GE

DEH-50010 User Manual

SecoVac* R Retrofill Vacuum Circuit Breaker

5-15kV 1200A & 2000A

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Hazard Classifications

The following important highlighted information appears throughout this document to warn of potential hazards or to call attention to information that clarifies a procedure. Carefully read all instructions and become familiar with the devices before trying to install, operate, service or maintain this equipment.

DANGER

Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

Failure to comply with these instructions may result in product damage.

NOTICE

Indicates important information that must be remembered and aids in job performance.

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SecoCube® SecoBloc®

SecoVac® VB2+ Multilin®

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Warranty

This document is based on information available at the time of its publication. While efforts have been made to ensure accuracy, the information contained herein does not cover all details or variations in hardware and software, nor does it provide for every possible contingency in connection with installation, operation, and maintenance. Features may be described herein that are not present in all hardware and software systems.

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No warranties of merchantability or fitness for purpose shall apply.

Contact your local sales office if further information is required concerning any aspect of SecoGear switchgear operation or maintenance.

1. Introduction

Summary

The GE SecoVac R Retrofill circuit breaker is designed and manufactured by GE Energy Management for application in AC power systems up to 15kV maximum rated voltage. SecoVac R conforms to the requirements of IEEE C37.59, C37.04, C37.06, C37.20.2 and C37.09. No such assurances are given with respect to local codes and ordinances, as they vary greatly. The SecoVac R circuit breaker has been designed as a direct replacement for use in existing legacy switchgear.

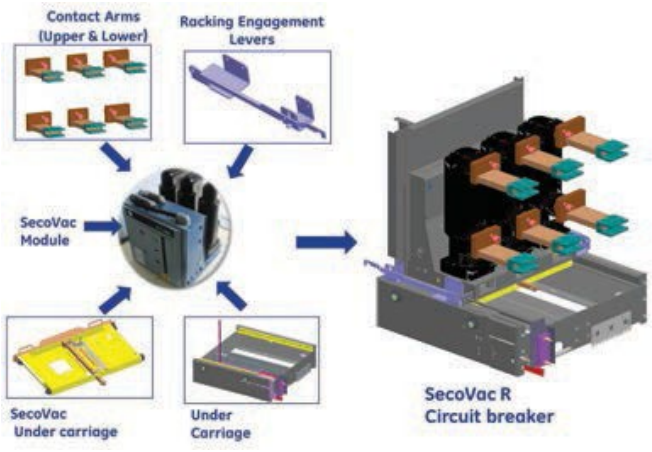


Figure 1: SecoVac R Circuit Breaker Main Components

Definitions

The definitions contained in this document are not intended to embrace all legitimate meanings of the terms, and they are applicable only to the subject treated in this document. Some of them are according to the IEEE Std. C37.59, if a specific term is not defined please refer to IEEE Std C37.100.

- **Racking:** The act of moving a removable element physically between the Connected position and the Disconnected/ Test position in its compartment.
- **Modular assembly:** A circuit breaker element including interrupters, operating mechanism, and connecting terminals.
- **Blocking/rejection interlock:** A mechanical device which prevents the insertion of removable elements into a compartment with incompatible ratings or MOC operating capabilities.
- **Retrofill:** A conversion process that includes replacement of the circuit breaker and circuit breaker compartment functional components of a qualified design within a vertical section or compartment of a vertical section with functional components of a different qualified design.
- **SecoVac Module:** Circuit breaker element including interrupters, operating mechanism and connecting terminals, see Figure 1.

2. Safety Instruction

Each user must maintain a safety program for the protection of personnel, as well as other equipment, from the potential hazards associated with electrical equipment.

The following requirements are intended to augment the user's safety program, but NOT supplant the user's responsibility for devising a complete safety program. The following basic industry practiced safety requirements are applicable to all major electrical equipment such as switchgear or switchboards. GE neither condones nor assumes any responsibility for practices which deviate from the following:

1. ALL ELECTRICAL PARTS MUST BE ASSUMED TO BE ENERGIZED UNLESS THEIR POTENTIAL HAS BEEN MEASURED AS GROUND POTENTIAL AND ADEQUATE CAPACITY GROUNDING ASSEMBLIES HAVE BEEN APPLIED. Accidents are caused by unplanned energization from non-recognized back feeds, equipment malfunctions, insulators can be deadly when the conductor is energized and from a wide variety of sources.
2. It is strongly recommended that all equipment be completely de-energized, verified to be "dead", and then grounded with adequate capacity grounding assemblies prior to any maintenance. The grounding cable assemblies must be able to withstand energizing fault levels so that protective equipment may clear the circuit safely. Additional discussion on this concept is covered in Chapter 20 of ANSI/NFPA 70B, Electrical Equipment Maintenance.
3. Although interlocks to reduce some of the risks are provided, the individual's actions while performing service or maintenance are essential to prevent accidents. Each person's knowledge, mental awareness, and planned and executed actions often determine if an accident will occur. The most important method of avoiding accidents is for all associated personnel to carefully apply a thorough understanding of the specific equipment from the viewpoints of its purpose, its construction, its operation and the situations which could be hazardous. All personnel servicing or operating electrical equipment must be trained on all safety requirements and rules applicable to the equipment.
4. The open gap of a vacuum interrupter should not be considered a safe means of isolating the circuit. Withdraw the circuit breaker from the connected position for proper lockout.
5. **Before starting maintenance, the secondary connectors and spring energy must be discharged and main contacts open. Failure to do so could result in physical injury.**
6. **Although the interrupting arc is quenched within a closed vacuum tube, it is recommended that flammable materials be stored away from the switchgear. Never extinguish an electrical fire.**

All personnel associated with installation, operation and maintenance of electrical equipment (such as power circuit breakers and other power handling equipment) must be thoroughly instructed, with periodic retraining, regarding power equipment in general as well as the particular model of equipment with which they are working.

Instruction books, actual devices and appropriate safety and maintenance practices such as IEEE application guides, OSHA publications, National Electric Safety Code (ANSI C2), National Electric Code, and National Fire Protection Association (NFPA) 70B Electrical Equipment Maintenance must be closely studied and followed. During actual work, supervision should audit practices to assure conformance.

3. Receiving

Every package leaving the factory is marked with the order number and customer's PO number. Contents of each shipping package are listed on the Packing List.

Note: To avoid loss of any parts when unpacking, the contents of each container should be carefully checked against the packing list before discarding the packing material.

Inspecting for Damage

All equipment leaving the factory is carefully inspected and packed by personnel experienced in the proper handling and packing of electrical equipment. Upon receipt of any equipment, immediately perform a visual inspection to ascertain if any damage has been sustained in shipping or if there are any loose parts.

Filing a Claim

If any damage is evident, or indication of rough handling is visible, file a claim for damage at once with the transportation company and notify the nearest GE Energy Management Sales Office immediately. Information on damaged parts, part number, case number, requisition number, etc., should accompany the claim.

Transport and Handling

Do not lift circuit breaker by inserting fork lift or trolley arms directly under it. Use a pallet or other support material between the circuit breaker and fork/trolley. Loading/unloading of the breaker should be carried out with a hoist if possible. To lift the breaker with a hoist, use two 1/2 inch diameter hooks rated at least 500 pounds each. Lifting locations are provided in the side frame members (Figure 2,1). Use a spreader wider than the breaker to prevent slings from contacting the interrupter poles. Do not let the lifting straps contact the epoxy pole unit during the lift.

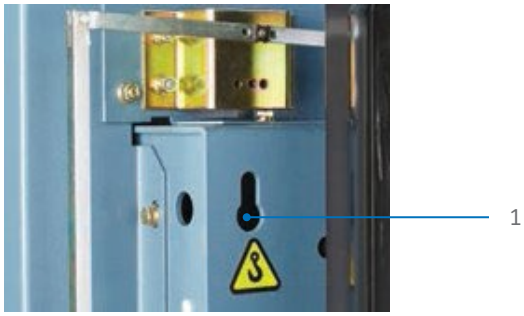


Figure 2: Lifting Hole Detail on Circuit Breaker Frame

When lifting the breaker, use of the specially designed lift truck is recommended. It is necessary to use the truck when placing a breaker into or removing it from the metalclad switchgear. Figure 3 and 4 show the recommended areas to handle the SecoVac R breaker

Figure 3: SecoVac R Handling Areas

Use this handle to maneuver the SecoVac breaker. CAUTION: Do not remove bolts and cover plate behind the handle (Figure 4 below).

Figure 4: SecoVac R Handling Areas

The locking bar handles can also be used to maneuver the SecoVac R breaker. See Section 8.0, (Figure 8,1) for function of the locking bar.

Figure 5: SecoVac R Additional Handling Areas

After the circuit breaker has been removed from its shipping pallet it may be rolled on its own wheels on a level and smooth floor. When rolling the circuit breaker, it should be pushed and steered by the steel frame (see Figure 3 for preferable areas).

CAUTION

Do not handle or transport the SecoVac R breaker by the primary disconnecting devices, as damage may result.

Storage

It is recommended that the breaker be immediately installed in the switchgear. If this is not possible, the following precautions must be taken to assure proper breaker storage.

1. The breaker should be protected against condensation, preferably by storing it in a dry room of moderate temperature (23° to 100°F/-5°C to 38°C) Short term covered storage and transportation is allowed at minimum -22°F (-30°C).
2. Circuit breakers for outdoor metalclad switchgear should be stored in the equipment only when power is available and the heaters are in operation to prevent condensation.
3. The breaker should be stored in a clean location, free from corrosive gases or fumes; particular care, for example, should be taken to protect the equipment from moisture and cement dust, as this combination is present at construction sites and has a very corrosive effect on many parts. Damage is possible if stored on side/back or top.
4. Rollers, latches, etc., of the operating mechanism should be coated with Mobilux EP Series Silicone 102 grease to prevent rusting.

If the breaker is stored for an extended period of time, it should be inspected periodically to see that corrosion has not started and to ensure good mechanical condition. If the breaker is stored under unfavorable atmospheric conditions – (See Section 4.1 for Normal Service Conditions), it should be cleaned and dried out before being placed in service.

4. Service Conditions

Normal Service Conditions

Unless otherwise specified, SecoVac R circuit breakers, including the operating devices and the auxiliary equipment which form an integral part of the breaker, are intended to be used in accordance with their rated operating parameters and normal service conditions, listed below.

- The ambient air temperature does not exceed 100°F (38°C). The minimum operating ambient air temperature is 5°F (-15°).
- The altitude does not exceed 3281 feet (1000m).
- The ambient air is not significantly polluted by dust, smoke, corrosive and/or flammable gases, vapors or salt.
- The conditions of humidity are as follows:
  - The average value of relative humidity, measured over a period of 24h, does not exceed 95%.
  - The average value of water vapor pressure, measured over a period of 24h, does not exceed 2.2kPa.
  - The average value of the relative humidity, measured over a period of one month, does not exceed 90%.
  - The average value of water vapor pressure, measured over a period of one month, does not exceed 1.8kPa.
  - For maintenance, high potential testing the humidity should not exceed 80% over a period of 24h prior to test as noted by IEEE.

Special Service Conditions

If the actual service conditions differ from the normal service conditions, the circuit breaker, associating devices and auxiliary equipment may require a special design to comply with any special service conditions required by the user, and must be discussed with GE in advance. Normally, the following special service conditions will be encountered:

- At sites with altitude above 3281 feet (1000m), the effects of the reduction in dielectric strength of the air must be taken into account. GE can supply circuit breakers which can be applied in areas above 3281 feet (1000m); however, derating factors as recommended by IEEE Standards may apply. At the same time, the insulation level in switchgear should be taken into account and should be discussed with GE in advance.
- If the ambient temperature is above 104°F (40°C), the continuous current limit of the circuit breaker may need to be de-rated as recommended by IEEE Standards. Please consult with GE in advance.

Attention:

When circuit breakers are operated in areas with high humidity and/or major rapid temperature fluctuations, there is a risk of condensation. Thus, the circuit breaker should be placed into operation as soon as possible after the packaging is removed. Energize equipment heaters, if installed, as soon as possible after the switchgear is installed.

Please contact your local GE rep for special application conditions.

5. Technical Data

Table 1: Circuit Breaker Weights, 5 to 15 kV- Gross

RATED CURRENT (A)	RATED SHORT-CIRCUIT CURRENT (KA)	WEIGHT		WEIGHT INCLUDING PALLET AND PACKAGING	
		(KG)	(LBS)	(KG)	(LBS)
1200	31.5	210	463	240	529
1200	40.0	270	595	300	662
2000	40.0	270	595	300	662

Table 2: Circuit Breaker Ratings

PARAMETER	UNIT	VALUE
Maximum Rated Voltage	kV	15
Rated Continuous Current	A	1200/2000
Frequency	Hz	50/60
Rated Power Frequency Withstand Voltage (1 min)	kV	36
Rated Lightning Impulse Withstand Voltage (Peak Values)	kV	95
Rated Short Circuit Interrupting Current	kA	31.5/40
Rated Short Time Withstand Current (2s)	kA	31.5/40
Rated Peak Withstand Current	kA	82/104
Rated Peak Close and Latch Current	kA	82/104
Rated Auxiliary Control Voltage	V	48/125/250 DC,120/240 AC
Opening Time	ms	20~35
Closing Time	ms	30~70

Table 3: Spring Operator Charging Motor

RATED VOLTAGE (V)	ENERGY STORING PERIOD UNDER RATED OPERATION VOLTAGE (S)	INPUT POWER (W)
DC 48	<15s	150
DC 125	<15s	150
DC 250	<15s	150
AC 120	<15s	150
AC 240	<15s	150

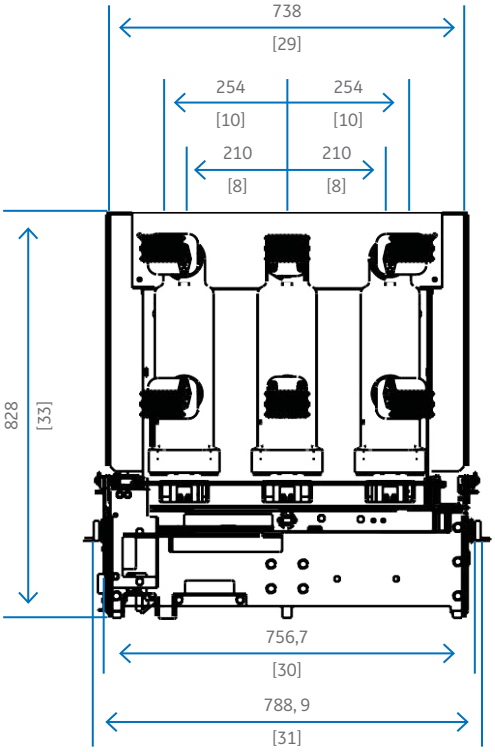
Table 4: Close and Trip Coils

RATED VOLTAGE (V)	MAXIMUM POWER CONSUMPTION (VA)
DC 48	350
DC 125	350
DC 250	350
AC 120	350
AC 240	350

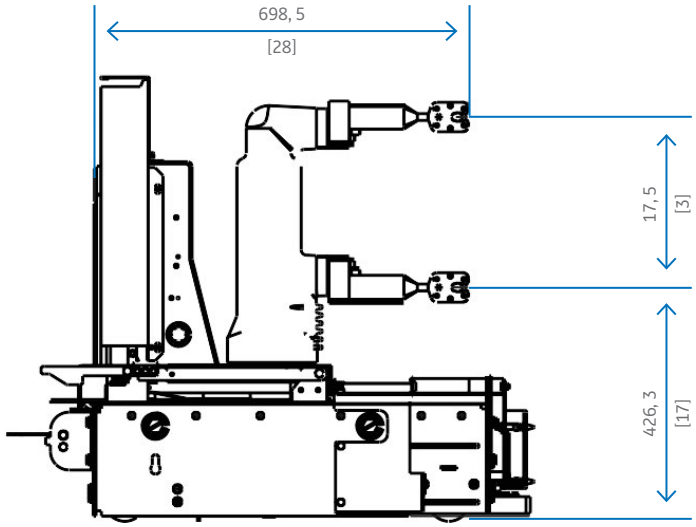
Table 5: Auxiliary Contact Rating

RATED VOLTAGE (V)	RATED CURRENT (A)	INTERRUPTING CURRENT (A)
48 AC	40	40
125 AC	16	16
250 AC	10	10

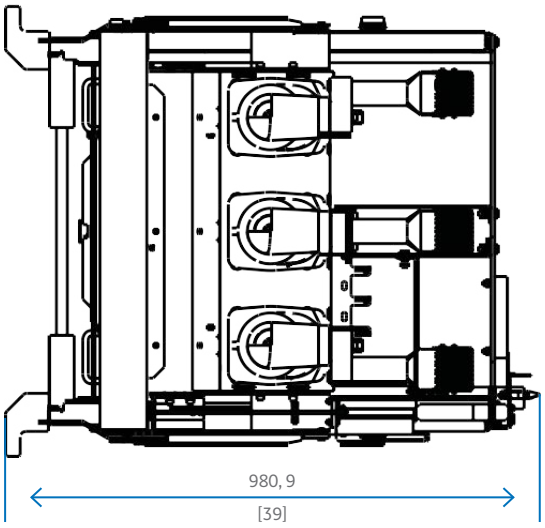
6. Overall Dimensions



Rear View



Side View

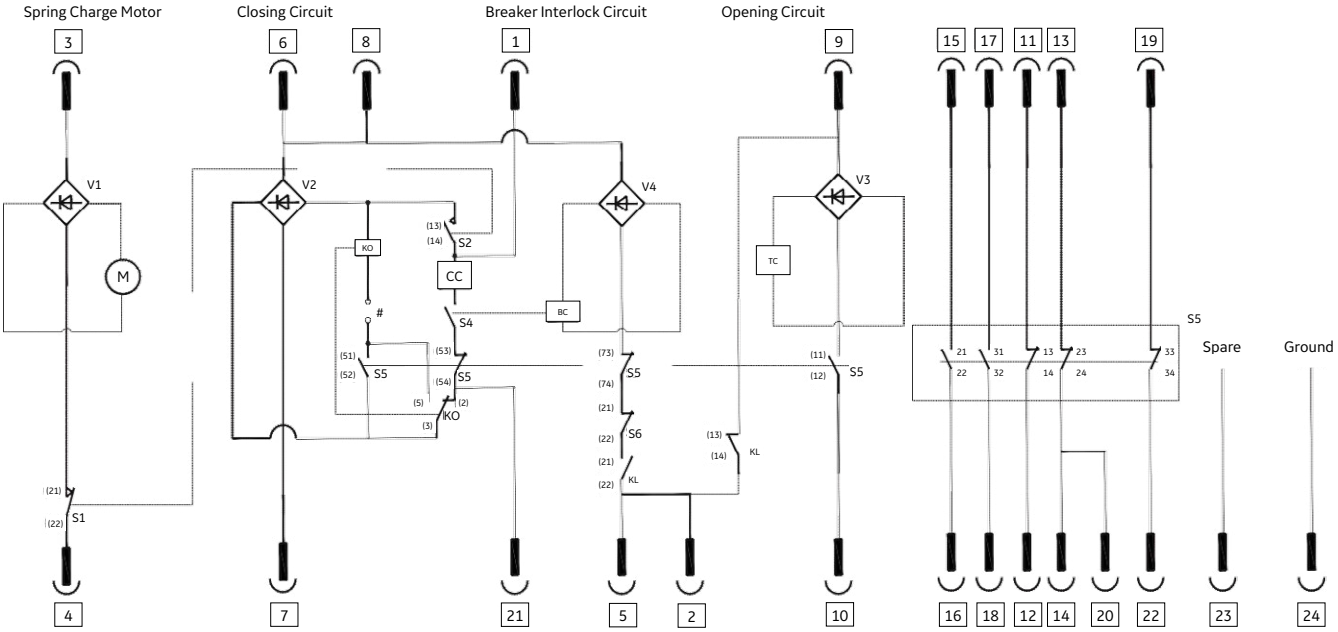


Top View

Figure 6: SecoVac R /1200A-31.5kA, mm

7. Internal Wiring Diagrams

Standard Wiring Diagram



Terminal numbering is in accordance with IEEE Std. C37.11 - Standard Requirements for Electrical Control for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.

CC: Close coil	K0: Anti-pumping relay
TC: Trip coil	ZC: Electromagnet for locking truck (optional)
S4: Electromagnet for close blocking auxiliary switch	M: Spring charge motor
S5: Auxiliary switch	V1~V4: Rectifier
S1~S3: Spring charge limit switch	BC: Electromagnet for close blocking (optional)

Note:

1. This wiring diagram describes the breaker open, racked to test position with spring discharged.
2. The polarity in dashed frame should be connected to common DC voltage terminal.
3. Rectifier will be removed if DC is applied.
4. If under voltage trip coil and/or optional second trip coil are required, see separate wiring diagram furnished with the circuit breaker.

8. Operation

Overview

The SecoVac R circuit breaker uses vacuum interrupters for the making and breaking of the electric power circuit. The primary cluster contacts on the draw-out breaker connect with fixed primary contacts in switchgear cell and the secondary disconnect connects with the secondary circuit plug located in the switchgear. The operating mechanism is a modular, compact spring charging design.

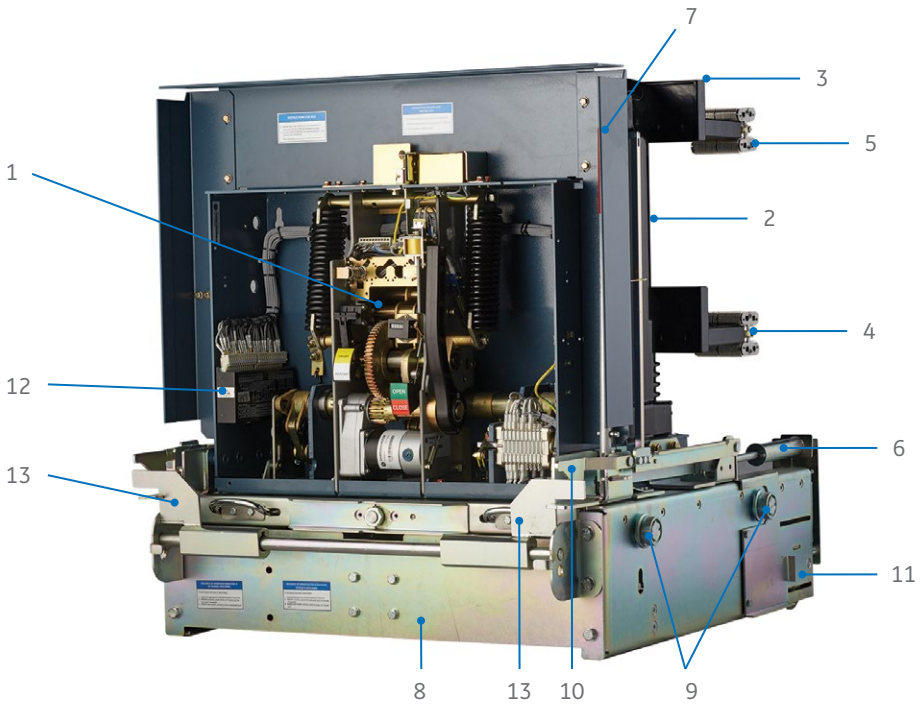


Figure 7: SecoVac R Without Front Cover and Components

1.	Spring charge mechanism	8.	Undercarriage
2.	Embedded poles	9.	Track rollers
3.	Upper primary arm	10.	Racking engagement lever
4.	Lower primary arm	11.	TOC operator bracket
5.	Primary cluster fingers	12.	Control wire board
6.	Secondary disconnect support	13.	Locking brackets
7.	Secondary disconnect handle		

The SecoVac R utilizes a conditional locking bar, which is operated by sliding of the locking handles (Figure 8, 1) together and then rotating (about 90°) towards the front of the undercarriage (Refer to Figure 7, 13 for full assembly). This is a dual function conditional lock. When the SecoVac R breaker is being transported or being inserted into the breaker cell, the locking handles are rotated to a vertical position, and then locking plates will rest in the notches of the front frame extensions (Figure 8, 2). Once the SecoVac R breaker has been inserted into the breaker cell, the locking handles are rotated to a horizontal position, with the locking plates (Figure 8, 3) engaging the lift truck slots in the left and right compartment guide rails, see figure below. This will lock the SecoVac R undercarriage in “DISCONNECTED/TEST” position. After ensuring locking of the levers, circuit breaker can be racked into the “CONNECTED” position.

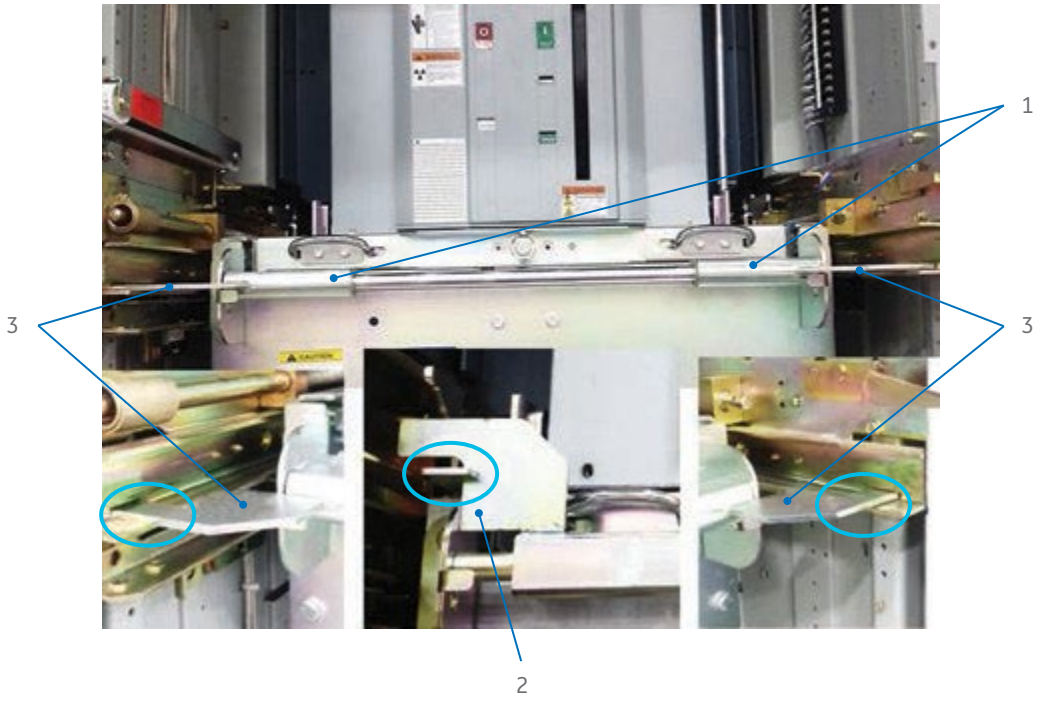


Figure 8: Front Isometric View

1.	Locking handles
2.	Notch for locking lever reset
3.	Locking lever

Primary Circuit

The primary circuit is made up of finger clusters, upper arms, lower arms and embedded poles (Figure 9). The vacuum interrupters and main contact parts are embedded in epoxy resin using APG (Automatic Pressure Gelation) process, which ensure the vacuum interrupters are protected from environmental influence and mechanical damage.

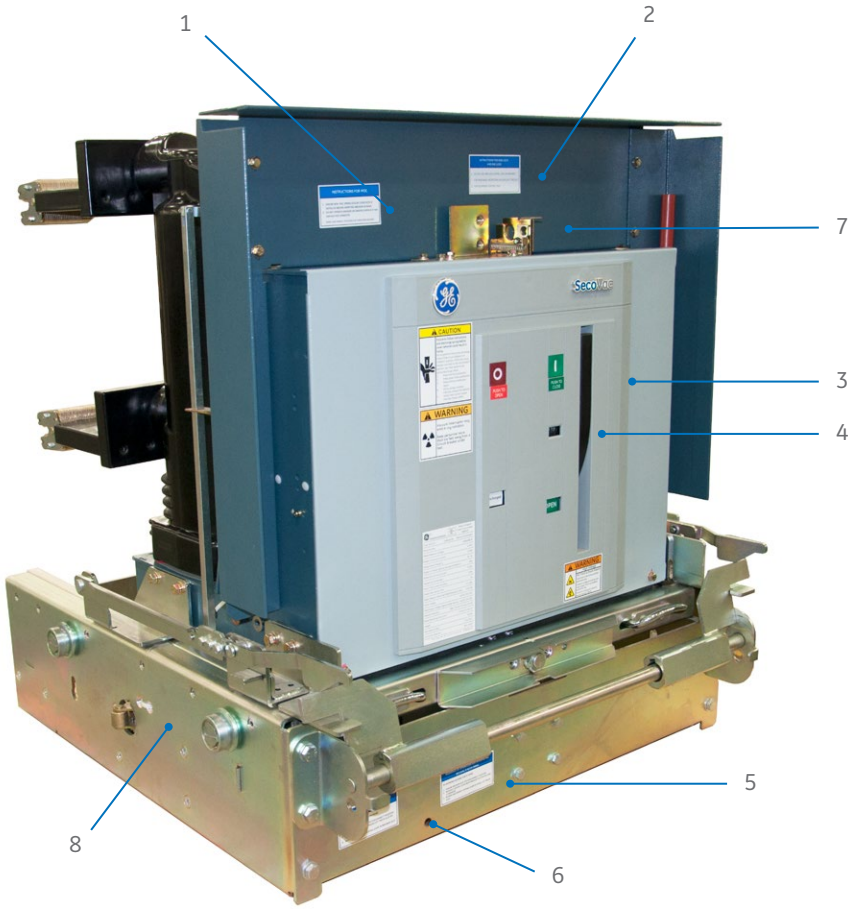


Figure 9: Front Isometric View of the SecoVac R

1.	Instruction for MOC label
2.	Instruction for Kirk Lock and Padlock label
3.	Charging handle
4.	Counter
5.	Sequence of operation for interfacing
6.	Sequence of operation for SecoVac R withdrawn from panel
7.	Trip free switch housing
8.	Electromechanical interlock-roller system

Operating Mechanism

The spring operating mechanism consists of a single module. The mechanism has immediate reclose capability. On the front panel of the circuit breaker, there are Open/Close, Charged/Discharged indicators and manual operating handle. The operator can charge the spring manually or by an electric powered charging motor and the status of the circuit breaker can be observed on the front panel (Figure 11). For maintenance purposes do not use manual trip and push buttons to operate a breaker that is racked in and energized. An instruction label for manual spring discharge is provided on the breaker (Figure 10).

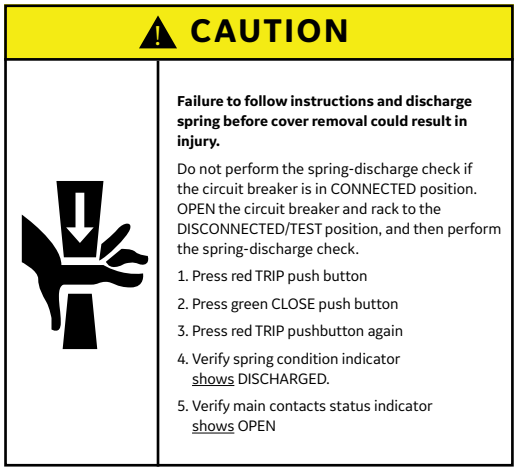


Figure 10: Spring Charge Instructions Label

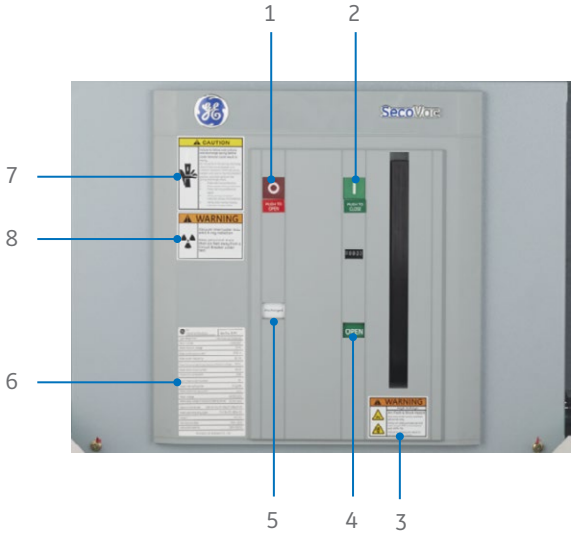


Figure 11: Circuit Breaker Face with Labels

1.	Tripping push button	5.	Spring charge status indicator
2.	Closing push button	6.	Name plate ratings
3.	HV warning label	7.	Spring discharge instruction
4.	Circuit breaker status indicator	8.	Warning label x-ray radiation

9. Principal of Operation

Vacuum Interrupter

The vacuum pressure within the evacuated envelope of vacuum interrupter is less than 10-5 torr. Under normal operating conditions the interrupter is closed. Arcing is established within the interrupter by withdrawing the lower moving contact from upper fixed contact. The arcing on contact separation releases metal vapor from the contact surfaces. The metal vapor continually leaves the inner contact region and recondenses on the contact surfaces and surrounding metal vapor condensation shield. The shield is isolated from both contacts and serves to protect the glass or ceramic envelope from vapor deposition. At current zero, vapor production ceases, the original vacuum condition is reinstated and the current is interrupted. The dielectric strength across the contacts of the interrupter also recovers, such that restrike is prevented. With the contacts in the open position, the system voltage is withstood internally by the contact gap and externally by the insulating envelope.

Stored Energy Mechanism and Close Spring Charging

Reference Figures 12 & 13.

The energy necessary for closing and charging the opening spring of the circuit breaker is provided by the closing spring. Spring charging can be accomplished by the electric charging motor, or by the integral manual charging handle.

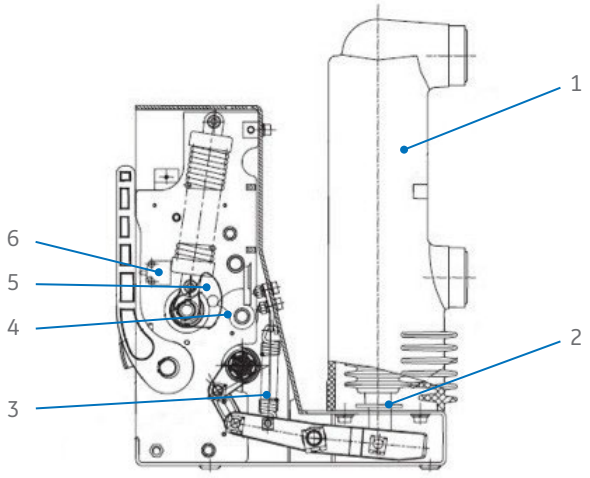


Figure 12: Cut-Away Side View of Breaker

1.	Embedded pole	4.	Holder
2.	Insulating rod	5.	Cam
3.	Opening spring	6.	Position switch

Spring Charged by Motor:

The spring charging mechanism consists of a charging motor, gear wheel, cam, holder and closing spring. When the spring charging motor (Figure 13, 11) is running, the pinion on the output shaft (Figure 13, 12) of the motor rotates, driving the gear wheel. The holder attached to the gear wheel rotates the cam fixed on the shaft, which then forces the shaft to rotate, stretching the closing springs (Figure 13, 17) for closing energy. When the block on the gear wheel is pushed away, the clutch is separated and the holder (Figure 13, 4) will hold the roller on the cam (Figure 13, 5) to keep the springs charged, the spring charge limit switch (Figure 13, 6) will cut the secondary supply to charging motor, thus the charging operation is completed.

Spring Charged Manually:

When spring is charged by manual means, the spring-charging handle on the mechanism is pumped up and down repeatedly, to complete the above-mentioned spring charging process. When the charging operation is completed, you can feel the free movement of the charging handle and the spring charging indicator (Figure 13, 13) will show Charged. The operating mechanism is ready for the next operation.

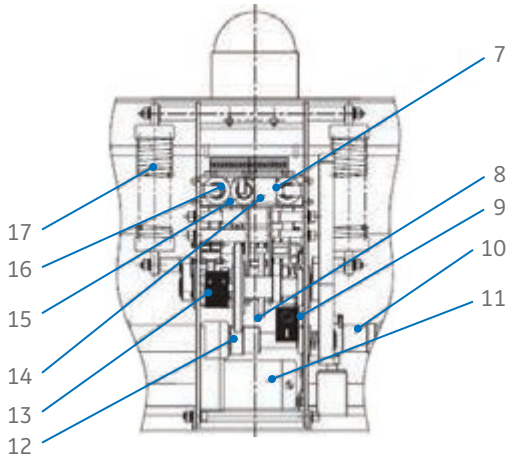


Figure 13: Cut-Away Front View of Breaker

7.	Closing coil	13.	Charging
8.	Holder	14.	Lock electromagnet
9.	Close/Open indicator	15.	Over current release
10.	Main shaft	16.	Tripping coil
11.	Electric motor	17.	Closing spring
12.	Output shaft		

Close Operation

When the closing coil is energized, the holder (Figure 12, 4) will rotate counter- clockwise to break away from the roller on the cam (Figure 12, 5). The cam, under the action of the force from closing spring (Figure 13, 17) will rotate clockwise, pushing the roller on the main shaft, which will cause the main shaft (Figure 13, 10) to rotate counter clockwise. The main shaft moves the connecting rods down via the arm, so that the insulating rods (Figure 12, 2) move upward, which intern moves the movable contacts to the fixed contacts. After the closing operation is finished, the closed/open indicator (Figure 13, 9) will indicate “Close”, and the power to the closing circuit is interrupted by breaker auxiliary contacts. If the external power supply is maintained, the charging circuit will recharge the spring.

Open Operation

When the breaker receives an opening command (the opening pushbutton is pressed or the trip coil (Figure 13, 16) is energized), trip coil pushes the trip latch, which intern rotates the trip shaft clockwise. Under the action of opening spring (Figure 12, 3) and contact wipe springs, main shaft will move clockwise, and the insulating rods (Figure 12, 2) will force the movable contacts to separate from the fixed contacts. The buffer will absorb the residual energy and tripping operation is completed. After the tripping operation is finished, the “Close/ Open” indicator (Figure 13, 9) will indicate “Open”. Meanwhile, the counter will record the operation.

Automatic Spring Discharge Mechanism

The Automatic Spring Discharge Mechanism (ASDM) will release the energy of closing and opening springs when the locking handles are manually rotated vertically (as described in section 8, Figure 8). This operation should be done in the “DISCONNECTED/TEST” position prior the extraction of the breaker from the switchgear.

Interlocks

The following interlocks are incorporated to help ensure the safe operation of the breaker.

Negative Interlock

The Negative Interlock will prevent closure of the circuit breaker while racking of the circuit breaker between the “DISCONNECTED/TEST” and the “CONNECTED” position by blocking the closing lever.

Positive Interlock

The positive interlock will prevent the racking of a CLOSED breaker into or out of the Metal-clad compartment. This is a redundant safety mechanism, by actuating a roller mechanism (Figure 14, 1) that will block the insertion of a racking handle. This roller mechanism is actuated when the breaker module is in the “CONNECTED” position and the breaker is CLOSED. The lever (Figure 14, 2) will travel vertically converting the movement to a horizontal motion (Figure 14, 3), which pushes the bracket outwards that holds the roller mechanism. Once the breaker is in its “OPEN” position, it can be racked out of the gear. Inserting the racking handle and actuating the racking system in the gear will push the roller mechanism inwards cutting off the power of the closing circuit and interlock circuit system simultaneously.

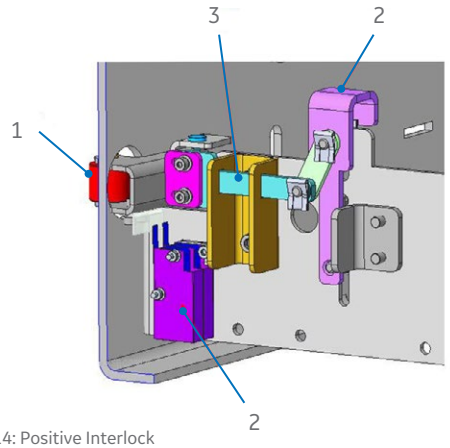


Figure 14: Positive Interlock

Trip Free

If the mechanical tripping signal is applied and held prior to the application of a closing signal (mechanical or electrical) the limit switch shown in (Figure 15, 1) will disconnect the supply to the closing coil magnet, and the plunger of the closing coil magnet will block the closing push button, preventing closure of the breaker mechanically. At the same time, the plunger will de-activate the micro switch (Figure 15, 4) whose N/O contact is connected in series with the closing coil, which will not allow the breaker to close electrically.

When no voltage is applied to the closing coil magnet, the circuit the breaker cannot be manually closed, unless the bypass lever, item 5 shown on Figure 15 (front cover removed for clarity purposes), is manually lifted upwards, which allows the CLOSE button to be actuated.

⚠ WARNING

It is not recommended to remove the front cover when secondary or primary power are present, follow installation checks (chapter 10) before attempting any type of maintenance regardless any position “DISCONNECTED/TEST” or “CONNECTED” SecoVac is placed in.

Anti-Pumping

This prevents the breaker from closing in the case of a fault that does not clear and a continuous close signal is given. This prevents the breaker from reclosing operation after an opening operation as long as the device initiating closing is maintained in the position for closing, SecoVac module is equipped with an electrical anti-pump.

Note: To ensure proper breaking of the current that may be established, it may be necessary for the contacts to momentarily reach the closed position, allowed behavior per IEEE C37.100.

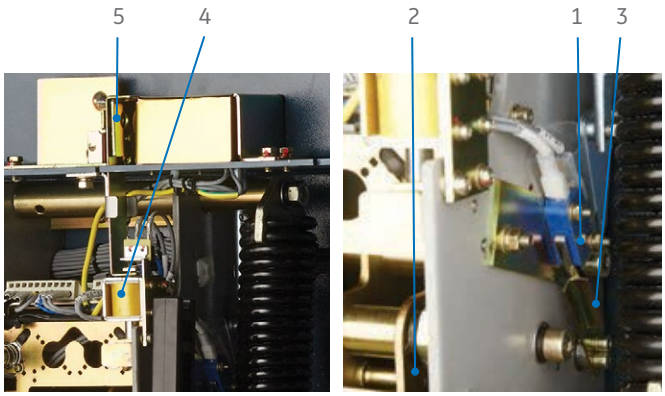


Figure 15: Circuit Breaker Trip Free Arrangement

1.	Limit switch	4.	Closing coil magnet
2.	Trip shaft	5.	Bypass lever
3.	Operating lever		

Rating Interference Plate

The rating interference plate is required by IEEE C37.20.2 (Figure 16, 1) permits only a breaker of the matching continuous current, voltage and interrupting kA rating to be inserted into a metal-clad breaker compartment.

Figure 16: Rating Interference Plate

Conditional Lock

With the SecoVac R breaker inserted into the cell and locked into the “DISCONNECTED/TEST” position, rotate the locking bar and engage the locking plates into the lift truck slots in the cell guide rails. Ensure that the locking plates are securely inserted into the lift truck slots as described in Section 8 (Figure 8). The SecoVac R breaker can now be racked into the “CONNECTED” position.

Figure 17: Front View of SecoVac R, Showing Conditional Lock Labels Area

Labels are located on the undercarriage left side frame to indicate the locking bar rotation depending upon task to be performed, see pictures below.

SEQUENCE OF OPERATION FOR SECOVAC R WITHDRAWAL FROM PANEL

TO WITHDRAW SECOVAC R FROM PANEL

1. **RACK OUT BREAKER TO TEST/DISCONNECT POSITION**
2. **REMOVE LOCKING LEVER FROM LIFT TRUCK SLOT BY PULLING IT INWARDS**
3. **ROTATE AND INSERT LOCKING LEVER IN BREAKER SLOT**

SEQUENCE OF OPERATION FOR INTERFACING SECOVAC R WITH PANEL

TO INTERFACE SECOVAC R WITH PANEL

1. **ENSURE BREAKER IS AT TEST/DISCONNECT POSITION**
2. **REMOVE LOCKING LEVER FROM BREAKER SLOT BY PULLING IT INWARDS**
3. **ROTATE AND INSERT LOCKING LEVER IN PANEL LIFT TRUCK SLOT**

Figure 18: Conditional Lock Labels

Key Lock

The keylock provision is located on the left-hand side of the switchgear below the racking mechanism. The purpose of this lock is to prevent the breaker from closing when it is in the “DISCONNECT/TEST” and/or “CONNECTED” positions.

To achieve this locking position, the SecoVac element must be opened/tripped, then push rearwards the sliding link Figure 19,1 until item 2 match (shown on Figure 19, 2). Rotate the

key lock clockwise until locking shaft is blocking the sliding link. This gives the same interlocking functionality as the padlock and it does not block the motion of the racking mechanism.

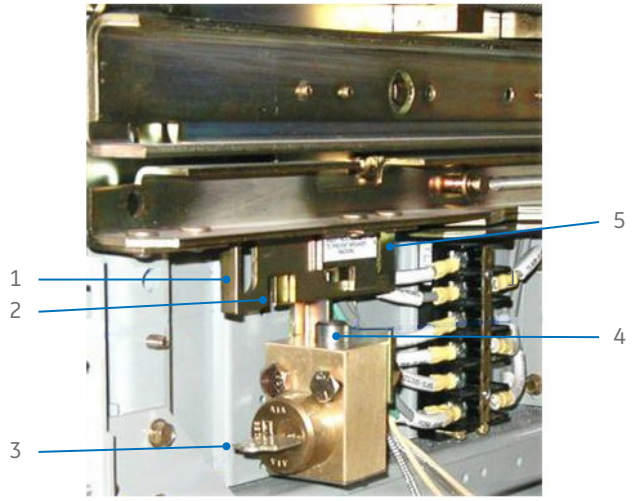


Figure 19: Padlock-Key Lock Interaction Mechanism

1.	Sliding link	4.	Locking shaft
2.	Detent	5.	Slot 2
3.	Keylock		

Padlock

The padlock system located on the left-hand side of the switchgear has two positions, capable of holding up to three padlocks on each position, see Figure 20.

To prevent the breaker from closing when it is in the “DISCONNECT/TEST” and/or “CONNECTED” positions, the SecoVac module must be opened/tripped, to obtain this position sliding link must be push rearwards Figure 19,1 until slots share concentric places, see Figure 20 item 6, then insert the desired amount of locks. This gives the same interlocking functionality as the keylock and it does not block the motion of the racking mechanism.

To lock the motion of the racking mechanism it is needed to use the second locking option of the padlock system Figure 20 item 5 (Slot 2) by keeping the hexagon turning shaft covered, the SecoVac element can be on its CLOSED or OPENED state and it can be located on the “DISCONNECT/TEST” or “CONNECTED” positions.

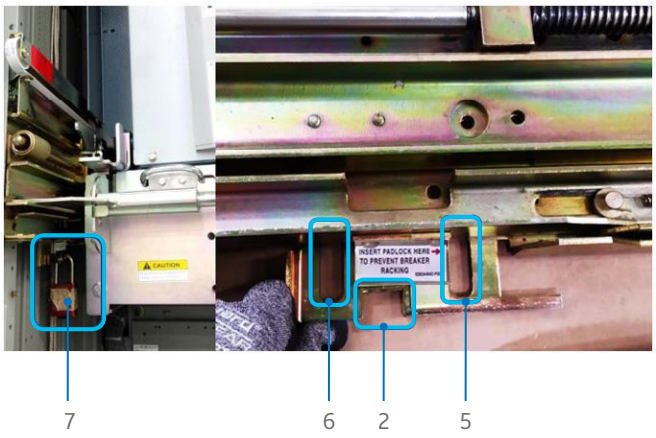


Figure 20: Padlock

2.	Notch for keylock shaft	6	Slot 1
5.	Slot 2	7	Padlock

Reclosing

When the circuit breaker is closed, and control power is present, the spring charge mechanism will recharge the closing springs so that the circuit breaker is capable of immediately reclosing after tripping.

10. Installation

This chapter contains complete instructions for installing the SecoVac R breaker.

CAUTION

Personnel installing this equipment must be thoroughly familiar with this instruction manual and all articles of the National Electrical Code applicable to the installation of this breaker. In addition, all drawings, both mechanical installation and electrical, must be understood and strictly followed to prevent damage to the breaker or equipment being protected by the breaker.

NOTICE

Before installation work is started, it is important to review all of the drawings provided, including the General Electric equipment arrangement drawings, site installation drawings, elementary and remote connection drawings, mechanical connection drawings, and the summary of equipment list.

DANGER

- It must be ensured that the supply power to the compartment is turned off/ compartment is de-energized for all the incoming and outgoing circuits of the equipment prior to any work being conducted on it.
- Ensure only qualified personnel install, operate, service, and maintain all electrical equipment.

Checks Before Installation

- After the breaker is unpacked, check the breaker poles for any cracks or breakage. The product nameplate and product certificate shall conform to the order.
- Check goods according with the packing list. Clean the insulating parts with a clean dry cloth.
- Check that the upper and lower terminals are clean and free of any damage caused by transport or storage.
- Verify the MOC switch spring has been replaced in accordance with Section 12.6 of this manual.
- Verify the condition of the vacuum interrupter through power frequency withstand voltage test (Hipot), apply the rated power frequency withstand phase to phase and phase to ground for 1 min. (See Figure 26).
- The SecoVac R circuit breaker uses powerful springs for energy storage, any person working with it should be familiar with the devices and should be aware of all safety precautions.

WARNING

Do not perform any type of work on the mechanism unless the closing spring is either discharged or removed, the breaker is open and all electrical control power is cut off.

Failure to do so could cause serious injury to the operator.

Circuit Breaker Racking

- Insert the circuit breaker into the cell using the lifting truck as per the equipment instruction manual and place into the “DISCONNECTED/TEST” position, the breaker will remain grounded in this position and at all times until its removal out of the equipment.
- When racking the breaker from “DISCONNECTED/TEST” to “CONNECTED” position, it is recommended to keep the door closed and secured, using the proper racking handle. Make sure the breaker is in the OPEN position and the locking levers are properly locked (as described in section 8, Figure 8), insert the racking handle onto the switchgear racking shaft (Figure 21, 2) push in and rotate the handle counterclockwise until the position indicator (1) shows “CONNECTED” position (about 60 rotations).

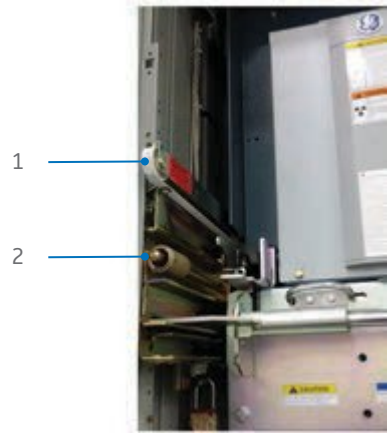


Figure 21: SecoVac R “DISCONNECTED/TEST” and Racking Position Indicator

- Rotating the racking screw will automatically move the SecoVac R module into the “CONNECTED” position. Figure 22 shows SecoVac element travel with respect to the undercarriage; this figure is for explanation purpose only.
- Figure 22 shows the SecoVac R breaker module racked into the “CONNECTED” position, on top of the fixed undercarriage. Total travel of the SecoVac R module into the “CONNECTED” position is approximately 10 inches.

CAUTION

To avoid possible damage to the racking mechanism, do not continue to turn the racking handle after the breaker has reached the “DISCONNECTED/TEST” or “CONNECTED” positions.

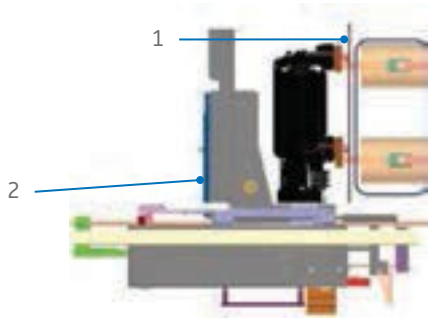


Figure 22: SecoVac R on “CONNECTED” Position

1.	Primary barrier	2.	SecoVac element

Commissioning

WARNING

HIGH VOLTAGE
Arc Flash & Shock Hazard

Operation & Service by qualified personnel only.

Follow all safety procedures and wear proper PPE in accordance with NFPA 70E

Failure to comply can result in serious injury or death.

- All commissioning and operation work shall be carried out by persons who have received suitable training and understand the performance of the circuit breaker. Correct protective and preventive measures shall be taken during commissioning.
- Before commissioning is performed, make sure that all control circuits are not energized and that the breaker is removed from the metal clad unit.
- Do not work on or install the breaker or mechanism while it is in the closed position.
- Do not work on or install the breaker while the closing spring is charged.
- Using the product under normal working conditions and within the range of technical data according to IEEE C37.04, will ensure the correct performance of the circuit breaker.
- After the installation of the circuit breaker into switchgear, the breaker should only be subjected to normal recommended operating conditions.

Preparation Work (Prior to Energization)

- Check the circuit breaker for any damage.
- Clean the pole assemblies and other insulated parts with a clean dry cloth
- Remove lifting hooks (if used) from the circuit breaker prior to insertion/operation
- Check the connecting status of the primary and secondary circuits as well as the grounding.
- Manually perform spring-charging, opening and closing operations to ensure the breaker is working properly.

11. Maintenance

WARNING

HIGH VOLTAGE
Arc Flash & Shock Hazard

Operation & Service by qualified personnel only.

Follow all safety procedures and wear proper PPE in accordance with NFPA 70E

Failure to comply can result in serious injury or death.

Maintenance Rules

- The user shall not replace any original parts with replacement parts from a different manufacturer
- Prior to maintenance, remove the circuit breaker from the switchgear. Make sure that the circuit breaker is open, closing spring discharged and the power supply is off.
- Before any maintenance work is performed, make sure that all control circuits are not energized and that the breaker is removed from the metal clad unit.
- Do not work on the breaker or mechanism while it is in the closed position.
- Do not work on the breaker while the closing spring is charged.
- Using the product under normal working conditions and within the range of technical data according to IEEE C37.04, will ensure the correct performance of the circuit breaker.
- The replacement of the embedded vacuum interrupter poles and operating mechanism should only be performed by GE authorized personnel.

Maintenance Cycle

The frequency of required maintenance depends on the severity of the service conditions of the switchgear application. With maintenance and normal operating duty, the typical mechanical life of the SecoVac R breaker is 10,000 operations, without replacement of parts. If the service conditions are mild, the suggested interval between maintenance operations is no more than 5 years or 2,000 normal load switching operations.

Mild service conditions are defined as an environment in which the switchgear is protected from the environmental effects of conditions such as:

- Salt spray
- Changes in temperature that produce condensation
- Conductive and/or abrasive dust
- Damaging chemicals and fumes
- Vibration or mechanical shock
- High relative humidity (90%)
- Temperature extremes, below –22° F (30° C) or above 104° F (40° C)

Maintenance after 2000 cycles includes inspection, cleaning and lubrication of circuit breaker mechanism, accessed by removing the front cover. Apply lubrication to all the moving parts and gears in the circuit breaker mechanism. See areas indicated by red circles in Figure 23.

After 10000 cycles or after 25 years operation, the circuit breaker should be checked to determine whether it requires replacement. Vacuum Interrupter integrity test shall be performed at 75% of rated Power Frequency Withstand voltage. Contact your local GE Sales Rep for further instructions if needed.

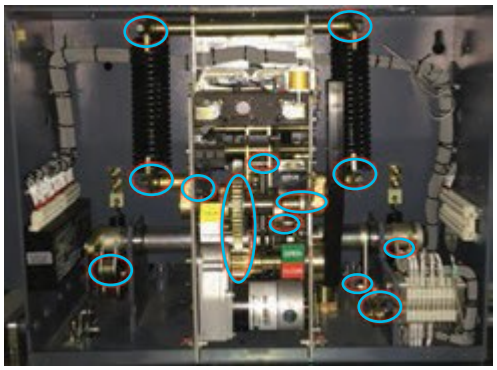


Figure 23: Areas for Recommended Lubrication

Interrupter Maintenance and Contact Wear

Early vacuum interrupter designs employed spiral contacts that formed intense arcs that could rapidly erode electrode surfaces. The type of contact found in this circuit breaker is a state of the art axial magnetic field type. This method creates a low energy highly defuse plasma arc that is evenly

distributed across the contact surface. The design is capable of 30,000 continuous current operations or 150 short circuit operations.

As the circuit breaker reaches the 10,000 operations limit, it is recommended that interrupter contact resistance readings be recorded and reported to GE service for evaluation. As the breaker approaches end of life, it is recommended that checks be made to guarantee the vacuum interrupter contacts have not exceeded the allowable wear of 3mm. SecoVac R provides a visual indication of the wear located on the back area of the circuit breaker element, under the vacuum poles. Other than these tests and checks, the vacuum interrupter is a sealed for life and does not need maintenance.

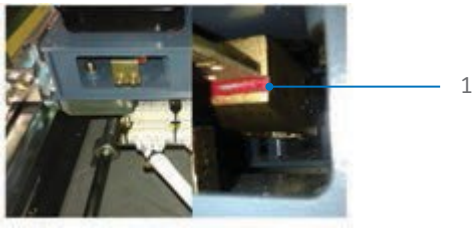


Figure 24: Contact Wear Indicator

Maintenance Checklist

Operating Mechanism

- Visual check of all elements and mechanical interlocks for any damage.
- Check the tightness of nuts and bolts. Check split pins for any breakage and for loose or missing parts.
- Check the rubbing and sliding surfaces inside the mechanism, lubricant shall be applied to the moving and friction areas prior to installation (See Figure 23).
- Check the counter for correct operation.
- Check and ensure the interlocks function as per section 9.5.
- Visually check the oil buffer (dashpot, Figure 25, 1) for oil leakage or any other damage.
- Check the auxiliary switch and position switch for proper operation by performing open close operation.
- Check the charging motor.
- Check the closing, tripping and latch coils functioning.
- Check the terminals of secondary wiring and connector.
- Check for loose parts and re-tighten per Table 6 below.

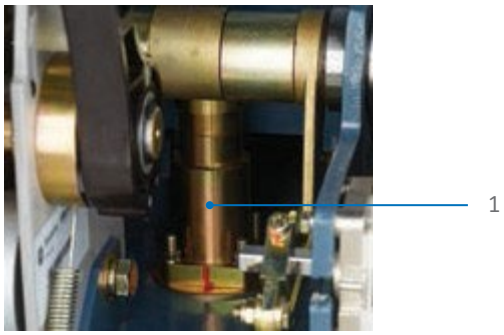


Figure 25: Oil Buffer Arrangement

BASIC DIMENSIONS OF BOLTS (MM)	TIGHTENING TORQUE WITHOUT LUBRICANT APPLIED (N-M(FT-LBS))	TIGHTENING TORQUE WITH LUBRICANT APPLIED (N-M(FT-LBS))
M8	25 (18.44)	10 (7.38)
M10	45 (33.19)	25 (18.44)
M12	85 (62.69)	45 (33.19)
M16	170 (125.38)	80 (59)

Draw-out Mechanism

- Check all the holders, pins and terminals (Mechanism shown in Figure 13). Apply lubricant grease to all movable shafts and bearings.
- Check the racking operation and ensure the functions work properly.

Primary Circuit

- Check and clean the pole insulation with a clean dry cloth. Check the bolts for tightness to ensure good contact.
- Carry out mechanical operating test of the circuit breaker by closing and opening 5 times each, at rated operating voltage, high voltage and low voltage (refer to table 7 for limits).

Table 7: Control Voltages

NORMAL VOLTAGE (V)	OPENING COIL		CLOSING COIL		MOTOR CHARGING	
	MIN (V)	MAX (V)	MIN (V)	MAX (V)	MIN (V)	MAX (V)
48 (DC)	28	56	38	56	38	56
125 (DC)	70	140	100	140	100	140
250 (DC)	140	280	200	280	200	280
120 (AC)	104	127	104	127	104	127
240 (AC)	208	254	208	254	208	254

- Carry out mechanical characteristics test of the circuit breaker. Measure the opening and closing time, average speed, synchronism of poles, bounce time, etc. using circuit breaker analyzer. Values should be within the limits as listed in Table 8. Opening distance is the gap between the contacts inside the Vacuum bottle. Results should be compared against the breaker values in the factory test procedure document.

Table 8: Circuit Breaker Mechanical Characteristics

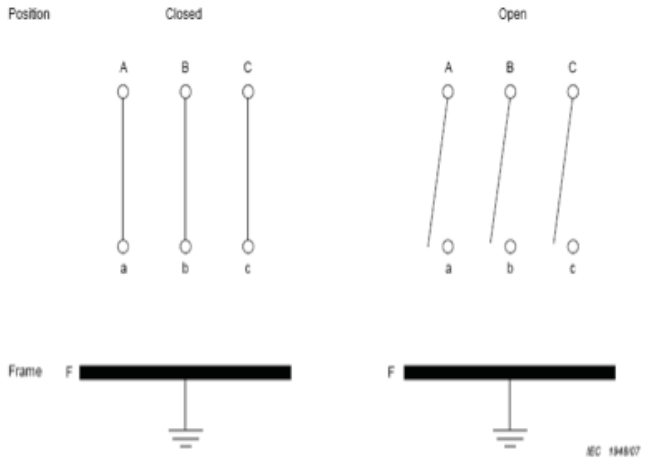
ITEM	CRITERIA	RESULT		
		PHASE A	PHASE B	PHASE C
Opening distance (mm)	9±1	38	56	38
Simultaneity (ms)	≤ 2	Close	Open	
Distance between phases (mm)	275±1.5	AB	BC	
Closing time (ms)	30 — 70			
Opening time (ms)	20 — 35			
Average closing speed (m/s)	0.5 — 0.9			
Average opening speed (m/s)	0.9 — 1.5			

- Tighten the bolts and measure the resistance of main circuit at 100A dc as recommended per standard IEEE C 37.09. If field testers are used with current significantly less than (e.g., 10A) and result in abnormally high readings, it is recommended to retest at 100A to confirm.
- Carry out the power frequency withstand (Hi-Pot) AC voltage test: Apply 75% of the power frequency (Hi-pot) AC voltage as per Table 9 for 1 min for each test conditions as listed in Figure 25 including vacuum bottle integrity test with contacts open.

Note: The vacuum integrity tests performed using dc Hi-pot sets often result in false failures. If an interrupter fails a DC test, retest with an AC Hi-pot tester.

Table 9: Preferred Power Frequency Ratings

RATED MAXIMUM VOLTAGE (KV RMS)	POWER FREQUENCY WITHSTAND KV(MAX)	POWER FREQUENCY WITHSTAND KV (75%)
4.76	19	14
8.25	36	19
15	36	19



TEST CONDITION	SWITCHING DEVICE	VOLTAGE APPLIED TO	CONNECTED TO EARTH
1	Closed	Aa	BCbcF
2	Closed	Bb	ACacF
3	Closed	Cc	AbabF
4	Open	A	BcabcF
5	Open	B	AcabcF
6	Open	C	AbabcF
7	Open	a	ABCbcF
8	Open	b	ABCacF
9	Open	c	ABCacF

Figure 26: Test Conditions for Power Frequency Withstand

Acceptance criteria: No Flash over for any of the test conditions.

- Vacuum Integrity Test - Perform vacuum integrity test with the breaker in open condition, apply 75% of power frequency withstand (Hi-pot) ac voltage from Table 9 across each pole for 1min.
  A-----a, B----b & C....c

Mechanical Tests

The value for mechanical characteristics should conform to technical data list. (Refer to table 9.)

Table 10: Troubleshooting

PROBLEM	SOURCE	SYMPTOM	POSSIBLE CAUSE	SOLUTION
Breaker will not close	Electrical	Closing coil will not energize	Coil has burned out	Replace the coil
			Fault in secondary circuit wiring	Recheck wiring and tighten connections
			Bad auxiliary switch contact	Check pins on auxiliary switch and replace if needed
		Closing coil energized but breaker will not close	Closing voltage too low	Measure control voltage to confirm
			Loose/disconnected secondary wiring	Check secondary wiring and connectors
			Breaker is not in connected or test position	Confirm the position of the breaker
			Under voltage release coil is not energized	Check under voltage release connection and energize the coil. Check to see if the control voltage has dropped to less than 70% of the rated voltage of the coil.
	Mechanical	Breaker cannot be closed manually	Breaker is not in connected or test position	Confirm the position of the breaker
Breaker will not open	Electrical	Tripping coil will not energize	Coil has burned out	Replace the coil
			Fault in secondary circuit wiring	Recheck wiring and tighten connections
			Bad auxiliary switch contact	Check pins on auxiliary switch and replace if needed
		Tripping coil energized but breaker will not open	Closing voltage too low	Measure control voltage to confirm
			Loose/disconnected secondary wiring	Check secondary wiring and connectors
	Mechanical	Breaker cannot be opened manually	Breaker is not in connected or test position	Confirm the position of the breaker
Open		Electrical Position indicator not functioning	Limit Switch in undercarriage is dam- aged or connecting linkage mechanism deformed.	Replace the Limit Switch or repair the connecting linkage mechanism
		Charging motor inoperable	Secondary wiring not connected or motor has failed	Recheck secondary wiring and tighten connections or replace Motor.
		Charging motor will not turn off	Wiring connected incorrectly or fault in position switch.	Recheck secondary wiring and tighten connections or replace position switch.

12. Removal and Replacement of Components and Parts

The pole assembly and closing/tripping module requires detailed time checks as required by IEEE C 37.09 production tests so these modules shall be replaced by GE service technicians. The replacement of other parts should be in accordance to this manual.

Removal and Replacement of Trip and Close Coils

As shown in Figure 27, disconnect the secondary wires (1) of close & trip coils and unscrew the bolts at both sides (2). Take out the support bracket of the trip & close coils and remove screws (3) for removing the coils.

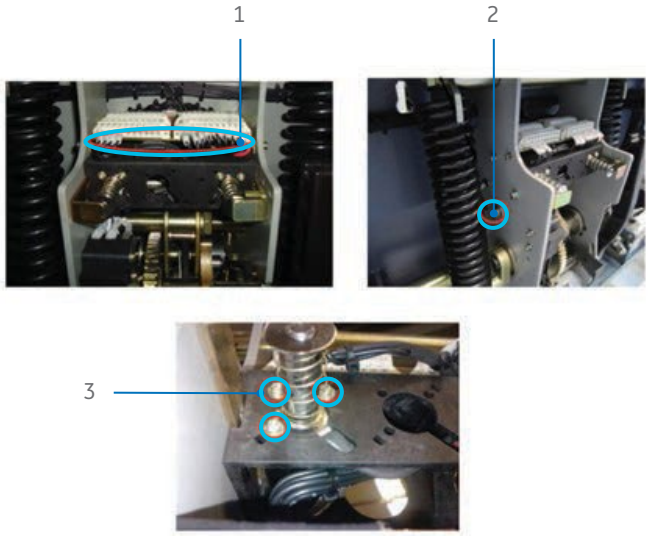


Figure 27: Removal and Replacement of Coils

Removal and Replacement of Counter

As shown in Figure 28, disconnect tension spring (2) and remove screw (1), the counter can be removed.

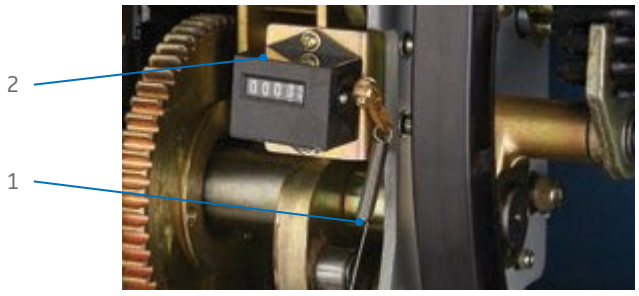


Figure 28: Removal and Replacement of Counter

Removal and Replacement of Auxiliary Switch (52AUX, S5)

As shown in Figure 29, loosen clamp bolt (2) and slide the operating arm off the shaft. Remove mounting bolts (left side photo, 1) take off the auxiliary switch and the secondary wiring as required.

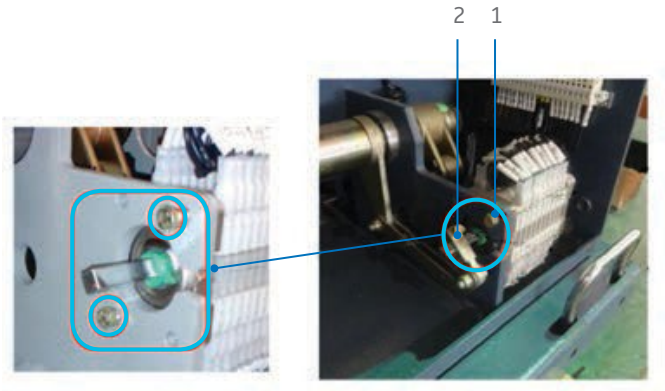


Figure 29: Removal and Replacement of Auxiliary Switch

Removal and Replacement of Spring Charge Indication Switch

As shown in Figure 30, first remove the secondary wiring and remove the bolts (2), then remove the position switch.

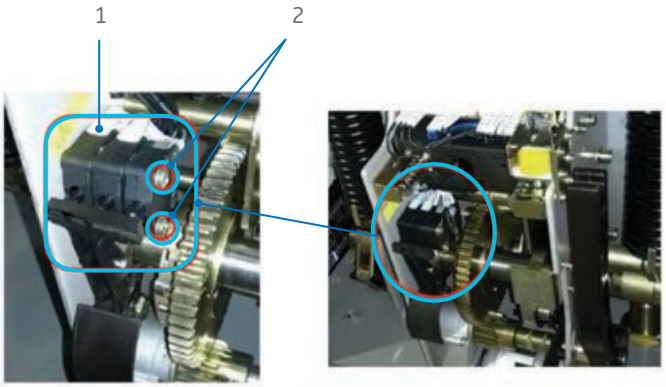


Figure 30: Removal and Replacement of Spring Charge Indication Switch

Existing MOC and TOC Switches

The mechanism operated cell switches (MOC) can be operated in both the “DISCONNECTED/TEST” and “CONNECTED” position. The return spring on the MOC assembly inside the cell needs to be replaced for proper operation by the SecoVac R breaker. The original switchgear utilized several variations of the MOC switch assembly over the years, and while yours may be different than the one shown, the spring installation is basically the same. Contact GE Energy Management for further assistance if needed.

The picture below shows the lever that actuates the switch assembly. The lever will rotate between 3/4” maximum and 1/2” minimum, to actuate the switches when SecoVac R breaker performs a close or open operation.

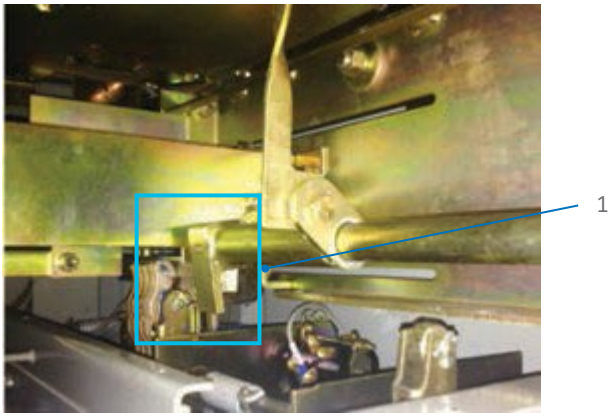


Figure 31: MOC Link

The truck operated cell switch (TOC) will be actuated when the breaker reaches the “CONNECTED” position and it will change the contacts state to open or close depending upon configuration upon withdrawal (Figure 7, 11).

Replacing Original MOC (52STA) Return Spring

The original MOC (52STA) switch return spring in the existing Switchgear must be replaced (using part number 8PVR002129 MOC SPRING, one supplied with the new SecoVac R breaker), to allow the SecoVac R MOC lever actuator to operate properly. Be aware of the label placed on the right side of the undercarriage to ensure MOC return spring gets replaced.

INSTRUCTIONS FOR MOC

1. **ENSURE NEW MOC SPRING (COLOR CODED RED) IS INSTALLED BEFORE INSERTING BREAKER IN PANEL**
2. **DO NOT OPERATE BREAKER ON UNEVEN SURFACE IT MAY DAMAGE MOC OPERATOR**

REFER USER MANUAL FOR DETAILS OF SPRING REPLACEMENT

Figure 32: MOC Spring Warning Label

The picture below shows the taptite (self-threading) fasteners that need to be removed, indicated by the blue circles.

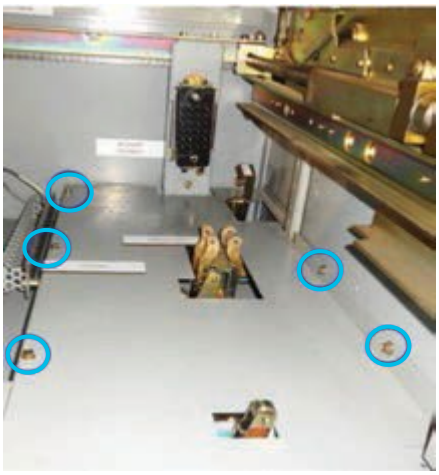


Figure 33: MOC Cover

After removing the taptite fasteners and cover, proceed to remove the wiring to the MOC switch as shown (Figure 34, 1). Once completed, remove the bolts that attach the MOC assembly to the pan.

Note: Actual switch style may vary from the one shown, however the removal/ replacement procedure is essentially the same (Figure 34, 2).

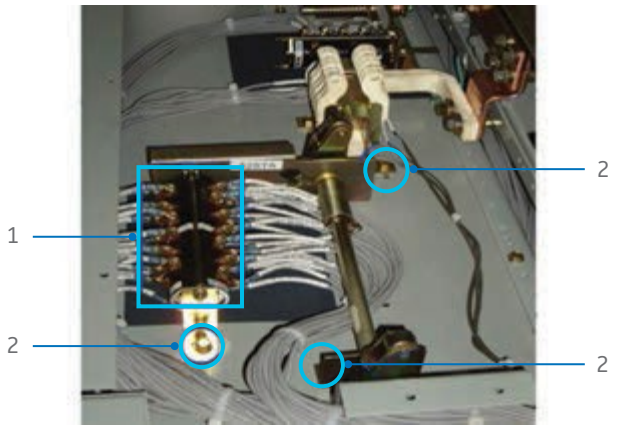


Figure 34: MOC Switch

When the MOC switch assembly is free, secure the operating shaft (Figure 35) in a vise (or similar clamp). Loosen nut on the end of the stop bolt (Figure 35, 6) and carefully back the bolt out to release tension on the spring. Remove the roll pin holding the roller arm and the dowel pin holding the spring to the shaft (shown on Figure 35, 1 and 3). With- draw the roller arm (5) and the mounting bracket (2), (Figure 34), slide the torsion spring off the shaft. Insert the new MOC torsion spring (part number 8PVR002129) onto the shaft and replace the dowel pin retainer. Pull the tension arm of the spring back, and return the stop bolt to its original position and secure nut. Slide mounting bracket back onto shaft, followed by the roller arm. Fix the roller arm to the shaft by reinserting the roll pin. Reinstall the MOC switch assembly and reconnect the wiring. Verify the switch operates freely.

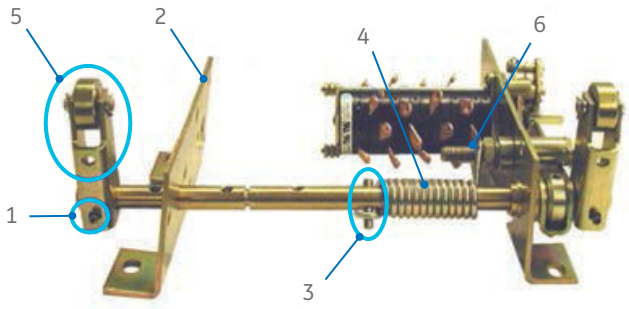


Figure 35: MOC Switch

When having a double MOC Switch (Figure 36), the process is the same and it is recommended to remove the bracket on the left side to minimize the disassembly and time to take apart.

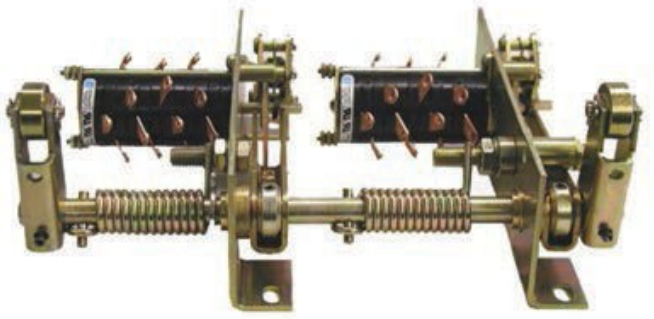


Figure 36: Double MOC Switch

Lubrication

The circuit breaker has an expected mechanical operation service life of 10000 operations. After each 2000 operations, inspection and lubrication is necessary on the SecoVac breaker element and after each 250 operations inspection and lubrication shall be made to the moving parts assembled in the undercarriage. See section 11.2 for further maintenance cycle instructions.

The following type of the lubrication is recommended:

- Mobilux EP Series
- Silicone grease 102

Spare Parts

For ordering, please contact GE.

Table 11: Spare Parts List

NAME	REF. CAT NO
Close Coil 48V DC	P-C6X
Open Coil 48V DC	P-C6X
Charge Motor 48V DC	P-MOTOR6
Close Circuit Blocking Solenoid 48V DC	P-L6R
Close Coil 125V DC	P-C8X
Open Coil 125V DC	P-C8X
Charge Motor 125V DC	P-Motor8
Close Circuit Blocking Solenoid 125V DC	P-L8R
Close Coil 250V DC	P-C9X
Open Coil 250V DC	P-C9X
Charge Motor 250V DC	P-Motor9
Close Circuit Blocking Solenoid 250V DC	P-L9XR
Close Coil 120V AC	P-C8X
Open Coil 120V AC	P-C8X
Charge Motor 120V AC	P-Motor8
Close Circuit Blocking Solenoid 120V AC	P-L8R
Close Coil 240V AC	P-C9X
Open Coil 240V AC	P-C9X
Charge Motor 240V A	P-Motor9
Close Circuit Blocking Solenoid 240V AC	P-L9XR
MOC Link	8PVR002072
Racking Arm LH Assy	5PVR002017
Racking Arm RH Assy	5PVR002020
Secondary Plug Handle Assy	5PVR002025
Leaf Spring Mtg Plate Assy	5PVR002037
Secondary Plug Handle Pin	8PVR002039
Secondary Plug Handle Spring	8PVR002040
TOC Plate	8PVR002045
Pin B	8PVR002046
Racking Support Spacer	8PVR002101
I Conrod	8PVR002201
MOC Crank Pin	8VBR001017
Cluster Bolt	8VBR001026
Cluster 2000A ,40kA	5DY551035.2
Cluster 1200A 40kA	4HD51P1Q14C
Undervoltage Coil 48V DC	P-UVCOIL5
Undervoltage Coil 125V DC	P-UVCOIL1
Undervoltage Coil 250V DC	P-UVCOIL2
Undervoltage Coil 120V AC	P-UVCOIL1
Undervoltage Coil 240V AC	P-UVCOIL2

NAME	REF. CAT NO
Internal Breaker Auxiliary Switch 9NO+9NC (S5, 52aux) N/A	P-AP701
Control Wiring Board 48V DC	P-AP916X
Control Wiring Board 125V DC	P-AP918X
Control Wiring Board 250V DC	P-AP919I
Control Wiring Board 120V AC	P-AP918X
Control Wiring Board 240V AC	P-AP919I

13. Documents and Accessories

Accompanying Documents

- Product certificate
- Manual
- Packing list

Accessories

- Racking handle

For more information on GE's SecoVac R retrofill circuit breaker, please refer to the following publications:

- DEA-614: SecoVac R Retrofill 5-15kV Vacuum Circuit Breakers Brochure
- DEQ-218: SecoVac R Retrofill 5-15kV Vacuum Circuit Breakers Factsheet

Notes

Notes

Imagination at work

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