switch for your mechanism.

The trip latch reset check switch (LS3) is mounted on the trip shaft actuator stop plate, as shown in **Figure 43a**. To replace this switch, the trip shaft actuator must be removed by backing out two #10-32 hex socket screws, and then removing two 3/8" nuts which secure the trip shaft actuator stop plate to the mechanism.

Wires to the switch must be marked and removed. The stop plate and switch may then be removed as a subassembly. The switch is a bushing type, for panel mounting, and threads into the stop bracket. After adjustment, it is secured by a jam nut and locking nut.

Adjustment requires the trip of the switch plunger to be set 0.06-0.09" ahead of the stop bracket tab, as illustrated in **Figure 43a**. Secure the switch, position the stop bracket assembly, and reattach the wires. Install the 3/8" nuts to secure the trip shaft actuator stop plate to the mechanism. Remount the trip shaft actuator.

Confirm that the switch is vertically aligned to ensure that it will not be struck by the closing hatchet or the trip shaft actuator.

Replacement of LS3 - Up to Mid-1991

The following paragraphs describe replacement of the trip latch reset switch for the mechanism used beginning in approximately mid-1991.

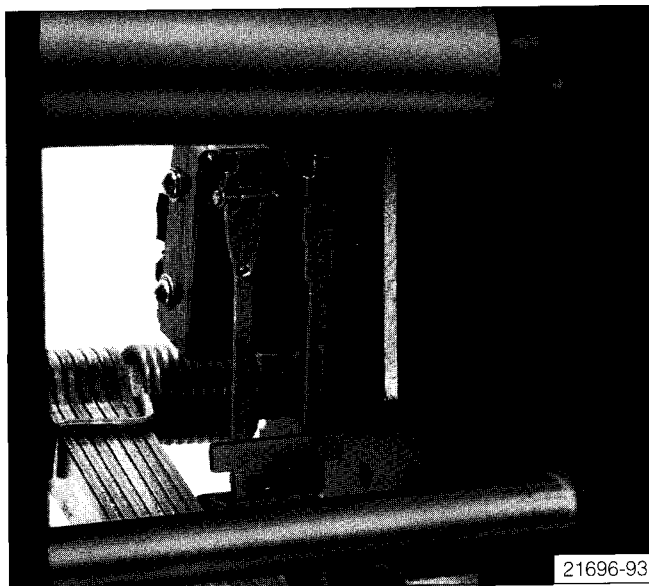


Figure 42: Motor Cut-Off Switch (LS1) and Spring Charged Switch (LS2).

This mechanism can be identified by observing the close latch above the spring charging motor on the left side of the circuit breaker. Refer to **Figure 18b**. The close hatchet 22 has a latch face which bears directly on the close shaft 72. If the close hatchet includes a bearing which contacts a hardened latch installed on the close shaft, refer to the preceding section for replacement of the trip latch reset switch for your mechanism.

The trip latch reset check switch is mounted to the left (when facing the front of the beaker) vertical mechanism side sheet as shown in **Figure 43b**. The switch is held in place by two screws. When replacement of the trip latch reset check switch is required, both screws need to be removed.

Next, mark both wires to the switch, and remove them. Then replace the switch, rewire and reassemble the switch to the left hand mechanism side sheet. Be sure to use the same washer and nut configuration as was present in the as-shipped condition.

Replacement of Spring Dump Switch (Device LS4) (Figure

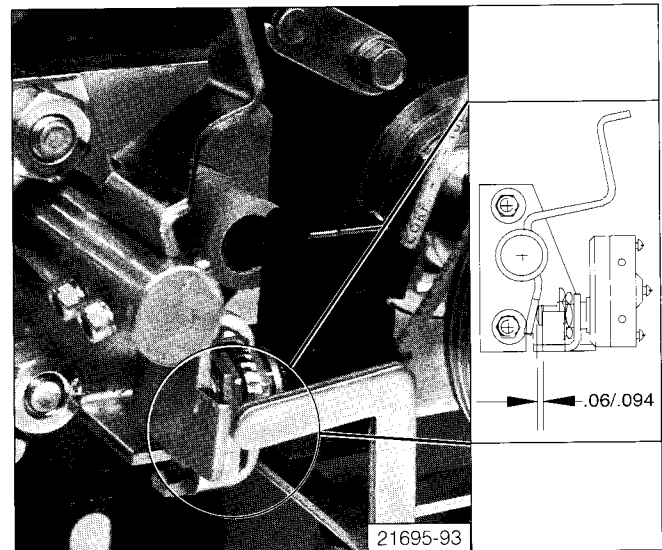


Figure 43a: Trip Latch Reset Switch (LS3) (From mid-1991 to present).

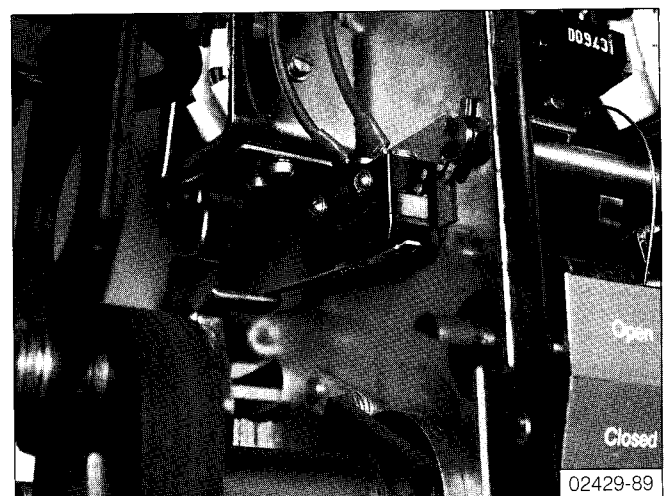


Figure 43b: Trip Latch Reset Switch (LS3) (From 1989 to mid-1991).

Overhaul

44) - The spring dump switch is mounted on the right (when facing the front of the breaker) vertical mechanism side sheet. The switch is actuated by a push rod which is actuated whenever the circuit breaker is inserted into or withdrawn from, the cubicle. Should difficulty be suspected with the spring dump switch, be sure to eliminate all mechanical reasons for difficulty before replacing the switch.

The switch is held in place by two mounting screws. Remove the two screws. Mark the wires, and remove them. Next, replace the switch. Be sure to use the same configuration of flat washers, lock washers and nuts as was present in the as-shipped condition.

Replacement of Damper Assembly - Damper replacement will require the removal of a pin which ties the damper mounting yoke to the circuit breaker frame. Refer to **Figure 45**.

The damper is attached to the mounting yoke with a lock washer and 5/8-18 jam nut. For added security, the jam nut is treated with a thread locking adhesive (Loctite 271 with Loctite type T primer), and then torqued to a value of 17-20 ft-lbs.

Check all associated parts, damper body and telescoping tube, for wear. Replace as necessary.

The telescoping tube and internal striker block employ slugs in variable thicknesses and quantity to control movable contact motion. If the telescoping tube is replaced, the tube must be replaced with the correct tube to assure that the correct type and number of slugs are present.

Replacement of Spring Charging Motor (Device 88) - Remove the quick-disconnect terminals. Then remove the screws holding the motor mounting bracket to the breaker housing. The motor slips out as a complete assembly. Check and replace as required.

Replacement of Primary Disconnect Fingers - The primary disconnect finger assembly is secured with standard hardware. With the bolt removed, the finger assembly can be slid off the retaining arm as a unit. Replace burnt fingers or broken springs as necessary.

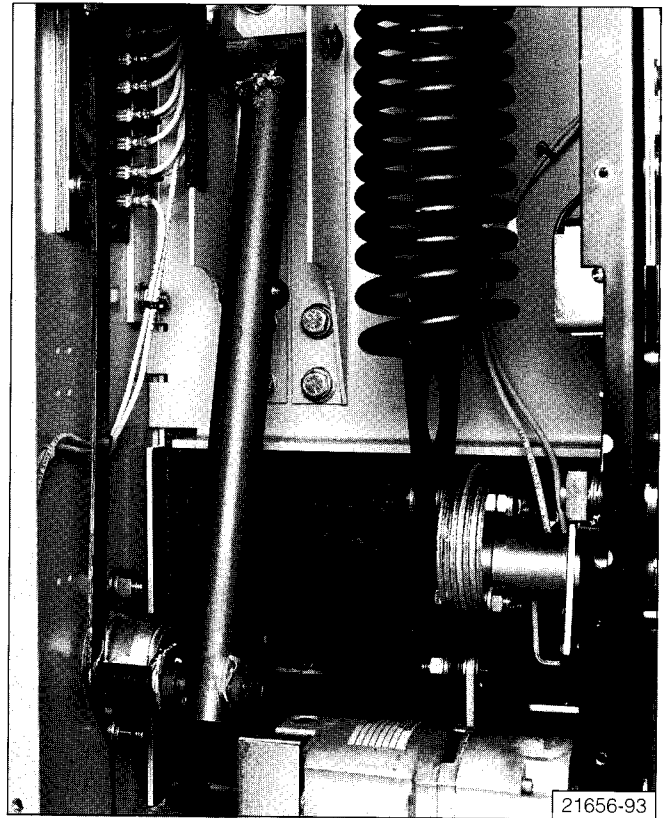


Figure 45: Damper Assembly.

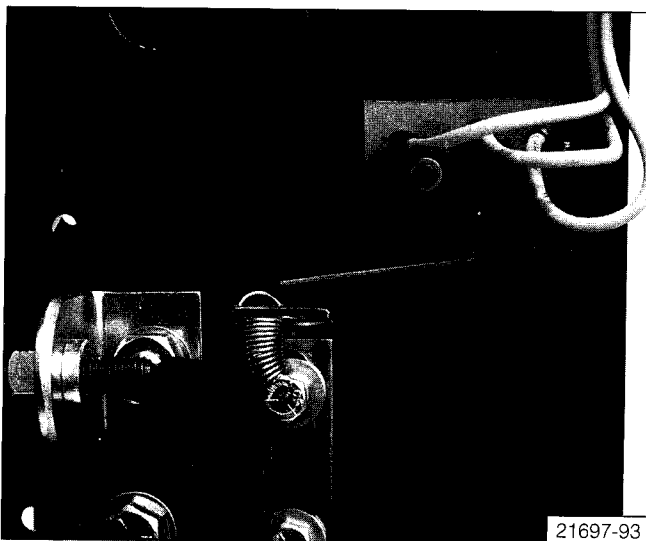


Figure 44: Spring Dump Switch (LS4).

Overhaul

Replacement of Vacuum Interrupters

The following procedures are for the removal and replacement of the vacuum interrupters.

Note: Special care needs to be exercised in removal of hardware around the bottom, or movable contact end, of the vacuum interrupter.

The movable contact uses a metal bellows assembly to maintain the vacuum seal while still permitting up and down motion of the contact. This bellows assembly is rugged and reliable, and is designed to withstand years of vertical movement. However, care should be exercised in subjecting the bellows to excessive torque during removal and replacement. Twisting the bellows through careless bolt removal or tightening may damage the vacuum interrupter.

Index of Figures and Tables

Vacuum Tube Family	Continuous Current	Figure
Pole Unit Assembly		
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VS10006	1200 Amp	47
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VS25002	1200 and 2000 Amp	48
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VS10028	2000 and 3000 Amp	49
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Gaging Procedure and Stroke Adjustments		52

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Recommended Tools	Table 6
Fastener Torque Limits	Table 7

Preparation

Identify tube family and breaker continuous current rating. The tube will have an identifying nameplate showing the family designation and the continuous current requirement can be taken from the breaker's rating label.

Check the "Index of Figures" to find the appropriate side elevation picture of the breaker pole unit assembly. Confirm that the figure applies by comparing the figure carefully to the breaker.

Read through the replacement procedures, noting recommended tools, gaging requirements and torquing limits, etc.

Vacuum Tube Removal

1. Make provision to save and retain hardware. Rejoin fastener parts (bolts, nuts, washers, lockwashers, etc.) as they are removed. Save in an appropriate container.
2. Remove interphase and outer barriers as required.

3. Loosen, but do not remove, bolt fastening trunnion to the movable contact stem of the vacuum tube. An 8mm or a 10mm Allen wrench is required.
4. Disconnect insulating pushrod at bell cranks. Remove and discard two 0.25" X-washers. Spread the bell crank elements and allow the push rod to drop down.
5. Refer to **Figure 51**, and using the procedure shown to secure head and nut proceed to loosen the bolts which fasten the flexible shunt clamp to the movable contact of the tube.
6. Remove the two X-washers (discard) fastening the bell cranks to the trunnion.
7. Loosen, but do not remove insulating centering devices near the movable contact end of the vacuum tube.
8. Remove the bolt fastening the trunnion to the end of the tube. Be certain to save the washers, spacer, trunnion and hardware for later use.

Note: List the order and location of each flat and lock washer.

It is critical that these spacing washers be replaced in their exact order upon reassembly to assure proper operation of the breaker.

9. Vacuum Tube Stationary Contact Disassembly and Tube Removal.

- 9.1 Circuit breakers rated 1200 amp using the VS12015 or VS25002 Interrupters (**Figure 48**).

Using an 19mm socket and extension remove bolt fastening vacuum tube stationary contact to the upper primary connectors and upper stab support. Save bolt washer and lockwasher.

Carefully remove and set aside the heavy copper spacer connecting the tube to the upper primary bars. Handle with care to maintain flat ends on the cylindrical spacer.

- 9.2 Circuit breakers rated 1200 amp using the VS10006 or VS10028 Interrupters (**Figure 47**).

Using 9/16 (and 11/16) socket and backup wrench remove two 3/8 fasteners joining upper primary extensions to the stab support. Rejoin hardware and save with primary extensions for reuse.

Using a 24mm socket and extension loosen and remove hex bolt joining the tubes stationary contact to the bus extensions and stab support. Remove primary extensions and save.

- 9.3 Circuit breakers rated 2000 amp using the VS10006 Interrupter (**Figure 50**).

Using a 24mm socket and extension loosen and remove hex bolt joining the tubes stationary contact to the primary extensions and stab support.

After removing the bolt carefully remove a 3/8 copper spacer, handle carefully and save protecting the flat contact surfaces.

Overhaul

- 9.4 Circuit breakers rated 2000 and 3000 amp using the VS10028 Interrupter (**Figure 49**).

Remove four hex socket flat head screws joining the insulating support plate to the upper primary stab support. A 5/32 (0.156) hex key and 7/16 back up wrench will be required (hex key socket preferred). These screws have been secured with a thread locking adhesive. Preheating the fasteners to 350°F using a hot air gun prior to breaking them free is recommended. Remove, rejoin and save fasteners for future use.

Using a 24mm socket and extension, loosen and remove the hex bolt joining the tubes stationary contact to the primary extensions.

Using 9/16 socket and extension, remove four 3/8 hex bolts fastening the upper primary stab support to the red post insulator. Lift and remove, set aside with care. This item is heavy, and two people may be required to safely remove.

10. Check the clamp on the movable contact to ensure that it will slide freely from the tubes movable stem. The clamp may have to be wedged or worked open in order to slide freely from the tube.

With the clamp free, the vacuum tube may be lifted clear of the clamp and pole unit structure.

Vacuum Tube Replacement

11. Inspect all silver plated surfaces for cleanliness. Wipe clean with solvent and clean rag. Do not abrade.

12. Insert vacuum tube replacements into the lower stab support with the evacuation nipple or tubulation oriented as follows:

VS12015	Tubulation toward primary fingers
VS25002	Tubulation toward primary fingers
VS10006	Tubulation toward mechanism housing
VS10028	Tubulation toward mechanism housing

13. Slip the flexible shunt clamp over the movable contact stem of the interrupter. Replace clamp hardware; bolt(s), washer(s), and nut(s). Raise clamp until it bears on step or retaining ring 33 to 48mm up from the end of the stem.

Note: Finger tighten only! Excessive clamping force at this time may deform movable contact stem.

Later in this procedure a trunnion bolt will be inserted and secured. After this bolts insertion and adjustment the clamp may then be tightened.

14. Stationary Contact Assembly.

- 14.1 VS12015 and VS25002 Interrupters.

Align copper spacer bar with large hole in stab support. Insert long M12 bolt through lockwasher, washer, stab support and copper spacer. Align tube stationary contact and (by hand) engage the M12 bolt (**Figure 48**).

Note: Stationary contact is annealed copper.

Thread damage will occur if threads are crossed. Be sure the bolt can be fully engaged with light manual torque.

- 14.2 VS10006 and VS10028 Interrupters in breakers rated 1200 amp (**Figure 47**).

With the tube in alignment under stab support, place the primary extension into the gap between stab support and tubes stationary contact. Make sure contact surfaces are wiped clean.

Replace, finger tight, two 3/8 fasteners joining the primary extension to the stab support.

Insert an M16 hex bolt through lockwasher, washer, stab support and primary extension. Align tube stationary contact, and (by hand) engage the M16 bolt.

Note: Stationary contact is annealed copper.

Thread damage will occur if threads are crossed. Be sure the bolt can be fully engaged with light manual torque.

Fasten two 3/8 fasteners securing the primary extensions (26-36 ft-lbs.)

- 14.3 VS10006 Interrupter in 2000 Amp Breakers (**Figure 50**).

With tube aligned under the primary stab, place the 3/8" copper spacer between primary extensions and stationary contact of the vacuum tube.

Insert the M16 hex bolt through a lockwasher, washer, stab support, primary extension and 3/8" copper spacer. Align vacuum tube stationary contact, and (by hand) engage the M16 bolt.

Note: Stationary contact is annealed copper.

Thread damage will occur if threads are crossed. Be sure the bolt can be fully engaged with light manual torque.

- 14.4 VS10028 Vacuum Interrupter Applied in Breakers Rated 2000 and 3000 Amperes (**Figure 49**).

Allow tube to rest on the lower stab support.

Replace upper primary stab support with primary bus extensions. Fasten with four 3/8" hex bolts to the primary insulator. Use 3/8 bolt, lockwasher and washer torqued 20-25 ft-lbs.

Align vacuum tube stationary contact. Insert M16 hex bolt through lockwasher, washer, upper stab support and primary bus extensions. Manually engage bolt into tube by applying hand torque only.

Overhaul

Note: Stationary contact is annealed copper.

Thread damage will occur if threads are crossed. Be sure the bolt can be fully engaged with light manual torque.

Fasten the insulating support plate to the upper primary stab support. Use four hex socket flat head screws. Clean external and internal threads. Apply "Loctite" Primer T to the external and internal threads. Apply "Loctite" threadlocker 262 to the external threads. Engage and torque 8-10 ft-lbs.

15. Trunnion and Movable Contact Adjustment

- 15.1 The trunnion is fitted to the tube's movable stem in concert with spacer and shim washers. A special tool consisting of a threaded shaft and gage block is to be used to determine the correct number of shimming washers. Gaging tool consists of:

Note: VS10028 Interrupter will not require a spacer.

Threaded Shaft	M12	18-658-137-105
Threaded Shaft	M10	18-658-137-102
Gage Block	6mm:	18-750-171-001
Gage Block	8mm:	18-750-171-002
Gage Block	11mm:	18-750-171-003

VS12015 requires 6mm gage and stroke.
VS25002 requires 8mm gage and stroke.
VS10028 requires 8mm gage and stroke.
VS10006 requires 11mm gage and stroke.

The gage will set the trunnion center at one half the stroke magnitude above the center of the bell cranks major pivot. The gage block includes allowances for trunnion thickness, 1/2 the stroke and radius of the major bell crank pivot (**Figure 52**).

- 15.2 Torque fastener at the tube's stationary contact to firm the tube stationary contact against the primary extensions, using torque shown in **Table 7**. The companion lock washer is to be fully collapsed. Hold tube in the alignment required under Article 12 of the vacuum tube replacement procedure while tightening this fastener.
- 15.3 Thread gaging shaft, by hand, into movable stem of the vacuum tube.

M10 thread for VS12015 and VS25002.

M12 thread for VS10006 and VS10028.

Thread by hand until fully and firmly seated.

- 15.4 Apply shim washers, approximately 7, spacer and correct gage block over the shaft. Raise the gage block until the gage foot just bears or comes within one washer thickness of bearing upon the lower surface of the bell crank shaft. Washers may have to be removed or added to achieve these conditions. The spacer and washers above the gage block must be packed against the vacuum interrupter movable stem when observation of the gage foot to bell crank clearance is made. The gage foot must just touch the shaft or be within one shim washer thickness of doing so.

Note: The VS10028 tube will not require a spacer.

- 15.5 Having determined the required number of washers, insert hex bolt through lockwasher, trunnion, spacer and shim washers. Engage bolt into the vacuum tube stem and tighten by hand to snugness. Engage trunnion to bell crank (both sides) and tighten hex bolt further until lockwasher is just collapsed.

- 15.6 Manually exercise bell cranks, opening tube approximately 1/4 to 3/8 of an inch. Release bell cranks, tube should snap freely to the closed position. The main contacts should be clearly heard as they meet upon closing.

Check to make certain the insulating centering blocks or rings at the base of the tube are loose to permit tube alignment. It may be necessary to repeatedly free the tube's stationary fastener, shift the tube slightly, retighten and recheck bell crank snap action closing until full movable contact freedom is assured.

- 15.7 Once free movement of the movable contact is achieved, the tube centering blocks or ring may be fastened. Select two X-washers from parts kit and crimp into grooves at each end of the trunnion.

16. Open Stroke Adjustment

The open position is established by the insulating coupler which when adjusted to the proper length, and attached to the bell cranks, will hold the tube open at the proper contact gap or separation.

In Article 15, the trunnion shaft center was set at one half the required vacuum tube stroke *above* the bell crank shaft horizontal center line. The open position will be established with the trunnion shaft center one half the required vacuum tube stroke *below* the bell crank shaft horizontal centerline.

The adjustment requires the insulating pushrod length be varied by turning the threaded pushrod end into or out of the pin coupling the pushrod to the breaker jack shaft.

Required trunnion center below bell crank shaft center:

VS12015	3mm	(0.118 in)
VS25002	4mm	(0.157 in)
VS10006	5.5mm	(0.217 in)
VS10028	4mm	(0.157 in)

Engage pushrod to bell cranks and gage trunnion shaft center distance below bell crank shaft center. If less than required, the pushrod must be shortened, screwed into the jackshaft pin. If greater than required, the pushrod must be lengthened by screwing it out of the jackshaft pin.

By interactively engaging the trunnion shaft center, disconnecting the coupler, adjusting the coupler, reattaching the coupler to the bell cranks, and again gaging the trunnion center, the required trunnion center position relative to the bell crank shaft center will be achieved.

The gage block (18-750-171-001, -002, or -003 as appropriate), when held firmly on the trunnion will just contact the lower surface of the bell crank shaft at the correct open position (**Figure 52**).

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17. Concluding Operations

- 17.1 Torque vacuum tube stationary and movable contact fasteners to values indicated in **Table 7**.
- 17.2 Using procedure shown in **Figure 51** and torque limits established in **Table 7** secure tube clamp hardware.

Note: Check to be certain the tube clamp has been raised into firm bearing against the movable stem step or retaining ring before securing the clamp.

- 17.3 Replace all barriers.
- 17.4 Perform High Potential Test across open vacuum tube and from each primary extension to ground (See **Table 3** on page 25).

Table 6: Recommended Tools

Open End or Box End Wrenches

7/16, 1/2, 9/16, 5/8, 11/16

Socket Wrenches: (1/2" drive preferred)

7/16, 1/2, 9/16, 5/8, 11/16

19mm, 24mm

Ratchet

2 Extensions (6" maximum)

Torque Wrench (0-150 ft-lbs.)

Hex Socket Keys:

5/16 (0.156) socket type preferred

Miscellaneous:

Pliers

Hot Air Gun

"Loctite" Threadlocker 262

"Loctite" Primer T

Allen Wrenches - 8mm, 10mm

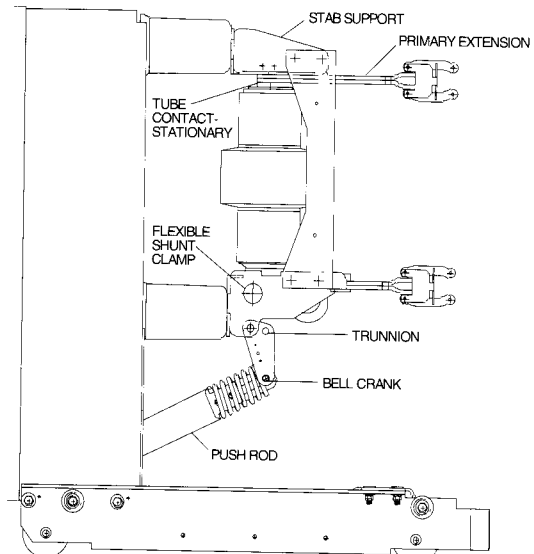


Figure 46: GMI Breaker Side Elevation (Typical).

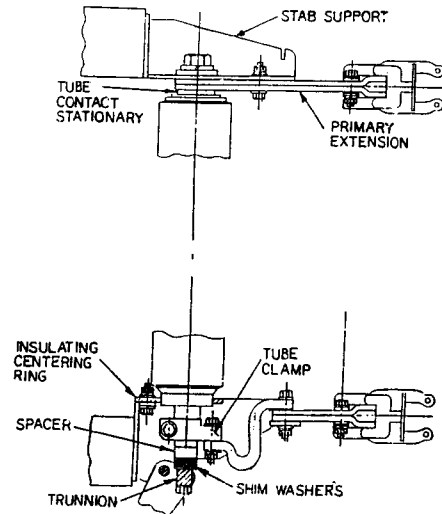


Figure 47: VS10006 and VS10028 1200 Amp.

Table 7: Critical Fasteners and Torque Limits

Tube Family	Stationary Contact		Movable Contact		Tube Clamp		
	Size	Torque	Size	Torque	Size	Torque	
All Current Ratings					1200	2000 & 3000	
VS12015	M12 x 1.75	60-65 ft-lbs.	M10 x 1.5	15-20 ft-lbs.	1-3/8-16	2-3/8-16	26-36 ft-lbs.
VS25002	M12 x 1.75	60-65 ft-lbs.	M10 x 1.5	15-20 ft-lbs.	1-3/8-16	2-3/8-16	26-36 ft-lbs.
VS10006	M16 x 2	60-65 ft-lbs.	M12 x 1.75	30-35 ft-lbs.	1-3/8-16	2-3/8-16	26-36 ft-lbs.
VS10028	M16 x 2	60-65 ft-lbs.	M12 x 1.75	30-35 ft-lbs.	1-3/8-16	2-3/8-16	26-36 ft-lbs.

Overhaul

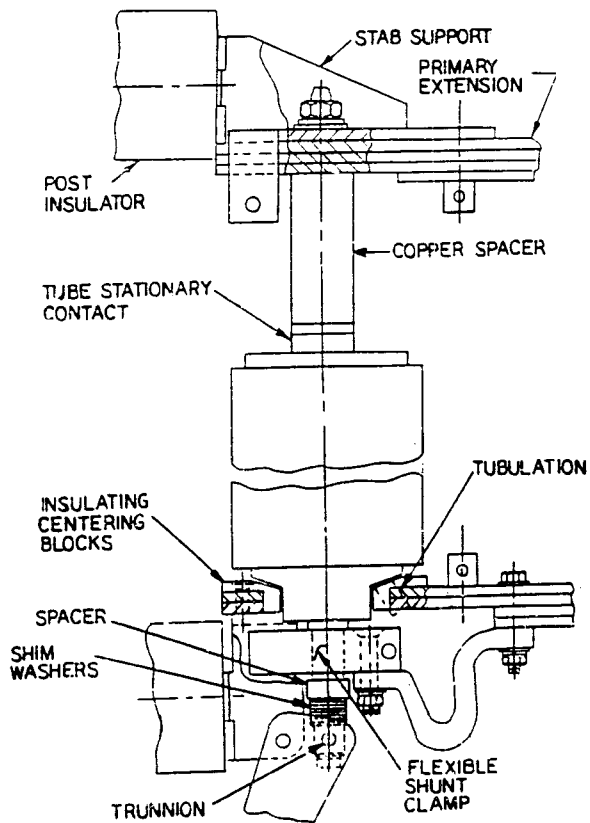


Figure 48: VS12015 and VS25002 1200 and 2000 Amp.

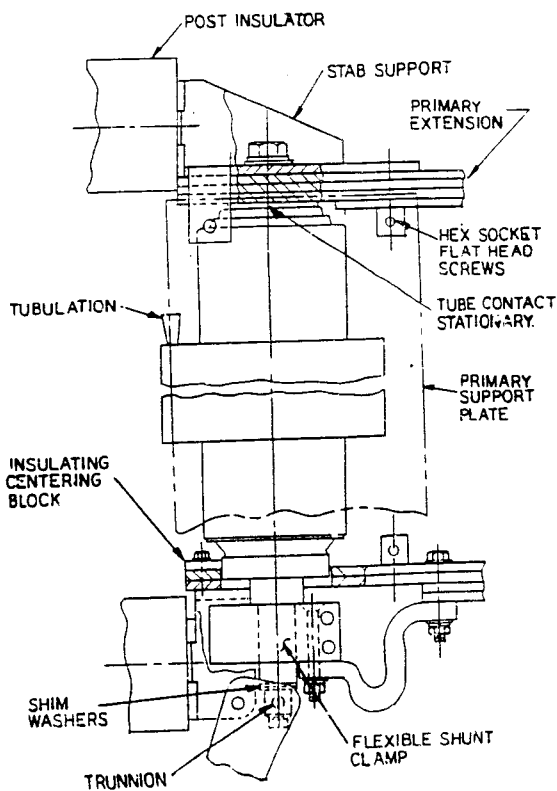


Figure 49: VS10028 2000 and 3000 Amp.

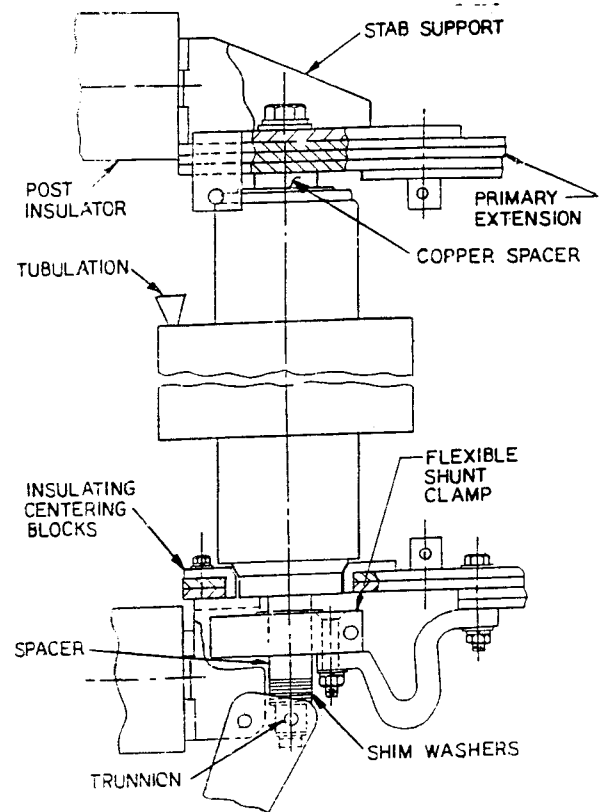


Figure 50: VS10006 2000 Amp.

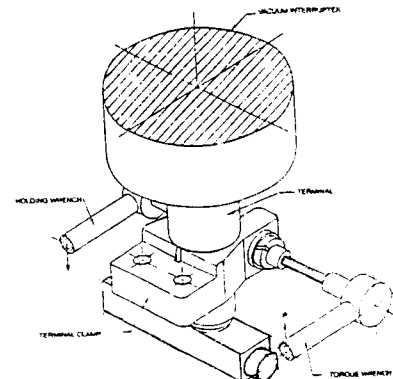


Figure 51: Tube Clamp Fastening Procedure.

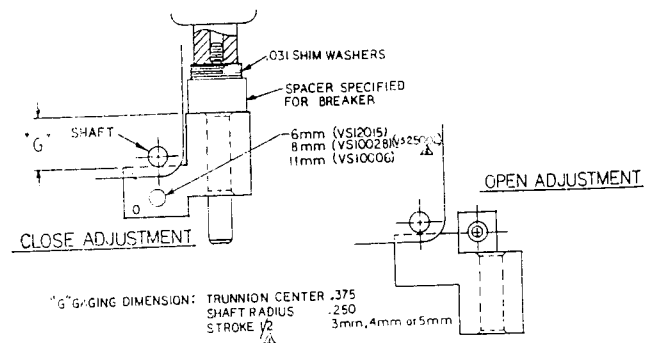


Figure 52: Gaging Procedure and Stroke Adjustments.

Overhaul

Periodic Maintenance and Lubrication Tasks

Sub-Assembly	Item	Inspect For
Primary Power Path	Vacuum Interrupter	<ol style="list-style-type: none"> 1. Cleanliness 2. Contact erosion Note: Perform with Manual Spring Checks 3. Vacuum integrity Note: Perform with High Potential Tests
	Primary Disconnects	<ol style="list-style-type: none"> 1. Burnt or damaged fingers 2. Lubrication of contact surfaces
	Vacuum Interrupter Contact Resistance	<ol style="list-style-type: none"> 1. Record contact resistance with contacts closed, and re-check each year to monitor condition.
Interrupter Operator Mechanism	Cleanliness	<ol style="list-style-type: none"> 1. Dirt or foreign material
	Fasteners	<ol style="list-style-type: none"> 1. Tightness of nuts and other locking devices
	Manual Spring Check	<ol style="list-style-type: none"> 1. Smooth operation of manual charging, and manual closing and tripping.
Electrical Controls	Lubrication	<ol style="list-style-type: none"> 1. Evidence of excessive wear 2. Lubrication of wear points
	Wiring	<ol style="list-style-type: none"> 1. Mechanical damage or abrasion
	Terminals and Connectors	<ol style="list-style-type: none"> 1. Tightness and absence of mechanical damage
High Potential Test	Close and Trip Solenoids, Anti-Pump Relay, Auxiliary Switches, Secondary Disconnect	<ol style="list-style-type: none"> 1. Automatic charging
	Spring Charging Motor (88	<ol style="list-style-type: none"> 2. Close and trip with control power 1. Replace brushes after 10,000 operations
	Primary Circuit to Ground and between Primary Disconnects	<ol style="list-style-type: none"> 1. 60 second withstand, 14 or 27kV, 60 Hz (20 or 38kV DC) (depending upon voltage rating of breaker)
Insulation	Control Circuit to Ground	<ol style="list-style-type: none"> 1. 60 second withstand, 1500V, 60 Hz
	Barriers and all Insulating Components	<ol style="list-style-type: none"> 1. Cleanliness 2. Cracking

Overhaul

Troubleshooting

Problem	Symptoms	Possible Causes and Remedies
Breaker fails to close	Closing springs will not automatically charge.	<ol style="list-style-type: none"> 1. Secondary control circuit is de-energized or control circuit fuses are blown. Check and energize or replace if necessary. 2. Secondary disconnect contacts 15 or 16 are not engaging. Check and replace if required. 3. Damage to wiring, terminals or connectors. Check and repair as necessary. 4. Failure of charging motor (88). Check brushes and replace if required. 5. Motor cut-off switch (LS1) fails to operate. Replace if necessary. 6. Mechanical failure of operating mechanism. Refer to factory or authorized service shop.
	<p>Closing springs charge, but breaker does not close</p> <ul style="list-style-type: none"> • Closing coil, or solenoid (52SRC) fails to energize. No sound of breaker closing. 	<ol style="list-style-type: none"> 1. Secondary control circuit de-energized, or control circuit fuses blown. Correct as indicated. 2. No closing signal to secondary disconnect pin 13. Check for continuity and correct relay logic. 3. Secondary disconnect contacts 13 or 15 are not engaging. Check and correct as required. 4. Failure of anti-pump relay (52Y) contacts 21-22 or 31-32 or 13-14. Check and replace as required. 5. Failure of close coil (solenoid) (52SRC). Check and replace as required. 6. Auxiliary switch NC contacts 3-4 are open when breaker contacts are open. Check linkage and switch. Replace or adjust as necessary. 7. Spring charged switch (LS2) NO contact remains open after springs are charged. Check and replace as required.
	<ul style="list-style-type: none"> • Closing coil energizes. Sound of breaker closing is heard, but breaker contacts do not close. 	<ol style="list-style-type: none"> 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.

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Troubleshooting (continued)

Problem	Symptoms	Possible Causes and Remedies
Nuisance or false close	Electrical problem	<ol style="list-style-type: none"> 1. Nuisance or false closing signal to secondary disconnect contact 13. Check relay logic. Correct as required. 2. Closing coil (52SRC) terminal 2 is shorted to ground. Check to determine if problem is in wiring or coil. Correct as required.
	Mechanical problem	<ol style="list-style-type: none"> 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.
	Circuit breaker will not trip	<ol style="list-style-type: none"> 1. Secondary control power is de-energized or control power fuses are blown. Correct as indicated. 2. Damage to wiring, terminals or connectors. Check and repair as necessary. 3. No tripping signal to secondary disconnect contact 1. Check for continuity and correct relay logic. 4. Secondary disconnect contacts 1 or 2 are not engaging. Check and replace if required. 5. Failure of trip coil (52T). Check and replace if necessary. 6. Auxiliary switch NO contacts 1-2 or 5-6 are open when breaker is closed. Check linkage and switch. Replace or adjust as necessary.
	Tripping coil, or solenoid (52T) does not energize. There is no tripping sound.	<ol style="list-style-type: none"> 1. Failure of tripping spring or its mechanical linkage. Check and replace if required.
Nuisance or false trip	Tripping coil (52T) energizes. No tripping sound is heard, and breaker contacts do not open (i.e., they remain closed).	<ol style="list-style-type: none"> 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.
	Tripping coil (52T) energizes. Tripping sound is heard, but breaker contacts do not open.	<ol style="list-style-type: none"> 2. One or more of the vacuum interrupters are held closed. Check and replace as necessary.
	Electrical problem	<ol style="list-style-type: none"> 1. Tripping signal remains energized on secondary disconnect contact 1. Check for improper relay logic.
	Mechanical problem	<ol style="list-style-type: none"> 1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.

Appendix

Table A-1
Type GMI Circuit Breaker Ratings

Identification			Rated Values								Rated Required Capabilities					
Circuit Breaker Type	Nominal Voltage Class	Nominal 3-Phase MVA Class	Voltage		Insulation Level		Current				Current Values					
			Rated Max. Voltage ②	Rated Voltage Range Factor ③	Rated Withstand Test Voltage		Rated Cont. Current ④	Rated Short Circuit Current (at rated Max kV) ⑤ ⑥	Rated Interrupting Time	Rated Permissible Tripping delay Y	Rated Max. Voltage Divided by K	Max. Sym. Interrupting Capability ⑦	3-Sec. Short Time Current Carrying Capability	Closing and Latching Capability (Momentary) ⑧		
					Low Frequency	Impulse								1.6 K Times Rated Short Circuit Current ⑨	2.7 K Times Rated Short Circuit Current	
																E kV rms
5-GMI-250 ①	4.16	250	4.76	1.24	19	60	1200 2000	29	5	2	3.85	36	36	58 & 78 ①	97 & 132 ①	
5-GMI-350	4.16	350	4.76	1.19	19	60	1200 2000 3000	41	5	2	4.0	49	49	78	132	
7-GMI-500	7.2	500	8.25	1.25	36	95	1200 2000 3000	33	5	2	6.6	41	41	66	111	
15-GMI-500 ①	13.8	500	15	1.30	36	95	1200 2000	18	5	2	11.5	23	23	37 & 58 ①	62 & 97 ①	
15-GMI-750	13.8	750	15	1.30	36	95	1200 2000 3000	28	5	2	11.5	36	36	58 & 77 ①	97 & 130 ①	
15-GMI-1000 ①	13.8	1000	15	1.30	36	95	1200 2000 3000	37	5	2	11.5	48	48	77	130	

- High close and latch (momentary) rating available for special application.
- Maximum voltage for which the breaker is designed and the upper limit for operation.
- K is the ratio of rated maximum voltage to the lower limit of the range of operating voltage in which the required symmetrical and asymmetrical interrupting capabilities vary in inverse proportion to the operating voltage.
- 3000 ampere units available with increased fan-cooled rating of 4000 amperes.
- To obtain the required symmetrical interrupting capability of a circuit breaker at an operating voltage between 1/K times rated maximum voltage and rated maximum voltage, the following formula shall be used:

$$\text{Required Symmetrical Interrupting Capacity} = \text{Rated Short Circuit Current} \times \frac{\text{Rated Maximum Voltage}}{\text{Operating Voltage}}$$

For operating voltages below 1/K times rated maximum voltage, the required symmetrical interrupting capability of the circuit breaker shall be equal to K times rated short circuit current.
- With the limitations stated in 5.10 of ANSI Standard C37.04-1979, all values apply for polyphase and line-to-line faults. For single phase-to-ground faults, the specific conditions stated in 5.10.2.3 of ANSI Standard C37.04-1979 apply.
- Current values in this column are not to be exceeded even for operating voltages below 1/K times rated maximum voltage. For voltages between rated maximum voltage and 1/K times rated maximum voltage, follow 5 above.
- Current values in this column are independent of operating voltage up to and including rated maximum voltage.
- Included for reference only.

Appendix

Table A-2

5kV, 7.2kV and 15kV Type GMI Circuit Breaker Control Data
Typical Spring Release (Close Coil), Trip Coil and Spring Charging Motor Characteristics

Control Voltages, ANSI C37.06 Table 10			Close Coil	Trip Coil	Spring Charging Motor		
Nominal	Range				Amperes		Charging
	Close	Trip			Run (Avg.) ^①	Inrush (Peak) ^①	
48 VDC	38-56	28-56	10 ^②	10 ^②	8.5	15	10
125 VDC	100-140	70-140	4	4	2.7	10.2	8
250 VDC	200-280	140-280	3	3	1.3	2.4	8
120 VAC	104-127	104-127	4	--	3.3	10.6	8
240 VAC	208-254	208-254	3	--	1.7	7.1	8

① Current at nominal voltage. ② 10A for coils supplied mid-1990s and later.

① Current at nominal voltage. ② 10A for coils supplied mid-1993 and later. For coils supplied up to mid-1993, current is 23A.

Table A-3

Interrupting Capacity Auxiliary Switch Contacts

Type Auxiliary Switch	Continuous Current Amperes	Control Circuit Voltage				
		120 VAC	240 VAC	48 VDC	125 VDC	250 VDC
		Non-Inductive Circuit Interrupting Capacity in Amperes				
Breaker Auxiliary Switch	20	20	20	20	10	2
TOC Auxiliary Switch	15	15	10	0.5	0.5	0.2
MOC Auxiliary Switch	20	15	10	10	10	5
		Inductive Circuit Interrupting Capacity in Amperes				
Breaker Auxiliary Switch	20	20	20	20	10	2
TOC Auxiliary Switch	15	15	10	0.5	0.5	0.2
MOC Auxiliary Switch	20	15	10	10	10	5

Table A-4

Circuit Breaker Weights

Breaker Type	Weight, Lbs.		
	Continuous Current, Amperes		
	1200 A	2000 A	3000 A
5-GMI-250	385	425	--
5-GMI-350	440	480	575
7-GMI-500	425	465	560
15-GMI-500	415	455	--
15-GMI-750	425	465	560
15-GMI-1000	440	480	575

SIEMENS

Siemens Energy
& Automation, Inc.
Switchgear and Motor Control
Business
P.O. Box 29503
Raleigh, NC 27626-0503