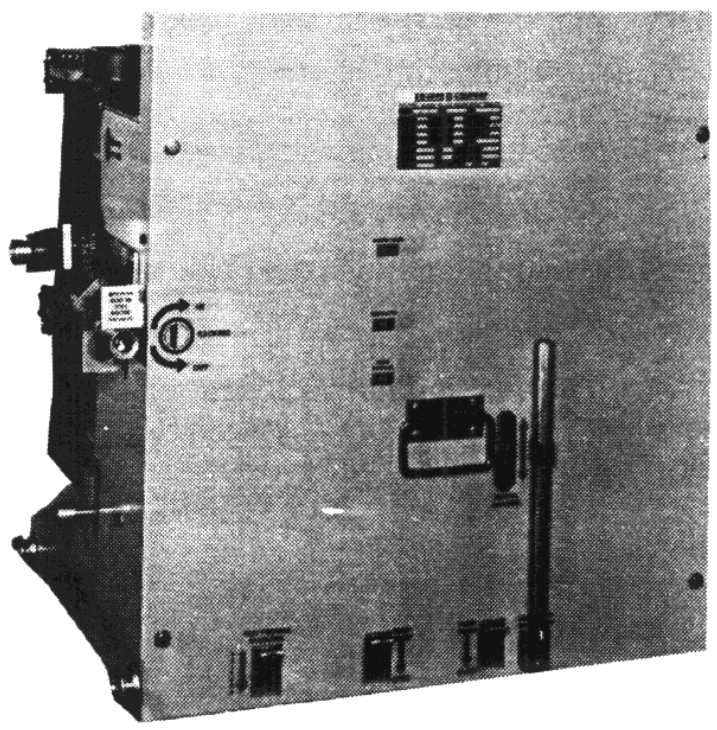
APRIL 1990

Instruction & Maintenance Manual

Vacuum Circuit Breaker

TYPE VAD3



SQUARE D COMPANY

VACUUM CIRCUIT BREAKER TYPE VAD3

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STATEMENT OF USE OF SURGE PROTECTION FOR VACARC CIRCUIT BREAKERS

VACARC medium voltage vacuum circuit breakers are designed and tested in accordance with ANSI C37.04, .06 and .09. Used in conjunction with switchgear designed and tested to ANSI C37.20, circuit breakers can be applied as general purpose devices.

Users may elect to install VACARC circuit breakers over a wide range of applications and system parameters. Several IEEE publications are available to provide guidance to the use for industry practices (IEEE Color Book Series).

Special attention is suggested by the user when considering old or aging distribution systems. Distribution systems can be exposed to lightning or switching surges. Older or aging systems may be more susceptible to damage due to system insulation aging or being built to older standards.

Recognizing this, users are encouraged to consider adding metal oxide surge arrestors to the circuitry on the load side of the terminals of VACARC breakers used in retro-fit applications. Placement should be in the switchgear or at the equipment being protected but not on the circuit breaker.

Metal oxide arrestors limit the magnitude of prospective overvoltages but do not affect the rate of rise (di/dt) of surge transients. Surge capacitors can be considered for this additional protection.

VACUUM CIRCUIT BREAKER TYPE VAD 3

1. INTRODUCTION

This manual provides installation, operation and maintenance instructions for the VAD3 series of horizontal drawout vacuum circuit breakers.

1.1 Receiving

Upon receipt, by the customer, the entire breaker should be inspected for damage that may have occurred in transit. All items should be checked against the packing list provided. The transportation company and the manufacturer should be notified immediately of damages or shortages.

1.2 Handling

Use care when uncrating and handling the breaker. **NEVER USE THE PRIMARY DISCONNECTS (Figure 2,1) OR RACKING ARMS (Figure 1,9) AS HANDLES.** Roll and maneuver the breaker by the handle at the front mechanism cover (Figure 1,3) or by grasping the top edge of the front mechanism cover. When using a forklift or hoist, lift the breaker by the strong points of the frame to prevent damage.

1.3 Storage

If the breaker must be stored before it is put into operation, keeping it in a place that is clean, dry and free of corrosive elements and mechanical abuse is absolutely necessary.

The manufacturer recommends that the breaker be put in its permanent location as soon as possible. If the breaker is to function in switchgear employing space heaters, install it only after the heaters are operating.

Breakers that must be stored for prolonged periods should be inspected regularly for rusting and overall condition. Lubrication should be performed when necessary.

2. INITIAL BREAKER PREPARATION

The following describes the steps that are necessary to prepare the breaker for installation into its enclosure.

1) Examine the entire breaker.

2) Use a clean, dry cloth to remove dirt and moisture that may have collected on all insulating parts.

3) Operate the breaker several times and check for proper operation.

4) To assure that damage has not occurred during shipment, perform a hi-pot test across the open contacts of each vacuum interrupter. Then, with the breaker in the closed position, perform a phase to ground and phase to phase hi-pot test for each pole.

   Gradually raise the voltage to the proper level. The hi-pot test voltage should be 27kV rms or DC. The breaker should sustain this potential for 1 minute. Observe the following instructions when performing the hi-pot test:

   a. Do not exceed the above voltages.

   b. All persons should stay at least 6 feet away from the breaker under test.

   c. Perform tests only when all insulating parts are installed.

   d. Discharge to ground the primary disconnects (Figure 2,1) before handling. These areas can retain a static charge after a hi-pot test.

5) Insert the breaker into its enclosure by following any applicable directions provided by the enclosure manufacturer.

6) With the main power off, cycle the breaker several times and check for proper operation.

7) The breaker is now ready for normal operation.

3. VACUUM CIRCUIT BREAKER DESCRIPTION

3.1 Vacuum Interrupters

Interruption in the vacuum circuit breaker is performed by the vacuum interrupters (Figure 2,6) mounted vertically within the breaker frame. Consisting of a pair of butt contacts, one moveable and one fixed, hermetically sealed in a high vacuum these interrupters require only a short contact gap for circuit interruption. The resulting high operating speed allows the entire operating sequence, from fault to clear, to be consistently performed in three cycles or less.

3.2 Primary Disconnects

The primary connection to the associated switchgear is made through the six primary disconnects (Figure 2,1) mounted horizontally at the rear of the breaker. Take care to insure that the primary disconnects do not receive rough treatment. **NEVER USE THE PRIMARY DISCONNECTS AS HANDLES WHEN MANEUVERING THE BREAKER.**

3.3 Operating Mechanism

The operating mechanism is of the stored energy type employing charged springs to perform breaker opening and closing functions. The operating mechanism contains all necessary controls and interlocks. It is mounted at the front of the breaker so that it can be easily accessed for inspection and servicing.

3.4 Control Circuitry

Typical schematic diagrams for the control circuitry of the circuit breaker are presented in Figures 1Ø and 11. The following describes the operation of the various components of the control circuitry. Depending upon customer requirements, the control circuit may vary. Always refer to the schematic diagram for the specific equipment in question.

3.4.1 AUXILIARY SWITCH

The auxiliary switch (Figure 3,5) is a multi stage switch used to operate those circuits which are dependent upon the position of the breaker contacts. The schematic diagrams of Figures 1Ø and 11 indicate how each of the auxiliary switch stages are interconnected with the breaker circuitry. The function of each stage is discussed below.

a. Two a-type auxiliary contacts are connected in series with the trip coil (TC). (NOTE: For 25ØVDC control three a-type contacts are employed.) Since these stages are open when the breaker is in the open position, the auxiliary contacts de-energize the trip coil when the breaker is in the open position.

b. The b-type contact connected in series with the closing coil (X) de-energizes the closing coil when the breaker contacts are in the closed position.

c. As shown, a number of a-type and b-type contacts are provided for optional use.

3.4.2 MOTOR LIMIT SWITCH

The motor limit switch (LS) (Figure 3,2) energizes the motor relay (Figure 3,6) when a drive spring charging operation is required and de-energizes the motor relay when the drive springs (Figure 4,6) reach the fully charged position. As shown in the schematic diagrams of Figures 1Ø and 11, the motor limit switch is connected in the normally open position. Whenever the drive springs are not in the fully charged position, the motor limit switch is activated.

3.4.3 MOTOR RELAY

When energized by the closing of the motor limit switch (LS) (Figure 3,2), the motor relay (MR) (Figure 3,6) energizes the spring charging motor (M) (Figure 3,8) through a pair of normally open contacts and disables the closing coil (X) (Figure 4,7) through a pair of normally closed contacts.

3.4.4 ANTI-PUMP RELAY

The anti-pump relay (Figure 3,7) insures that, should the closing coil (X) circuit remain continuously energized the drive springs will not be continuously charged and discharged. The anti-pump relay performs this function by allowing the closing coil to be activated only if the circuit is energized after the drive springs have reached the fully charged position and the motor relay (MR) has been de-energized.

The anti-pump relay will be activated if the close circuit is energized and the motor relay (MR) is energized. If the close circuit is energized continuously, the anti-pump relay will be latched in the energized position after the motor relay is de-energized by a pair of its own normally open contacts. When the anti-pump relay is energized, a pair of its normally closed contacts, in series with the closing coil, insure that the closing coil cannot be energized. The closing coil cannot be activated unless the closing circuit is first de-energized (de-energizing the anti-pump relay), then closed again.

3.4.5 Latch Check Switch

The latch check switch (Figure 3,4) allows the breaker to be used for instantaneous reclosing. The contacts of the latch check switch are connected in series with the closing coil (X). The latch check switch is actuated by the guide cam (Figure 5,4) whenever the guide cam is not in its normal position. Thus, the closing circuit cannot be energized until the guide cam has fully returned to its normal position and the mechanism is in position to allow a close operation.

3.5 Indicators

Two indicators are provided on the operating mechanism. The open-close indicator (Figure 1,11) designates the state (opened or closed) of the vacuum interrupter contacts. The charge-dischage indicator (Figure 1,12) displays the state (charged or discharged) of the drive springs (Figure 4,6).

3.6 Manual Charging

The drive springs (Figure 4,6) can be manually charged by using the handle supplied with the breaker to move the manual charging arm (Figure 1,8) up and down until the drive springs are fully charged. The drive springs are fully charged when the charge-discharge indicator (Figure 1,12) reads charged and the manual charging arm no longer advances the gear.

3.7 Slow Closing Feature

For some users it may be desirable to manually slow close the circuit breaker. For such purposes, the operating mechanism provides a built-in slow closing feature. Manual slow closing is accomplished as follows:

a. With the breaker in the open position and the drive springs discharged, slide the manual charging handle onto one of the drive spring brackets as shown in Figure 6. Press up on the manual charging handle just enough to off load the drive spring and remove pin A (Figure 6,2). Release the drive spring pressure. Perform the same operation on the other drive spring.

b. Using the manual charging handle as described in Section 3.6, advance the gear (Figure 7,4) until the drive pawl (Figure 7,2) rides up on the lift cam (Figure 7,3). Remove the manual charging handle.

c. While pressing down on the close lever (Figure 8,1) use a 1" open-end wrench to rotate the drive shaft until the drive pawl clears the lift cam and once again engages the gear. (See Figure 8 for use of the wrench. Press down on the wrench to achieve the correct direction of rotation.)

d. Release the close lever. Remove the 1" wrench.

e. Continue use of the manual charging handle to perform a manual charging operation. The breaker will slowly close with each advance of the gear.

3.8 Drawout Operation

IMPORTANT: THE BREAKER MUST BE IN THE OPEN POSITION WHENEVER IT IS RACKED IN OR OUT OF ITS CUBICLE. THE RACKING SHUTTER (FIGURE 1,1) IS INTERLOCKED WITH THE BREAKER MECHANISM SUCH THAT IT BLOCKS ACCESS TO THE RACKING PORT (FIGURE 1,2) ANYTIME THE BREAKER IS IN THE CLOSED POSITION. TO ACCESS THE RACKING PORT, PLACE THE BREAKER IN THE OPEN POSITION.

3.8.1 RACKING IN PROCEDURE

1. Check that the breaker racking arms (Figure 1,9) are in the "drawout position" before inserting the breaker into the cell. In the drawout position the racking arms are extended towards the rear of the breaker and are just below the horizontal.

2. If required, move the racking arms to the drawout position by:

   a. Place the breaker into the open position.

   b. Insert the racking handle into the racking port (Figure 1,2).

   c. Rotate the racking handle counterclockwise until the racking mechanism comes to a stop. Do not over torque.

3. Insert the breaker into the cell until the rollers on the racking arms come into contact with the channels on the sides of the cell.

4. Rotate the racking handle clockwise until the racking mechanism stops. Do not over torque.

RACKING OUT PROCEDURE

1. Place the breaker into the open position.

2. Insert the racking handle into the racking port (Figure 1,2).

3. Rotate the racking handle counterclockwise until the racking mechanism stops. Do not over torque.

4. Press down on the test position interlock (Figure 1,4) at the lower left front of the breaker and roll the breaker out of the cell.

3.9 Test Position Operation

The secondary disconnect (Figure 2,3) is mounted on a retractable slide so that it can be connected to the control circuit of the cell while the cell shutters are down and the primary connections have not been made. This provides a convenient and safe method for electrically testing the operation of the breaker mechanism and control circuit. Test position operation is achieved by:

1. Insert the breaker into the test position of the cell by following steps 1 through 3 of the "Racking In Procedure" outlined in Section 3.8.1. (Do not rack the breaker into the cell.)

2. Pull the secondary disconnect handle (Figure 1,7) out of its retaining clip and rotate it down so that is protruding straight out from the breaker.

3. Lift slightly on the secondary disconnect handle and push it into the breaker until connection is made.

4. The control circuit of the breaker is now connected with that of the cell.

5. The secondary disconnect may be retracted by reversing the above procedure.

4. OPERATING MECHANISM-DESCRIPTION OF OPERATION

The following is a description of the operating mechanism. This manual will refer to the operating mechanism as the front of the breaker. The terms left and right will be used as if facing the operating mechanism. The terms clockwise and counterclockwise will be used as if facing the left side of the breaker.

4.1 Drive Spring Charging

Assume that the interrupter contacts are in the open position and that the drive springs (Figure 4,6) and the return springs (Figure 4,1) are discharged. When power is supplied to the breaker control circuitry, the charging motor (Figure 3,8) is energized. The eccentric mounted on the charging motor shaft drives the ratchet arm (Figure 4,5) backward and forward. With each forward stroke of the ratchet arm, the spring loaded drive pawl (Figure 7,2) mounted on the ratchet arm, engages a tooth on the gear (Figure 7,4) and advances the gear a few degrees clockwise. The holding pawl holds the gear in position while the drive pawl makes its reverse stroke to engage another tooth. The gear is free to rotate on the drive shaft (Figure 7,5).

As the gear is advanced, the drive pin, mounted on the face of the gear, engages the lift cam (Figure 7,3) and rotates the lift cam. The lift cam is keyed to the drive shaft. The drive shaft thus rotates with the lift cam.

The crank arms (Figure 4,4) rotate with the drive shaft and pull the drive springs to the charged position. As the spring loads against the crank arms pass top dead center and attempt to discharge, the closing roller (Figure 5,3) on the drive cam (Figure 5,2) contacts the close cam (Figure 5,1) and the drive springs are held in this charged position until a closing operation is initiated.

When the drive springs reach the fully charged position, the charging motor limit switch contacts open de-energizing the charging motor. Simultaneously, the raised surface on the lift cam lifts the drive pawl above the gear. This arrangement allows the charging motor and ratchet arm to coast smoothly to a stop.

4.2 Closing Operation

Once the drive springs (Figure 4,6) have been charged, the breaker can be closed by energizing the closing coil (Figure 4,7) or by manually pressing the close lever. This disengages the close cam (Figure 5,1) from the closing roller and allows the drive springs to discharge. The discharging drive springs rotate the drive shaft (Figure 7,5) counterclockwise. The counterclockwise rotation of the drive shaft gives the drive cam (Figure 5,2) a counterclockwise rotation.

The drive cam follower (Figure 5,6) is pushed downward by the rotation of the drive cam and, through linkage to the mainshaft (Figure 7,7), causes a downward motion of the mainshaft. The downward motion of the mainshaft charges the return springs (Figure 4,1) and pushes the front of the rocker arms (Figure 2,7) downward. The resulting upward motion of the rear of the rocker arms closes the vacuum interrupter contacts and charges the bias springs (Figure 9,2).

The counterclockwise rotation of the drive shaft also rotates the lift cam out of contact with the drive pin. Since the gear rotates freely on the drive shaft, the gear remains stationary. The rotation of the lift cam allows the drive pawl to engage the gear. The motor limit switch energizes the charging motor which once again charges the drive springs.

4.3 Opening Operation

With the return springs charged, the operating mechanism is now ready to perform an opening operation. If the open lever (Figure 1,5) is pushed or if the opening coil (Figure 3,3) is energized, the trip cam (Figure 5,5) will be rotated counterclockwise away from the guide cam (Figure 5,4). The force of the charged return springs pulling up on the mainshaft will cause the guide cam to move out toward the front of the mechanism and allow the drive cam follower (Figure 5,6) to collapse off the top of the drive cam. The mainshaft will be pulled upward, pulling the front of the rocker arms (Figure 2,7) upward. The resulting downward motion of the rear of the rocker arms opens the vacuum interrupter contacts.

5. MAINTENANCE

For safety, always remove the breaker from its cubicle and discharge the drive springs (Figure 4,6) and the return springs (Figure 4,1) before performing any maintenance or repair work.

Because of the wide variations in operating uses and environments, each operating company should develop a maintenance schedule, based on operating experience, which will provide assurance of proper breaker condition. Until such a schedule is determined, it is recommended that breakers be inspected after three years, or every 3000 operations, whichever occurs first. It is also recommended that breakers be inspected after severe fault operations and notation of any contact erosion be recorded (See section 5.1).

5.1 Vacuum Interrupters

To assure reliable interruption, perform the following two checks:

a. Contact erosion: Any contact erosion will result in a reduction of the spring overtravel. Contact erosion can therefore be determined by closing the breaker and measuring the spring overtravel. The spring overtravel is represented by dimension "E" in Figure 9. The difference between this measurement and the original spring overtravel setting at the time the interrupter was first put into service represents contact erosion.

The factory set spring overtravel (Dimension "E") for a new breaker rated 23KA or less maximum interrupting is .188". For a new breaker rated above 23KA maximum interrupting the Dimension "E" setting is .210". End of life for the vacuum interrupter is reached when the spring overtravel has been reduced to .060" on a breaker rated 23KA or less maximum interrupting or .085" on a breaker rated above 23KA maximum interrupting.

b. Hi-pot test: Hi-pot test the circuit breaker in accordance with the instructions provided in Section 2, paragraph 4.

5.2 Insulating Surfaces

Using a clean, dry cloth, remove all dirt and moisture from insulating parts.

5.3 Mechanism

The entire breaker and operating mechanism should be inspected for loose hardware and worn or broken parts. All wiring should be checked for loose connections and damaged insulation. Inspect all bearings and contact surfaces for damage or excessive wear.

5.4 Lubrication

It should be noted that all bearings used in this series of vacuum circuit breakers are sealed and do not require lubrication.

The lubrication chart below provides the location of all lubrication points and the method of lubrication required. Lubrication is performed after 3000 operations or three years, whichever occurs first.

Severe operating conditions may warrant different lubrication intervals and procedures. Variations should be based on the experience of the operating company.

It is recommended that the breaker be manually operated several times after lubrication and observed for proper operation.

LUBRICATION CHART

LUBRICATION POINT	METHOD Lubrication at Maintenance Period
Gear Teeth.	Wipe clean and apply lubricant*
Contact surfaces on guide cams & trip latch.	Wipe clean and apply lubricant.
Motor eccentric and eccentric roller.	Wipe clean and apply lubricant to slot in ratchet arm.
Silver plated primary disconnect contacts and grounding contacts.	Wipe clean and apply a high quality conductive contact lubricant, such as Square D Co. #PJC 7201.

*It is recommended that a high grade, heavy duty lubricant, such as Lubriplate #630-2 be used.

5.5 Electrical

Insure that all electrical connections are tight and clean.

6. RENEWAL PARTS

6.1 Minimum Requirements

Sufficient renewal parts should be maintained in stock to assure prompt replacement of worn, broken or damaged parts. A list of factory recommended renewal parts is provided below.

Because of the wide variation in operating uses and environments, the recommended renewal parts are presented only as a minimum requirement. Each operating company should develop its own renewal parts stock, based on operating experience, which will provide assurance of proper breaker condition.

DESCRIPTION	MIN. QTY.	PART NO.
Vacuum Interrupter 500MVA	1	WL35188
Vacuum Interrupter 750MVA	1	WL34999
Open Solenoid	1	2021D3
Close Solenoid	1	2022D3
Charging Motor 120VAC/DC	1	50501
Charging Motor 230VAC/DC	1	50511
Charging Motor 48VDC	1	50521
Anti Pump Relay	1	2033D3
Motor Relay	1	2032D3
Motor Limit Switch	1	9001-KA2
Auxiliary Switch	1	102112LH

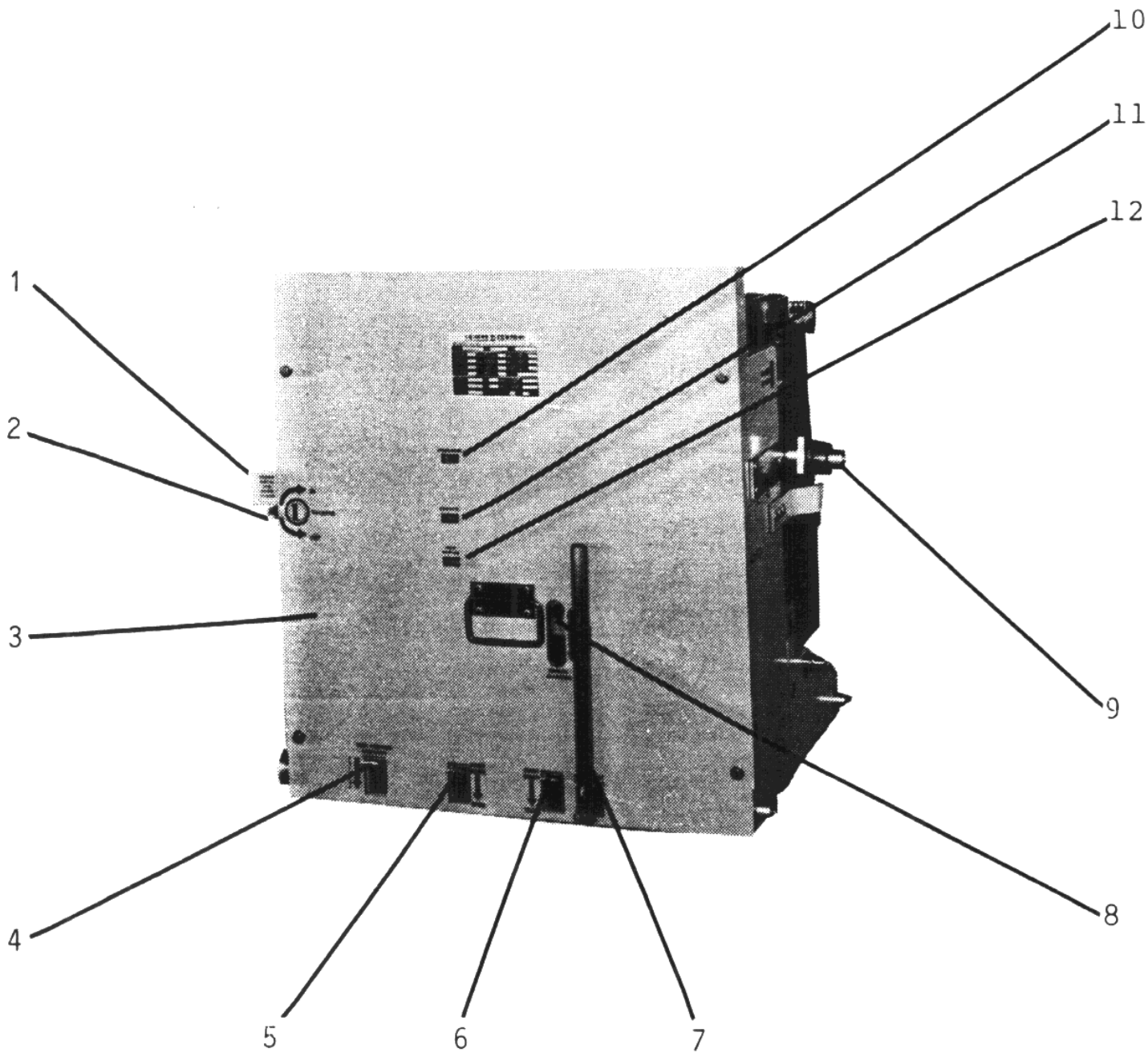
6.2 Ordering Instructions

When ordering renewal parts:

1) Always specify the complete rating information and breaker serial number.

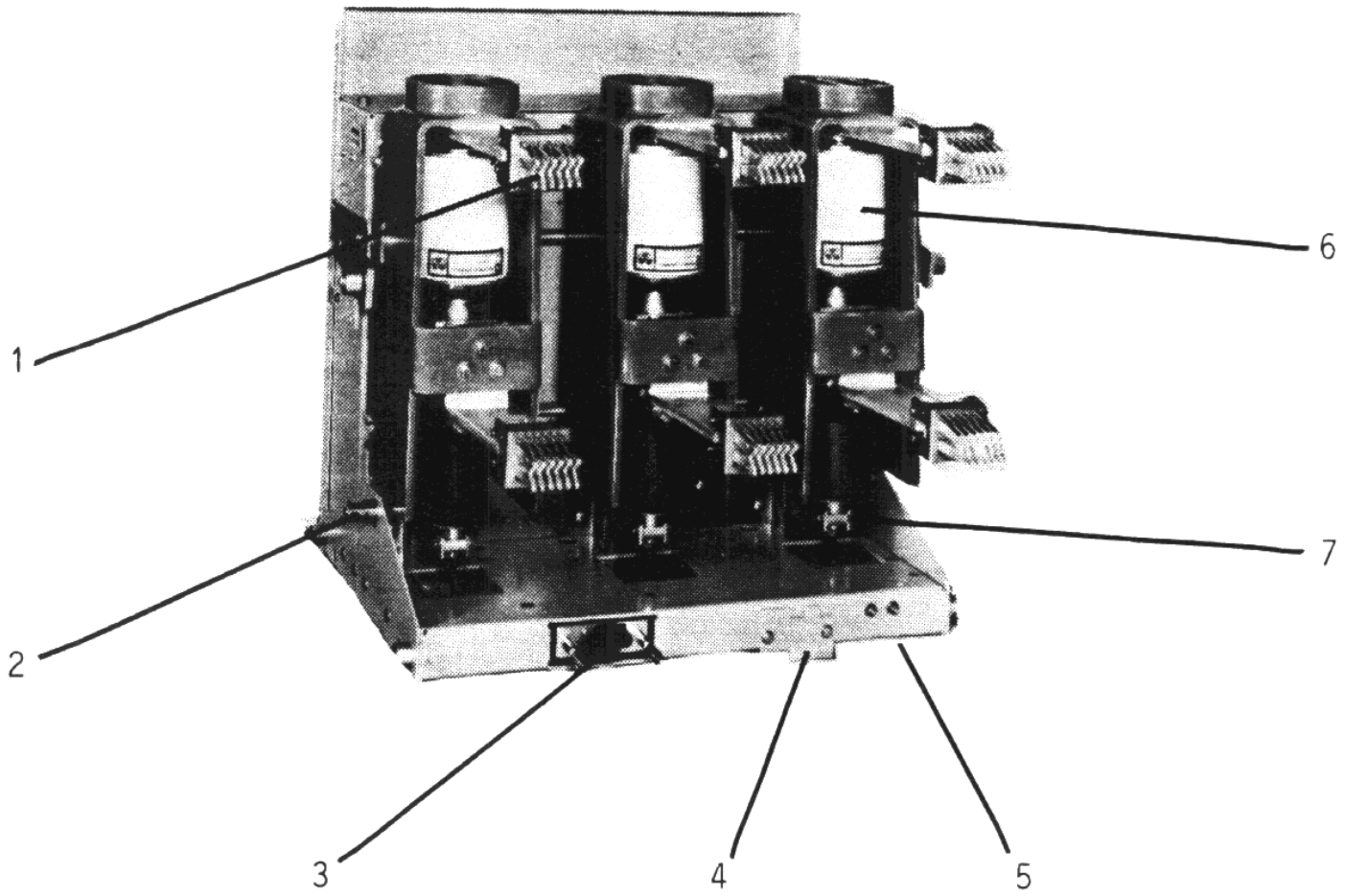
2) Specify part number, description of part, and the catalog from which this information is taken.

3) For electrical components, specify operating voltage.



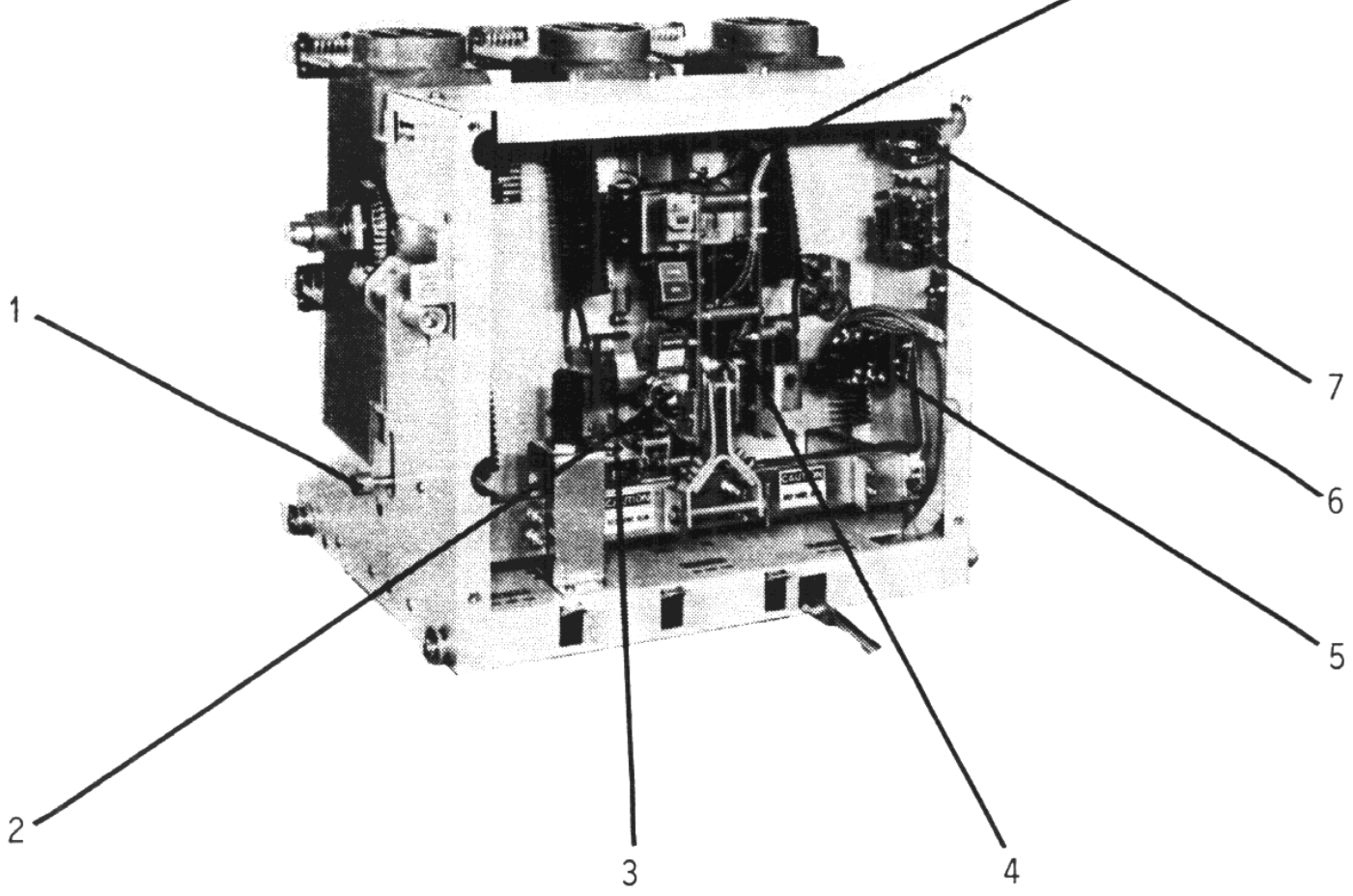
1. RACKING SHUTTER
2. RACKING PORT
3. FRONT MECHANISM COVER
4. TEST POSITION INTERLOCK
5. OPEN LEVER
6. CLOSE LEVER
7. SECONDARY DISCONNECT HANDLE
8. MANUAL CHARGING ARM
9. RACKING ARM
10. COUNTER
11. OPEN-CLOSE INDICATOR
12. CHARGE-DISCHARGE INDICATOR

FIGURE 1



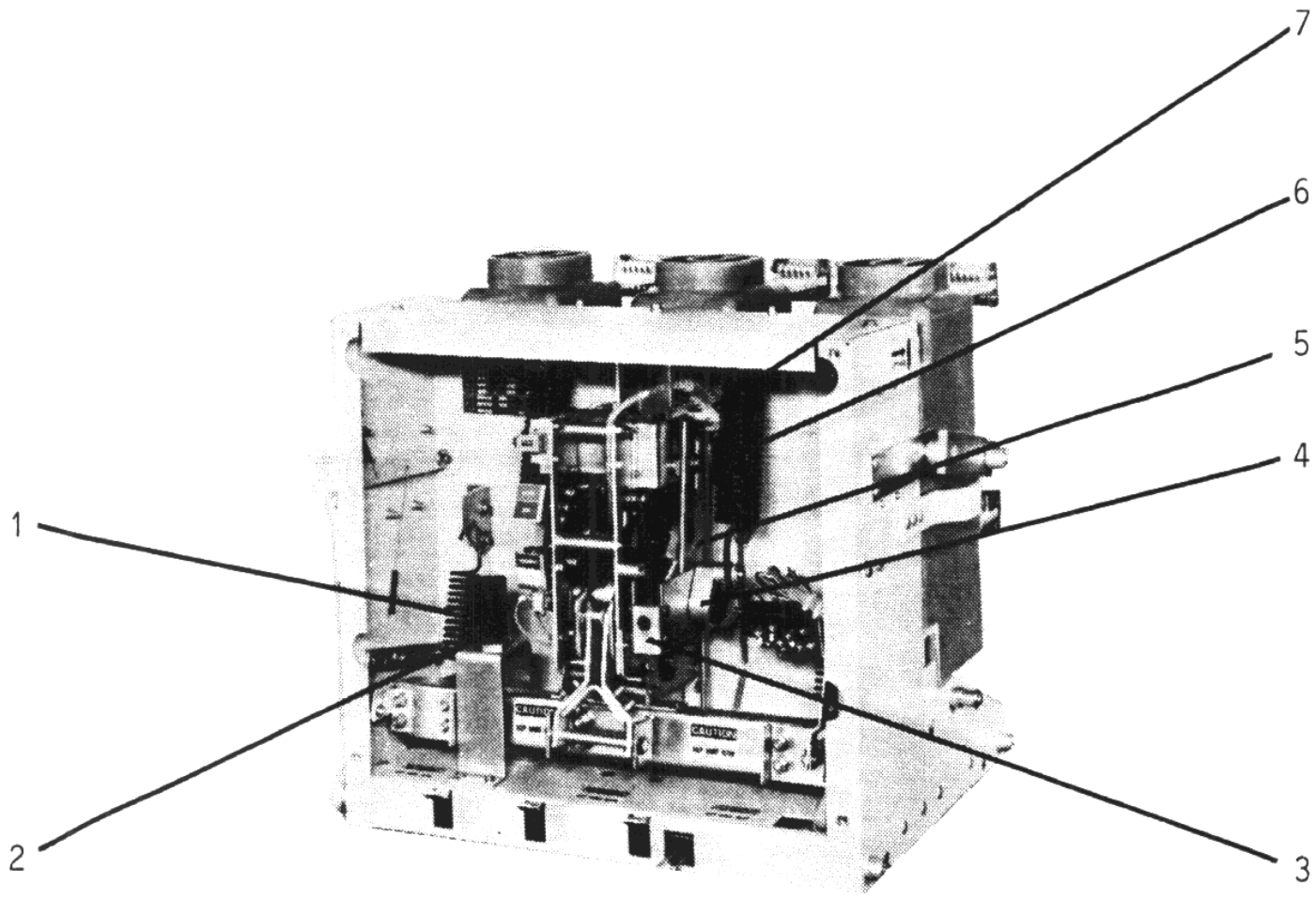
1. PRIMARY DISCONNECT
2. SHUTTER ROLLER
3. SECONDARY DISCONNECT
4. CODE PLATE
5. GROUND CONTACT
6. VACUUM INTERRUPTER
7. ROCKER ARM

FIGURE 2



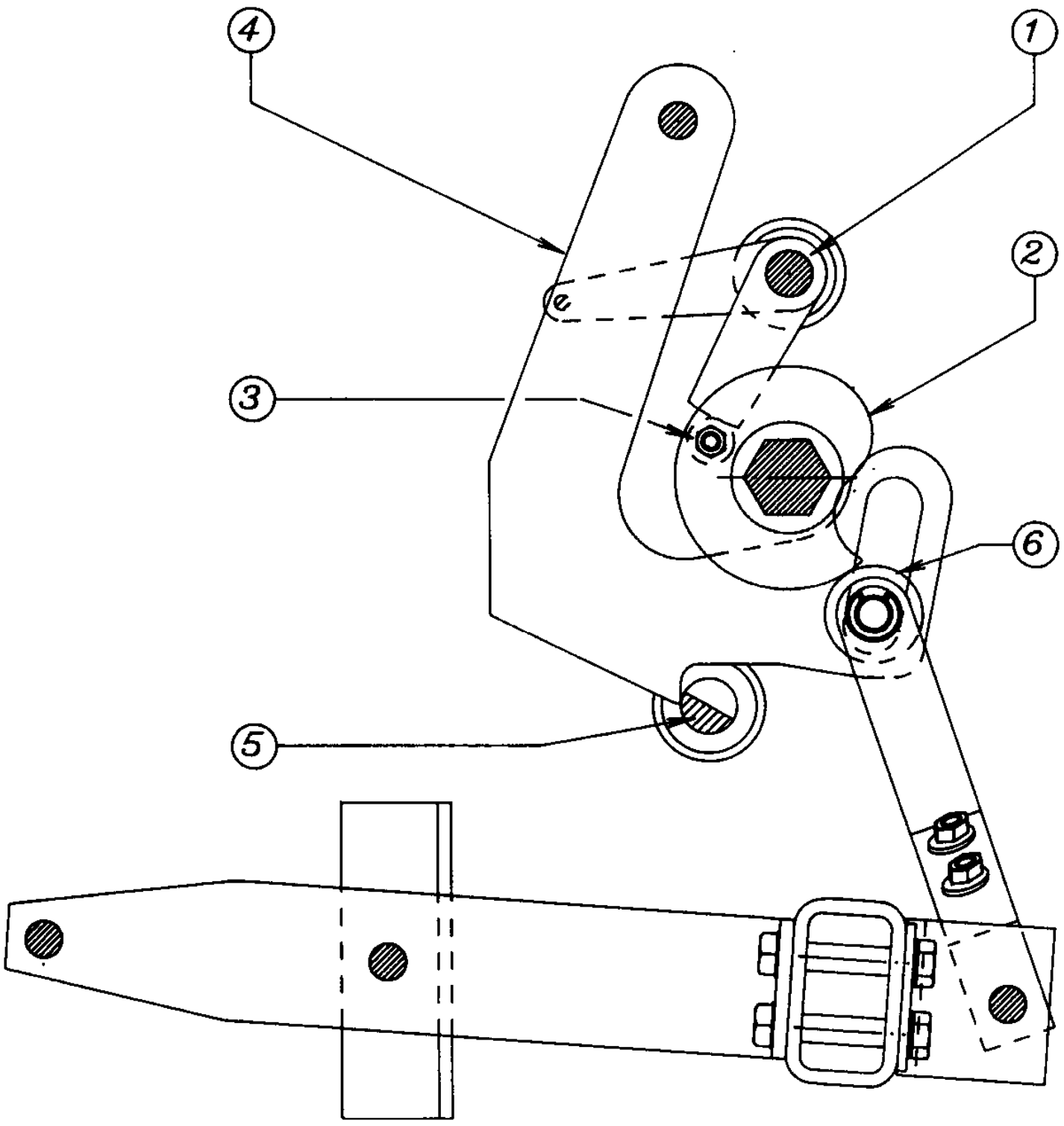
1. MOC OPERATOR
2. MOTOR LIMIT SWITCH
3. OPENING COIL
4. LATCH CHECK SWITCH
5. AUXILIARY SWITCH
6. MOTOR RELAY
7. ANTI-PUMP RELAY
8. SPRING CHARGING MOTOR

FIGURE 3



1. RETURN SPRING (Two Places)
2. SHOCK ABSORBER
3. MANUAL CHARGING ARM
4. CRANK ARM (Two Places)
5. RATCHET ARM
6. DRIVE SPRING (Two Places)
7. CLOSING COIL

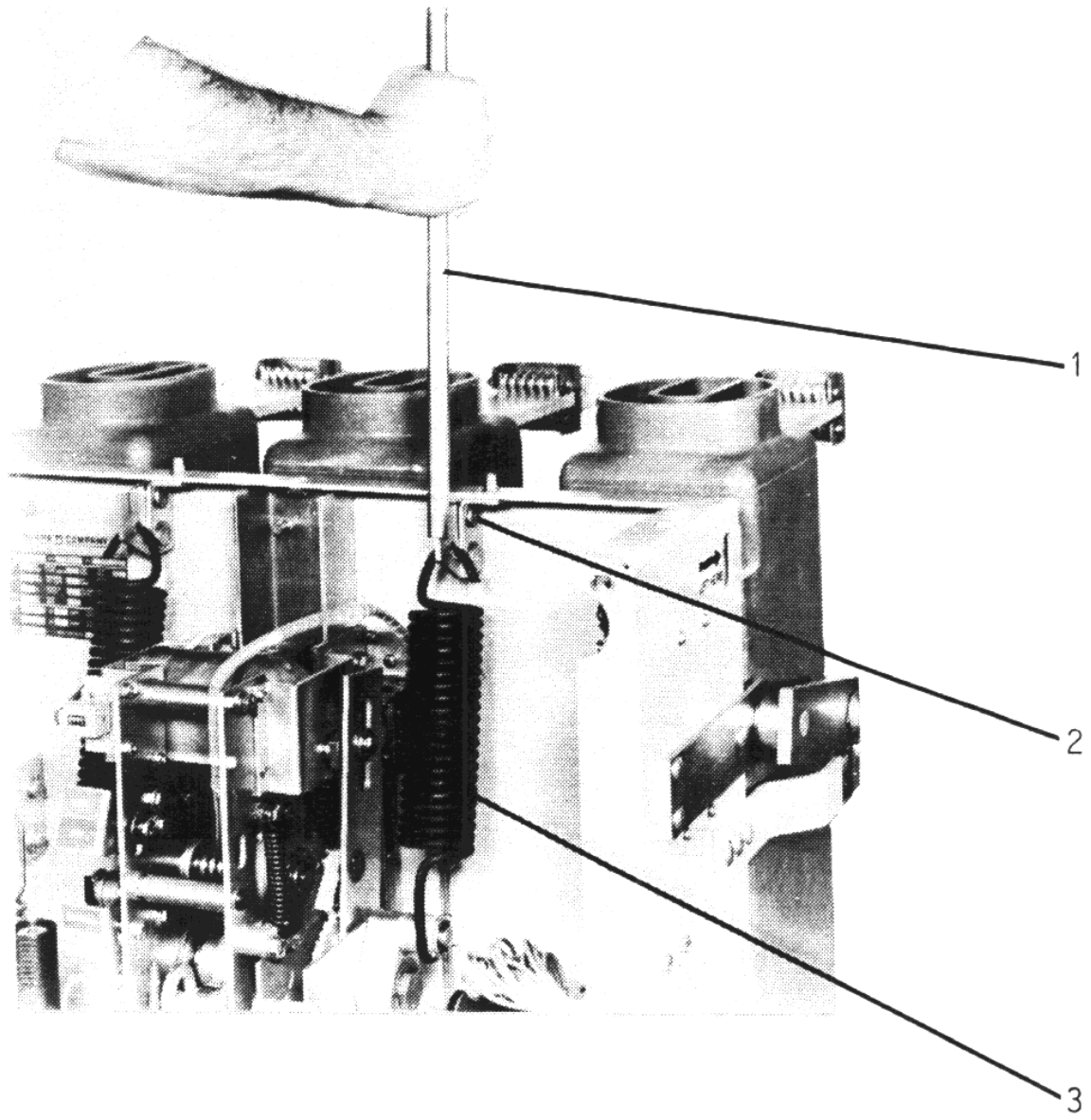
FIGURE 4



1. *CLOSE CAM*
2. *DRIVE CAM*
3. *CLOSING ROLLER*
4. *GUIDE CAM*
5. *TRIP CAM*
6. *DRIVE CAM FOLLOWER*

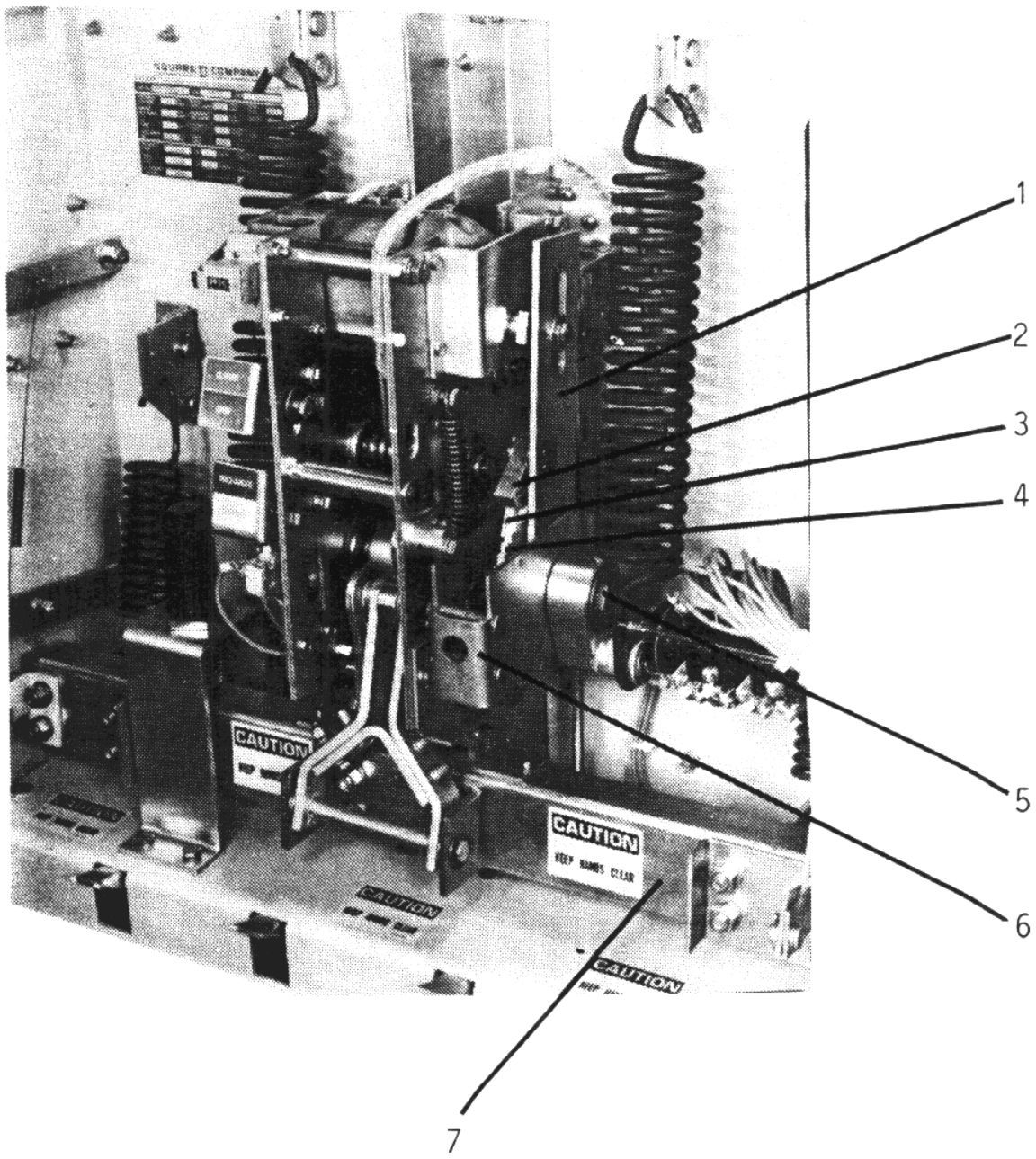
MECHANISM SIDE VIEW (CUTAWAY)
(SHOWN IN CLOSED POSITION)

FIGURE 5



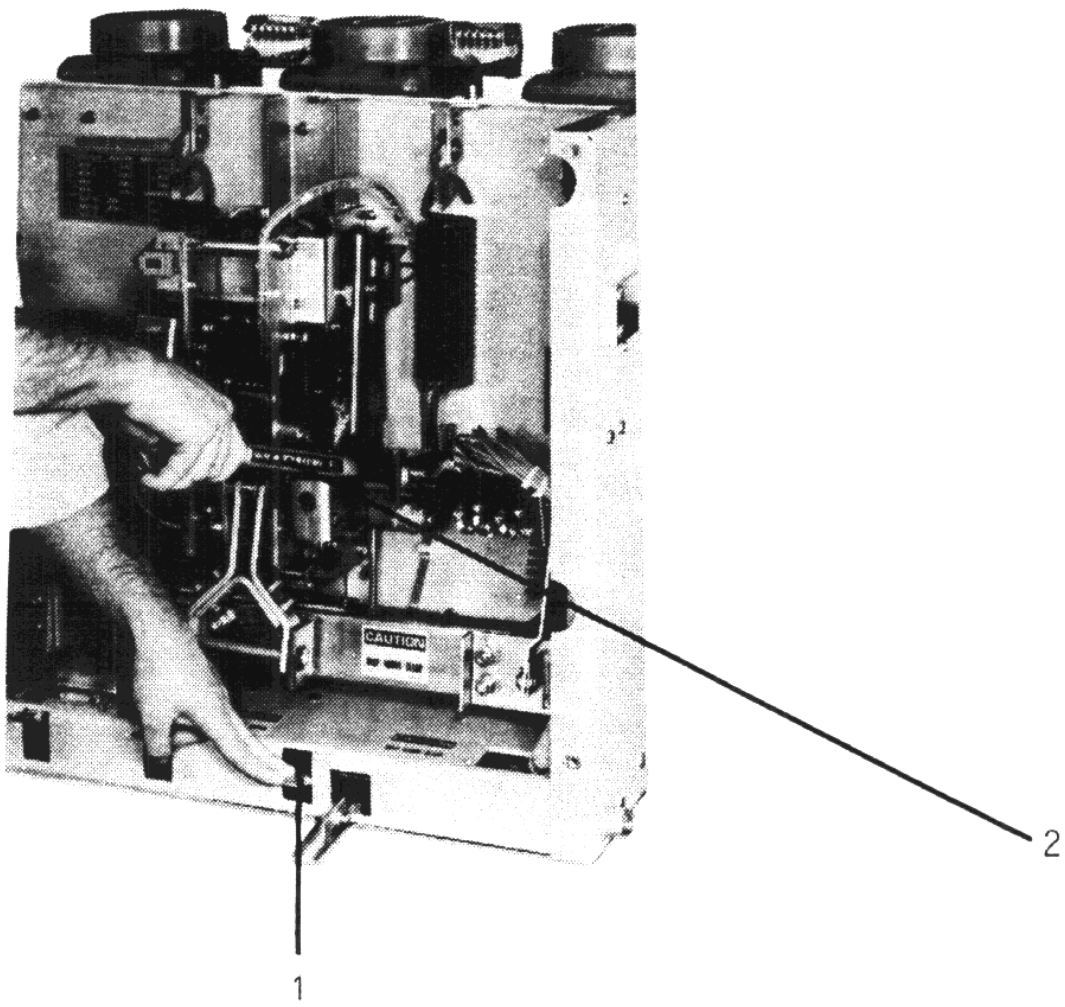
1. MANUAL CHARGING HANDLE
2. PIN A
3. DRIVE SPRING

FIGURE 6



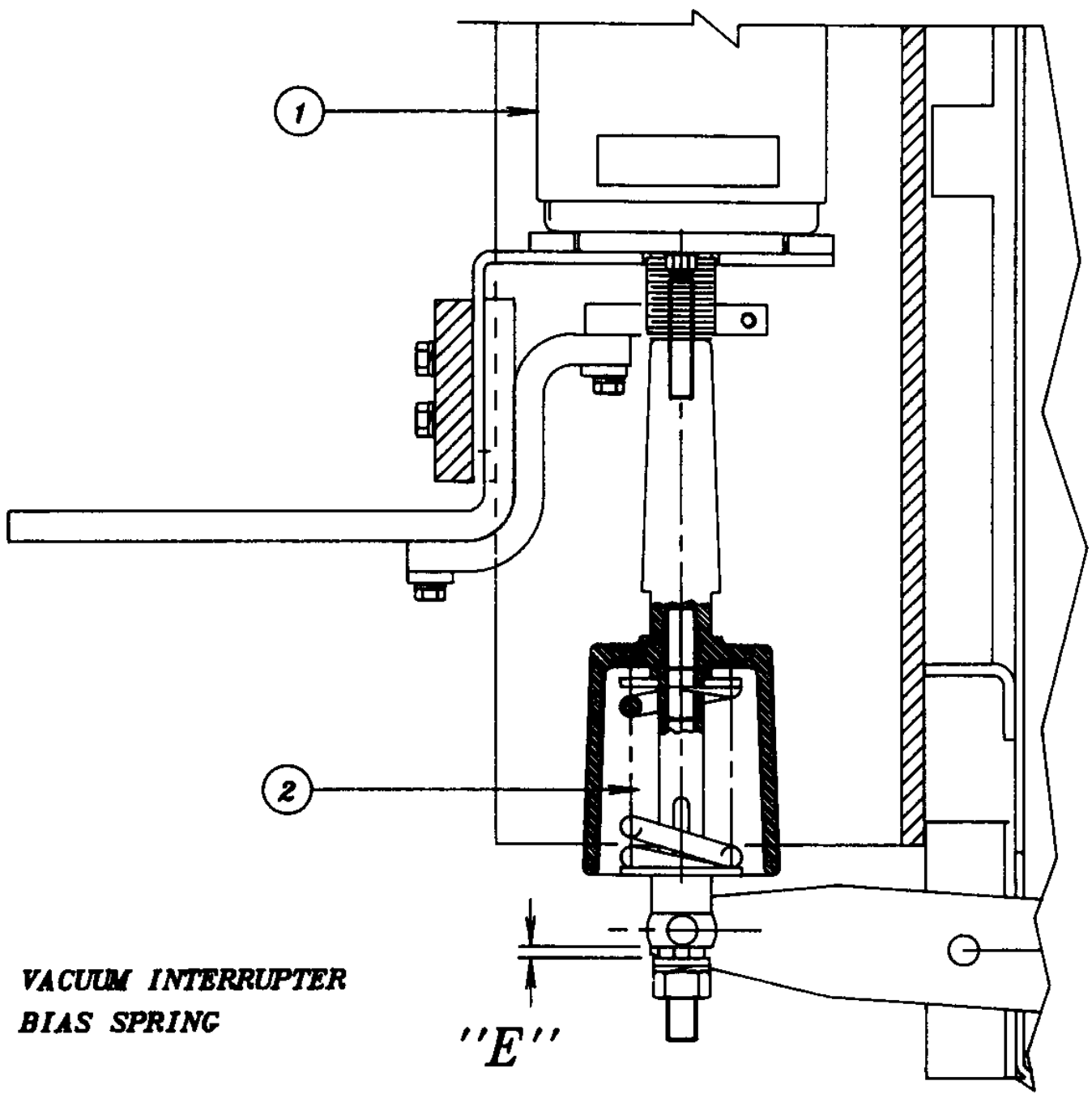
1. RATCHET ARM
2. DRIVE PAWL
3. LIFT CAM
4. GEAR
5. DRIVE SHAFT
6. MANUAL CHARGING ARM
7. MAINSHAFT

FIGURE 7



1. CLOSE LEVER
2. 1" WRENCH

FIGURE 8

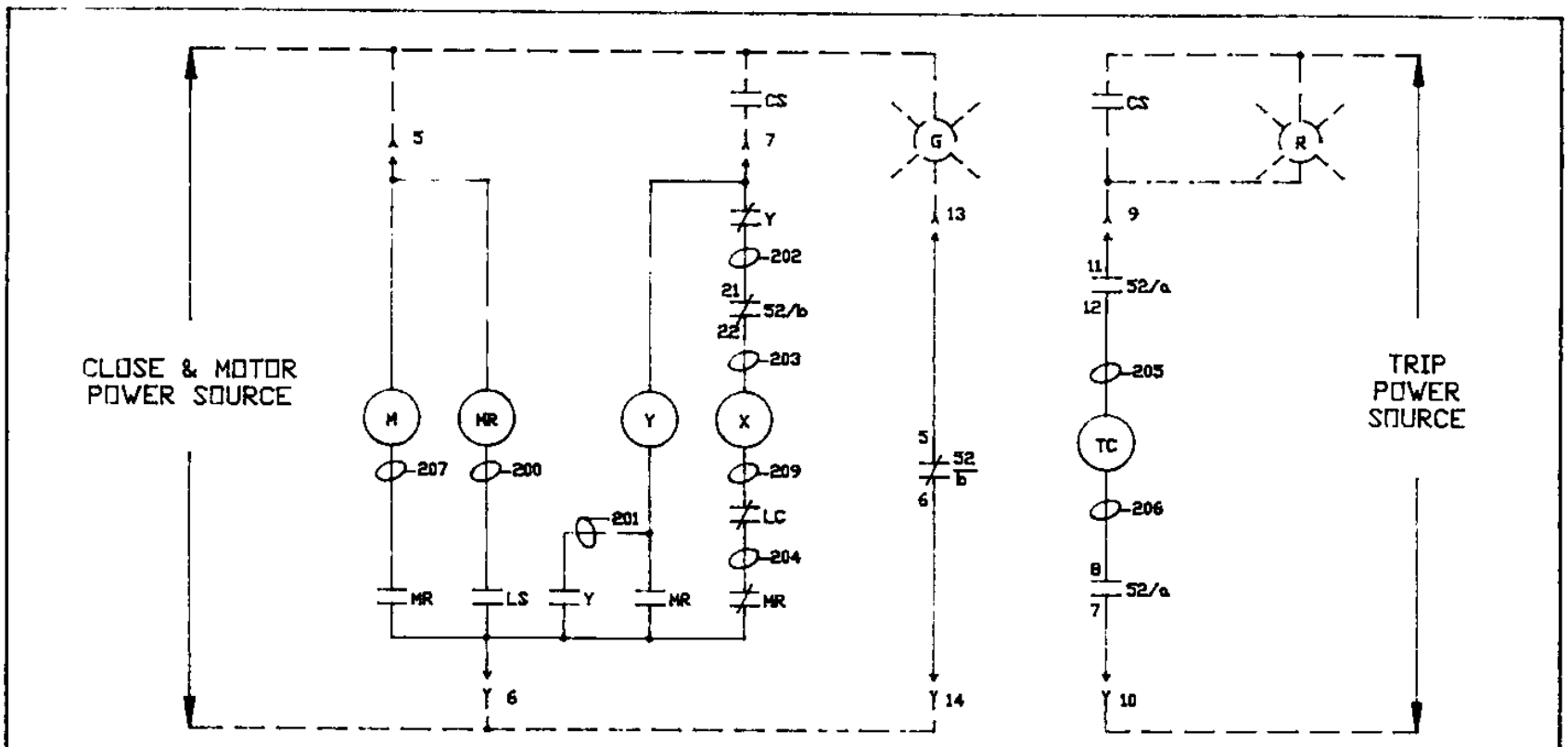


1. VACUUM INTERRUPTER
2. BIAS SPRING

VAD 3 VACUUM INTERRUPTER ASSEMBLY

SIDE VIEW (CUTAWAY)

FIGURE 9

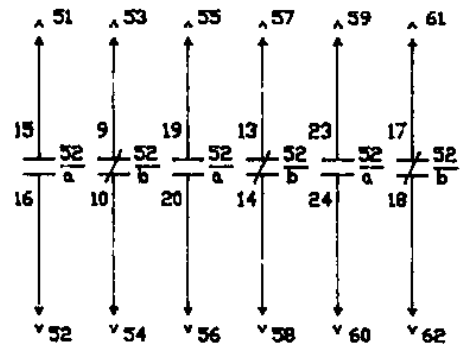


LEGEND:

52	VACUUM CIRCUIT BREAKER
M	SPRING CHARGING MOTOR
LS	SPRING CHARGING MOTOR LIMIT SWITCH
TC	TRIP COIL (OPENING COIL)
X	SPRING RELEASE COIL (CLOSING COIL)
Y	ANTI-PUMP RELAY
MR	MOTOR RELAY
52/a	AUX. SWITCH CONTACTS, OPEN WHEN BREAKER IS OPEN
52/b	AUX. SWITCH CONTACTS, CLOSED WHEN BREAKER IS OPEN
LC	LATCH CHECK SWITCH

FOR CONTROL VOLTAGE:

TRIP	24V, 48V, 125V DC - 120V AC
CLOSE	48V, 125V, 250V DC - 120V, 230V AC



AUXILIARY CONTACTS

SECONDARY DISCONNECT WIRING

(CIRCUIT BREAKER SIDE CONNECTION VIEW)

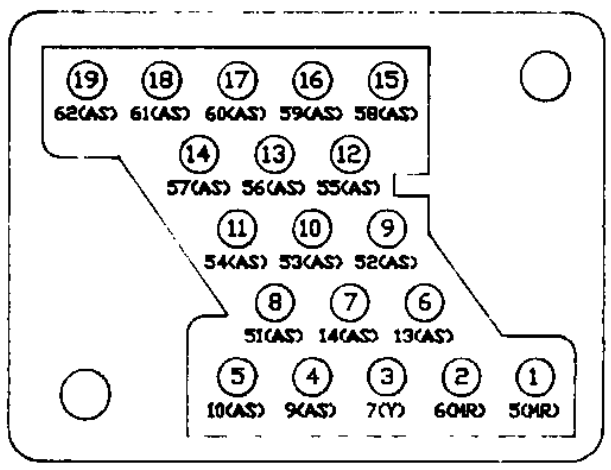
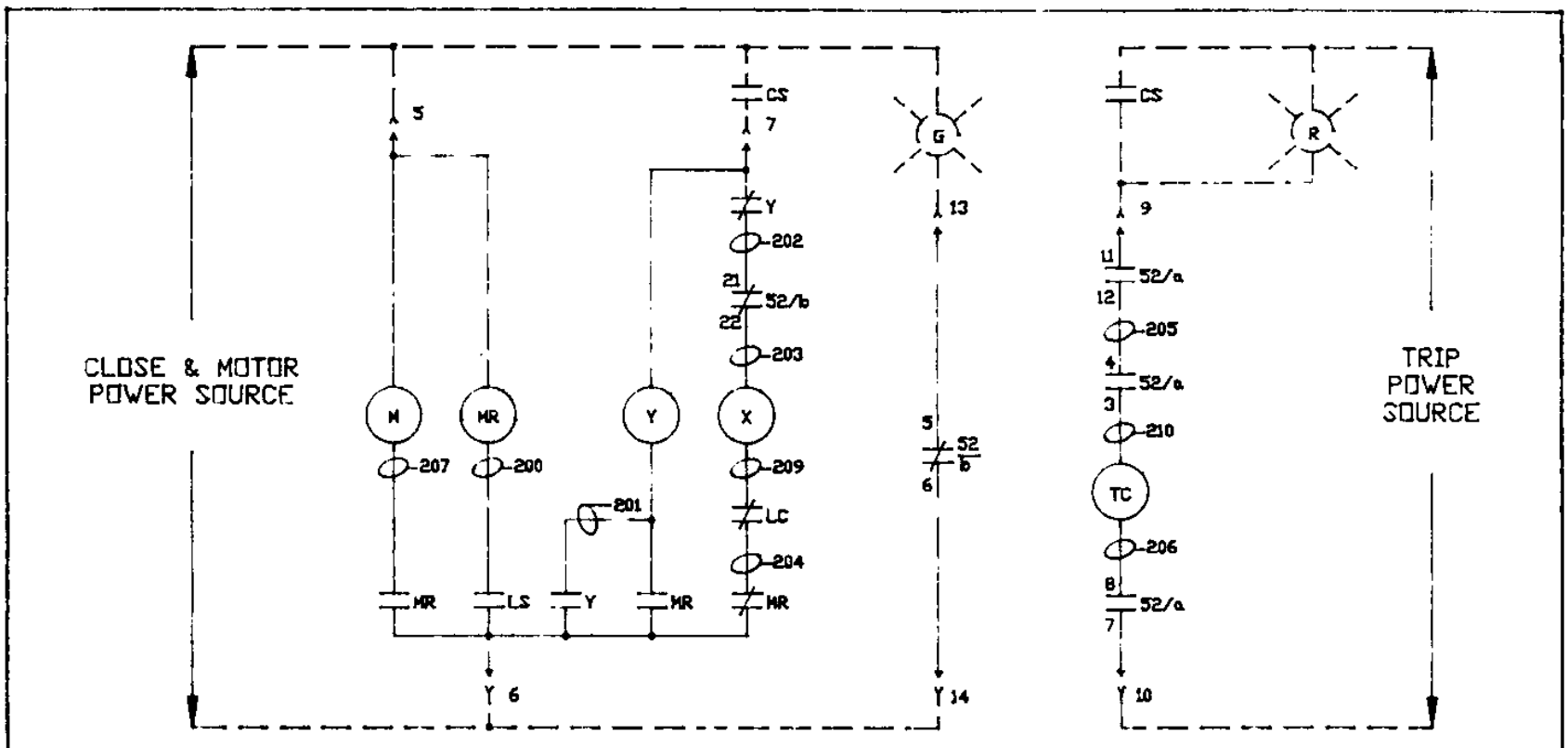


Figure 10

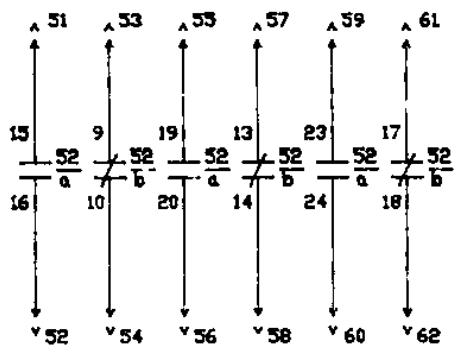


LEGEND:

52	VACUUM CIRCUIT BREAKER
M	SPRING CHARGING MOTOR
LS	SPRING CHARGING MOTOR LIMIT SWITCH
TC	TRIP COIL (OPENING COIL)
X	SPRING RELEASE COIL (CLOSING COIL)
Y	ANTI-PUMP RELAY
MR	MOTOR RELAY
52/a	AUX. SWITCH CONTACTS, OPEN WHEN BREAKER IS OPEN
52/b	AUX. SWITCH CONTACTS, CLOSED WHEN BREAKER IS OPEN
LC	LATCH CHECK SWITCH

FOR CONTROL VOLTAGE:

TRIP	250V DC
CLOSE	48V, 124V, 250V DC - 120V, 230V AC



AUXILIARY CONTACTS

SECONDARY DISCONNECT WIRING

(CIRCUIT BREAKER SIDE CONNECTION VIEW)

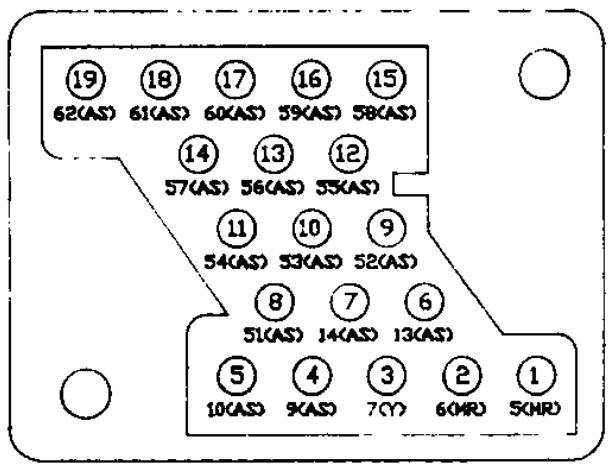


Figure 11