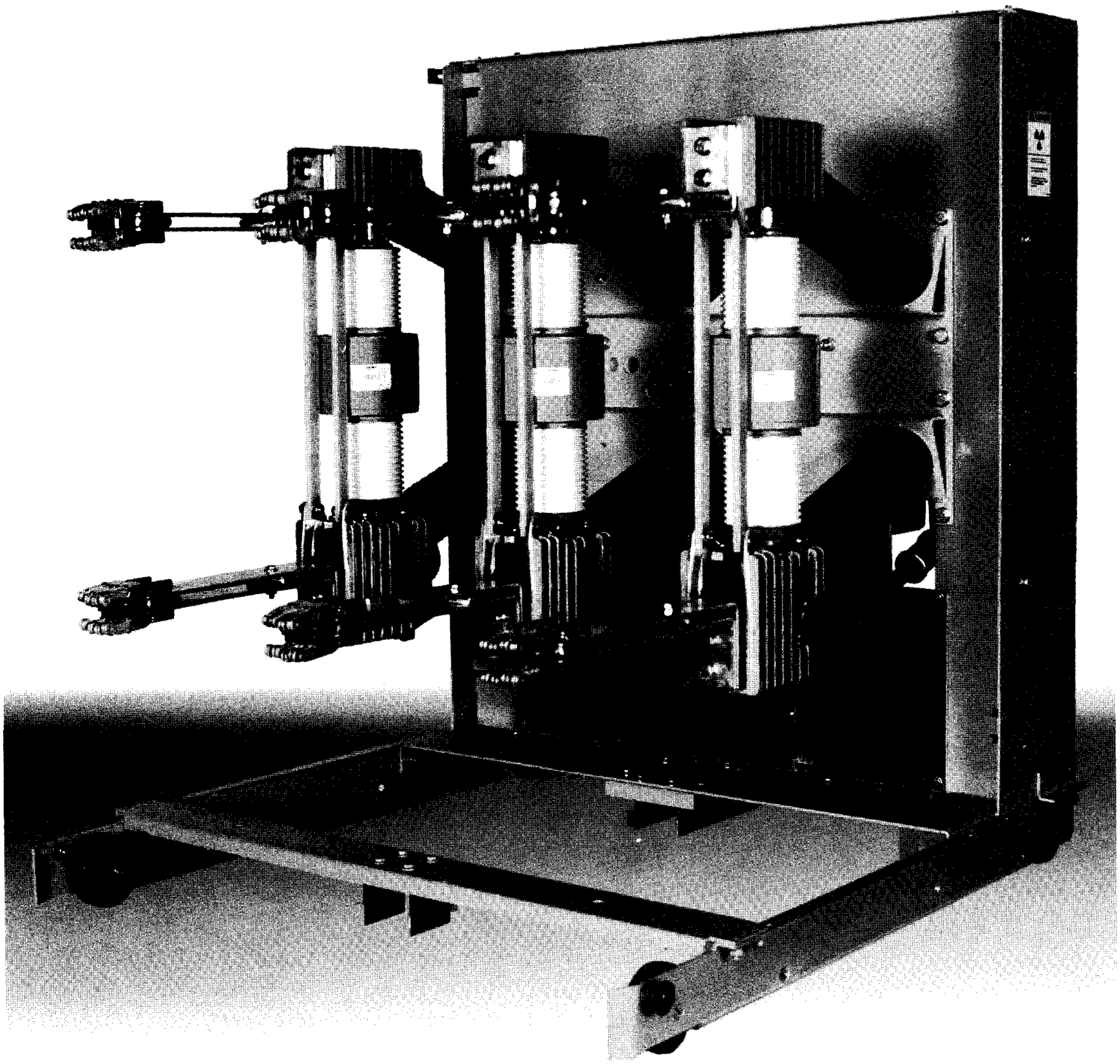
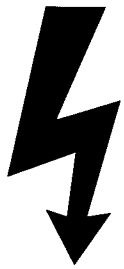
SIEMENS

38kV Vacuum Circuit Breakers

Type 38-3AF

Instructions
Installation
Operation
Maintenance
SG-3528





⚠ 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.

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Introduction and Safety

Introduction

The 38-3AF 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

Hazardous voltages and high-speed moving parts.

Will cause death, personal injury or 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 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:

- 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 de-energized equipment. Always de-energize a breaker, and remove it from the switchgear before performing any tests, maintenance or repair.

2. Always perform maintenance on the breaker after the spring-charged mechanisms are discharged.

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
This manual covers the Receiving, Handling and Storage instructions for Type 38-3AF vacuum 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 crank, the racking crank and the split plug jumper (optional) 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 the 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 using a Siemens lift truck or lift sling. 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 38-3AF circuit breakers weigh between 800 and 1000 pounds (364-455 kg).

4. The palleted 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, SG-3518.
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. During storage, 250 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.

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.

The control power disconnect device is normally located on the secondary device panel in the upper cell of the vertical section. The normal control power disconnect device is a pull-out type fuse holder. Removal of the fuse holder de-energizes control power to the circuit breaker in the associated switchgear cell. In some switchgear assemblies, a molded case circuit breaker or knife switch is used in lieu of the pull out type fuse holder. Opening this circuit breaker or switch accomplishes the same result: control power is disconnected.

Spring Discharge Check (Figure 1) - Perform the Spring Discharge Check before removing the circuit breaker from the pallet or removing it from the switchgear.

The spring discharge check should be performed after de-energizing control power. This check assures that both the tripping and closing springs are fully discharged.

⚠ DANGER

Hazardous voltages and high-speed moving parts.

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

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

NOTE: Do not perform Spring Discharge Check if the circuit breaker is in the CONNECT position. Open circuit breaker and rack to the DISCONNECT position, and then perform Spring Discharge Check.

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 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 (see "Racking Crank Engagement"). This action operates the racking interlock latch. **Figure 2** shows racking of a circuit breaker.
2. Rotate the racking crank **counterclockwise** until the breaker is in the DISCONNECT position.
3. Move the breaker release latch (on the floor of the cell near the right side of the circuit breaker) to the left and pull the circuit breaker out from the DISCONNECT position. The breaker can now be removed from cubicle.
4. The circuit breaker is now free to be rolled out on the floor using the handles on the front. The wheels of the circuit breaker are at floor level (unless the switchgear is installed on a raised pad), and one person can easily handle the unit.

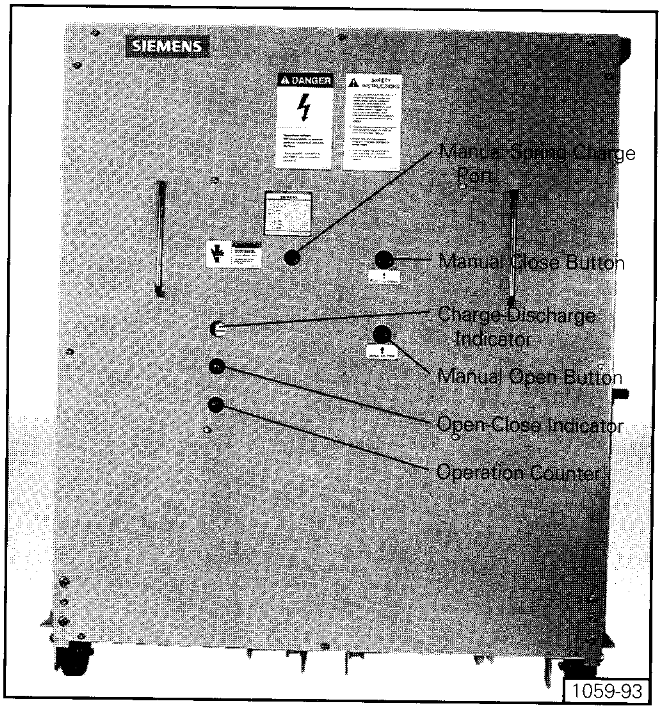


Figure 1. Front Panel Controls of Type 38-3AF Circuit Breaker

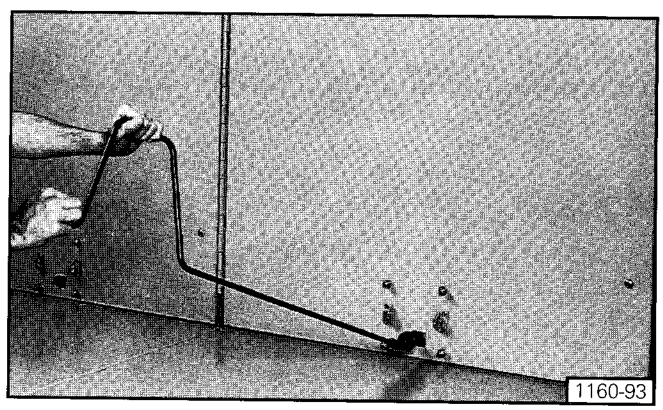


Figure 2. Racking of 38-3AF Circuit Breaker

Removal from Cell in Outdoor Non-Walk-In Enclosures, or for Indoor Switchgear Installed on a Raised Pad

Removal of the breaker from a non-walk-in outdoor switchgear assembly is similar to removal of a breaker at floor level, with several additional steps.

Figure 3 shows one of the two breaker extension rails being inserted into the fixed rails within the breaker cell. The rails engage locking pins in the fixed rails to secure them in position.

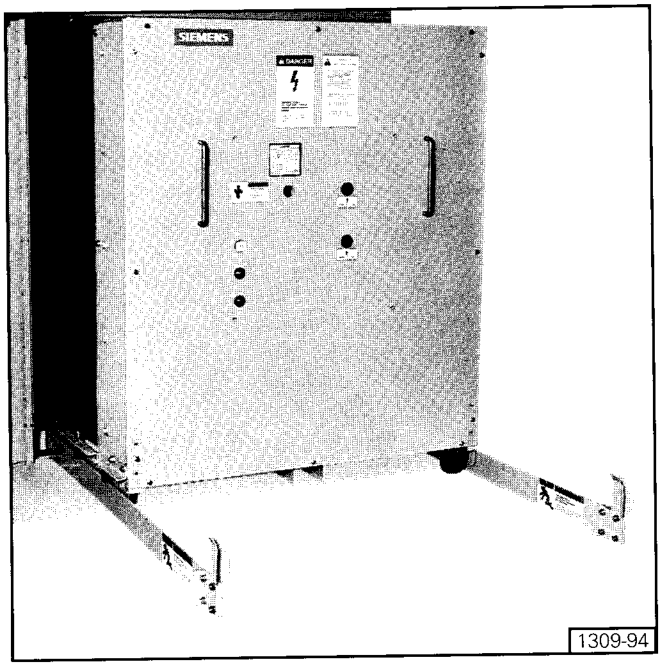


Figure 3. Use of Extension Rails for Removal of Circuit Breaker not at Floor Level

The procedure for removal of a circuit breaker not located at floor level 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 (see "Racking Crank Engagement Procedure"). This action operates the racking interlock latch.

3. Rotate the racking crank **counterclockwise** until the breaker is in the DISCONNECT position.

4. If you have not yet installed the extension rails, do so now.

⚠WARNING

Heavy Weight.

Can cause death, serious injury, or property damage.

Always use extension rails to remove or install circuit breaker 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 or a Siemens lifting sling and a suitable crane.

7. Lift the two extension rails and withdraw them from the switchgear.

Type 38-3AF circuit breakers weigh between 800 and 1000 pounds (364-455 kg), depending upon their ratings. The breaker can be moved using a properly rated crane and lift sling. A lift sling can be attached to the breaker, and then used to hoist the circuit breaker vertically clear of the extension rails. When clear, remove the rails and lower the circuit breaker to the floor.

⚠WARNING

Heavy Weight.

Can cause death, serious injury, or property damage.

Never transport a circuit breaker on a lift truck with the circuit breaker in the raised position.

Racking Crank Engagement Procedure

A crank for racking the drawout unit is provided as a standard accessory. Racking of a circuit breaker can be accomplished with the drawout compartment front door open or through a small opening (or window) in the front door, with the door closed. Racking of a rollout fuse truck is accomplished with the compartment front door open.

The racking crank consists of an offset handle end with a custom socket assembly welded to the end. The socket end of the crank is designed to engage the shoulder of the racking mechanism shaft and remain engaged during racking by means of two spring plungers located 180 degrees from each other. The socket plungers operate in a manner similar to the retainers of an ordinary mechanic's socket wrench.

The portion of the racking mechanism shaft which is visible is cylindrical, and the shoulder of the racking mechanism shaft is hidden by a shroud until the engagement procedure starts. The square socket end of the crank will only engage the shoulder of the shaft if it is aligned properly.

The suggested procedure to engage the racking mechanism is as follows:

1. The breaker must be open. (The racking shroud cannot be moved if the breaker is closed).

2. Hold the socket end of the crank in one hand and the crank handle in the other hand.

3. Place the socket over the end of the racking mechanism shaft. Align the socket with the shoulder on the racking mechanism shaft. **Note**: If the socket is not aligned, the socket will not be able to engage the shoulder of the racking mechanism shaft.

4. Once alignment is achieved, firmly push the crank and socket assembly toward the racking mechanism.

5. When properly engaged, the crank should remain connected to the racking mechanism, due to the socket plungers. If the crank does not remain in position, adjust the spring plungers clockwise one-half turn. This will increase the contact pressure of the spring plunger.

6. To remove the crank, simply pull the assembly off of the racking mechanism shaft.

NOTE: If the effort to rack the circuit breaker increases considerably during racking, or if turning of the racking crank requires excessive force, stop racking immediately. Do not try to "force" the racking crank to rotate, or parts of the circuit breaker or racking mechanism could be damaged. Determine the source of the problem and correct it before continuing with racking.

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 crank into the manual charge handle socket as shown in **Figure 4**. Turn the crank clockwise (about 45 revolutions) 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.

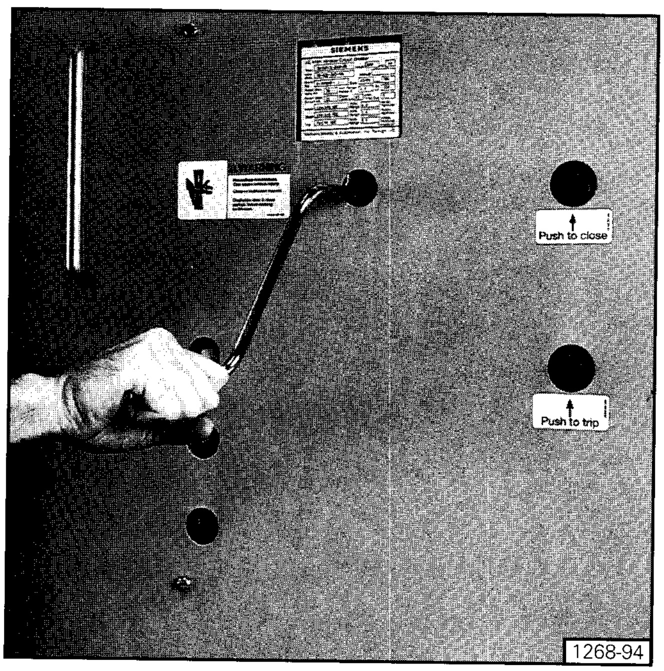


Figure 4. Manual Charging of Closing Springs

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.) Note, secondary disconnect terminals are numbered 1-16, from **right to left**. When control power is connected to the 38-3AF 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 opening the control power disconnect device.

2. Install breaker end of split plug jumper (if furnished) as shown in **Figure 5** to the circuit breaker. The plug jumper is secured over the circuit breaker's secondary contacts, by means of screws.

3. Install the switchgear end of the plug jumper shown in **Figure 6** 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.

5. Use the Close and Trip controls (**Figure 1**) 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 38-3AF circuit breaker are open.

Figure 5. Split Plug Jumper Connected to Circuit Breaker

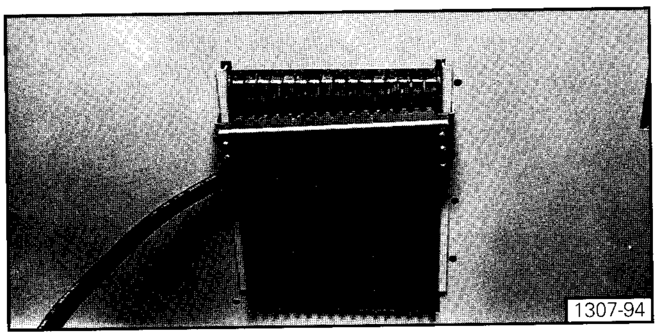


Figure 6. Split Plug Jumper Connected to Switchgear

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 7**. Verify mechanical condition of finger springs and the disconnect studs, check for loose hardware, damaged or missing primary disconnect contact fingers, and damaged disconnect sheds.

3. Coat movable primary contact fingers (**Figure 7**) and the secondary disconnect contacts (**Figure 23**) with a light film of Siemens Contact Lubricant No 15-171-370-002.

4. The 38-3AF 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.

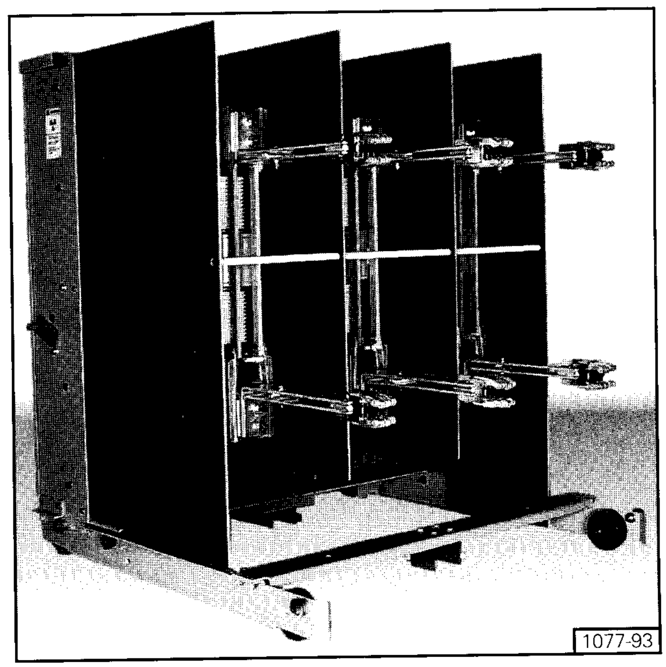


Figure 7. Breaker Primary Disconnects

Introduction

The Type 38-3AF vacuum circuit breaker is of drawout construction designed for use in medium voltage, metal-clad switchgear. The 38-3AF circuit breaker conforms to the requirements of ANSI Standards, including C37.20.2, C37.04, C37.06, C37.09 and C37.010.

Type 38-3AF 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. Insulating barriers are located between the vacuum interrupters and along the sides.

This section describes the operation of each major sub-assembly as an aid in the operation, installation, maintenance and repair of the type 38-3AF vacuum circuit breaker.

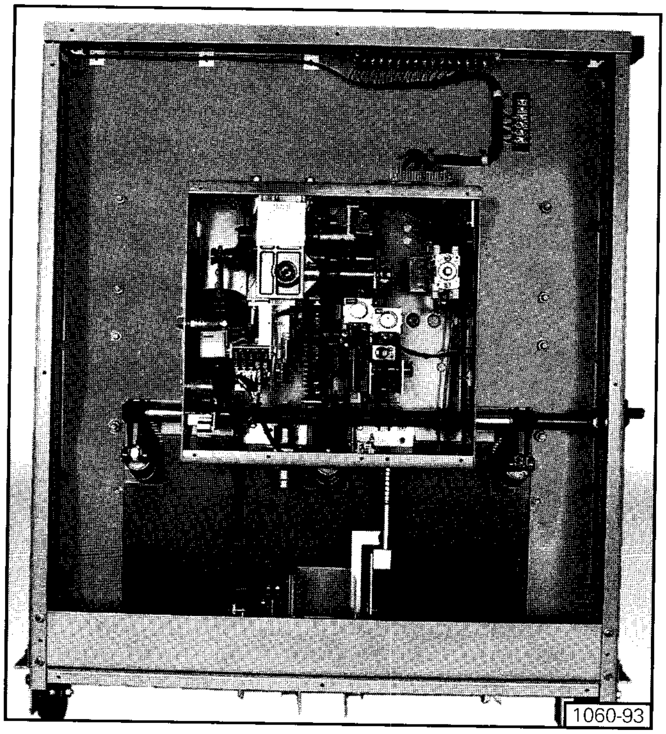


Figure 8. Front View of Type 38-3AF Breaker with Panel Removed

Vacuum Interrupters

The operating principle of the type 38-3AF vacuum interrupter is simple. **Figure 9** 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 provides a secure seal around the movable contact, preventing loss of vacuum while permitting vertical motion of the movable contact.

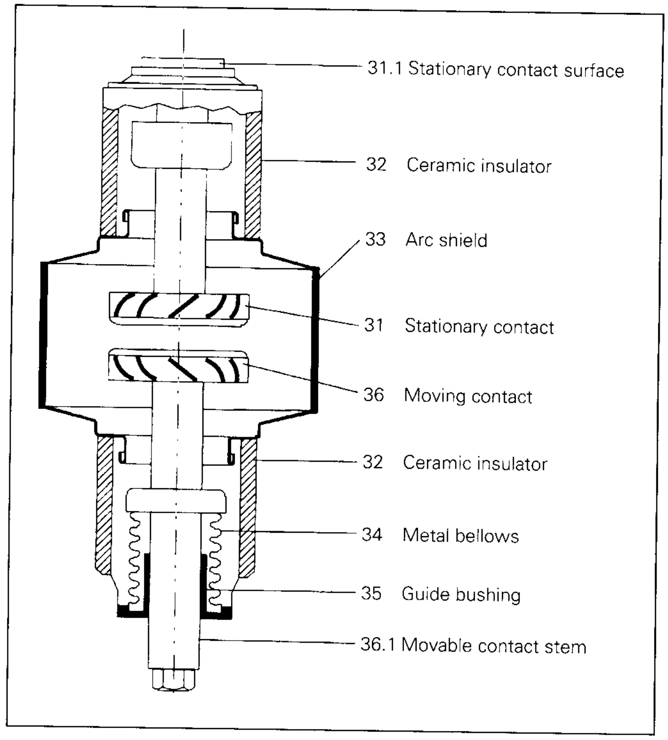


Figure 9. Cutaway View of Vacuum Interrupter

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, resist welding, and to minimize switching disturbances.

Primary Disconnects

Figure 10 is a side view of the circuit breaker with interphase and outer barriers 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.

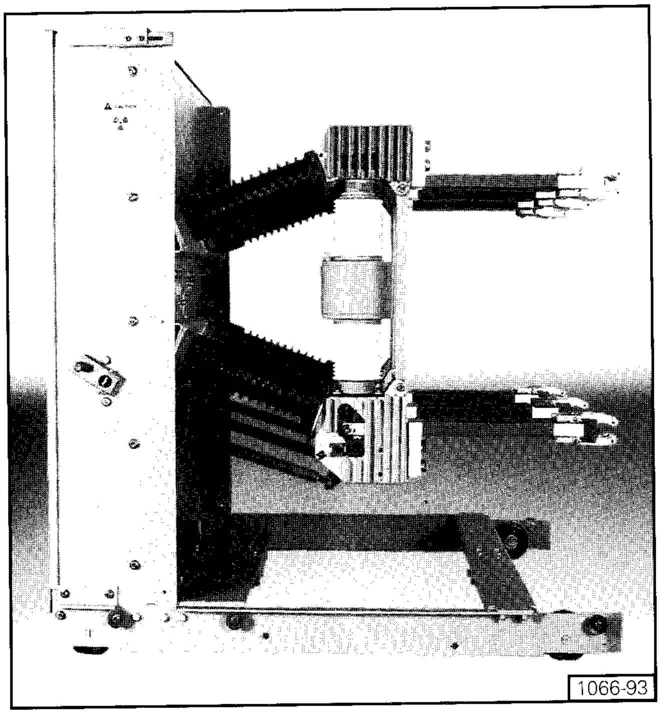


Figure 10. Upper and Lower Primary Disconnects

Phase Barriers

Figure 11 is a rear view of a type 38-3AF circuit breaker that shows the two outer (phase to ground) insulating barriers and the two inner (phase to phase) barriers. 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.

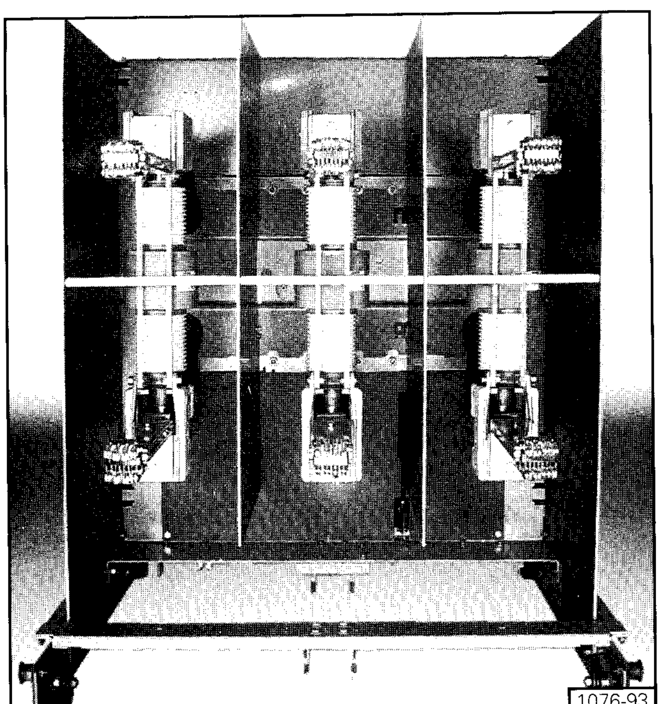


Figure 11. 38-3AF Breaker with Interphase and Outer Phase Barriers Installed

Stored Energy Operating Mechanism

The stored energy operating mechanism of the type 38-3AF 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. The operation of the stored energy mechanism will be discussed later in this section.

The vacuum circuit breaker consists of a combination of two sub-assemblies. The "interrupter/operator" module is a unitized assembly of the three vacuum interrupters, primary insulators, and operating mechanism. The second module, the "vehicle" is the supporting drawout structure module for the operating mechanism. The vehicle provides primary stud extensions, closed breaker racking interlocks, closing spring discharge feature, and other requirements needed to ensure safe and reliable use during racking and fully connected operations.

These two sub-assemblies will be separately described.

Interrupter/Operator Module

The interrupter/operator module consists of the three poles, each with its vacuum interrupters and primary insulators, mounted on the common motor or hand charged spring stored energy operating mechanism housing. This module is shown in **Figure 12**.

Construction (Refer to Figures 12 - 15)

Each of the circuit breaker poles are fixed to the rear of the operating mechanism housing (60) by two cast-resin insulators (16). The insulators also connect to the upper (20) and lower (40) pole supports which in turn support the ends of the vacuum interrupter (30). The pole supports are aluminum castings on all circuit breaker ratings. Primary stud extensions are attached directly to the upper pole support (20) and lower terminal (29).

The energy-storing mechanism and all the control and actuating devices are installed in the mechanism housing (60). The mechanism is of the spring stored energy type and is mechanically and electrically trip free.

Capacitor Trip Device
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 a 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 resulting reduction of the primary source voltage, the capacitor trip device will provide short term tripping energy for breaker opening due to relay operation.

The capacitor trip includes a rectifier to convert the 120 or 240 VAC control voltage to a DC voltage which is used to charge a large capacitor to the peak of the converted wave. See **Figure 22**.

Shock Absorber
Type 38-3AF circuit breakers are equipped with a sealed, oil-filled, viscous damper, or shock absorber (61.8) **Figure 15**. The purpose of this shock absorber is to limit overtravel and rebound of the vacuum interrupters movable contacts during the conclusion of an opening operation. The shock absorber action affects only the end of an opening operation.

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 top of the circuit breaker. These fingers are shown in **Figure 23**.

When the circuit breaker is racked into the TEST or CONNECT positions in the metal-clad switchgear, these disconnect fingers engage a mating disconnect block on the inside of the switchgear shown in **Figure 24**. 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 the same disconnect block.

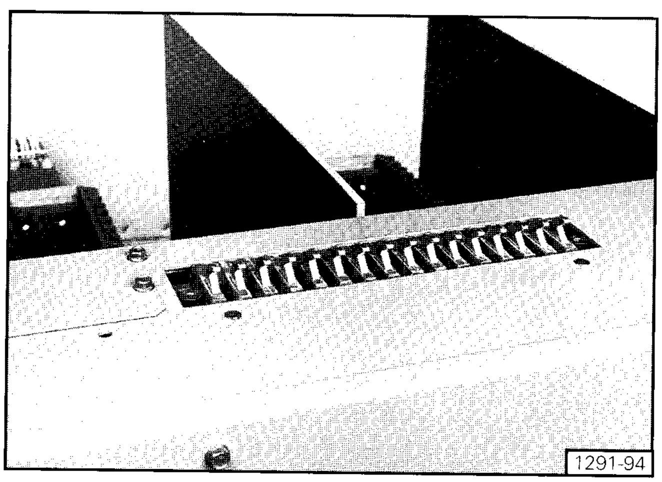


Figure 23. Secondary Disconnects on Circuit Breaker

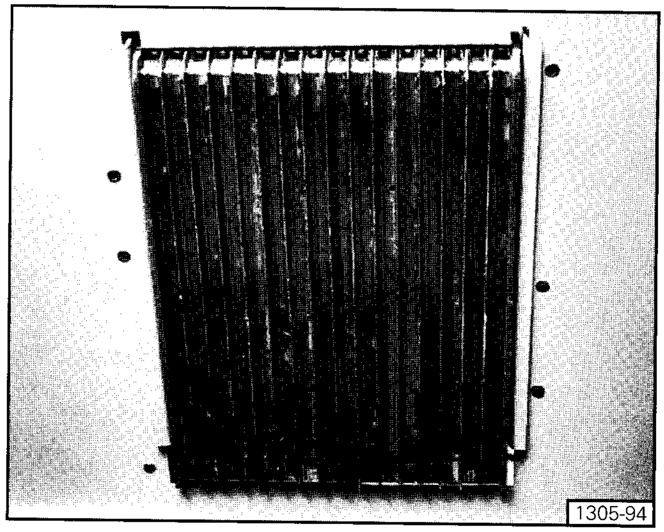


Figure 24. Secondary Disconnect Inside Switchgear

Auxiliary Switch
Figure 25 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 26 and **27** show the principal components that provide optional control flexibility when operating the circuit breaker in the TEST and CONNECT positions.

Figure 26 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.

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 27**. 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 CONNECT (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. Up to 24 stages may be provided.

TOC (Truck Operated Cell) Switch
Figure 27 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.

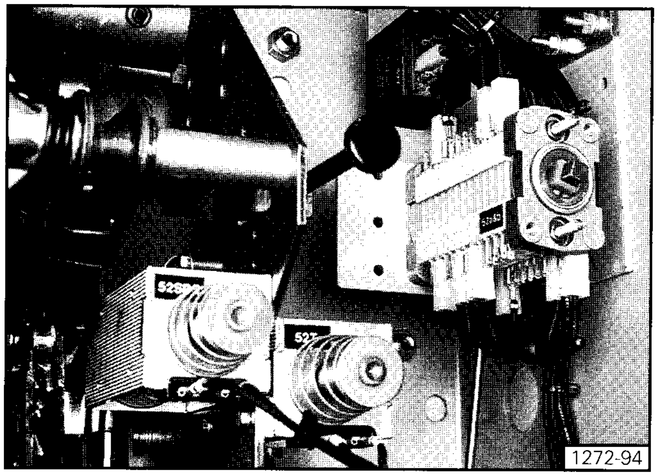


Figure 25. Auxiliary Switch

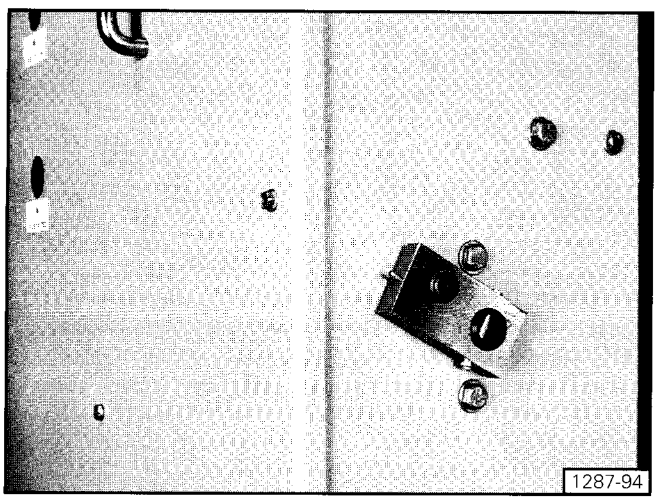


Figure 26. MOC Switch Operating Arm on Circuit Breaker

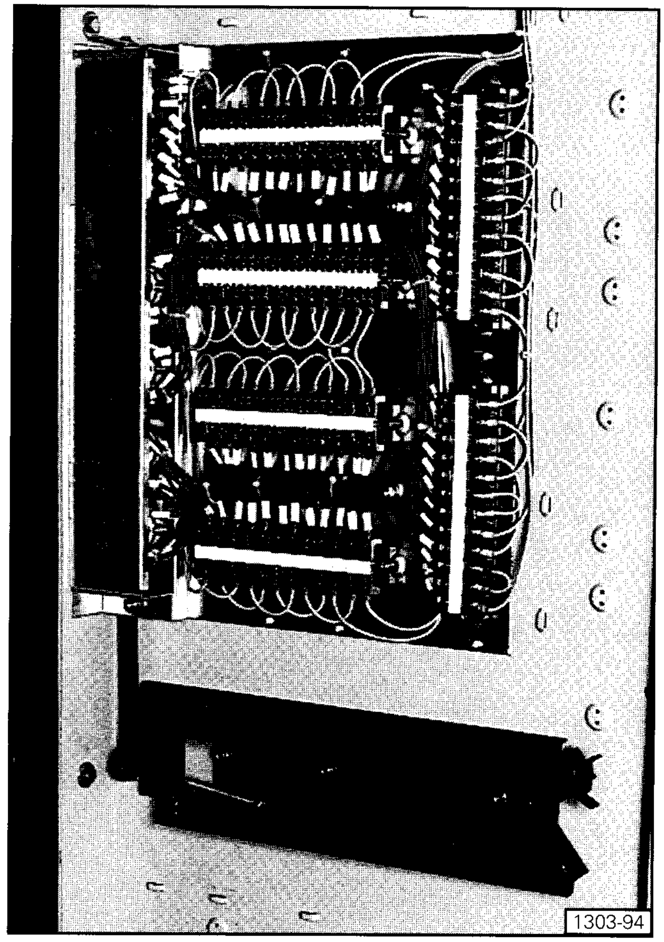


Figure 27. MOC and TOC Switches Inside Switchgear

Trip Free Interlock
Figure 28 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. The breaker is held trip free during racking and whenever the breaker is between the TEST and CONNECT 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 28 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 type 38-3AF 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 28 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 29)** 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 type 38-3AF 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 at floor level. 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.

When circuit breakers are located above floor level, handling of the circuit breakers requires the use of a hoist or crane.

Racking Mechanism
Figure 29 shows the racking mechanism in the switchgear used to move the circuit breaker between the DISCONNECT, TEST and CONNECT 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.

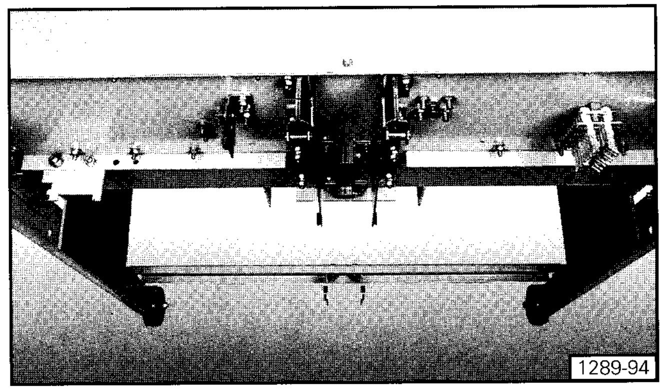


Figure 28. Breaker Interlocks and Ground Disconnect

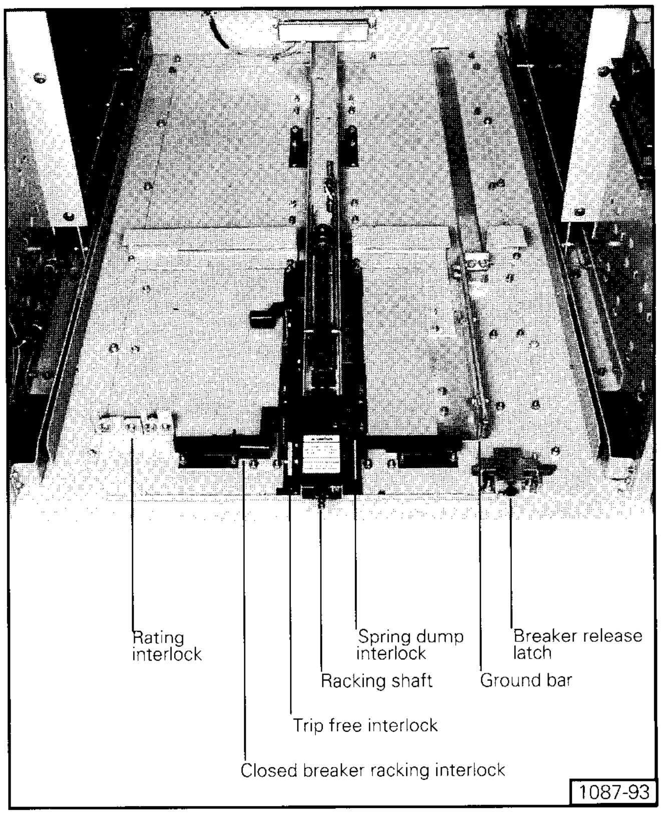


Figure 29. Racking Mechanism and Floor Interlocks

Vehicle Function and Operational Interlocks

Type 38-3AF vacuum circuit breakers are comprised mainly of the interrupter/operator module fitted to a vehicle. This interrupter/operator module is an integral arrangement of operating mechanism, dielectric system, vacuum interrupters, and means of connecting the primary circuit. The vehicle supports the interrupter/operator module, providing mobility and fully coordinated application in Siemens type GM38 switchgear.

Successful coordinated application of the fully assembled type 38-3AF vacuum breaker is achieved thru precise alignment in fixtures during manufacture, and important functional interlocking.

Alignment

All aspects of the circuit breaker structure which impact alignment and interchangeability are checked using master fixtures at the factory. Field adjustment will not normally be required.

Interlocks

⚠DANGER

Hazardous voltages and high-speed moving parts.

Will cause death, personal injury, and property damage.

Do not by-pass interlocks or otherwise make interlocks inoperative. Interlocks must be in operation at all times.

Read this instruction manual. Know and understand correct interlock function. Check interlock function prior to inserting breaker into switchgear cubicle.

Breaker Racking Interlocks

The interrupter/operator module and the vehicle portions of the circuit breaker, and the racking mechanism in the switchgear all cooperate to provide important operational interlocking functions.

1. **Rating Interlock**
   The rating interlock consisting of a coded interference plate is mounted on the vehicle as shown in **Figure 28**. A mating interference blocking plate is mounted in the drawout compartment as seen in **Figure 29**. The two plates are mounted in alignment and must pass through each other in order for the breaker vehicle to enter the drawout compartment. The interlock is coded to test rated voltage, as well as interrupting, close & latch, and continuous current ratings. The circuit breaker must equal or exceed all of the cubicle ratings in order to enter the compartment.

2. **Racking Interlocks**
   a. **Closed Breaker Interlock - Figure 28** shows the location of the closed breaker interlock plunger on the circuit breaker frame. The purpose of this interlock is to positively block breaker racking operations whenever the breaker is closed. The plunger is coupled to the jack shaft (**Figure 15,** 63). When the jack shaft rotates 60 degrees to close, the interlock plunger is driven straight downward beneath the frame of the breaker.

   The downward projecting plunger blocks racking operation when the breaker is closed. **Figure 29** shows the racking mechanism located on the floor in the center of the breaker compartment. On the left side of the racking mechanism, two "wing-like" elements project. The closed breaker interlock plunger, when down (breaker closed), falls behind the front wing in the TEST position and behind the rear wing in the CONNECT position.

   The wings are coupled to the element of the racking mechanism which shrouds the racking screw. This shroud must be moved rearward to insert the racking crank socket in order to engage the racking shaft. With the plunger down (breaker closed), the wings and shroud cannot be moved and thus racking is blocked.

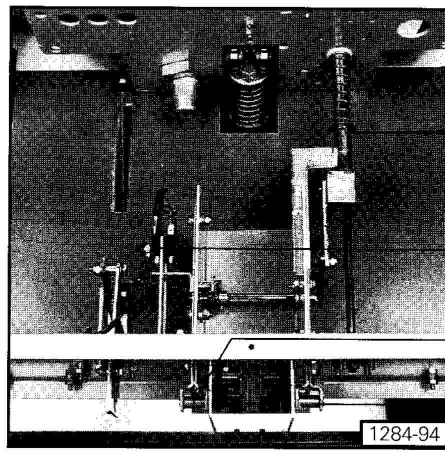


Figure 30. Interlock Mechanisms on 38-3AF Circuit Breaker

   b. **Trip Free Interlock - Figure 28** shows the trip free racking interlock, a plunger with a roller on the lower end. It has spring return to the reset or lowest position. The plunger roller tracks the shape of the racking cam on the racking mechanism in the switchgear.

   The racking cam allows the trip free racking interlock to be in the lowest position (reset) only when the circuit breaker is in the TEST or the CONNECT position. Thus, during racking, the trip free interlock is held in an elevated condition except when the breaker reaches the TEST or the CONNECT position. The circuit breaker can be closed only when the interlock plunger is down, and will trip if the plunger is moved up.

   The operation of the trip free racking interlock may be seen in **Figure 30.** As the interlock (6) rises, it moves a series of linkages, which cause a guided tube (4) to rise, and enter the operating mechanism enclosure.

Figure 31 shows the operating mechanism detail components which establish a trip free condition as the tube (4) rises. The rising tube raises a lever attached to the base of the operating mechanism enclosure. This lever raises the trip free pushrod. The rising trip free pushrod elevates the trip free pushrod cam, which pushes the trip free coupling lever (62.8.3) (**Figure 15**) toward the rear of the enclosure.

The movement of the trip free coupling lever toward the rear of the enclosure is transmitted through the trip free coupling link (62.8.2) to the spring return latch (62.8.1). With the latch displaced from a normal reset position, the trip free coupling rod (62.8) is incapable of applying closing effort to the jack shaft (63). Thus, upon release, the closing spring energy will not be transmitted to the jack shaft.

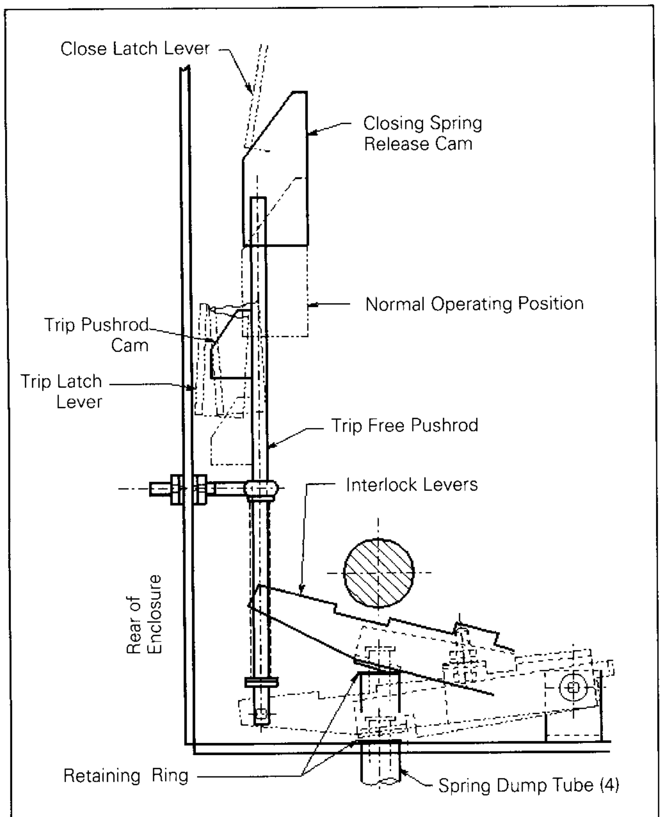


Figure 31. Closed Breaker Interlock Mechanisms in Stored Energy Mechanism

3. **Automatic Closing Spring Energy Release**
The automatic closing spring energy release (spring dump) (**Figure 28**) is a plunger with a roller on the lower end. The spring dump has a return spring which returns the spring dump to the reset or lowered position. The plunger roller tracks the shape of the spring discharge cam on the racking mechanism in the switchgear (**Figure 29**).

The spring dump cam raises the spring dump interlock upon insertion of the breaker into the compartment, or upon withdrawal from the compartment. The interlock is raised at about the time the front wheels pass over the cubicle sill. It allows the spring dump interlock to be in the reset (lowest) position at all other times.

The operation of the spring dump interlock may be seen in **Figure 30**. As the interlock rises (5), it causes the guided tube (4) to rise and enter the operating mechanism enclosure.

Figure 31 shows the operating mechanism detail components which establish a spring dump condition as the tube rises. The rising tube raises a lever attached to the base of the operating mechanism enclosure. This lever raises the trip free pushrod, which elevates the closing spring release cam. The closing spring release cam moves the closing spring latch, which causes the closing springs to discharge. However, the trip free interlock is raised, so that the operating mechanism is held trip free (see trip free interlock discussion). Thus, the energy in the closing springs is released (spring dump), without movement of the jackshaft or the vacuum interrupter contacts.

4. **Trip Free Interlock Position Mechanical Interlock**
In order to prevent the motor charging circuit from "making and breaking" as the breaker and cubicle secondaries make or break physical contact, an electrical switch is provided. This switch is mounted as shown in **Figure 30**. This switch is mounted in the line of action taken by the trip free interlock plunger, which follows the racking mechanism cam, and is elevated at all times while the breaker is in the drawout compartment, except when in the TEST or CONNECT positions. A striker plate, integral with the trip free interlock plunger, engages and operates (opens) the switch when the plunger is in an elevated position blocking spring charging motor operation. The switch is closed when the breaker occupies the TEST or CONNECT position, allowing the charging motor to operate automatically.

Maintenance

Introduction and Maintenance Intervals

Periodic inspections and maintenance are essential to obtain safe and reliable operation of the type 38-3AF circuit breaker.

When type 38-3AF circuit breakers are operated under "Usual Service Conditions", maintenance and lubrication is recommended at five year 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 moving parts.

Will cause death, personal injury, and 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 38-3AF breakers use both standard American and metric fasteners. Metric fasteners are used for the vacuum interrupters and in the interrupter/operator module. American fasteners are used in most other locations. This list of hand tools describes those normally used in disassembly and re-assembly procedures.

Metric

- Sockets and open end wrenches: 7, 8, 10, 13, 16, 18, 19, and 24mm
- Hex keys: 2, 5, 6, 8 and 10mm
- Deep Sockets: 19 and 24mm
- Torque Wrench: 0-150 Nm (0-100 ft-lbs.)

American

- Socket and Open-End Wrenches: 5/16, 3/8, 7/16, 1/2, 9/16, 11/16, 3/4, and 7/8 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
- Flashlight
- Drift Pins: 1/8, 3/16, and 1/4 in.
- Retaining Ring Plier (external type, tip diameter 0.040 in.)

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 will 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.

- Checks of the primary power path
  - Cleanliness check
  - Inspection of primary disconnects
- Checks of the stored energy operator mechanism
  - Maintenance and lubrication
  - Fastener check
  - Manual spring charging check
  - Contact erosion check
- Electrical control checks
  - Wiring and terminals check
  - Secondary disconnect check
  - Automatic spring charging check
  - Electrical close and trip check
- Vacuum integrity check
- High potential test
- Insulation test
- Contact resistance test
- Inspection and cleaning of breaker insulation
- Functional tests

Table 1: Maintenance Tasks

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 will 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.

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.

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 back Close pushbutton. Third, depress the red Trip pushbutton again, and observe the spring condition indicator. It should read Discharge. **Figure 32** shows the breaker spring condition indicator in the Discharged position.

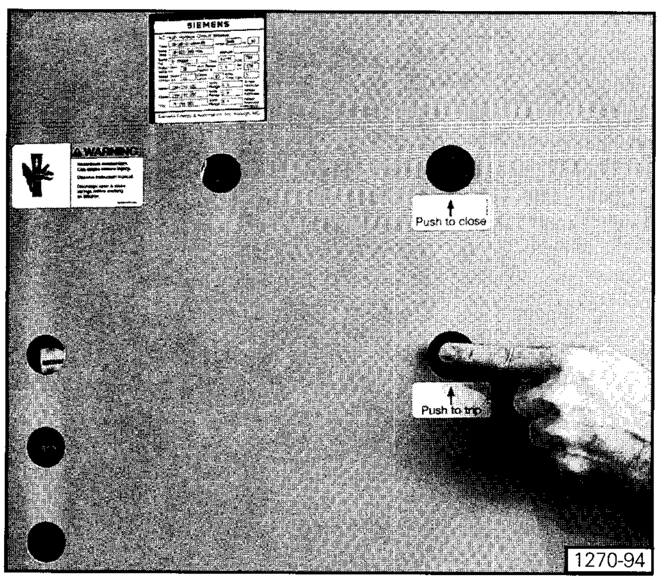


Figure 32. Manual Tripping of Circuit Breaker

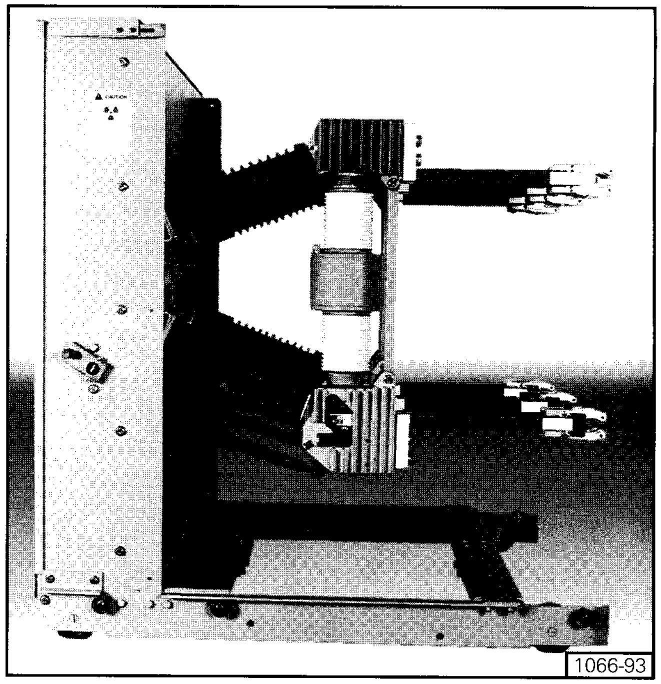


Figure 33. 38-3AF Breaker Showing Vacuum Interrupters and Primary Disconnects (Barriers removed)

5. Remove the breaker from the switchgear. Refer to the preceding installation section of this manual for special instructions and precautions regarding removal of a breaker which is not at floor level.

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 38-3AF circuit breaker with the 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 a very thin layer of Siemens contact lubricant (reference 15-171-370-002).

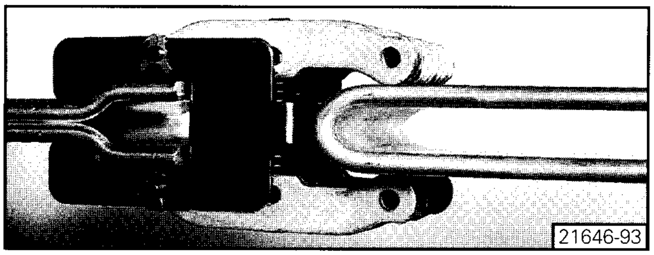


Figure 34. Primary Disconnect in Mated Position

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

Breaker Type	Number of
38-3AF	Years/Closing Operations 5 years/1000 operations

Table 2: Maintenance and Lubrication Intervals (ANSI C37.06 Table 8 - Usual Service Conditions) Maintenance Based Upon Number of Breaker Closing Operations

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 closing spring are shown. The movable end of the 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.

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 crank and the various pushrods and linkages.

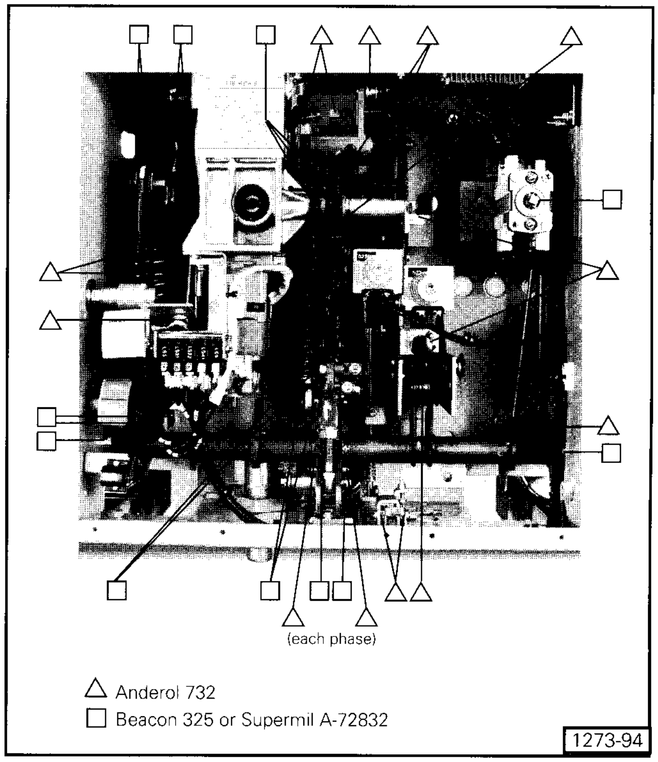


Figure 35. Front View of Operator Mechanism

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).

Primary disconnect contacts (multi-fingered clusters) and secondary disconnect contacts (strips and fingers) are to be wiped clean, and a film of Siemens contact lubricant (15-171-370-002) applied. Avoid getting contact lubricant on any insulating materials.

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 crank into the manual charge socket at the front of the operator control panel. Turn the crank clockwise (about 45 revolutions) to charge 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.

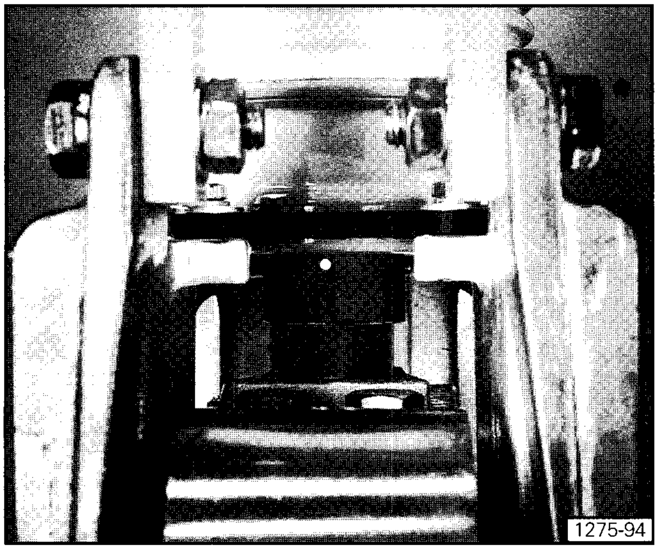


Figure 36. Contact Erosion Check Mark

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 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:
   a. Be sure the breaker primary contacts are Closed.
   b. Observe the white erosion mark (**Figure 36**) of each pole. When this mark is visible, contact wear is within acceptable limits.

⚠WARNING

High Speed Moving Parts.

Can cause serious injury.

Tripping spring is charged. If trip latch is moved, the stored energy springs will discharge rapidly.

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.

Electrical Control Checks
The electrical controls of the type 38-3AF circuit breaker should be checked during inspections to verify absence of any mechanical damage, and proper operation of the automatic spring charging, 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, and 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.

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 5**).

4. Install the switchgear end of the plug jumper over the secondary disconnect block inside the switchgear (**Figure 6**).

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 type 38-3AF 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.

Vacuum Interrupters
The life expectancy of vacuum interrupters is a function of the number of interruptions and magnitude of current interrupted.

They must also be replaced before 30,000 mechanical operations or when the contacts have been eroded beyond allowed limits. Vacuum tube replacement procedures are detailed in the following maintenance instructions.

The curve is **Figure 37** is offered as a guide to life expectancy.

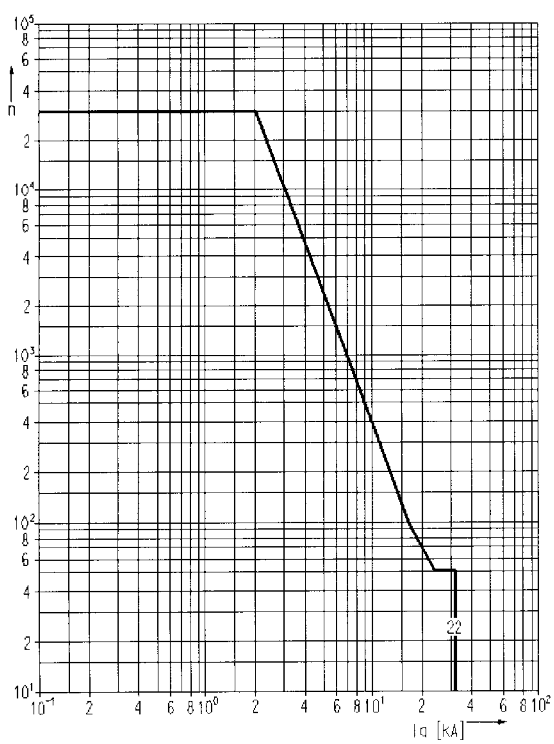


Figure 37. Typical Vacuum Interrupter Contact Life Curve

Interrupter Vacuum Check Mechanical (Figures 38-40)
Before putting the breaker into service, or if an interrupter is suspected of leaking as a result of mechanical damage, check the vacuum either mechanically as described in this section, or alternatively, electrically using a high potential test set as described in the next section.

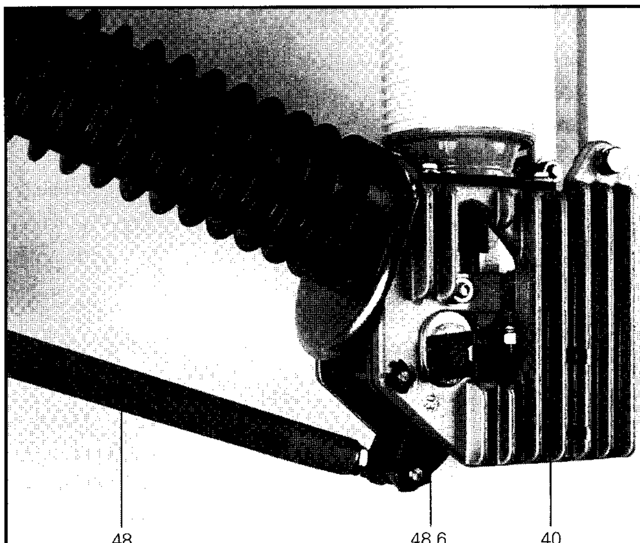
Open and isolate the breaker and detach the insulated coupler (48) from lever (48.6) (**Figure 38**).

The atmospheric pressure will force the moving contact of a hermetically sealed interrupter into the "Closed" position, causing lever (48.6) to move into the position shown in **Figure 39**.

A vacuum interrupter may be assumed to be intact if it shows the following characteristics:

An appreciable closing force has to be overcome when lever (48.6) is moved to the "Open" position by hand **Figure 40**. When the lever is released, it must automatically return to the "Closed" position with an audible sound as the contacts touch.

After checking the vacuum, reconnect the lever (48.6) to the insulated coupler (48).



48 Insulated coupler
48.6 Lever
40 Lower pole support

1279-94

Figure 38. Lower Pole Support with Insulated Coupler

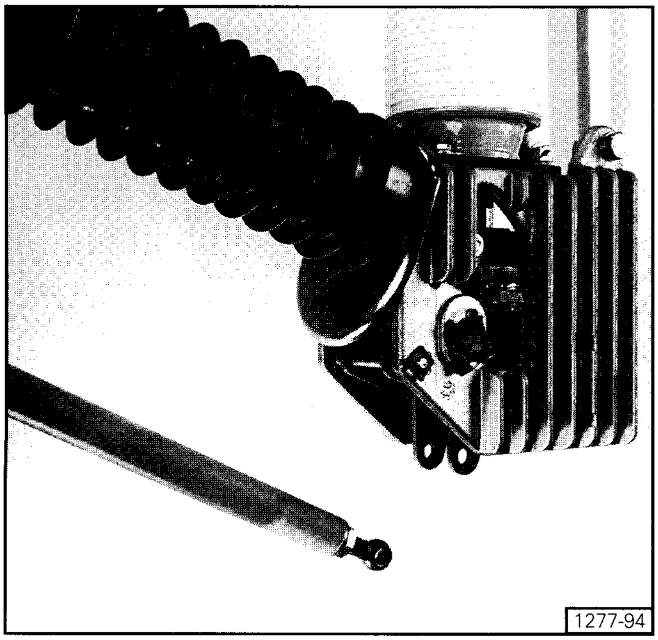


Figure 39. Primary Contact Closed - Insulated Coupler Disconnected

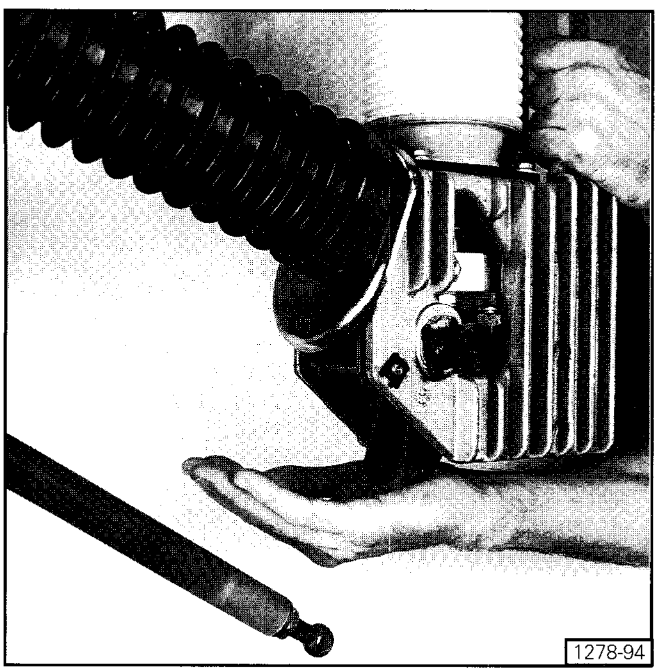


Figure 40. Primary Contact Forced Open by Manual Pressure

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 (using Dielectric Test)

A high potential test is used to verify the vacuum integrity of the circuit breaker. The 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.

⚠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**.

Equipment kV Rating	Max AC rms	Max DC Avg
38kV	60kV	85kV

Table 3. High Potential Test Voltages

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 warning 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. (Breaker open).
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
- Test equipment 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.
3. Apply the proper AC (60kV) or DC (85kV) 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. Contact resistance should not exceed the values listed in **Table 4**.

Current Rating (Amps)	Contact Resistance (Micro-Ohms)
1200	40
2000	35
3000	35

Table 4. Maximum Contact Resistance

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 outerphase barriers as shown in **Figure 7**.
3. Clean barriers and post insulators using clean cloth and one of the following 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
The 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 type 38-3AF vacuum circuit breaker.

> **⚠WARNING**
>
> **Hazardous voltages and high speed moving parts.**
>
> **Can cause death, severe personal injury, or property damage.**
>
> Read instruction manual. All work must be performed with the breaker completely de-energized and the springs discharged. Limit work to qualified personnel.

Circuit Breaker Overhaul
Table 5 lists the recommended overhaul schedule for type 38-3AF 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.

Breaker Type	Number of Closing Operations
38-3AF	30,000

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

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 Release Coil, 52SRC
- Shunt Trip Coil, 52T
- Trip Free Drive Bar Mechanism

When these parts are changed, locking devices must also be removed and replaced. These include lock washers, retaining rings, retaining clips, spring pins, cotter pins, etc.

1. Replace Vacuum Interrupter, instructions follow.

2. Spring Release Coil (52SRC) and Shunt Trip Coil (52T).
   a. Remove two "push on" terminal connections
   b. Remove two M4 hex head screws and dismount solenoid drawing it towards you.
   c. Install replacement solenoids with two M4 hex head screws and replace "push on" terminals.
   d. Solenoid mounting screws must be installed using thread locking adhesive (Loctite #222, Siemens part 15-133-281-007) and primer (Loctite primer T, Siemens part 15-133-281-005).

3. Lubricate operating mechanism in accordance with instructions which follow.

4. When work is finished operate circuit breaker (close/open) several times, and check that all screw connections are tight.

Replacement of Vacuum Interrupters
Replacement interrupters are furnished as a complete assembly. They have been completely tested and are dielectrically and mechanically conditioned.

It is recommended that one interrupter be removed and replaced completely rather than removing two or more interrupters at a time. The following procedure in check list format describes the procedure for removing and replacing a vacuum interrupter. Components may be identified by reference to **Figures 41** and **42**.

1. Removing the Interrupter

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

1.1 Before starting work, the circuit breaker should be isolated from all primary and control power sources and all stored energy discharged by tripping, closing, and tripping the breaker by hand. Discharge any static charge by grounding all end and center metal sections of the vacuum interrupter. Carefully remove exterior and interphase barriers.

1.2 Loosen the lateral bolt(s) on terminal clamp (29.2). Refer to **Figure 42** and employ the illustrated procedure to loosen clamp hardware. (6 or 8mm hex key and 13 or 16mm socket).

1.3 Withdraw pin (48.5) from insulating coupler (48) and levers (48.6).

1.4 Remove coupling pin from the eye bolt (36.3)

1.5 Free struts (28) from the upper pole support (20). Loosen the strut hardware on the lower support (40) and swing the struts forward and downward (16mm open end wrench and 16mm socket).

1.6 Loosen screws which secure the centering ring (28.1) (10mm open end).

1.7 Remove bolt (31.2), lockwasher and large washer at stationary contact of the vacuum interrupter (24mm socket). Carefully note location of the conductive spacer between interrupter and pole support. This spacer has a concave surface which must be handled with care to avoid damage.

1.8 Using a deep 24mm socket, loosen and remove hex capscrew fastening the upper pole support to the post insulator. Completely remove the upper pole support and set aside.

1.9 Grasp the vacuum interrupter (30) and withdraw vertically. Assistance may be required to work the terminal clamp off the movable stem of the tube. **FORCIBLE TWISTING EFFORT IS NOT ALLOWED**. If the terminal clamp cannot be easily removed, **STOP!**, check to be certain hardware is loose, and the clamp is not binding.

2. Installing an Interrupter

NOTE: Replacement interrupter (30) will be received from the factory with an eyebolt (36.3) in place, adjusted and torqued to specific requirements. DO NOT ALTER THE ADAPTER SETTING.

2.1 Inspect all silver plated connection surfaces for cleanliness. Clean only with a cloth and solvent. Do not abraid.

2.2 Insert interrupter (30) in the lower pole support (40) with the evacuation nipple (P) facing the mechanism housing. Slip terminal clamp (29.2) into position on the movable stem.

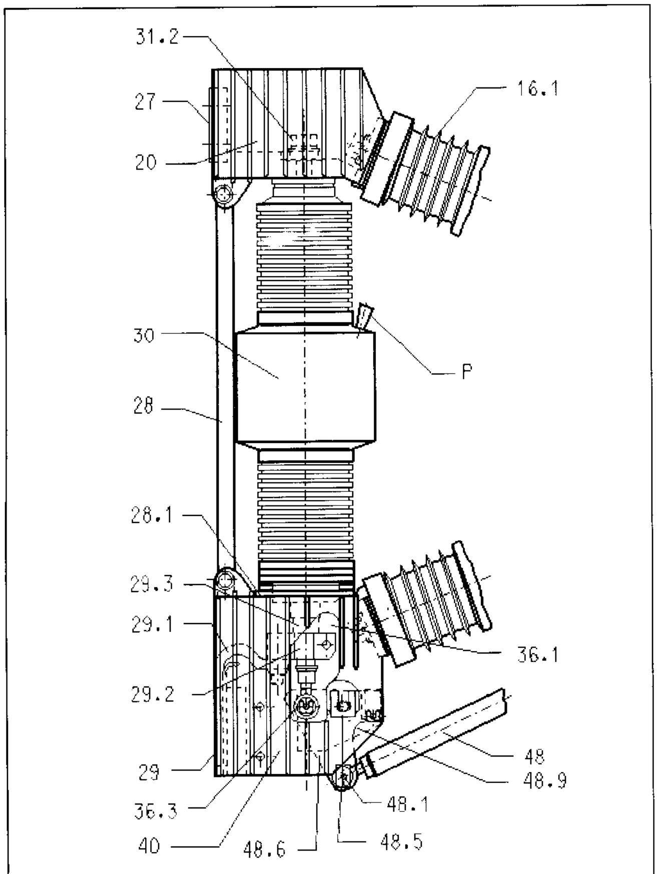


Figure 41. Vacuum Tube Replacement Illustration

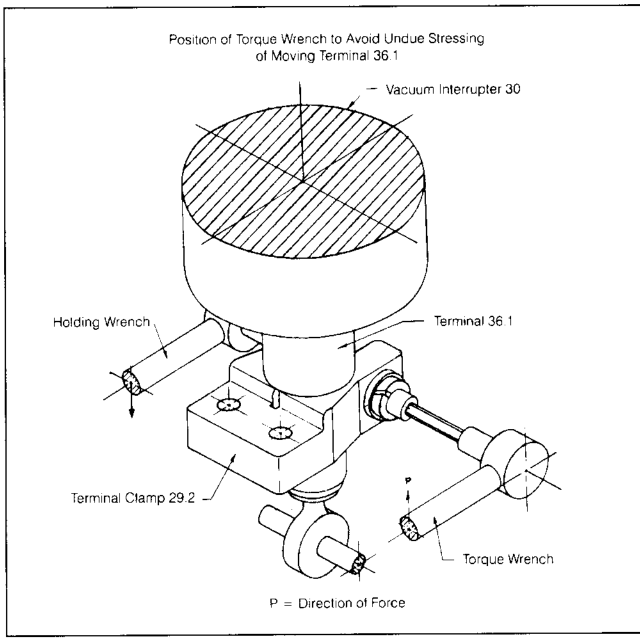


Figure 42. Illustration Showing Required Technique for Fastening Terminal Clamp Hardware

2.3 Install the conductive spacer between the fixed (upper) terminal of the vacuum interrupter (30) and the upper pole support (20), with the concave side of the spacer facing the vacuum interrupter. Align and fasten "finger tight" using heavy flat washer, lock washer and nut, (31.2).

2.4 Fasten the upper pole support to the post insulator using finger pressure only using a hex head (M16) bolt, lock washer and flat washer.

2.5 Attach struts (28) to the upper pole support (20) replace hardware (M10), but do not tighten at this time.

2.6 Couple levers (48.6) to the eyebolt (36.3), using the pin supplied. Apply retention clips. Appropriate pin is modestly chamfered, not to be confused with pin for the insulated coupler.

2.7 Raise terminal clamp (29.2) against the spacer (29.3) on the movable terminal of the vacuum tube (36.1) and position the interrupter (30) so that its groove faces the connecting surface of flexible strap (29.1). Refer to **Figure 42** and employ the technique illustrated to fasten the terminal clamp. Note opposing wrenches. Tighten the bolt(s) of the terminal clamp to a torque of 40 Nm (30 ft. lbs.), taking care to see that the terminal of the interrupter is not subjected to excessive bending movement.

NOTE: Excessive bending movement exerted while fastening the terminal clamp will damage the vacuum interrupter.

2.8 Align pole support (20) correctly and tighten bolt fastening it to the post insulator. Fasten securely all bolts associated with struts (28).

2.9 Tighten interrupter fastening bolt (31.2) on the upper pole support (20) holding the interrupter firmly by its upper insulator and operate levers (48.6), by hand, to see whether the movable contact moves freely. If any binding or lack of freedom is noted, loosen bolt (31.2) and adjust the interrupter in pole support by turning the interrupter and moving it slightly.

2.10 The centering ring (28.1) has been loose and "floating"during installation of the vacuum interrupter. Check that the movable contact is free to move vertically without binding, and then tighten the hardware which secures the centering ring. Recheck that the movable contact is free to move vertically without binding.

2.11 Attach insulating coupler (48) and lever (48.6) together, using pin (48.5). Apply retaining clips. Correct pin has ends which have been generously chamfered.

2.12 Open and close breaker several times and then check to see that all bolted joints and devices are tight.

3. Checking the Contact Stroke

3.1 Open the circuit breaker.

3.2 Free insulating coupler (48) by removing pin (48.5). The interrupter contacts must now close automatically as a consequence of atmospheric pressure.

3.3 Observe the terminal clamp (29.2) through the openings on each side of the lower pole support (40). Using vernier calipers measure the distance from the bottom surface of the terminal clamp to the bottom edge of the cutout opening. Measure carefully and record your result.

3.4 Connect the insulating coupler (48) using pin (48.5) and the retaining clips provided.

3.5 Repeat the measurement described in step 3.3 again with care to maximize accuracy. Record your result.

3.6 Determine difference between the measurements made under steps 3.3 and 3.5. Your result should be 19-20mm (0.748-0.787 in.)

3.7 If you fail to achieve the listed results, carefully repeat the entire procedure making certain of your measurements.

3.8 Loosen locking nut on eyebolt on insulated coupler (48), and retain position of the eye. Make adjustments in one-half turn increments. After adjustment is completed, tighten eyebolt locking nut to 26-34 ft-lb. (35-45 Nm).

4. After eyebolt is tightened to proper torque, repeat all measurement procedures, making certain they are in agreement with values indicated in 3.6.

5. Complete all other maintenance procedures. Completely reassembled breaker should pass high potential test before it is ready for service.

Hydraulic Shock Absorber
The type 38-3AF mechanism is equipped with hydraulic shock absorber and a stop bar that functions when the breaker opens. See **Figure 15**. The shock absorber (61.8) should require no adjustment. However, at maintenance checks, the shock absorber should be examined for evidence of leaking. If evidence of fluid leakage is found, the shock absorber must be replaced to prevent damage to the vacuum interrupter bellows.

Sub-Assembly	Item	Inspect For
Primary Power Path	Vacuum Interrupter	1. Cleanliness 2. Contact erosion. Note: Perform with Manual Spring Checks 3. Vacuum integrity. Note: Perform with High Potential Tests
	Primary Disconnects	1. Burnt or damaged fingers 2. Lubrication of contact surfaces.
	Vacuum Interrupter Contact Resistance	1. Record contact resistance with contacts closed, and re-check each year to monitor condition.
Interrupter Operator Mechanism	Cleanliness	1. Dirt or foreign material
	Fasteners	1. Tightness of nuts and other locking devices.
	Manual Spring Check	1. Smooth operation of manual charging, and manual closing and tripping
	Lubrication	1. Evidence of excessive wear 2. Lubrication of wear points
Electrical Controls	Wiring	1. Mechanical damage or abrasion
	Terminals and Connectors	1. Tightness and absence of mechanical damage
	Close and Trip Solenoids, Anti-Pump Relay, Auxiliary Switches, Secondary Disconnect	1. Automatic charging 2. Close and trip with control power
High Potential Test	Primary Circuit to Ground and between Primary Disconnects	1. 60 second withstand, 60kV, 60 Hz (85kV DC)
	Control Circuit to Ground	1. 60 second withstand, 1500V, 60 Hz
Insulation	Barriers and all Insulating Components	1. Cleanliness 2. Cracking, crazing, tracking, or other sign of deterioration

Table 6. Periodic Maintenance and Lubrication Tasks

Problem	Symptoms	Possible Causes and Remedies
Breaker fails to close	Closing springs will not automatically charge	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) Replace if required. 5. Motor cut-off switch LS21 or LS22 fails to operate. Replace if necessary. 6. Mechanical failure of operating mechanism. Refer to factory or authorized service shop.
	Closing springs charge, but breaker does not close • Closing coil, or solenoid (52SRC) fails to energize. No sound of breaker closing.	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 41-42 are open when breaker contacts are open. Check linkage and switch. Replace or adjust as necessary. 7. Spring charged switch LS9 NO contacts remains open after springs are charged. Check and replace as required.
	• Closing coil energizes. Sound of breaker closing is heard, but breaker contacts do not close.	1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.

Table 7. Troubleshooting

Problem	Symptoms	Possible Causes and Remedies
Nuisance or false close	Electrical problem	1. Nuisance or false closing signal to secondary disconnect contact 13. Check relay logic. Correct as required. 2. Closing coil (52SRC) terminal A2 is shorted to ground. Check to determine if problems in wiring or coil. Correct as required.
	Mechanical Problem	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.	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 23-24 or 33-34 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 (ie., they remain closed).	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.	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	1. Tripping signal remains energized on secondary disconnect contact 1. Check for improper relay logic.
	Mechanical problem	1. Mechanical failure of operating mechanism. Check and contact factory or authorized service shop.

Table 7. Troubleshooting

Appendix

Table A-1
Type 38-3AF Circuit Breaker Ratings

Identification			Rated Values									Rated Required Capabilities			
	Nominal Voltage Class	Nominal 3-Phase MVA Class ①	Voltage		Insulation Level		Current				Rated Max. Voltage Divided by K	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		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 ①	2.7 K Times Rated Short Circuit Current
Circuit Breaker Type	kV Class	MVA Class	E kV rms	K	kV rms	kV Crest	Amps	I kA rms	Cycles	Sec.	E/K kV rms	kA rms	kA rms	kA rms	kA Crest
38-3AF-31 ⑩	38	—	38	1.0	80	150	1200 2000 3000 ④	31.5	5	2	38	31.5	31.5	50	85
38-3AF-1500 ⑨	38	1500	38	1.65	80	150	1200 2000 3000 ④	21	5	2	23	35	35	56	95

1. Included for reference only (no longer shown in ANSI C37.06)
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. 2000 ampere units available with increased fan-cooled rating of 3000 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 limitation 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 and including rated maximum voltage.
9. Ratings in accordance with ANSI C37.06-1987.
10. Ratings in accordance with propsed ANSI C37.06-199x. (proposed)

Table A-2
Type 38-3AF Circuit Breaker Control Data

Control Voltages, ANSI C37.06 Table 10			**Close Coil**	**Trip Coil**	**Spring Charging Motor**	
Nominal	**Range**				**Amperes**	**Charging**
	Close	**Trip**	**Amperes ①**	**Amperes ①**	**Run (avg.) ①**	**Seconds**
48 VDC	38-56	28-56	2.1	20	8	10
125 VDC	100-140	70-140	1.0	5.4	4	10
250 VDC	200-280	140-280	0.5	2.1	2	10
120 VAC	104-127	104-127	0.9	— ②	6	10
240 VAC	208-254	208-254	0.4	— ②	3	10

1. Current at nominal voltage. 2. Capacitor trip

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	20	10	5	20 ①	5	3
TOC Auxiliary Switch	15	15	10	0.5	0.5	0.2
MOC Auxiliary	20	15	10	10	10	5
		Inductive Circuit Interrupting Capacity in Amperes				
Breaker Auxiliary Switch	20	10	5	20 ①	5	3
TOC Auxiliary Switch	15	15	10	0.5	0.5	0.2
MOC Auxiliary	20	15	10	10	10	5

1. 2 Contacts in series

Table A-4
Circuit Breaker Weights

Breaker Type	Weights, Lbs. (kg) ①		
	Continuous Current, Amperes		
	1200A	2000A	3000A
38-3AF	780 (355)	880 (400)	880 (400)

1. For shipping, add 100 lbs (45kg).

Table A-5
Selected Spare Parts Listing
Type 38-3AF Vacuum Circuit Breakers

Description		Part No.	Quantity per Breaker
Close Coil	48 VDC	18-741-745-506	1
	125 VDC/120 VAC	18-741-745-507	1
	250 VDC/240 VAC	18-741-745-508	1
Trip Coil	48 VDC	18-809-123-501	1
	125 VDC/120 VAC	18-741-745-503	1
	250 VDC/240 VAC	18-741-745-504	1
Anti-Pump Relay	48 VDC	15-172-275-002	1
	125 VDC	15-172-275-003	1
	250 VDC	15-172-275-004	1
	120 VAC	15-172-275-005	1
	240 VAC	15-172-275-006	1
Spring Charging Motor	48 VDC	18-480-848-001	1
	125 VDC/120 VAC	18-480-848-002	1
	250 VDC/240 VAC	18-480-848-003	1
Limit Switches	LS41 (Spring charged)	18-809-506-501	1
	LS21 or LS22 (Motor circuit)	18-809-506-502	2
	LS3 or LS9 (Anti-Pump circuit)	18-809-506-503	2
Auxiliary switch		33-101-600-022	1
Vacuum Interrupter Assembly (VS30030)		18-737-104-511	3
Breaker secondary disconnect assembly		18-814-029-501	1
Primary disconnect finger assembly	1200A	18-816-350-503	6
	2000A	18-816-350-502	6

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