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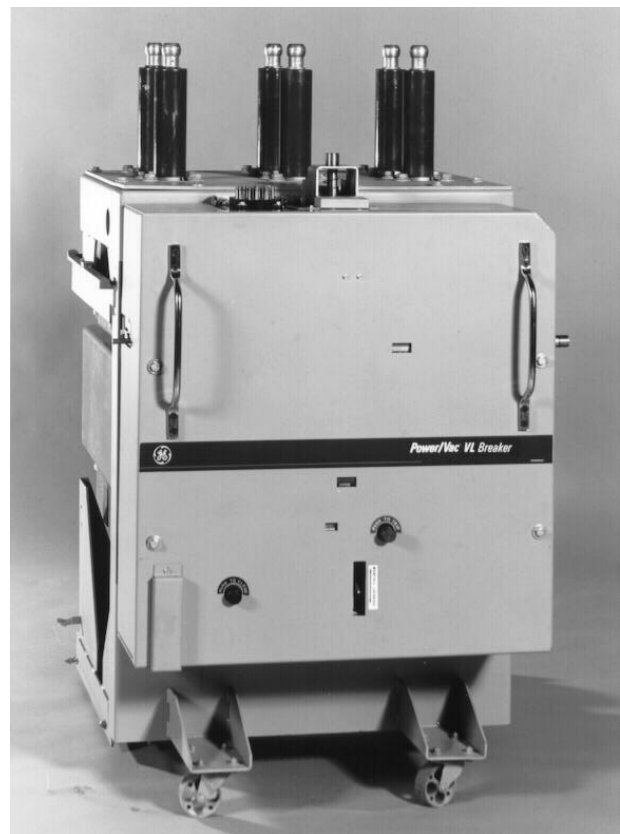
**GEH-6468A Instructions**

## **GE PowerVac<sup>®</sup> VL Vacuum Circuit Breaker**

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### **TYPE**

**PV-VL 13.8-500-0 and -1  
PV-VL 13.8-750-0 and -1  
PV-VL 13.8-1000-0 and -1  
With ML-18VL Mechanism**





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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 Seller.

To the extent required, the products described herein meet applicable ANSI, IEEE and NEMA standards, but no such assurance is given with respect to local codes and ordinances because they vary greatly.

## **POWER/VAC® VL VACUUM CIRCUIT BREAKER WITH ML-18VL MECHANISM**

### **1. INTRODUCTION**

#### **1.1. SAFETY**

**IT IS IMPERATIVE THAT ALL PERSONNEL ASSOCIATED WITH THIS EQUIPMENT READ AND COMPLETELY UNDERSTAND THE WARNINGS LOCATED THROUGHOUT THIS INSTRUCTION BOOK. FAILURE TO DO SO CAN RESULT IN DAMAGE TO PROPERTY, PERSONAL INJURY OR DEATH.**

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 CONDUCTORS MUST BE ASSUMED TO BE ENERGIZED UNLESS THEIR POTENTIAL HAS BEEN MEASURED AS GROUND AND ADEQUATE CAPACITY GROUNDING ASSEMBLIES HAVE BEEN APPLIED TO PREVENT ENERGIZING. Many accidents have been caused by unplanned energization from non-recognized back feeds, equipment malfunctions, and from a wide variety of sources.
2. It is strongly recommended that all equipment be completely de-energized, verified to be "dead", then grounded with adequate capacity grounding assemblies prior to any maintenance. The rounding 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 of 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 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 equipment in general as well as the particular model of equipment which they are working.

Instruction books, actual devices and appropriate safety and maintenance practices such as 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.

It is strongly recommended that all equipment be completely de-energized, verified to be "dead", then grounded with adequate capacity grounding assemblies prior to any maintenance.

#### **2. DESCRIPTION**

The PowerVac® VL vacuum circuit breaker is a vertical lift, removable and interchangeable interrupting element, for use in metal-clad switchgear to provide protection and control of electrical apparatus and power systems. The PowerVac® VL Type PV-VL circuit breaker with ML-18VL mechanism

ism is available in continuous current ratings of 1200, 2000 and 3000 amperes in accordance with industry standards. In addition, extended ratings of 3500, (not part of the original Magnablast offering) and 4000 amperes is available as well as a 5000 ampere fan cooled option. Refer to the breaker nameplate for complete rating information of any particular breaker. The nameplate also describes the control power requirements for that breaker. The application of a breaker must be such that its voltage, current and interrupting ratings are never exceeded. Since this book is written to include all ratings of the breaker, as well as several design variations, the instructions will be of a general character and all illustrations will be typical unless otherwise specified.

### **3. RECEIVING, HANDLING AND STORAGE**

#### **3.1. RECEIVING**

Each breaker is carefully inspected before shipment. Immediately upon receipt of the circuit breaker, an examination should be made for any damage sustained in transit. If injury or rough handling is evident, a claim should be filed immediately with the transportation company, and the nearest GE Sales Office should be notified.

#### **3.2. HANDLING**

It is expected that care will be exercised during the unpacking and installation of breakers so that no damage will occur from careless or rough handling, or from exposure to moisture or dirt. Loose parts associated with the breaker are sometimes included in the same crate. Check all parts against the packing list to be sure that no parts have been overlooked.

#### **3.3. STORAGE**

It is recommended that the breaker be put into service immediately in its permanent location. If this is not possible, the following precautions must be taken to assure the proper storage of the breaker.

The breaker should be stored in a clean location, free from corrosive gases or fumes. Particular care should be taken to protect the equipment from moisture and cement dust, as this combination has a very corrosive effect on many parts.

Breakers should be carefully protected against condensation, preferably by storing in a warm, dry room of moderate temperature such as 40 to 100° F. High humidity may have an adverse effect on the insulating parts and should be avoided. Circuit breakers for outdoor metal-clad switchgear should be stored in the equipment only when power is available and the heaters are in operation to prevent condensation.

Rollers, latches, etc. of the operating mechanism should be coated with GE part No. 0282A2048P009 (Mobil 28 red) grease to prevent rusting.

If the breaker is stored for any length of time, it should be inspected periodically to see that corrosion has not started. Should the breaker be stored under unfavorable atmospheric conditions, it should be serviced before being placed on line.

#### **3.4 PACKING LIST**

With your breaker, you should have received:

1. Manual charging handle. (Part No. 0282A7227P001)
2. Gag tool. (Part No. 0209B8043G003)
3. Breaker Instruction Book - Contact your GE office for additional copies or verification of present revision.
4. (1) piece of edge protector (See section 4.1)
5. (12) wire ties. (See section 4.1)
6. Lower blocking plate and screws for lower notch in positive interlock cam plate in existing breaker cell units. (Kit # 254-089) NOTE: This assembly eliminates the test provision for closing the breaker in the cabinet, except in the "connect" position, as has been recommended to improve safety of the VL equipment.
7. Existing unit wiring and device WARNING NOTICE sheet.
8. (1) GE tool parts kit (0282A3060G003) with each breaker order of single or multiple breakers.
9. A spring discharge interlock cam - to be installed if none exists in your switchgear cell. NOTE: Customer option to implement, if required.
10. GE grease Part No. 0282A2048P009.

Contact your local GE office if you have not received the above materials.

#### 4. INITIAL INSTALLATION PROCEDURES

Although GE has made every effort to assure interchangeability and satisfactory interface with existing equipment, older equipment and field modifications made over the years, may require additional procedures before the new vacuum breaker can be installed in the cubicle.

##### 4.1 DOOR WIRING INTERFERENCE

In some of the older GE Metal-Clad switchgear units, the wiring from the door to the stationary structure was run through a perforated steel wire assembly grill. (Figure 1.)

As the new replacement breaker is elevated, the front cover MAY interfere with the subject wiring grill, approximately 4" to 6" before the final connected position.

The front cover shield on the replacement breaker is wider than all previous AM breaker units. Due to the large forces required to operate the existing stationary auxiliary switches, the operating mechanism cannot be decreased in width.

If this condition exists, use the modification kit shipped with the breaker and make the following modifications to the switchgear cubicle.

1. Cut out the bottom section of the grill as shown in figure 1 on page 12.
2. Cover the sharp edges with the edge protector furnished with the breaker accessories.
3. Fold any wire back and re-tie with the furnished wire ties.
4. Elevate the replacement breaker in accordance with the instructions.

##### 4.2 POSITIVE INTERLOCK TEST PROCEDURES

The positive interlock system functions to prevent closing the breaker contacts when the breaker is being raised or lowered and prevents raising or lowering the breaker when the breaker contacts are closed. In most AM breaker Metal-Clad Switchgear units, there is a breaker "Test Position" which allows you to functionally test the breaker without connecting to the bus. This position is usually about 5" out from the breaker being fully inserted into the cubicle. When in the "test position", a secondary coupler cable must be used to connect the secondary control circuits since the breaker is fully lowered position.

The lower "Vee" notch in the positive interlock cam plate allows closing and opening the breaker electrically.

**FOR IMPROVED SAFETY, IT IS RECOMMENDED THAT THE ABILITY TO FUNCTIONALLY OPERATE THE BREAKER IN THE "TEST" POSITION BE ELIMINATED AND THAT BREAKER FUNCTIONAL TESTING BE PERFORMED WITH THE BREAKER COMPLETELY REMOVED FROM THE CUBICLE.**

##### 4.3 BY-PASS KIT INSTALLATION

(See Figures 2 & 7).

The ability to electrically close and open the breaker in the "Test Position" is eliminated by covering the lower Vee notch in the positive interlock cam plate. Materials for accomplishing this modification are provided in Kit #254-089 furnished with the new vacuum breaker. This by-pass kit should be installed on GE breaker cubicles that have a lower interlock roller Vee notch on the positive interlock cam plate. Some GE breaker cubicles do not have this lower Vee notch on the interlock cam plate. In that case, the by-pass kit is not required. If additional by-pass kits are required for the remainder of the switchgear line-up, order Kit #254-089.

**WARNING: FAILURE TO FOLLOW THE INSTRUCTIONS BELOW COULD CAUSE A CLOSED BREAKER TO BE RAISED TOWARDS THE CONNECTED POSITION, CAUSING INJURY OR DEATH TO THE OPERATOR AND EXTENSIVE EQUIPMENT DAMAGE.**

To make the modification proceed as follows:

1. Remove the existing clutch switch cover plate and discard (save the mounting hardware).
2. Measure and record the distance from the bottom of the cam plate to the bottom of the switch operator bracket. See Figure 2.
3. Remove the existing switch operator bracket.
4. Install the new switch operator bracket supplied with the kit, using the two existing ¼ - 20 screws. Adjust the bracket in the exact same location as the removed bracket, in relation to the motor activation switch lever. Make sure that the lower notch in the positive interlock cam plate is covered and that the edge is even with the front edge of the positive interlock cam plate. (Figures 2 and 7.)

5. Drill two #22 (.157) diameter holes in the positive interlock cam plate from locations in new bracket supplied with kit. See Figure 2.

6. Install two #10-24 thread cutting screws (supplied with kit).

7. Install the new clutch switch cover plate supplied with the kit using the existing hardware.

8. All breaker cubicles that undergo this modification to the positive interlock cam plate must be checked according to the dimensions given in Figure 7.

a. The 10-7/8" +1/16" -0" dimension from the breaker to the front edge of the positive interlock cam plate must be verified and maintained prior to inserting a replacement PVVL vacuum breaker into the cubicle. See Figure 7(C).

b. The 1/16" clearance between the stationary flag, just behind the upper "Vee" notch and the interlock roller must be maintained or reset if required. The breaker should be in the fully raised position. See Figure 7(A).

#### **4.4 CHECKING FOR PROPER INTERLOCK AND**

##### **TRIP FREE FUNCTIONS BEFORE LOWERING THE BREAKER FROM THE ELEVATED POSITION.**

When the breaker is in the fully elevated and connected position, releasing the motor operating handle will return the positive interlock roller into the upper notch in the interlock cam plate, closing the interlock switches and energizing the circuit that will charge the springs. The breaker may now be closed.

In order to lower the breaker from the connected position, the breaker must be open. If the breaker is not open, the operator can not, and should not be able to engage the clutch or activate the motor circuit. The positive interlock roller will remain locked and will not allow the interlock cam plate to move vertically far enough to activate the elevating motor.

To test the function of the positive interlock system and trip free function, the following checks should be made:

1. With the breaker closed and in the elevated position, the positive interlock roller on the breaker

must remain locked and not allow the motor handle to be moved far enough to engage the clutch and close the clutch switch contacts that energize the motor circuit. There should be 1/16" clearance between the clutch and motor coupler, when the motor handle is pulled forward. See Figure 7(A).

2. Disconnect the elevating motor plug from its socket.

3. Trip the breaker to the open position.

4. Using the manual charging handle, charge the closing springs in the breaker until the semaphore shows "charged".

5. Pull back the elevating handle on the motor so that the interlock roller is at the dimension shown in Figure 7. (11/16" +0 -1/16) Hold it in this position while pressing the manual close push button on the breaker. The main power springs must discharge and the breaker must remain open, as indicated by the semaphores on the front of the breaker. This indicates that the breaker contacts will not close during raising or lowering the breaker.

#### **5. ADJUSTMENTS TO BREAKER/SWITCH-GEAR INTERFACES.**

The interfacing parts on all ratings of type AM breakers and switchgear are functionally the same.

##### **5.1 STATIONARY AUXILIARY SWITCH (MOC)**

The Stationary Auxiliary Switch is an optional switch mounted in the switchgear cubicle. When the breaker has been elevated to the fully connected position, the switch will be actuated whenever the breaker is closed. The switch is actuated by the plunger interlock (plunger) mounted on the top of the breaker mechanism. The switch has a number of "a" contacts (closed when the breaker is closed and open when the breaker is open) and "b" contacts (open when the breaker is closed and closed when the breaker is open). The following paragraph defines the essential dimensions relating to the interfacing elements of the breaker and switchgear, to assure reliable performance.

The following elements are important factors which commonly affect the operation of the stationary auxiliary switch.

1. Plunger travel on the breaker.



2. The gap between the top of the plunger on the breaker and the bottom of the rod on the stationary auxiliary switch mechanism.
3. Variations between breakers in the distance from the underside of the lift rail and the top of the plunger.
4. Variations in the rotation requirements to "make" and "break" the stationary auxiliary switch contacts.
5. Condition of the plunger interlock components on the breaker.
6. Elevating mechanism limit switch consistency.
7. Breaker elevating mechanism positive stops.
8. Seismic events.

Some of these elements also affect the other important interfaces required for reliable operation of the equipment, such as:

1. Primary disconnect penetration.
2. Secondary coupler penetration.
3. The positive interlock mechanism.

A major goal in the design of switchgear has always been the interchangeability of breakers. GE Switchgear has been very successful in achieving that goal for many years. Analysis of instruction book adjustments, shop tolerances, and service advice letters issued in recent years, however, has demonstrated that tolerances in switchgear equipment installed and presently operating can result in situations where it is impossible to meet all adjustments or that an adjustment is brought into specification and it causes a problem with another interface.

With specific reference to the plunger / stationary auxiliary switch interface, the following instructions and recommendations supersede all previous Service Advice Letters and instructions. Refer to Figure 1 for details.

Nominal breaker plunger travel is 1-1/8". Nominal auxiliary switch rod travel is 1-1/16". It is imperative that a gap is present between the top of the plunger and the bottom of the rod, when the breaker is in the fully connected position and the breaker is open.

To assure the most reliable switch operation, it is recommended that the plunger travel be measured for each breaker and recorded in maintenance records. It is further recommended that the auxiliary switch mechanism be adjusted, if necessary, to result in a gap that is in accordance with the table given in Figure 10. It may require the roll pin which

secures the auxiliary switch mechanism plate to be removed and a new hole drilled after loosening the two mounting bolts and moving the entire auxiliary switch mechanism up or down.

This action may mean future adjusting when and if different breakers are interchanged. Reliable switch operation is critical and it may require limiting your interchangeability of breakers. At a minimum, the criticality requires adjustment verification when swapping breakers.

Specifically, paragraph (f) on page 11 of Service Advice Letter (S.A.L.) #073-323-1, dated 02-01-78 is rescinded and the instruction in GEH-1802X on gap clearance is rescinded and both are replaced with the gap dimension ("G") given in the table of Figure 10.

The plunger dimensions given in the breaker instruction books are not rescinded because they are correct nominal dimensions. It is permissible to let the breaker adjustment be out of specification, if it conflicts with the dimensions given in Figure 10.

## 5.2 PRIMARY CONTACT PENETRATION

The nominal contact penetration is 7/8" as shown in Figure 11. The tolerance on penetration is plus 5/32", minus 1/8" on non 1E equipment and plus 1/16", minus 1/8" on 1E equipment.

Reference Service Advice Letter # 073.323.1, which addresses methods to check both the penetration and the contact wipe for 5kV equipment. The same methods and means of adjustment also apply to 15kV equipment. GEH-1802X and the similar illustrations it contains showing proper contact wipe patterns should also be consulted. It is essential to maintain proper contact penetration while maintaining the stationary auxiliary switch adjustment given in Figure 10.

## 5.3 POSITIVE INTERLOCK

The purpose of the positive interlock is to prevent moving the breaker to or from the connected position while the main contacts are closed, and to prevent closing the contacts unless the breaker is in the fully connected position. These important safety features are achieved by means of the positive interlock roller on the right side of the breaker and positive interlock cam and stationary "flag" on the switchgear, as shown in Figure 7.

The following adjustments are made at the factory and verified for proper operation per Figure 7. The distance from the top of the stationary flag to the top of the switchgear guide rails is set. This maintains the surface upon which the breaker wheels rest when the breaker is lowered. The upper elevating motor limit switch is then adjusted to achieve a roller to flag clearance of 1/16" to 1/8" as shown in Figure 7. The limit switch de-energizes the elevating motor circuit and should be activated when the primary disconnects and secondary coupler reach their nominal contact penetration position. If the timing of this sequence is off, the cubicle must be adjusted back to factory specifications.

Instructions for positive interlock adjustment are detailed on Figures 13, (1000 MVA Equipment), Figure 14, (M-26 Equipment); and Figure 15, (M-36 Equipment). These adjustments are also detailed in instruction book GEH-1802X.

#### **5.4 SECONDARY COUPLER**

On the top front of the breaker, there is a black plastic block which holds male secondary coupler pins. This block should make contact with, and slightly raise a spring loaded black plastic block which holds female secondary coupler sockets on the switchgear. The contact depression should be 1/8". The stationary block is adjustable in the vertical direction as described in Service Advice Letter 073-323-1. It is not always possible to have the black plastic blocks in contact over their entire flat surface. Often, the rear of the blocks are engaged while a gap exists along the front edge. This is an acceptable condition. The contacting block surfaces should touch and the female block edge move upward between 1/32" to 1/8".

#### **5.5 SPRING DISCHARGE CAM**

The purpose of the spring discharge interlock is to discharge all stored energy in the breaker mechanism whenever the breaker is withdrawn from the cubicle. The discharge interlock is located on the left side of the breaker. The spring discharge cam mounted in the switchgear should discharge the breaker closing spring when the breaker is lowered.

The cam has minimal adjustment provision. The holes may be slightly slotted to adjust the cam vertically to allow discharge when the breaker wheels reach 1/8" to 1/4" height above the floor.

Refer to GE drawing 0184B7344 for instructions on installing a spring discharge cam in the switchgear cubicle.

#### **5.6 STOPS**

The stop pins and stop bolts on the elevating mechanism are emergency mechanical stops which would come into use only if the upper elevating motor switch is completely out of adjustment or has failed. Elevating against these stops may be quite audible and the operator should release the clutch handle, de-energizing the elevating motor circuit or, the elevating motor circuit protective fuse will open to protect the motor. The stop bolts should be set to 3/32 to 1/8" clearance and only set after all other elevating adjustments are made.

#### **5.7 GROUND**

A visual check should be made to observe the ground connection. The ground shoe on the moveable breaker is designed to have a nominal engagement of 1-1/2" + 1/4" vertically with the steel and copper spring loaded disconnects of the ground device in the switchgear.

#### **5.8 POSITION SWITCH (TOC)**

The position switch is an optional device mounted in the rear left side of the switchgear cubicle. The switch contacts operate when the lifting mechanism is in either the fully raised or fully lowered position. Switch operation should be checked with the breaker withdrawn manually and the equipment de-energized, and again electrically, with the breaker in the cubicle. Refer to Service Advice Letter 073-326.1, dated 5-23-78 for a description of design changes made to improve the switch operating mechanism in 1978.

## **6. TYPICAL WIRING DIAGRAMS**

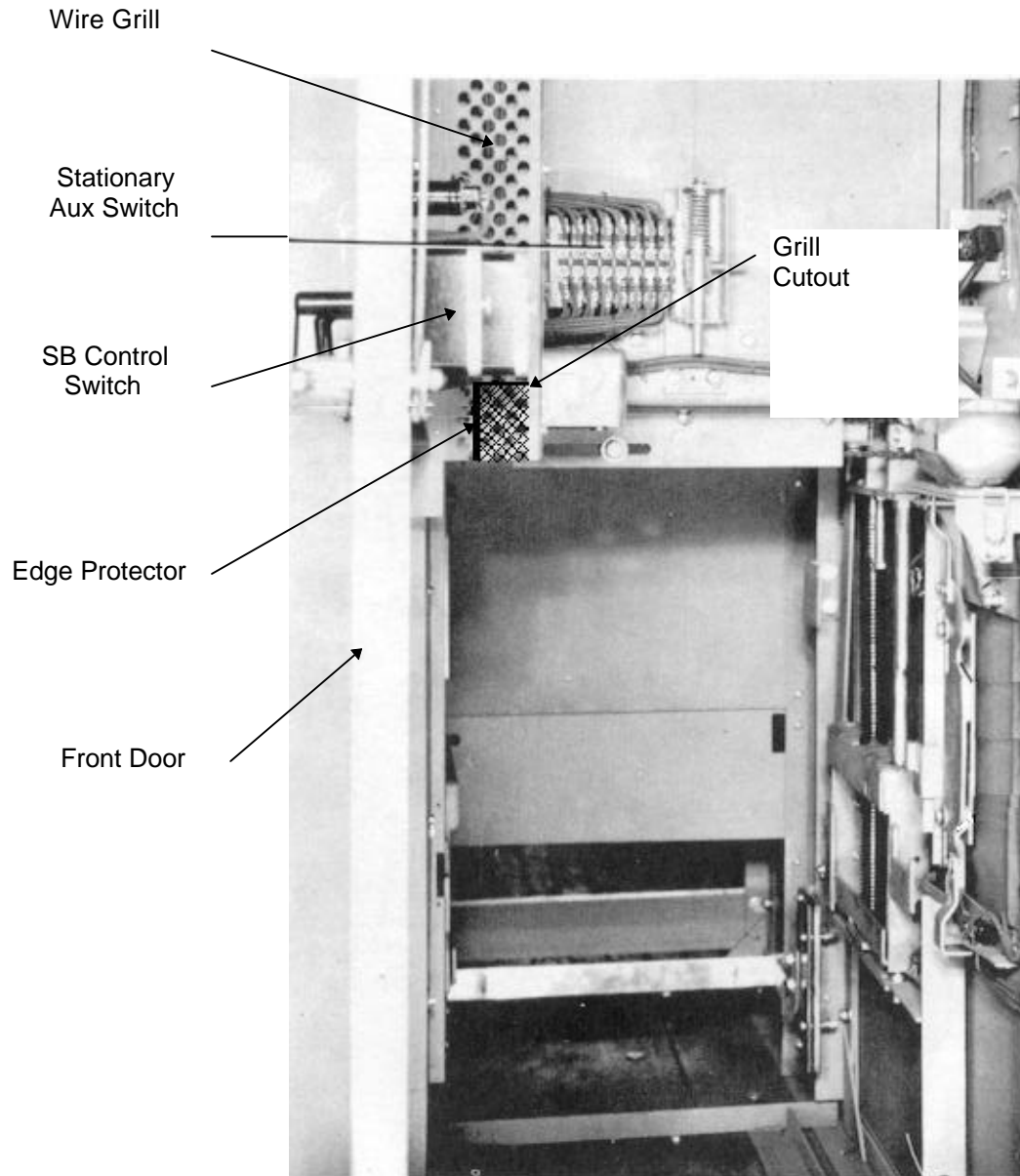
Figures 8 and 9 show typical wiring diagrams for PowerVac<sup>®</sup> VL breakers.

Replacement breakers for old units with solenoid mechanisms (AM breakers with MS type mechanisms) are typically wired per the drawing in Figure 8.

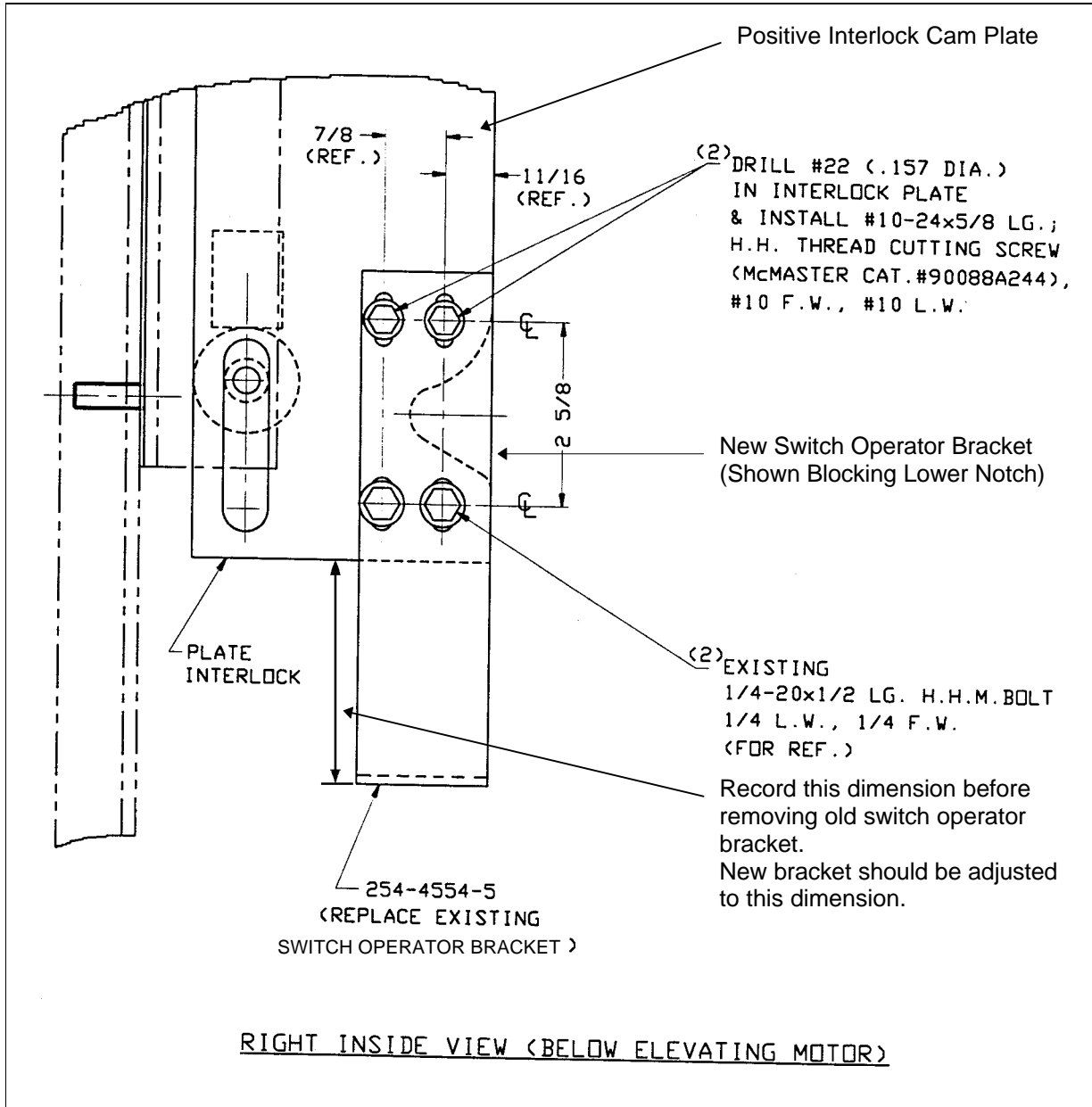
Replacement breakers for old units with stored energy mechanisms (AM breakers with ML type mechanisms) are typically wired per the drawing in Figure 9.

The wiring on your breakers may be different. Consult your nameplate for the correct drawing number and call your local GE office for additional copies of this drawing are required.

**FIGURE 1**  
**INTERIOR VIEW OF STATIONARY CUBICLE**



**FIGURE 2  
INTERLOCK MODIFICATION**





**FIGURE 4  
ELEVATING MOTOR TROUBLESHOOTING**

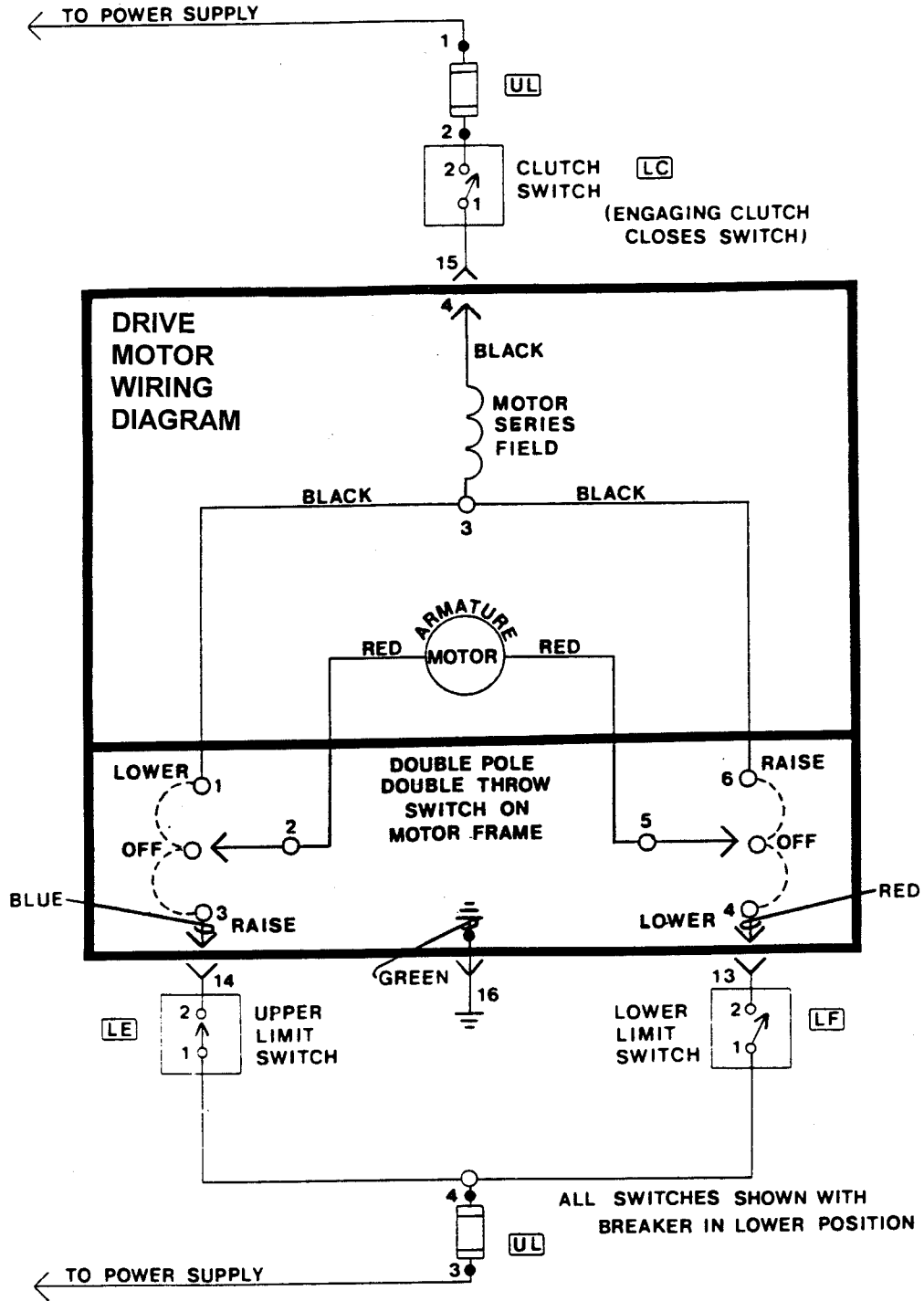
**TROUBLE SHOOTING**

IF ELEVATING MOTOR DOES NOT OPERATE:

CORRECTIONS

1. Check power supply
2. Check fuses **UL**
3. Check and adjust mechanical clutch linkage to clutch switch **LC**
4. Check **LC** for proper performance
5. Check motor switch
6. Check motor
7. Adjust upper **LE** and lower **LF** limit switches for proper breaker position
8. Check and adjust leaf springs to provide proper tilt to operate limit switches
9. Check plug and receptacle for proper connections
10. Check clutch and mechanism

**FIGURE 5  
SCHEMATIC DIAGRAM  
VERTICAL LIFT ELEVATING MECHANISM**

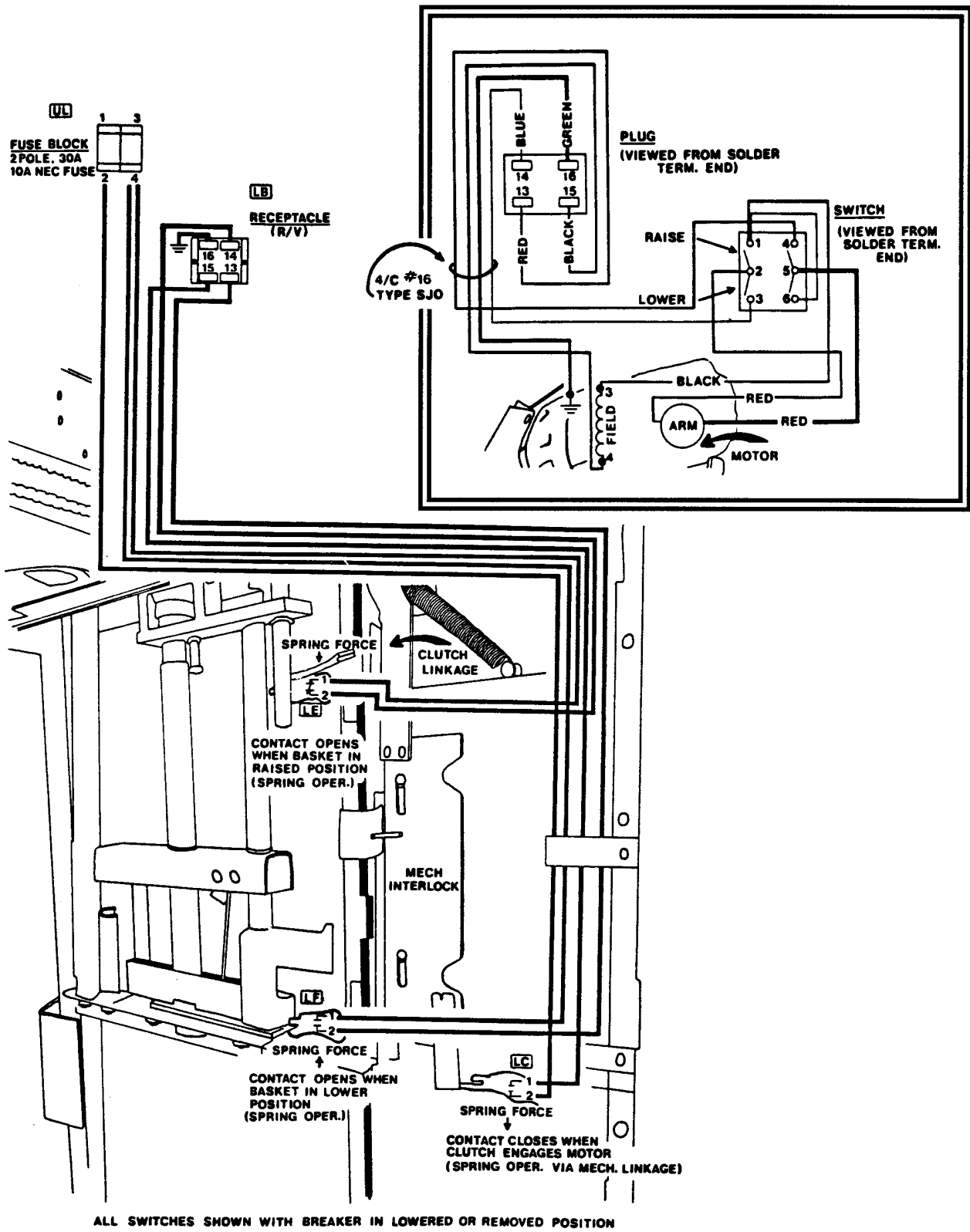


**DO NOT USE RAISE/LOWER SWITCH TO STOP & START MOTOR.**

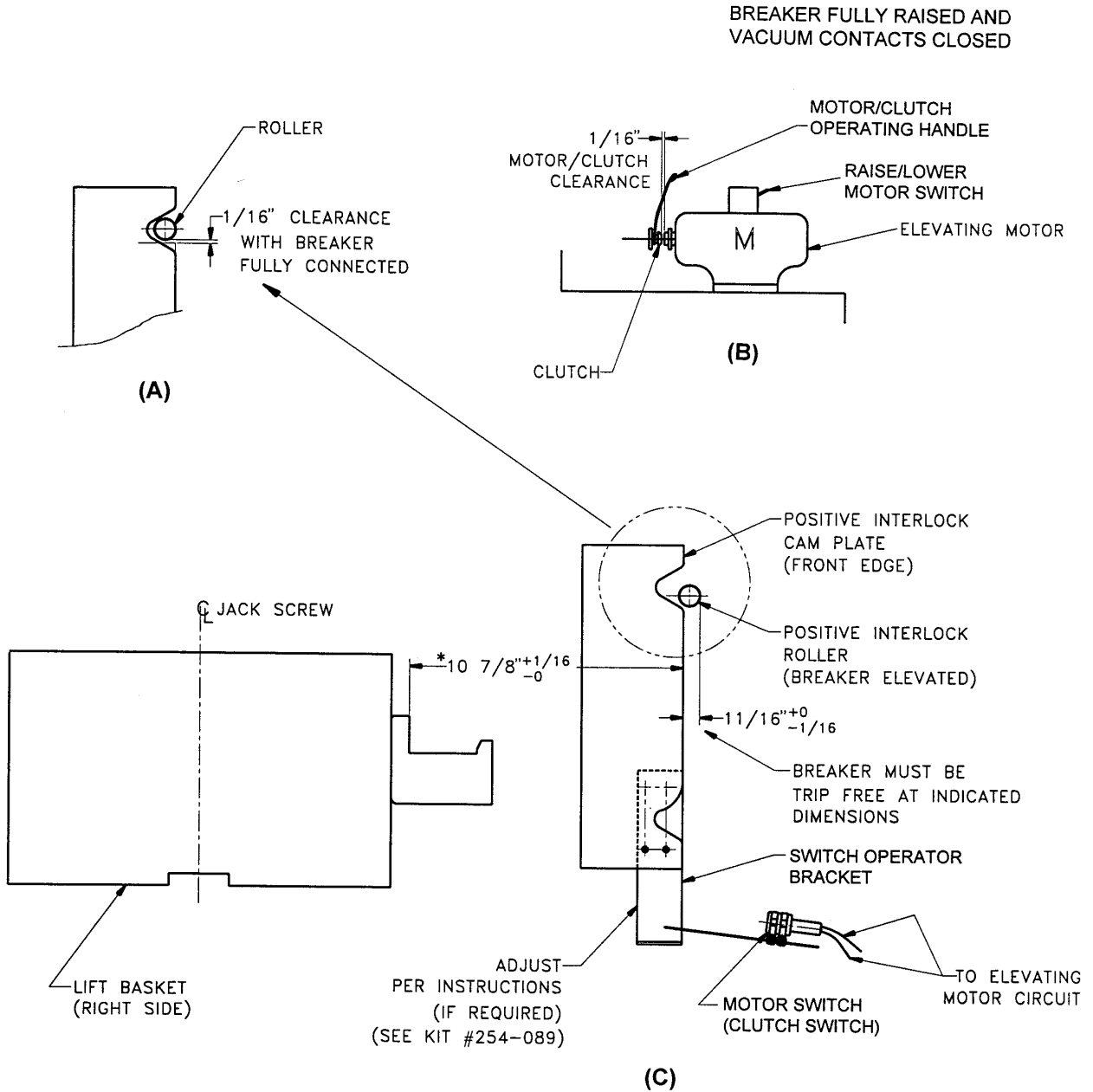


FIGURE 6  
STATIONARY STRUCTURE WIRING

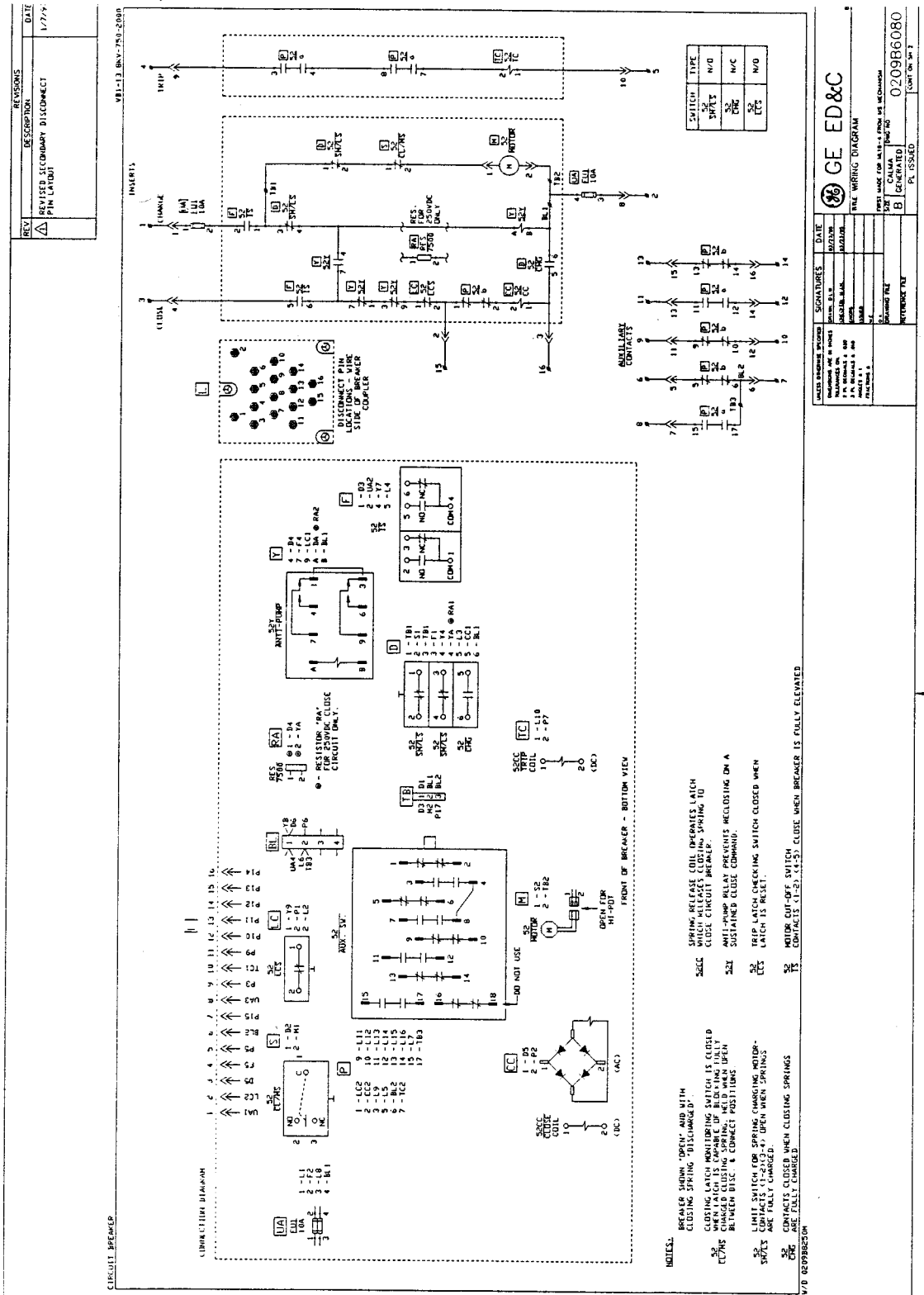
REMOVEABLE ELEVATING  
MOTOR ASSEMBLY



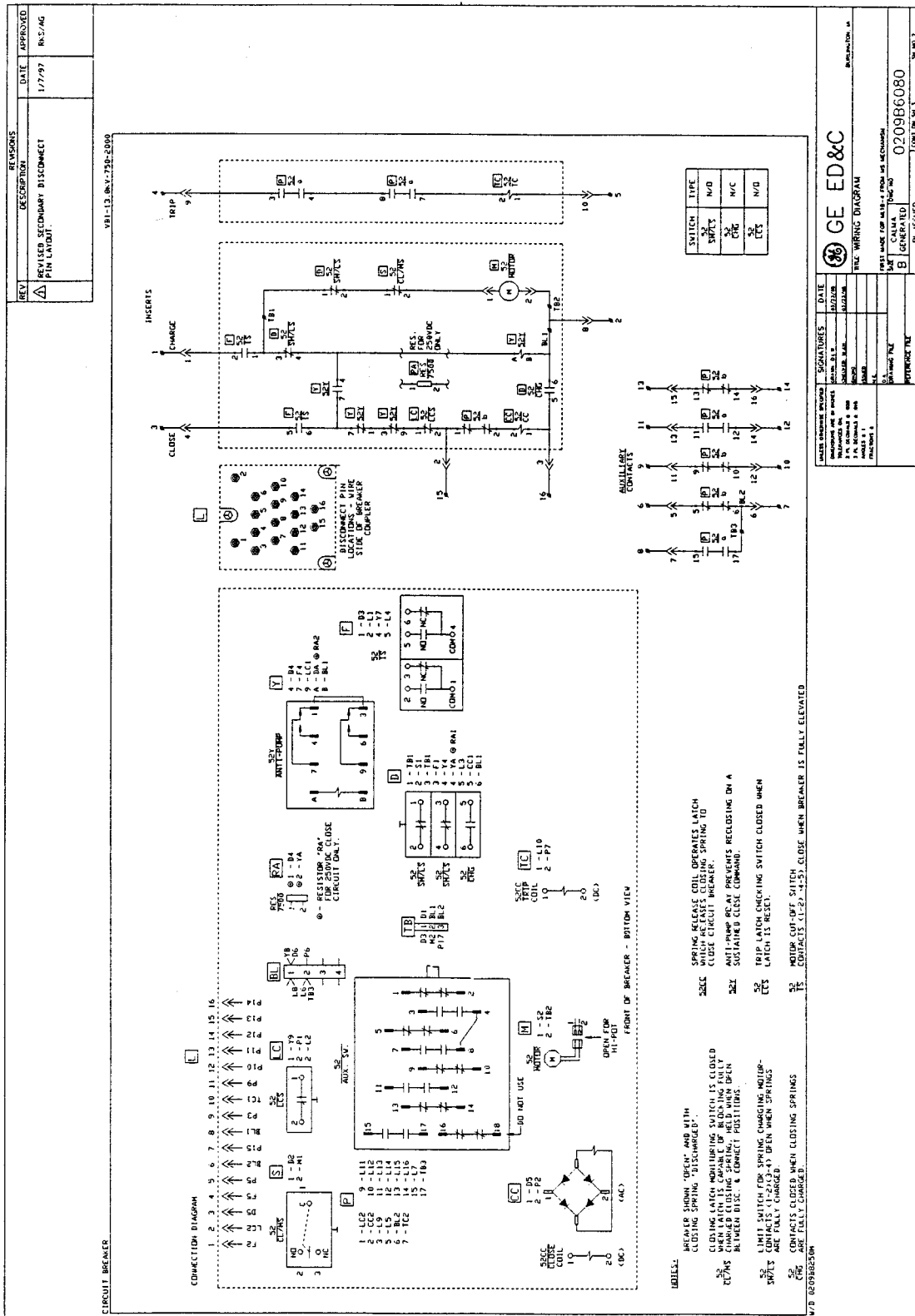
# FIGURE 7 BY-PASS KIT INSTALLATION



# FIGURE 8 TYPICAL BREAKER WIRING DIAGRAM (REPLACEMENT FOR BREAKERS WITH MS MECHANISMS)



**FIGURE 9  
TYPICAL BREAKER WIRING DIAGRAM  
(REPLACEMENT FOR BREAKERS WITH ML MECHANISMS)**



## FIGURE 10 ADJUSTMENT OF PLUNGER INTERLOCK

Adjustment of plunger interlock - Breaker raised to connect position. Gap adjustment as a function of breaker plunger travel to assure proper switch operation.

P	G		R	
Plunger Interlock Travel (To be measured)	Gap between top of plunger interlock and bottom of aux. switch rod		Resulting travel of the aux. switch rod	
1-1/16	Min. .001	Max. 1/16	Min. 1"	Max. 1-1/16

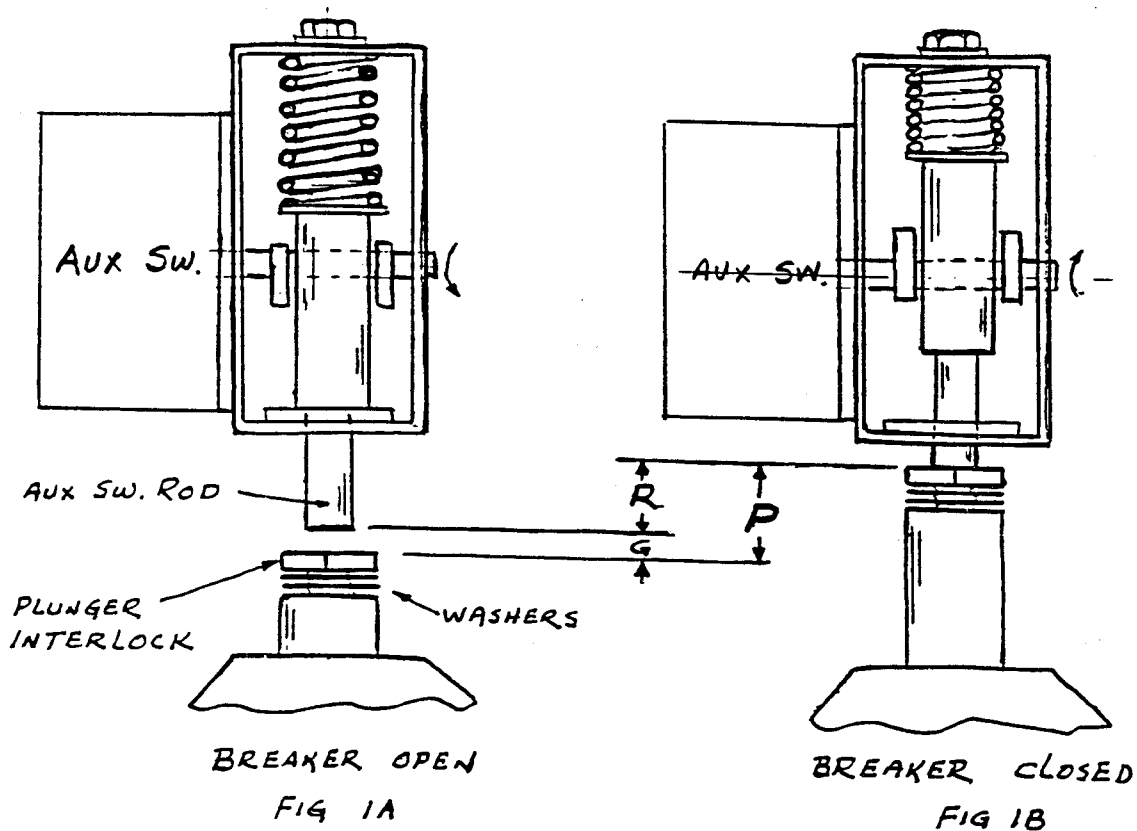


FIGURE 11  
PRIMARY CONTACT PENETRATION

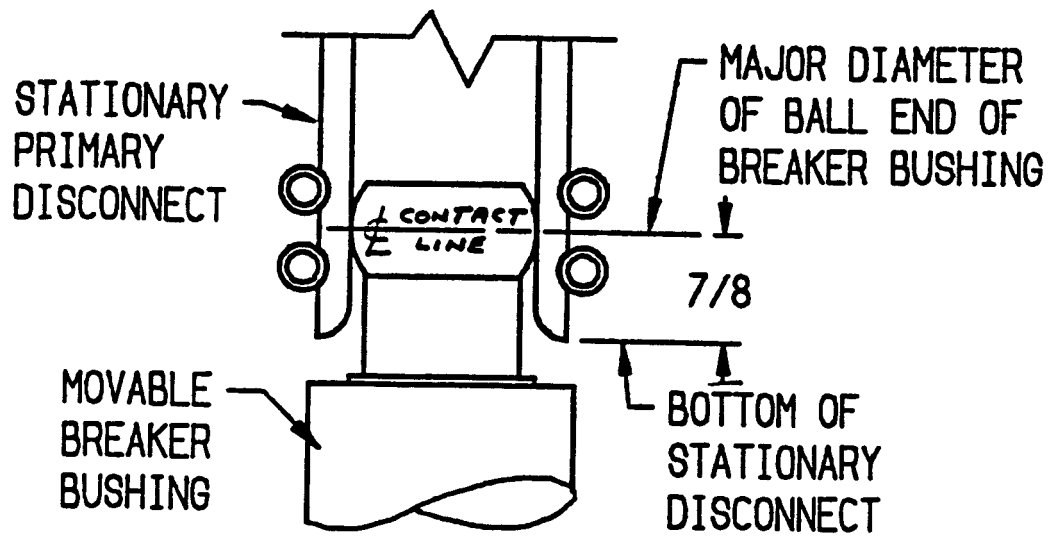
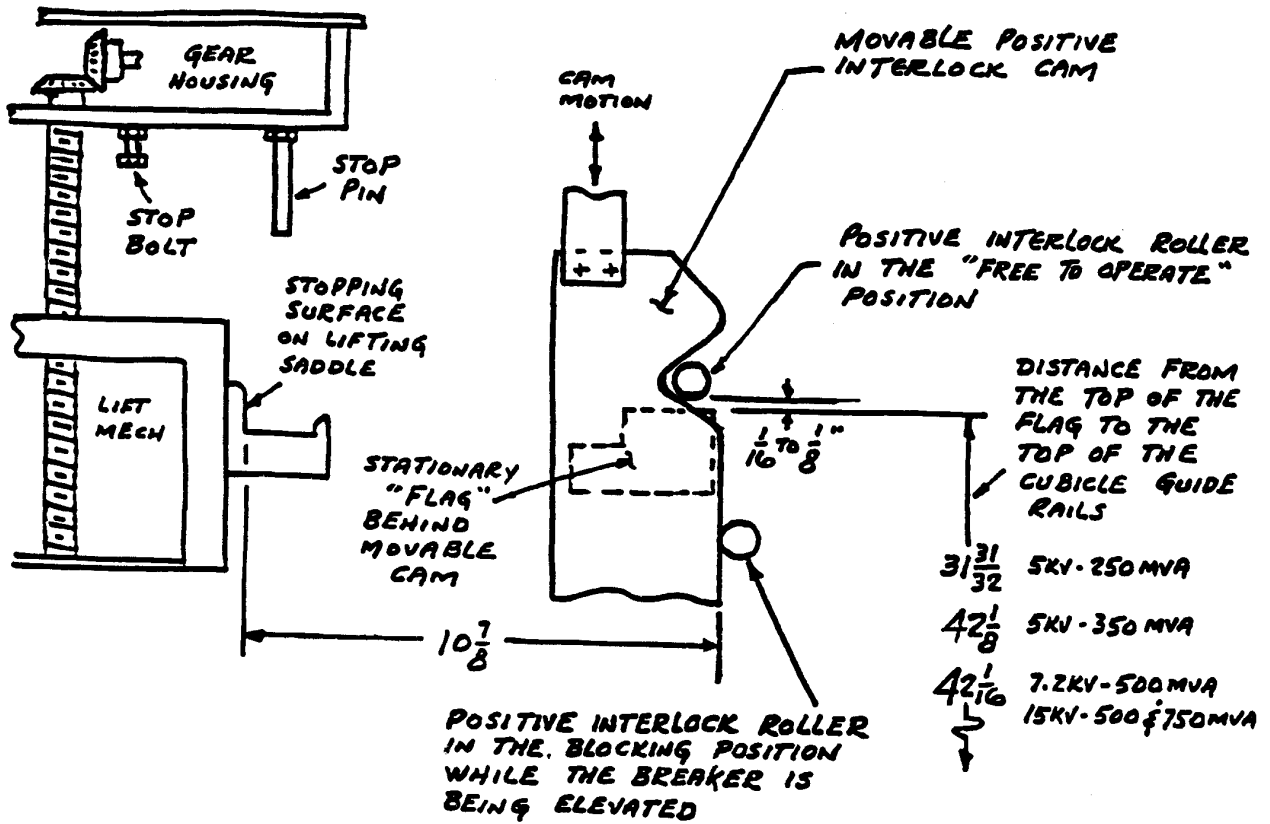
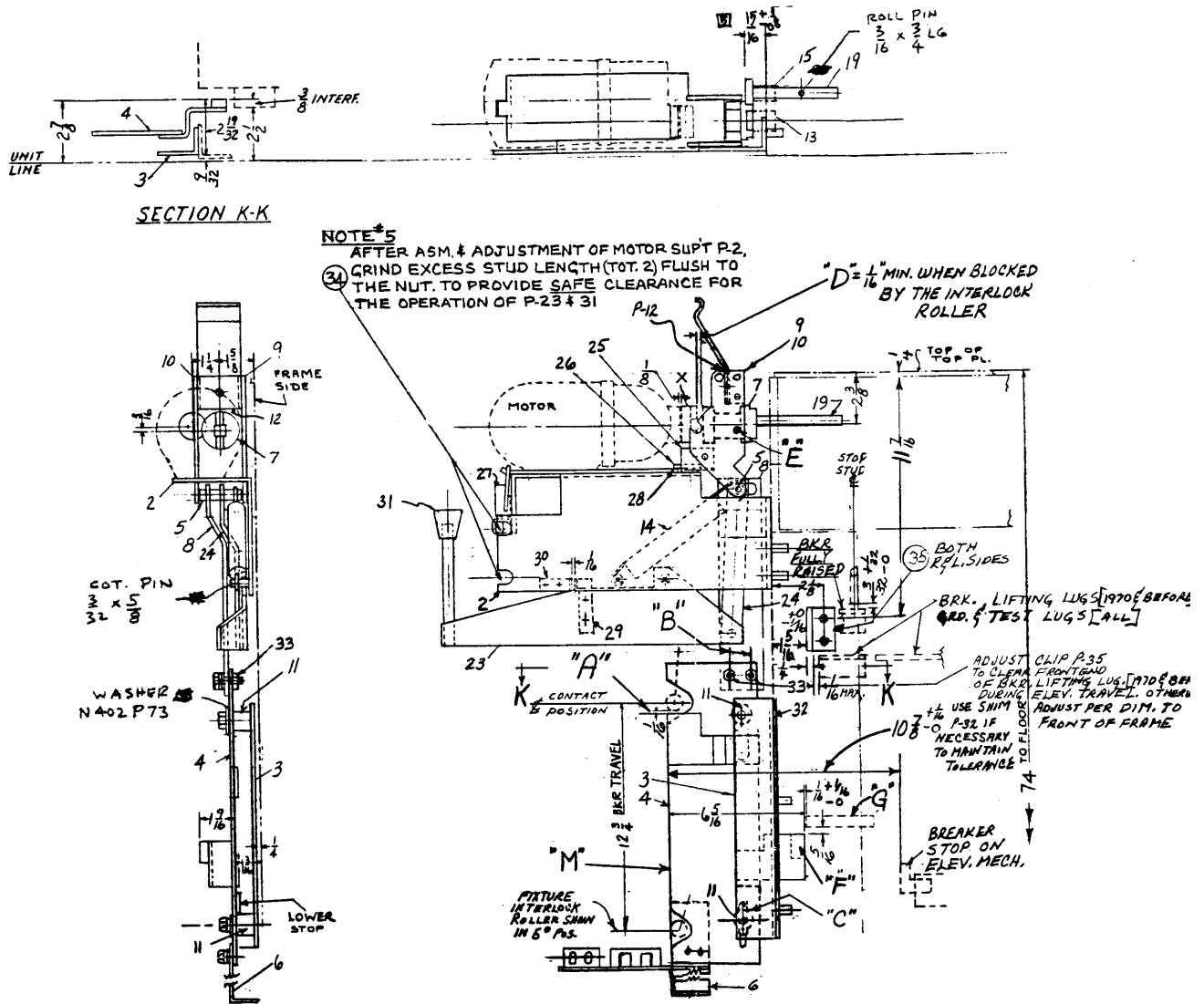


FIGURE 12  
POSITIVE INTERLOCK ROLLER



**FIGURE 13  
POSITIVE INTERLOCK 1000 MVA UNITS**

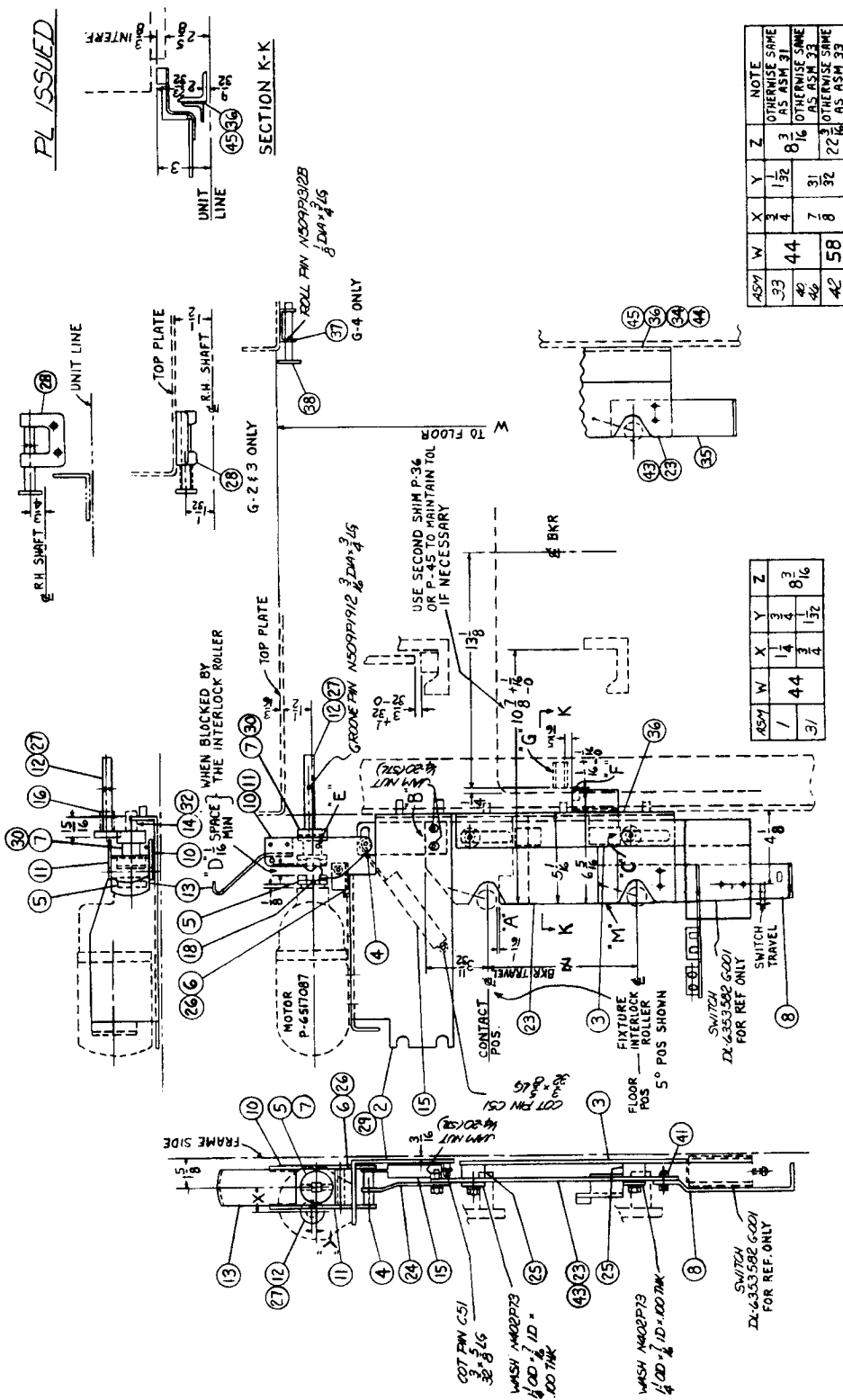


**INSTRUCTIONS FOR POSITIVE INTERLOCK ADJUSTMENT**

Insert breaker fixture and raise to stops as shown. The clearance between the breaker fixture supporting rail and the stop bolts should not be less than 3/32" and both sides to be equal. Set fixture interlock at 50 position. Shim cam support P-3 to maintain a 10-7/8" ± 1/16" dimension between the back of the lifting saddle and the front of the interlock cam plate indicated as "H". Also adjust for a 1/16" clearance between the back of the lifting saddle and the front of the interlock cam plate indicated as "M". Set handle P-2 so that cradle P-9 is vertical. Tighten bolts at "B". After tightening bolts, lock securely with a jamb nut. Remove fixture interlock pin. Adjust striker P-6 so that contacts of motor switch close in the last 1/4" of vertical travel of cam. Fixture interlock roller must indicate between 130° and 280° when contacts in motor switch close. When handle P-12 is in forward position and clutch X & P-7 fully engaged, pins "E" must be free of clutch P-7. Set fixture interlock in 130° position, operate unit interlock: movement must be stopped by the breaker fixture interlock roller before contacts of motor switch close and before clutch X & P-7 engage. Lower breaker fixture to rails. Set fixture interlock in 50° position, breaker interlock roller must be centered in the unit cam "V" notch. Remove fixture interlock pin and operate unit interlock: block "F" on cam must pass in front of block "G" on fixture. The clearance between the interference block on the breaker fixture and the interference block on the interlock cam assembly should be 1/16" to 1/8" maximum. Move fixture out of housing to a point that block "G" is over block "F". Operate unit interlock: block "F" must engage block "G" and stop movement of cam before contacts in motor switch close. For final interlock check: set breaker fixture interlock roller in 130° position, and move fixture into the housing. Operate unit interlock by pulling clutch handle forward. Movement of interlock cam must be stopped by the breaker fixture interlock roller before the contacts of the motor switch close and before the sliding clutch P-7 engages the motor clutch coupling X. A minimum of 1/16" at "D" must be maintained between the two clutch parts when the interlock is blocked by the fixture interlock roller.



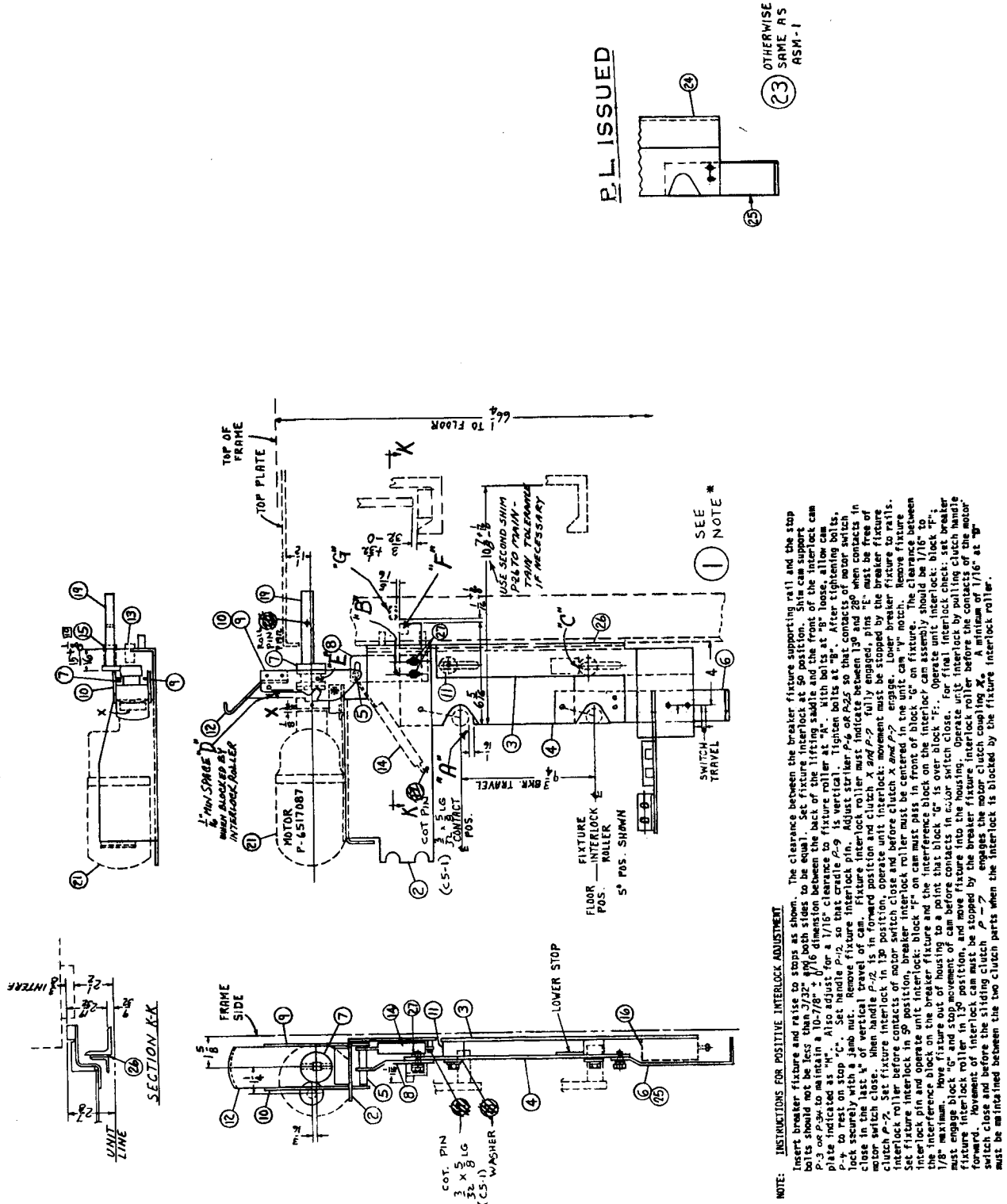
# FIGURE 14 POSITIVE INTERLOCK M-26 UNITS



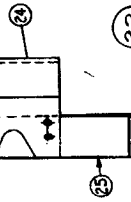
**NOTE: INSTRUCTIONS FOR POSITIVE INTERLOCK ADJUSTMENT**

Insert breaker fixture and valve to stops as shown. The clearance between the breaker fixture supporting rail and the stop bolts should not be less than 3/32" and both sides to be equal. Set fixture interlock at 5° position. Shim cam support block P-34 or P-44 to maintain a 10-7/8" (+1/16"-0) dimension between the back of the top support block and the breaker fixture cam plate indicated as "C". Also shim fixture roller at top with bolts at "B" loose. Allow cam P-23 to rotate until it is in the 5° position. Set handle P-13 so that cradle P-11 is vertical. Tighten bolts at "B". After tightening bolts, lock breaker fixture interlock pin. Adjust breaker P-8 or P-35 so that contacts of motor switch close in the last 1/4" of vertical travel of cam. Fixture interlock roller must indicate between 13° and 28° when contacts in motor switch close. When handle P-13 is in forward position and clutch P-5 and P-7 fully engaged, plus "B" must be free of interlock roller before contacts of motor switch close and before clutch P-5 and P-7 engage. Lower motor cam support block. Set fixture interlock in 5° position, breaker interlock roller must pass in front of block "G" on fixture. The clearance between interlock pin and roller must be 1/16". Shim cam support block on the breaker fixture and the interlock cam assembly should be 1/16" to 1/8" maximum. Move fixture out of housing to a point that block "G" is over block "F". Operate unit interlock: block "F" must engage block "G" and stop movement of cam before contacts in motor switch close. For final interlock check: set breaker fixture interlock roller in 13° position, and move fixture into the housing. Operate unit interlock: set breaker fixture interlock roller before contacts of motor switch close and before the sliding clutch P-7 engages. Shim cam support block of the motor switch and before the sliding clutch P-7 engages. Shim cam support block of the motor switch to 1/16" at "B". Must be maintained between the two clutch parts when the interlock is blocked by the fixture interlock roller.

**FIGURE 15  
POSITIVE INTERLOCK M-36 UNITS**



P.L. ISSUED



OTHERWISE SAME AS ASM-1

## 7. FEATURES

### 7.1. SAFETY PRECAUTIONS.

This circuit breaker uses powerful springs for energy storage. **DO NOT WORK ON THE INTERRUPTERS OR THE MECHANISM UNLESS THE CIRCUIT BREAKER IS IN THE "OPEN" POSITION AND BOTH THE CLOSING AND OPENING SPRINGS ARE EITHER DISCHARGED OR GAGGED AND ALL ELECTRICAL POWER IS REMOVED.** These precautions are required to prevent accidental operation. Anyone working on the circuit breaker should be familiar with the contents of this instruction book.

The circuit breaker has been shipped in the CLOSED position. After removing packing material, open the breaker by pushing in firmly on the manual trip button (8, Fig. 16), while keeping hands away from moving parts. Verify that the operation counter advances one count.

Closing and opening springs are now in their discharged positions. Check this by first pressing the manual close button, then the manual trip button. The indicator flags on the front of the breaker should show "OPEN" and "DISCHGD". All mechanical and electrical checks should be completed before putting breakers in service.

### 7.2. INTERLOCKS

Each PowerVac<sup>®</sup> VL vacuum circuit breaker is provided with the following interlocks:

#### 7.2.1. RATING INTERFERENCE PLATE

This interlock permits only a breaker with a matching continuous current, voltage and interrupting rating to be inserted into a metal-clad compartment of identical rating. The rating interference plate must be adjusted to match the current rating of the compartment. This adjustment is done by positioning a pin on the lower left side of the breaker truck to align with the proper cubicle interference plate.

#### 7.2.2. POSITIVE INTERLOCK SYSTEM

The positive interlock system prevents connecting or disconnecting the breaker when the breaker vacuum contacts are closed.

This interlock feature is accomplished by a roller and lever located on the interlock shaft, on the right side of the breaker (Fig. 16 & 17). When the breaker is closed, this roller and lever are locked in

their vertical positions, preventing the clutch handle from being pulled forward and engaging the elevating motor in the cubicle. The closed breaker must be manually or electrically tripped open before the clutch handle can connect the elevating motor to the elevating mechanism, and allow the breaker to be raised or lowered.

When the breaker is raised or lowered, the positive interlock roller and lever are forced forward by the positive interlock plate on the right side of the frame and top plate. The interlock roller and lever are held in this forward position during raising and lowering operations, preventing the breaker from being closed in any intermediate position between the connect and the fully lowered position. An attempt to close the breaker will cause the stored energy springs to discharge without the breaker contacts closing or moving. The breaker must be fully connected (raised) and the clutch handle must be released before the breaker can be closed. Releasing the clutch handle allows the interlock plate in the cell to move downward allowing the interlock roller and lever to return to their normal vertical positions. The breaker may then be closed. When in the fully lowered position, the breaker must be pulled forward 2-1/4" in the cubicle and the test coupler installed to allow the breaker to be closed electrically.

### 7.2.3. SPRING DISCHARGE SYSTEM

The spring discharge lever and pin, (Fig. 17) are provided as a safety feature for operating personnel, and to prevent closing the breaker in the lowered position in the cell.

The spring discharge pin and lever operate in conjunction with the spring discharge bracket mounted in the front left side of the vertical frame angle in the cubicle. The spring discharge pin rides on the cam edge surfaces of the spring discharge bracket, when the breaker is inserted into or withdrawn horizontally from the cell.

If the breaker is outside the cell, and an operator charges the stored energy mechanism, the spring discharge bracket will lift the discharge pin and discharge the stored energy springs, when the breaker is pushed into the lowered position in the cell. When the breaker is fully inserted into the lowered position within the cell, the discharge pin is held in an upward position by the spring discharge bracket, and prevents the breaker from being closed. Attempting to charge a breaker in this full inward and lowered position will discharge the

stored energy mechanism without closing the breaker.

## 8. OPERATION

The PowerVac<sup>®</sup> VL vacuum circuit breaker uses a sealed vacuum power interrupter to establish and interrupt a primary circuit. Primary connections to the associated metal-clad switchgear are made by pole assemblies, electrically and mechanically connected to the vacuum interrupters. Molded supports, one per pole on a three pole breaker, provide interchangeable mountings for the primary poles, interrupters, and heat dissipation fins (where used). The operating mechanism provides horizontal motion at each pole location in order to move the lower contact of the vacuum interrupters from an open position to a spring-loaded closed position and then back to the open position on command.

The ML-18VL mechanism (Figs. 17 & 23) is the stored-energy type and uses a gear motor to charge a closing spring. During a closing operation, the energy stored in the closing spring is used to close the vacuum interrupter contacts, charge the wipe springs which load the contacts, charge the opening springs, and overcome bearing and other frictional forces. The energy then stored in the wipe and opening springs will open the contacts during an opening operation.

Closing and opening operations are controlled electrically by the control switch on the metal-clad door or remote relaying. Mechanical control is provided by manual close and trip buttons on the circuit breaker.

The closing spring may be manually charged, and a method for slow closing the primary contacts is available when the circuit breaker is withdrawn from the metal-clad cubicle. (See Section 10) The mechanism will operate at the ac or dc voltage indicated on the circuit breaker nameplate.

### 8.1. CLOSE SPRING CHARGING

Figure 23 shows a front view of the ML-18VL in a schematic form. The primary contacts are open and the closing spring is charged. The closing spring charging system consists of a closing spring (1, view B) mounted on the left side of the breaker and the electrical charging system mounted on the right side of the breaker. Both components are fastened

to the cam shaft (2, view B). A manual charging system (3, view A) is provided so that the mechanism can be slow closed and the closing spring can be charged if there is a loss of electrical control power.

Spring charging is accomplished electrically by a rotating eccentric on the output shaft of a gear motor driving pivoted charging arms (4, view C). The charging arms oscillate about the centerline of a ratchet wheel (5, view C). A driving pawl (6, view C), mounted within the charging arms, oscillates with the charging arms. Starting from its rear-most position, the charging arms rotate forward, while spring forces engage the driving pawl with a tooth on the ratchet wheel. The ratchet wheel is advanced by the rotating charging arms and pawl assembly. Advancement of one tooth spacing is provided for each oscillation of the system. The ratchet motion is restricted to one direction by a spring-loaded holding pawl that prevents the ratchet wheel from going backwards as the charging arms oscillate back to pick up the next tooth. Thirteen complete cycles of the charging arms are needed for a full charge of the closing spring.

The efficient, compact gear motor accomplishes this action in about two seconds. When the charging cycle is complete, the ratchet wheel is positioned so that a missing tooth is adjacent to the driving pawl and any motor overspin will not drive the ratchet wheel, thus preventing damage to the system.

When the spring is completely charged, the assembly is retained in that position by the close latch until it is desired to close the circuit breaker.

The closing coil cannot be electrically energized unless the closing spring is completely charged. This action is prevented by the 52/CHG switch in the closing circuit.

The manual charging system (3, view A) works directly on the cam shaft where a one-way clutch (7, view A), driven by a manual handle, provides rotation of the ratchet wheel. Manual pumping of the handle advances the ratchet wheel and the holding pawl prevents counter-rotation while the handle is returning for another stroke. Approximately eight complete strokes of the manual handle are required for one complete spring-charging operation. When the spring charge indicator (8, Fig. 17) shows "CHARGED", MANUAL CHARGING MUST BE DISCONTINUED TO AVOID MECH-ANISM DAMAGE.

## **8.2. CLOSING OPERATION. (REFER TO FIG. 23)**

By either energizing the close solenoid or depressing the manual close button, the close latch (8, view C) is rotated, releasing the closing spring (1, view B). This action releases the energy in the closing spring and transmits it to the closing cam (9, view D) and closing roller (10, view D) causing the linkage to rise until the close prop (11, view D) can slip under the close roller (10, view D) and hold the linkage in place. As the linkage moves, the output crank (12, view D) rotates the cross shaft (13, view D) which in turn rotates the phase bell cranks (14, view E) on all three poles. The rotation of the phase bell cranks compresses the two opening springs (15, view E) on poles 1 and 3, closes the vacuum interrupters, and compresses the wipe springs (16, view E) on each pole. The rotation of the cross shaft (13, view D) also changes the auxiliary switch (7, view D) position. The position flag on the front panel will then indicate "CLOSED". After the breaker is closed, the charging motor is again energized and the closing spring is charged as described under "CLOSE SPRING CHARGING". Spring charging is possible when the breaker is in the closed position because the linkage is held in place by the prop.

## **8.3. OPENING OPERATION. (REFER TO FIG. 23)**

By either energizing the trip solenoid (18, view B) or depressing the manual trip button (23, view B), the trip latch (19, view D) is rotated, permitting the linkage to collapse. The vacuum interrupter contacts will then open under the force of the wipe springs (16, view E) and opening springs (15, view E). At the end of the opening stroke, the center phase wipe spring assembly hits a stop on the frame limiting overtravel and rebound. Rotation of the cross shaft from the closed to the open position operates the auxiliary switch (17, view D) opening the trip coil circuit. When the closing spring has been recharged, the linkage is reset allowing the trip latch to rest in place on the trip roller, ready for another closing operation.

If the closing spring has not been recharged, the trip latch will be held out of position. A latch-checking switch (LCS) (21, view C) will not close unless the latch is in its normal position. The contacts of the latch-checking switch are part of the closing circuit and will not allow for an electrical close until the latch is reset.

## **8.4. TRIP FREE OPERATION.**

The linkage is mechanically trip-free in any location

on the closing stroke. Electrically energizing the trip coil while closing will, after the auxiliary switch contacts change position, rotate the trip latch and permit the circuit breaker to open fully. The linkage will reset as in a normal open operation and the closing spring will recharge as described under "CLOSE SPRING CHARGING".

## **9. CONTROL CIRCUIT**

A typical PowerVac<sup>®</sup> VL circuit breaker ML-18VL mechanism wiring diagram is shown in Fig. 8 and 9. Check the wiring diagram supplied with the actual circuit breaker for its wiring.

The close spring charging motor circuit is established through the Close Latch Monitor Switch (CL/MS) if the close latch is reset and the Spring Motor Limit Switch (SM/LS) if the closing spring is discharged. When the closing spring is charged, the SM/LS interrupts the circuit.

The close coil circuit is established through two normally closed 52Y relay contacts, and the Latch Checking Switch (LCS), if the trip latch is reset. An auxiliary switch contact 52B is also in series with the close coil and closes when the breaker is open and opens when the breaker is closed. During a close operation, cam rotation closes the SM/LS contact allowing the 52Y relay to be energized. The 52Y relay opens its contacts, in the close coil circuit and seals itself in through one of its own contacts. This seal-in action prevents reclosing on a sustained close command. The close signal must be removed to drop out the 52Y relay and reestablish the closing circuit. This provides an anti-pump feature.

Circuit breaker-mounted auxiliary switch contacts not used in the control circuit are brought out for control and indication functions. The metal-clad equipment may provide a breaker-operated stationary auxiliary switch for additional contacts.

## **10. MECHANICAL CHECKING AND SLOW CLOSING**

### **10.1. VISUAL INSPECTION**

Visually inspect the circuit breaker for any signs of damage or loose hardware.

### **10.2. CLOSING SPRING CHARGING**

Manually charge the breaker closing spring using the charging handle provided (1, Fig. 18). The closing spring is charged by a ratcheting mech-

anism that advances one ratchet tooth at a time. When the spring is fully charged, the spring load is held by the closing latch. The spring indicator (6, Fig. 16) changes from "DISCHGD" to "CHARGED", and a positive snap is heard as the spring travels over center.

**CAUTION:** AFTER THE SPRING IS COMPLETELY CHARGED, AS INDICATED ABOVE, FURTHER FORCING THE CHARGING HANDLE MAY CAUSE DAMAGE TO THE CLOSING LATCH AND ITS ASSOCIATED PARTS.

### 10.3. CLOSING SPRING GAG

Removing the mechanism cover and inserting the tip of the closing spring gag tool (3, Fig. 19) between the end of the spring and the spring guide, engaging the détentes on the gag tool into the slots in the closing spring guide.

With the gag tool in position depress the manual close button. This action will partially discharge the closing spring and also partially close the vacuum interrupter contacts. Do not energize the secondary control circuit at this time.

**CAUTION:** USE OF THE GAG TOOL SHOULD ONLY BE ATTEMPTED WHEN THE BREAKER IS OUT OF THE CUBICLE.

### 10.4. SLOW CLOSING

To manually slow close the breaker contacts, install the closing spring gag, as described above. Put the manual charge handle on the manual charge lever and move the handle up and down. The breaker will be fully closed when the spring charge indicator shows "CHARGED"

**CAUTION:** WITH THE GAG TOOL INSTALLED, THE BREAKER CLOSED, AND OPENING SPRINGS CHARGED, THE BREAKER CAN BE TRIPPED AT FULL SPEED.

### 10.5. GAG TOOL REMOVAL

To remove the gag tool, the closing spring must be fully charged. If the spring charge indicator does not show "CHARGED" in the window, manually charge the spring until it does. Lift up and push in on the gag tool to clear the détentes on the gag tool from the slots in the closing spring guide. While holding the gag tool up, remove it from the opening. Close the gag hole cover. For safety, first close the breaker by depressing the manual "CLOSE" button and then depress the manual "TRIP" button. All stored energy is now removed from the breaker.

## 11. DIMENSIONAL CHECKS

With the breaker closed and the gag tool installed, remove the front portion of the breaker top plate before performing the following dimensional checks:

### 11.1. PRIMARY CONTACT EROSION

In the closed position, the erosion disk (5, Fig. 21), located below the operating rod insulator, is aligned with a reference arm (4, Fig. 21) on new interrupters. As contact erosion occurs, the erosion disk will move upward from alignment with that reference arm. When erosion reaches 1/8 inch, the POWER/VAC VL interrupters should be replaced. DO NOT READJUST THE ALIGNMENT OF THE EROSION INDICATOR ARM EXCEPT WHEN INSTALLING A NEW VACUUM INTERRUPTER.

### 11.2. SPRING WIPE

With the breaker closed and the closing spring gagged, measure with a feeler gauge and record the distance between the top of the wipe indicator and the bottom of the erosion disk for each phase (see Figure 33 Dimension W). Trip the breaker with the closing spring gag tool still installed and measure and record the distance between the wipe indicator and erosion disk. Subtract the closed position measurement from the open position measurement. The result is the amount of wipe on each individual pole. The wipe is to be greater than 0.075 inch. Adjustment is not required until wipe is 0.075 inch or less. If adjustment is required see WIPE ADJUSTMENT in MECHANICAL ADJUSTMENTS section.

The ML-18VL mechanism is furnished with very low gradient wipe springs so that adjustment is not a precision operation and considerable loss of wipe can be tolerated without affecting performance.

### 11.3. CONTACT GAP

The method of measuring the contact gap is as follows: With the breaker in the open position, the closing springs charged, and the closing spring gag tool installed, apply a piece of masking tape to the surface of the operating rod insulator as shown in Figure 27. Using a reference block, make a mark on the tape near the top on all three poles. It is also advisable to put a reference mark on the tape to identify to which pole the tape is applied. Remove the closing spring gag tool and close the breaker. Using the same procedure as above, re-mark the tape. This new mark will be near the bottom of the tape. Trip the breaker, remove the tapes and re-apply them to a flat surface. Measure the distance between the two lines. A caliper will give an accurate reading of the contact gap, Dimension G.

The gaps must be between the 0.60 inch maximum for the center phase and 0.54 inch minimum for all phases. It is not necessary that all readings correspond. A properly adjusted breaker often has more gap and wipe on the center pole than on the outside poles.

**CAUTION:** DO NOT ALLOW ANYTHING TO COME IN CONTACT WITH THE INTERLOCK ROLLER ON THE RIGHT SIDE OF THE MECHANISM, OR THE SPRING DISCHARGE PIN ON THE LEFT SIDE OF THE MECHANISM.

#### 11.4. CLOSE COIL PLUNGER GAP

The close coil plunger gap is shown in Figure 30. With the closing spring discharged, operate the plunger to make certain that the plunger moves freely over its full stroke in the coil. To check the closing coil plunger gap the breaker should be open and the closing spring charged and gaged. Dimension C is obtained by depressing the close plunger button until resistance is felt. The gap between the plunger button and the coil housing should be between 0.35 and 0.40 of an inch.

#### 11.5. TRIP COIL PLUNGER GAP

The trip coil plunger gap is shown in Figure 32. With the breaker in the open position and the closing spring in the charged position, make certain that the trip linkage and trip shaft move freely over the full plunger travel. To check the trip coil plunger gap adjustment, the breaker is to be closed with the closing spring discharged. Dimension T between the plunger button and the coil housing should be between 0.20 and 0.25 inch. This dimension is obtained when the trip plunger button is depressed until resistance is felt. If the breaker is equipped with an optional second trip coil, use same procedure.

#### 11.6. CONTROL SWITCH ADJUSTMENT

The breaker is to be in the open position with the opening and closing springs discharged. This results in the control switch plungers being in the depressed position. The switches to be checked are shown in Figure 31. On the LCS and stacked switches (SM/LS & CHG), the plunger rod is to be recessed within the rear of the switch body. The recess should measure between 0 and 1/32 inch. This is a visual check. The CL/MS switch with wiring terminals on the side is to be adjusted as described above. For the CL/MS switch with wiring terminals on the rear, the plunger is set to 0.99 to 1.01" from its mounting bracket.

## 12. ELECTRICAL CHECKS

### 12.1. ELECTRICAL OPERATION

To check the electrical operation, attach a secondary test coupler to the circuit breaker connector. Check the control voltage on the nameplate and close and open the breaker several times.

**CAUTION:** REPEATED OPERATIONS AT A RATE EXCEEDING TWO PER MINUTE MAY CAUSE CHARGING MOTOR OVERHEATING AND FAILURE.

Leave the circuit breaker in an open and spring discharged condition after checks are complete and refer to metal-clad instruction book GEH-1802X before inserting the circuit breaker into a metal-clad unit. Reinstall the front cover if it has been removed.

### 12.2. HIGH-POTENTIAL TEST

If high potential tests to check the integrity of the insulation are required, the AC high potential test described below is strongly recommended. DC high potential testing is not recommended. The following procedure must be adhered to.

**CAUTION:** IF DC HIGH POTENTIAL TESTING IS REQUIRED, THE DC HIGH POTENTIAL MACHINE MUST NOT PRODUCE PEAK VOLTAGES EXCEEDING 50 kV.

#### 12.2.1. PRIMARY CIRCUIT

Electrical checking consists of electrical breaker operation, primary and secondary wiring high-potential testing (if required), primary circuit resistance (if required), POWER/VAC interrupter high-potential testing, and insulation resistance to ground.

The breaker should be hipotted in the closed breaker mode. An AC hipot machine capable of producing the test voltages shown below may be used to hipot the breaker phase to phase and phase to ground.

BREAKER VOLTAGE	TEST VOLTAGE
4.16 kV	14 kV
7.2 kV	27 kV
13.8 kV	27 kV

The machine should be connected with its output potential at zero and the voltage increased at 500

vps to the test voltage and that voltage maintained for 60 seconds. The voltage should then be returned to zero and the hipot machine removed from the circuit. Do not exceed the test voltage indicated for the applicable breaker voltage rating.

### 12.2.2. SECONDARY CIRCUIT

Prior to hipotting the breaker secondary circuit, disconnect the motor leads and thread a wire connecting all secondary coupler pins. Increase the voltage to 1125 volts (rms) 60 Hz and maintain for 60 seconds. Reduce the voltage to zero and remove the hipot machine from the circuit. Remove the wire connecting the secondary coupler pins and reconnect the motor leads.

### 12.3. PRIMARY CIRCUIT RESISTANCE

A resistance check of the primary circuit may be made with the breaker closed. Use a low resistance measuring instrument which measures micro-ohms. The 100 ampere reading should be 5 to 25 micro-ohms for a 3000 amp breaker, 25 to 50 micro-ohms for a 2000 amp breaker and 30 to 60 micro-ohms for a 1200 amp breaker when connected across the primary and secondary stabs on the breaker.

### 12.4. VACUUM INTERRUPTER INTEGRITY TEST

**CAUTION:** X-RADIATION WILL BE PRODUCED IF AN ABNORMALLY HIGH VOLTAGE IS APPLIED ACROSS A PAIR OF ELECTRODES IN A VACUUM. X-RADIATION WILL INCREASE AS VOLTAGE INCREASES AND/OR AS CONTACT SEPARATION DECREASES. ONLY TEST A CORRECTLY-ADJUSTED CIRCUIT BREAKER.

DURING A HIGH POTENTIAL OR A VACUUM INTEGRITY TEST, ANY X-RADIATION WHICH MAY BE PRODUCED WILL NOT BE HAZARDOUS AT A DISTANCE SAFE FOR HIGH POTENTIAL TESTING, IF THE TEST IS CONDUCTED AT THE RECOMMENDED VOLTAGE AND WITH THE NORMAL OPEN CIRCUIT BREAKER GAP.

DO NOT APPLY VOLTAGE THAT IS HIGHER THAN THE RECOMMENDED VALUE. DO NOT USE CONTACT SEPARATION THAT IS LESS THAN THE RECOMMENDED OPEN-POSITION BREAKER CONTACT GAP.

This test of the vacuum interrupter will determine its internal dielectric condition and vacuum integrity.

A vacuum integrity test is performed using an AC high potential tester. A vacuum integrity test of the interrupter is required to insure that no loss of vacuum has occurred. With the breaker open, individually check each interrupter by connecting the hi-pot machine "Hot," lead to the primary bushing and the ground lead to the load side bushing. If the machine has a center point ground, the connections can be made either way. Apply 36 kV (rms) 60 Hz at 500 vps and hold for 10 seconds. If no breakdown occurs, the interrupter is in acceptable condition. After the high potential voltage is removed, discharge any electrical charge that may be present through the internal ground of the test machine or by a grounded cable to one of the phase bushing.

If a failure of a vacuum bottle should occur during the integrity test, the test procedure should be reviewed and the pole piece cleaned. GE failure rate for vacuum bottles is 0.0007 per field unit. Note the voltage level at failure on the first test, and retest the phase pole piece. If the pole piece passes test, the vacuum bottle is acceptable **STOP**.

If the test fails again but at a higher voltage level than was observed in the first test, clean the pole piece and retest. If a failure of the integrity test occurs a third time, consider the vacuum bottle to have lost vacuum and replace the complete pole piece as described under Repair of Interrupter Assembly

Although a AC high potential test is recommended for Checking the vacuum integrity, a DC high potential test can also be conducted on the vacuum interrupters at 50 kV and held for 10 seconds with the restrictions noted as follows.

No attempt should be made to try to compare the one vacuum interrupter with another nor to correlate the condition of any interrupter to low values of DC leakage current. There is no significant correlation.

After the high potential voltage is removed, discharge any electrical charge that may be retained.

**CAUTION:** MANY DC HIGH POTENTIAL MACHINES ARE HALF-WAVE RECTIFIERS. THIS TYPE OF HIPOT TESTER MUST NOT BE USED TO TEST VACUUM INTERRUPTERS. THE CAPACITANCE OF THE POWER/VAC BOTTLES IS VERY LOW AND THE LEAKAGE IN THE RECTIFIER AND ITS DC VOLTAGE MEASURING EQUIPMENT IS SUCH THAT THE PULSE FROM THE HALF-WAVE RECTIFIER MAY BE IN THE NEIGHBORHOOD OF 120 Kv WHEN THE METER IS ACTUALLY READ-



ING 40 kV. IN THIS CASE, SOME PERFECTLY GOOD BOTTLES CAN SHOW A RELATIVELY HIGH LEAKAGE CURRENT SINCE IT IS THE PEAK VOLTAGE OF 120 kV THAT IS PRODUCING ERRONEOUS BOTTLE LEAKAGE CURRENT. IN ADDITION, ABNORMAL X-RADIATION WILL BE PRODUCED.

An acceptable AC high potential machine is available from: GE Company, Burlington, Iowa, Catalog Number 282A2610P001. The following machines are also acceptable.

AC machines:	Hipotronics	Model 7BT 60A
	Hipotronics	Model 60HVT
	Biddle	Cat. 222060
	Phoenix	Model 7BT 60A
DC machines:	Hipotronics	Model 860PL
	Hipotronics	Model 880PL

### 12.5. INSULATION TESTS

The primary circuit insulation on the breaker may be checked phase to phase and phase to ground using a 2500 Volt or other suitable megohmmeter.

Since definite limits cannot be given for satisfactory insulation values, a record should be kept of the megohmmeter readings as well as temperature and humidity readings. This record should be used to detect any weakening of the insulation from one check period to the next. Generally, readings should equal or exceed 10,000 megohms.

To measure the breaker secondary circuit insulation resistance, disconnect the motor leads and thread a wire connecting together all secondary coupler pins. The measurement is made by connecting a 500 Volt megohmmeter from the wire to ground.

### 13. CHECKING AND INSTALLING BREAKERS

Roll the PV-VL breaker into the cell (frame & top plate). If the breaker stored energy springs were charged, the spring discharge lever, located on the left side of the breaker, will be actuated by the spring discharge bracket and discharge the stored energy springs, (closing and opening springs). The yellow semaphore on the front of the breaker will indicate "**DISCHGD**".

The breaker cannot be closed when it is fully inserted into the cell, in the lowered position.

The breaker may be operated electrically when in the lowered position by completely removing it from

the cubicle and connecting the breaker test coupler accessory set (optional). The breaker functions may now be checked electrically or manually via the breaker control switch on the switchgear unit, or the manual push buttons on the breaker front.

## 14. MAINTENANCE

### 14.1. GENERAL

POWER/VAC VL circuit breakers have been designed to be as maintenance-free as practicable. They include features such as sealed vacuum interrupters and long-life synthetic greases which contribute to many years of trouble-free performance with a minimum amount of maintenance.

If maintenance on the PowerVac<sup>®</sup> VL breaker is being performed to an extended schedule such as a 5-year or 10-year program, the vacuum interrupter integrity test should be performed if the breaker is removed for reasons other than scheduled breaker maintenance, and it has been more than one year since the last vacuum integrity test, a test should be performed.

Both long and short term maintenance of all electrical equipment is essential for reliability and safety. Maintenance programs MUST be customized to the specific application, well planned, and carried out consistent with both industry experience and manufacturer's recommendations. Local environment must always be considered in such programs, including such variables as ambient temperatures, extreme moisture, number of operations, corrosive atmosphere or major insect problems and any other unusual or abusive condition of the application.

One of the critical service activities, sometimes neglected, involves the servicing and calibration of various control devices. These devices monitor conditions in the primary and secondary circuits, sometimes initiating emergency corrective action such as opening or closing circuit breakers. In view of the vital role of these devices, it is important that a periodic test program be followed. As was outlined above, it is recognized that the interval between periodic checks will vary depending upon environment, the type of device and the user's experience. It is the General Electric recommendation that, until the user has accumulated enough experience to select a test interval better suited to his individual requirements, all significant calibrations should be checked at an interval of one to two years.

To accomplish this, protective relays can be adequately tested using field test sets. Specific calibration instructions on particular devices typically are provided by supplied instruction books.

Instruction books supplied by manufacturers address components that would normally require service or maintenance during the useful life of the equipment. However, they can not include every possible part that could require attention, particularly over a very long service period or under adverse environments. Maintenance personnel must be alert to deterioration of any part of the supplied switchgear, taking actions, as necessary, to restore it to serviceable status.

Industry publications of recommended maintenance practices such as ANSI/NFPA 70B, Electrical Equipment Maintenance, should be carefully studied and applied in each user's formation of planned maintenance.

Some users may require additional assistance from GE in the planning and performance of maintenance. GE can be contacted to either undertake maintenance or to provide technical assistance such as the latest publications.

The performance and safety of this equipment may be compromised by the modification of supplied parts or their replacement by non-identical substitutes. All such design changes should be qualified by GE factory engineering.

The user should methodically keep written maintenance records as an aid in future service planning and equipment reliability improvement. Unusual experiences should be promptly communicated to GE.

### **POWER/VAC® INTERRUPTER**

The POWER/VAC interrupter used in this breaker is a reliable, clean interrupting element. Since the contacts are contained in a vacuum chamber, they remain clean and require no maintenance at any time. The metallic vapors eroded from the contact surfaces during high current interruption remain in the chamber and are deposited on metal shields thus insuring a high dielectric value of the vacuum and the walls of the interrupter.

### **TROUBLE REPORTING**

Although all reputable manufacturers design their products to perform satisfactorily with a minimum of problems, the IEEE Switchgear Committee, an organization of both users and manufacturers, rec-

ognized the need for a common trouble reporting format. A reproducible copy of this form is included on pages 67 and 68 of this book and is recommended for use with any manufacturer's circuit breakers. Forward completed forms to GE at Burlington Iowa.

The intent is for each maintenance organization to keep specific problem files with this information documented. If the problem is serious or repetitive, a summary should be sent to the appropriate manufacturer for action. The level of detail included on the form is considered very desirable so that the manufacturer's investigator may more thoroughly understand and solve the reported problem.

### **14.2. SERVICE CONDITIONS**

The frequency of required maintenance depends on the severity of the service conditions of the switch-gear application. If the service conditions are mild, the interval between maintenance operations may be extended to 10 years or 10,000 no load or 5000 for normal load switching operations.

Mild service conditions are defined as an environment in which the switchgear is protected from the deleterious 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 -30° C or above +40° C).

**WARNING:** BEFORE ANY MAINTENANCE WORK IS PERFORMED, MAKE CERTAIN THAT ALL CONTROL CIRCUITS ARE DE-ENERGIZED AND THAT THE BREAKER IS REMOVED FROM THE METALCLAD UNIT. DO NOT WORK ON THE BREAKER OR MECHANISM WHILE IT IS IN THE CLOSED POSITION WITHOUT TAKING PRECAUTIONS TO PREVENT ACCIDENTAL TRIPPING. DO NOT WORK ON THE BREAKER WHILE THE CLOSING SPRING IS CHARGED UNLESS IT IS SECURED IN THAT POSITION BY THE CLOSING-SPRING GAG.

### **14.3. FAULT INTERRUPTIONS**

The erosion rate of the primary contacts in the vacuum interrupters is very low for no-load and normal load switching operations. However, fault current interruptions at or near the breaker rating may result in appreciable contact erosion. With frequent fault interruptions it is necessary to

form maintenance based on the number of interruptions. After each 15 full fault interruptions the following should be performed:

1. Contact erosion check.
2. Wipe and gap check.
3. Vacuum interrupter integrity test.

#### **14.4. CONTACT EROSION**

Check in the breaker-closed condition per PRIMARY CONTACT EROSION section 11.1. When erosion reaches 1/8 inch, the interrupter should be replaced.

#### **14.5. TRANSFER FINGER WEAR**

With breaker open, examine the moving contact rod projecting below the transfer fingers (10, Fig. 22). Wipe off the lubricant in order to see the metal surface condition. The finger locations should present a burnished silver contact without copper appearance at more than one location. If copper is visible at more than one location per pole or the silver plating is torn, the interrupter assembly should be replaced. Relubricate with grease, part # 0282A2048P009 (mobil 28 red grease).

#### **14.6. MECHANISM**

Check all items covered in INSTALLATION and readjust or tighten hardware as required. Lubricate as recommended under LUBRICATION.

#### **14.7. PRIMARY INSULATION PARTS**

Using dry, non-linting cloth or industrial-type wipers, clean accessible insulation surfaces on the interrupter supports and operating rod insulators. In service locations where contamination is heavy or external flashovers, have occurred during interrupter high-potential testing, remove the interrupter assemblies per the procedure in REPAIR AND REPLACEMENT and clean the inside surfaces of the interrupter supports and the outer insulation surfaces of the POWER/VAC interrupters.

Be sure to discharge the interrupter midband ring before removing the interrupter assemblies. Removal and reassembly of interrupter assemblies will normally not require adjustment due to the design of the interrupter operating rod insulator connection. They should be returned to the same location from which they were removed.

#### **14.8. LUBRICATION**

Proper lubrication is important for maintaining reliable circuit breaker performance. The ML-18VL mechanism uses bearings which have a synthetic lining in

some locations. These bearings do not require lubrication to maintain low friction, but lubrication does not harm them and oiling lightly is recommended. Sleeve bearings are used in some linkage locations and needle or roller bearings are used for low friction on trip shaft and close shaft.

Bearings are lubricated during factory assembly with grease and oil, but all lubricants have a tendency to deteriorate with age. Providing a fresh lubricant supply at periodic intervals is essential to proper breaker operation, especially where frequent operation may have forced lubricant out of the bearing surfaces. Apply a few drops of light synthetic machine oil such as Mobil 1 at each bearing. Apply a coat of 0282A2048P009 grease on the four corners of the closing spring guide where it enters inside the spring. Metal-to-metal contact surfaces should be cleaned and lubricated with 0282A2048P009 grease to provide cleanliness and prevent oxidation.

Electrical primary contact surfaces also require periodic lubrication to inhibit oxidation and minimize friction. At each inspection and maintenance interval, do the following:

- 1) Wipe clean and coat lightly with 0282A2048P009 grease all silvered primary contact surfaces such as the movable contact rod of the interrupter and the primary disconnect fingers.
- 2) Clean and coat lightly with 0282A2048P009 grease the pins of the secondary coupler.

#### **14.9. RECOMMENDED MAINTENANCE**

The following operations should be performed at each maintenance check:

1. Perform a visual inspection of the breaker. Check for loose or damaged parts.
2. Perform slow closing operation described under MECHANICAL CHECKING AND SLOW CLOSING.
3. Check the erosion indicator and the wipe and gap as described under DIMENSIONAL CHECKS.
4. Perform the vacuum interrupter integrity test as described under ELECTRICAL CHECKS.
5. Lubricate the breaker operating mechanism as described under LUBRICATION.
6. Check the electrical operation using the test cabinet.

**CAUTION:** REPEATED OPERATIONS AT A RATE EXCEEDING TWO PER MINUTE MAY CAUSE CHARGING MOTOR OVERHEATING AND SUBSEQUENT MOTOR FAILURE.

7. Examine the movable contact rod of the vacuum interrupter. With the breaker open, wipe the lubricant off the rod and examine the silver surface. The rod should have a burnished appearance without copper appearing through the silver. If copper is visible at more than one location per pole, or if the silver plating is torn, the interrupter assembly should be replaced. Relubricate breaker movable contact rod with 0282A2048P009 grease.

8. If desired, perform the additional tests (Megger, Primary and Secondary High Potential, and Primary Circuit Resistance). See ELECTRICAL CHECKS.

## 15. TIMING

Timing and speed checks are optional and also depend on the level of maintenance performed. Generally these tests are not required for normal maintenance. If a new mechanism has been installed or extensive repair, replacement or major disassembly has been performed, it is recommended that these tests be performed.

To determine contact velocity, a travel recorder and oscillograph are required. Optional travel recorders can be obtained through your local GE Sales Office by ordering part number 0144DI235G001. A typical travel trace and interpretation are shown in Fig. 29.

Timing may be checked by monitoring control circuit voltage and using no more than six volts DC and one ampere through the vacuum interrupter contact to indicate closed or open condition. Typical time ranges vary with coil voltage, but nominal values are:

Initiation of trip signal to contact parting

32-45 Milliseconds

2 Milliseconds maximum pole spread

Initiation of close signal to contact closing

35-75 Milliseconds

2 Milliseconds maximum pole spread.

Trip-free operation may be checked by applying a simultaneous close and trip signal, and a minimum reclose operation may be checked by tripping a charged breaker open while maintaining a close signal.

Instantaneous reclose time 85-150 Milliseconds.

\*Time from application of trip signal until breaker contacts reclose.

## 16. OPENING AND CLOSING SPEED

The opening speed is modified by moving the speed adjusting nuts on the opening spring assemblies. A change in the opening speed affects the closing speed Reference Figure 29.

The operating speeds for 5 cycle breakers are as follows:

Operation	Feet Per Second
Open	5.0 normal, 4.5 minimum
Close	3.5 nominal, 4.0 maximum

## 17. REPAIR AND REPLACEMENT

### 17.1.GENERAL

The following information covers in detail the proper method of removing various parts of the breaker in order to make any necessary repairs. This section includes only those repairs that can be made at the installation site, or parts of the breaker that are most subject to damage.

**Important:** Upon completion of any kind of repair work, all interrupter and mechanism adjustments must be checked.

Refer as needed to sections on mechanical and electrical adjustments.

### 17.2. REPLACEMENT OF INTERRUPTER ASSEMBLIES

Interrupter are supplied in complete interrupter assemblies which include the vacuum interrupter mounted in the interrupter support, the primary studs and disconnect fingers.

**CAUTION:** DO NOT ATTEMPT TO REMOVE OR REINSERT THE VACUUM INTERRUPTER IN THE INTERRUPTER SUPPORT ASSEMBLY. SPECIAL TOLLS AVAILABLE ONLY AT THE FACTORY ARE REQUIRED.

1 . Remove the front portion of the breaker top plate. Close the breaker and remove the coupling clamp, (8, Fig. 22). Hold hex projection (6, Fig. 22) at the bottom of the operating rod insulator with a 1 inch wrench and loosen the adjacent lock nut with a 3/4 inch wrench. Screw down the lock nut and the operating rod insulator until clear of interrupter rod. Remove the four bolts holding the pole assembly to the mechanism and remove the old pole assembly.

2. Set the new pole assembly in place and install the four mounting bolts. Set the pole assembly so that the distance between the primary studs and the studs on the adjacent pole are ten (10) inches center line to center line.

3. Screw the operating rod insulator up to mate with the base of the interrupter rod. Install coupling clamp. Tighten coupling clamp cap screws, then loosen them 1-2 turns.

a. With continuity indicator across the contacts, back off the operating rod until the contacts separate, (continuity indicator off).

b. Advance operating rod until contacts touch, (continuity indicator on).

c. Advance operating rod two and one-half (2-1/2) additional turns.

d. Tighten lock nut to 40-50 foot pounds and the coupling clamp cap screws to 8-10 foot pounds.

e. Check wipe - must be 0.15-0.18 inch (set all three phases before measuring). It is not necessary that all three poles have the same wipe measurement as long as all three poles fall within the specified limits.

f. Check gap - must be 0.54-0.60 inch. Adjust if needed per CONTACT GAP ADJUSTMENT in MECHANICAL ADJUSTMENT section.

4. If new interrupter assembly is installed, check and adjust the erosion indicator (4, Fig. 21) by bending the indicator to line up with erosion disk.

5. Perform the VACUUM INTERRUPTER INTEGRITY TEST as described in ELECTRICAL CHECKS section.

**CAUTION:** PRIMARY DISCONNECT WIPE CAN ONLY BE CHECKED WHEN THE SWITCH IS DE-ENERGIZED.

### 17.3. PRIMARY DISCONNECT BUSHINGS

The primary disconnect bushing assemblies should not be removed. Alignment of these items is critical to the function of the vertical lift equipment. If these bushings are removed, contact your local GE office for the location of a GE Authorized Service Center that can re-install them.

### 17.4. MECHANISM

Pin Retaining Rings – These rings are widely used in the ML-18 mechanism to retain pins. They can be installed and removed with a pair of standard pliers. Reuse is not recommended. To remove, slowly squeeze the removal ears while pulling. To install, position in the pin groove and squeeze the installation ears closed leaving no more than 1/16 inch gap between ears. Retaining rings can be obtained from your local GE Sales office by ordering part number 0282A2015G001.

### 17.5. CONTROL SWITCHES

Control switches may be removed from their mounting brackets by disconnecting the wires and removing the mounting hardware. When replacing the switches, check that the correct type, normally open or normally open or normally closed, is used. Reinstall, wire, and adjust per DIMENSIONAL CHECKS - CONTROL SWITCH ADJUSTMENT.

### 17.6. TRIP COIL REPLACEMENT

#### TOOLS REQUIRED

- 5/16" Allen wrench
- Needle nose pliers
- 7/16" Socket wrench
- 7/16" Box/combo wrench
- 1/4" Square drive ratchet
- 1/4" Square 3" extension
- Loctite #271 or equivalent

Perform the operation in the following sequence:

1. Charge closing spring and install gag tool.
2. Depress the close and then the trip buttons.
3. Pump the manual close handle 3 - 4 times.
4. With the 5/16" Allen wrench, remove the pivot bolt (10, Fig. 26) on the closing spring (1, Fig. 26).
5. Remove the closing spring.
6. Disconnect the trip linkage tension spring.
7. Loosen the interlock bracket (11, Fig. 26).
8. Remove the 4 bolts from the coil bracket leaving the two bolts nearest the front of the breaker in place in the mechanism frame.
9. Cut coil leads and remove the coil and armature.

To install the new coil reverse the above procedure and connect leads with insulated butt connectors. See TRIP COIL PLUNGER in MECHANICAL ADJUSTMENTS section for setting the stroke of the armature. Apply Loctite to the threads of the pivot bolt (10, Fig. 26) when it is replaced. Charge the breaker and electrically close and trip it to make certain it has been reassembled correctly.

### 17.7. CLOSING COIL REPLACEMENT

Disconnect the close linkage tension spring then remove the retaining ring from the close linkage pivot pin (17, Fig. 26) and disconnect the linkage. Remove the closing coil and housing (6, Fig. 26). Cut the leads to the closing coil and remove the coil. Reassemble the coil and housing with armature and butt-splice the new coil into the wiring harness. Reassemble linkage and spring. Readjust the closing coil armature travel in accordance with instructions in MECHANICAL ADJUSTMENTS section under CLOSE COIL PLUNGER.

### 17.8. AUXILIARY SWITCH REPLACEMENT

With the breaker open and the closing spring discharged, remove retaining clip from auxiliary switch

shaft, or loosen clamping bolt in operating link. Observe and make note of the direction of the index mark on the end of the shaft and the position of the operating link in relation to the stop screw.

Remove mounting hardware securing auxiliary switch to mechanism plate. Slide auxiliary switch and shaft out of operating link. Before removing any wires from switch terminals, make sure they are properly tagged with switch terminal numbers to assure proper placement on new switch. Remove wires.

To install new switch, attach leads then install switch, or install switch then attach leads depending upon type of switch and its terminal accessibility. Install switch shaft in operating link with index mark aligned as noted above. Reverse above procedure to complete installation.

### **17.9. MOTOR REPLACEMENT**

With the breaker open and the closing spring discharged, remove auxiliary switch as described above but do not disconnect leads. Move switch toward side of mechanism far enough to clear motor and tie there temporarily. Disconnect motor leads. Remove the long bolt and spacer securing the motor to the mechanism mid-plate. Remove the two socket head cap screws securing the motor to the mechanism top plate using a 5/16" Allen socket and a 24" extension. Disengage the motor output shaft from the charge linkage arms and withdraw motor.

To install the new motor, reverse the above procedure.

### **17.10. "Y" RELAY REPLACEMENT**

Before removing the "Y" relay, make sure all leads are marked with terminal locations. Next, disconnect all leads and remove the two fasteners securing the "Y" relay's shock absorbing mounting bracket to the mechanism rear plate. Withdraw relay and bracket. Remove fasteners securing relay to mounting bracket.

Reverse above procedure to install new relay.

## **18. RENEWAL PARTS**

It is recommended that sufficient renewal parts be carried in stock to enable the prompt replacement of any worn, broken or damaged parts. A stock of such parts minimizes service interruptions caused by breakdowns, and saves time and expense. When continuous operation is a primary consideration, more renewal parts should be carried, the amount depending upon the severity of

the service and the time required to secure replacements.

Renewal parts which are furnished may not be identical to the original parts, but they will be interchangeable.

A separate Renewal Parts Bulletin may be available from your local GE Sales office.

## **18.1. ORDERING INSTRUCTIONS**

1. Always specify the complete nameplate date of both the breaker and the mechanism.

2. Specify the quantity, catalog number (if listed), reference number (if listed), and description of each part ordered, and the parts bulletin number.

3. Standard hardware, such as screws, bolts, nuts, washers, etc. are not listed in this bulletin. Such items should be purchased locally.

4. For prices or information on parts not listed in the Renewal Parts Bulletin, refer to the nearest GE office.

## **19. MECHANICAL ADJUSTMENTS**

### **19.1 GENERAL**

The ML-18VL Mechanism has been designed for extended intervals between maintenance. In most cases only the wipe and gap adjustments will require re-setting throughout the life of the circuit breaker.

### **19.2. WIPE ADJUSTMENT**

Wipe is the additional compression of a preloaded spring, used to apply force to the vacuum interrupter contacts and to provide opening kick-off force. Always adjust the contact wipe before adjusting the gap.

An indicator is provided on the wipe spring assembly with graduations given in 0.05 inch on which the wipe is indicated directly. See Figure 22.

Improved accuracy of the wipe measurement may be obtained by using a feeler gauge between the top of the wipe indicator and the erosion disk. The difference in readings on each pole with the breaker closed and open is the contact wipe. Adjustment not required if wipe is more than 0.075 inch. After adjustment the wipe should be 0.15-0.18 inch.

To adjust the primary contact wipe, close the breaker. Remove the front portion of the breaker top plate, (do not remove the entire top plate assembly) and proceed as follows:

1. Loosen, but do not remove, the two cap screws (9, Fig. 22) holding the interrupter clamp.

2. Check that the interrupter clamp is loose. A light pry at the clamp half junction may be required to loosen the wedging action of the clamp.

3. Hold the hexagon projection (6, Fig. 22) at the bottom of the operating rod insulator (1 inch wrench) and loosen the adjacent locknut (4, Fig. 22), with (3/4 inch wrench). Adjust by rotating the operating rod insulator. The thread is 1/2-13 and each turn will give about 0.078 inch change in primary wipe. Screw the operating rod insulator toward the interrupter to increase wipe.

4. After setting the contact wipe on each phase, torque the operating rod locknut (4, Fig. 22) to 40-50 foot pounds while holding the hex projection (6) to prevent the operating rod insulator (7) from turning. Tighten the clamp screws (9) to 8-10 foot pounds and trip the breaker open. This procedure prevents accidental twisting of the interrupter's operating rod by loading the contacts with the wipe springs and forcing relative rotation to occur at the clamp interface. After adjustment, remeasure the wipe dimensions. If the wipe settings are within the required limits, there is an adequate contact closing relationship between the poles.

### 19.3. CONTACT GAP ADJUSTMENT

To adjust the contact gap, remove the front portion of the breaker top plate. The gap adjustment refers to the separation, or gap, between the primary contacts within the vacuum interrupter. Before attempting to measure or set the gap adjustment, verify that the wipe settings are within acceptable limits. Any change of the wipe settings will affect the gap settings.

1. With the breaker in the open position and the closing spring discharged, locate the gap adjusting nuts on the opening spring rods connected to the outer phase bell cranks (Fig. 27). Loosen the jam nut on both rods. Back off the adjusting bolt on the center phase VI stop (Fig. 27).

2. Advance or retard the adjusting nuts depending on which way you want to change the gap. Move both nuts the same amount.

3. Lock the jam nuts after setting the adjusting nuts. Operate the breaker a few times and remeasure the gap following the procedure described in DIMENSIONAL CHECKS, item 3.

Readjust the center phase VI stop (Figure 27). Set adjusting screw for no clearance between stop and wipe spring rod striker with the breaker open.

### 19.4. TRIP COIL PLUNGER

To adjust trip coil plunger gap (Figure 32), lift locktab away from adjusting nut. Turn adjusting nut until trip pin makes contact with trip arm while maintaining dimension T. Bend locktab to secure the adjusting nut.

Reference DIMENSIONAL CHECKS for breaker position and spring status.

### 19.5. CLOSE COIL PLUNGER

To adjust close coil plunger gap (Figure 30), lift locktab away from adjusting nut. Turn adjusting nut until close latch actuator makes contact with close latch while maintaining dimension C. Bend locktab to secure adjusting nut.

Reference DIMENSIONAL CHECKS for breaker position and spring status.

### 19.6. CLOSE SPRING DISCHARGE INTERLOCK

THIS INTERLOCK IS FACTORY SET AND **SHOULD NOT** BE ROUTINELY ADJUSTED IN THE FIELD. The adjustment for this interlock is as follows. (See Fig. 25).

The breaker should be open with the closing spring charged.

1. Back off 1/4 inch linkage adjusting screw.
2. While holding roller at 0.995 inch dim., advance adjusting screw to just touch interlock lever.
3. Close latch must reset as indicated.

### 19.7. POSITIVE INTERLOCK

**THIS INTERLOCK IS FACTORY-SET AND SHOULD NOT BE ROUTINELY ADJUSTED IN THE FIELD.**

## TABLE OF MEASUREMENTS

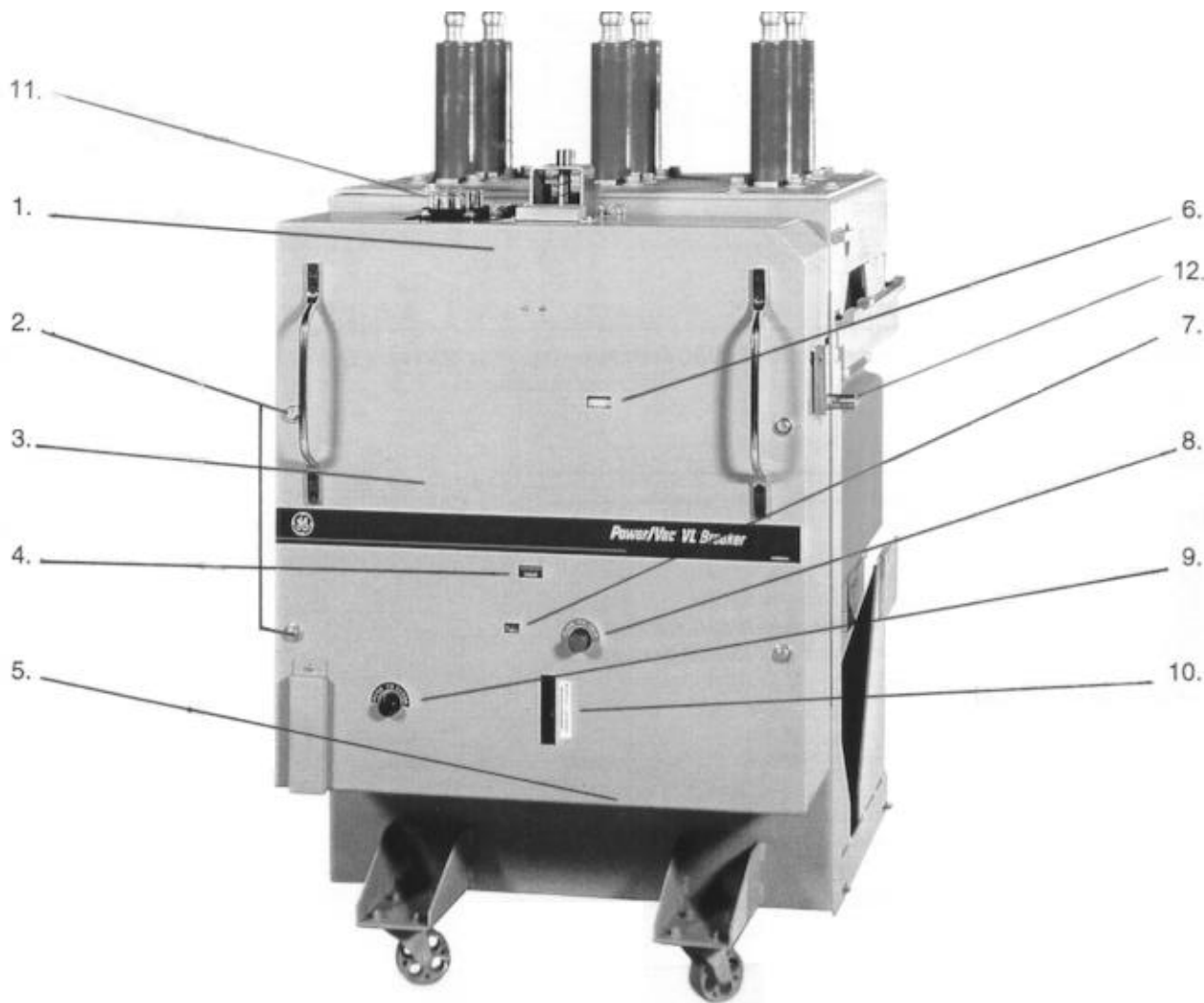
ITEM	BREAKER	CL SPRING	OP SPRING	MEASUREMENT
Contact Wipe	Open Closed	Charged Charged	Discharged Charged	Measure between erosion disk and wipe indicator.
Contact Gap	Open Closed	Charged Charged	Discharged Charged	Measure the travel of the operating rod insulator.
Contact Erosion	Closed	Discharged	Charged	Measure between erosion disk and reference arm.
Trip Coil	Closed	Discharged	Charged	Measure between plunger button and coil housing.
Close Coil	Open	Charged	Discharged	Measure between plunger button and coil housing
Control Switches	Open	Discharged	Discharged	Depends on switch type See Section 8.6.
Timing				See Section 12.
Contact Speeds				See Section 13.

## TABLE OF ADJUSTMENTS

ITEM	BREAKER	CL SPRING	OP SPRING	MEASUREMENT
Contact Wipe	Closed	Charged	Charged	Adjust operating rod to obtain required dimensions.
Contact Gap	Open	Charged	Discharged	Advance or retard gap adjusting nuts to set gap.
Contact Erosion	Closed	Discharged	Charged	Align Reference arm with disk on new units only.
Trip Coil	Closed	Discharged	Charged	Turn adjusting nut to obtain required dimension.
Close Coil	Open	Charged	Discharged	Turn adjusting nut to obtain required dimensions.
Control Switches	Open	Discharged	Discharged	Adjust mounting bracket to obtain required dimension.
Overtravel Stop	Open	Discharged	Discharged	See Section 16.3 for adjustment.

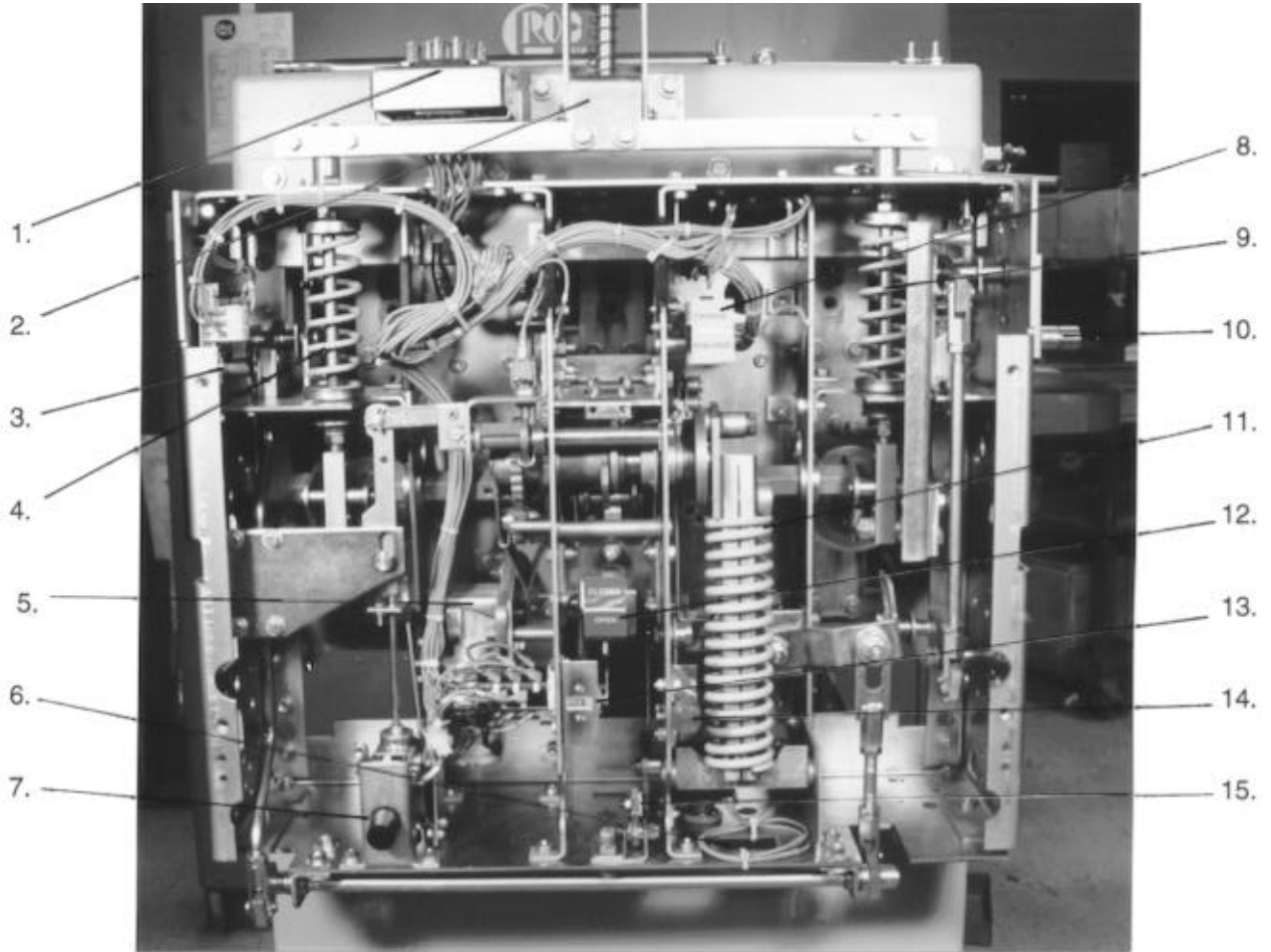


**FIGURE 16  
FRONT VIEW OF POWER/VAC VL BREAKER  
WITH FRONT COVER**



- |     |                            |      |                           |
|-----|----------------------------|------|---------------------------|
| 1 - | Nameplate                  | 7 -  | Counter                   |
| 2 - | Cover Counting Bolts       | 8 -  | Manual Trip Button        |
| 3 - | Front Cover                | 9 -  | Manual Close Button       |
| 4 - | Open/Close Indicator       | 10 - | Manual Charge Slot        |
| 5 - | Close Spring Gag Access    | 11 - | Secondary Coupler         |
| 6 - | Charge/Discharge Indicator | 12 - | Positive Interlock Roller |

**FIGURE 17  
FRONT VIEW OF POWER/VAC VL BREAKER  
WITH FRONT COVER REMOVED**

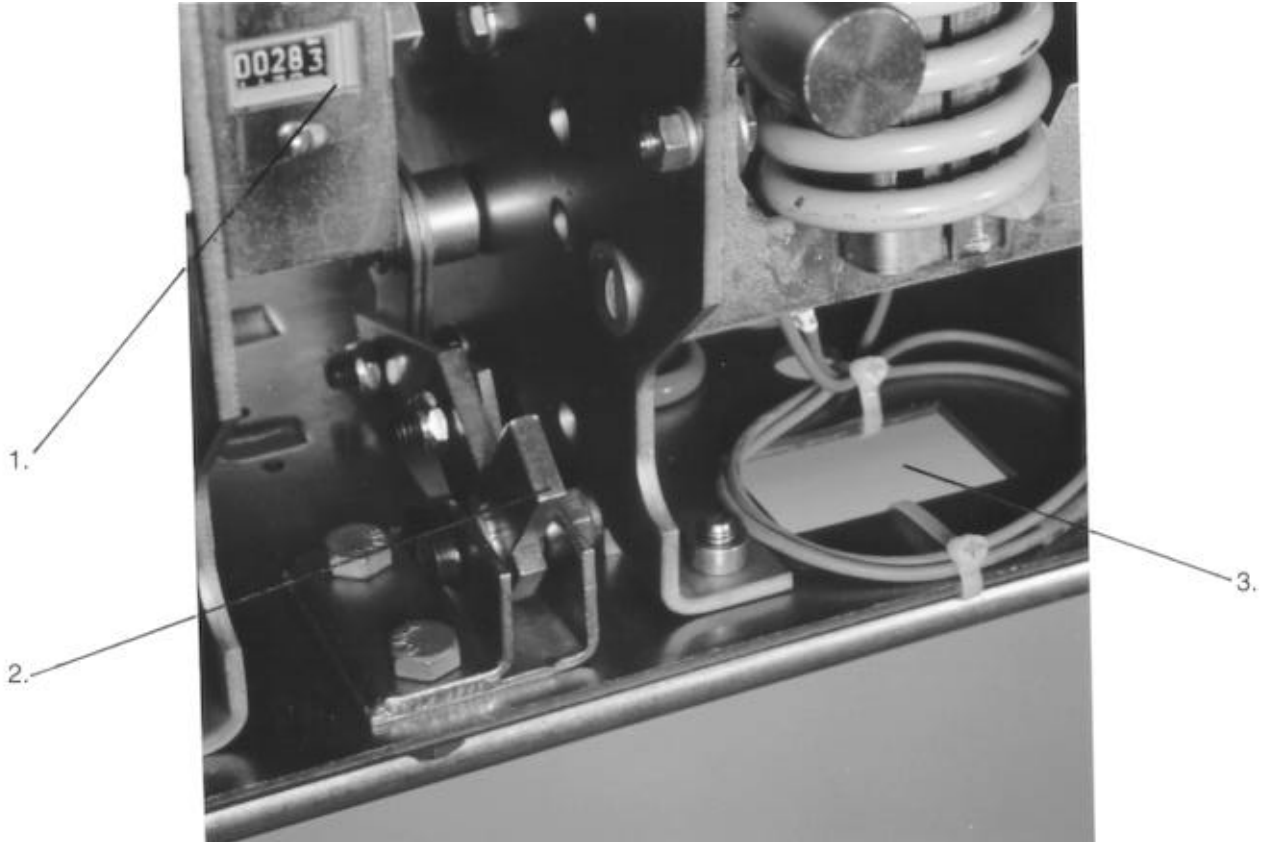


- |     |                         |      |                           |
|-----|-------------------------|------|---------------------------|
| 1 - | Secondary Coupler       | 9 -  | Opening Spring            |
| 2 - | Plunger Interlock       | 10 - | Positive Interlock Roller |
| 3 - | Spring Discharge Lever  | 11 - | Closing Spring            |
| 4 - | Opening Spring          | 12 - | Open/Close Indicator      |
| 5 - | Charging Motor          | 13 - | Counter                   |
| 6 - | Close Spring Gag Access | 14 - | Manual Trip Button        |
| 7 - | Manual Close Button     | 15 - | Manual Charge Lever       |
| 8 - | Spring Charge Indicator |      |                           |

**FIGURE 18  
MANUAL CHARGING HANDLE  
(INSERTED)**

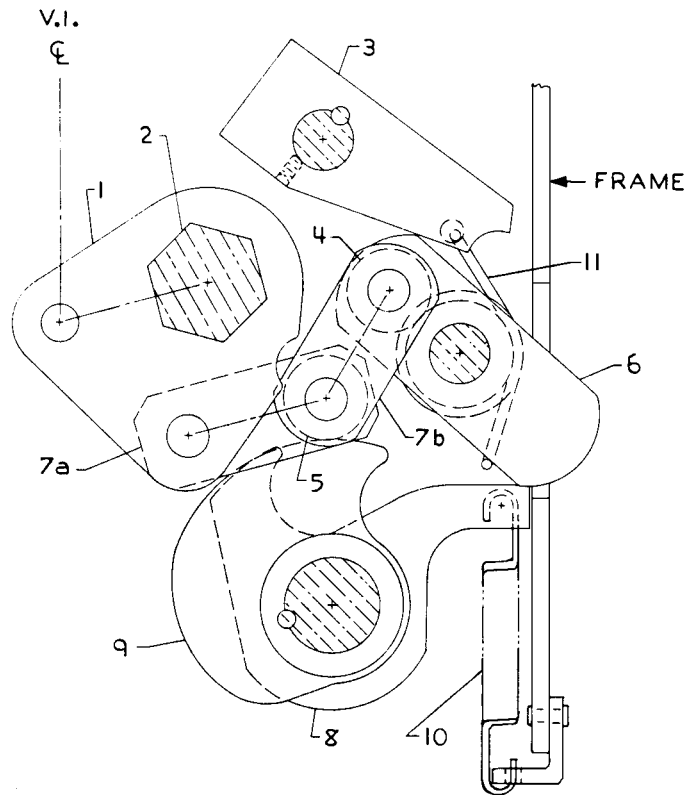


**FIGURE 19**  
**CLOSING SPRING GAG ACCESS**  
**(COVER REMOVED TO SHOW ACCESS HOLE)**



- 1 - Counter
- 2 - Manual Charge Mechanism
- 3 - Gag Hole

**FIGURE 20**  
**TOGGLE LINKAGE POSITIONS**  
**(VIEW FROM RIGHT SIDE)**

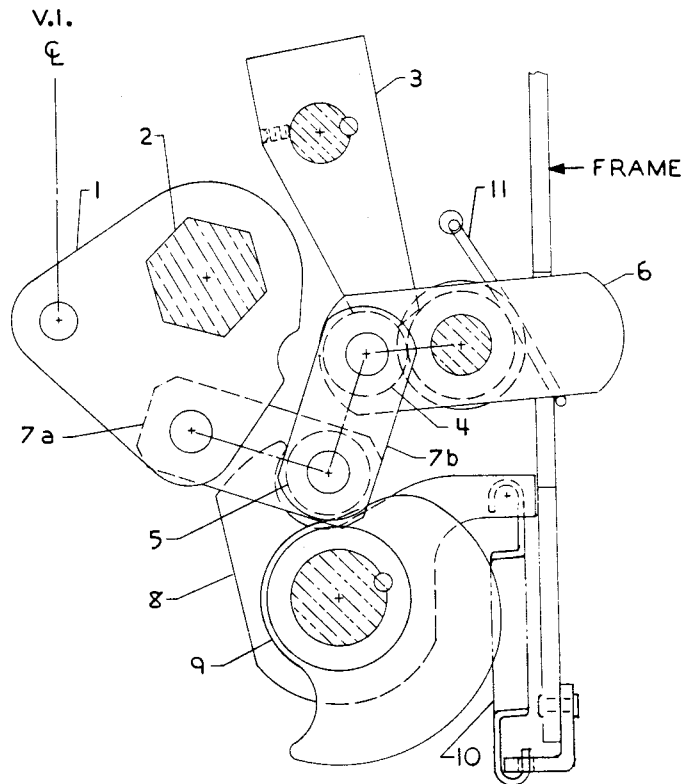


**(A) BREAKER OPEN — SPRING DISCHARGED**

**FIGURE 20 (Continued)**  
**TOGGLE LINKAGE POSITIONS**  
**(VIEW FROM RIGHT SIDE)**

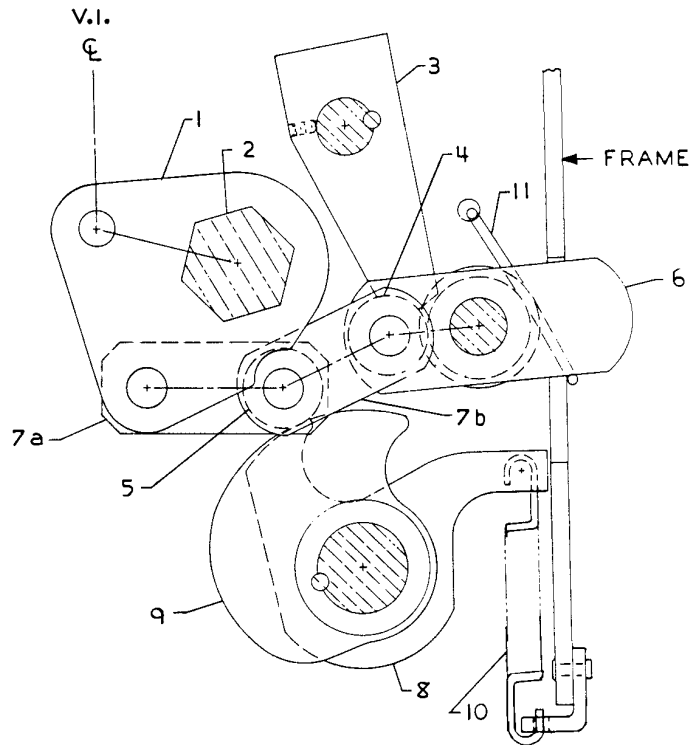
- 1 OUTPUT CRANK
- 2 JACKSHAFT
- 3 TRIP LATCH
- 4 TRIP ROLLER
- 5 CLOSING ROLLER
- 6 TRIP LINK
- 7a CLOSING TOGGLE
- 7b CLOSING TOGGLE
- 8 PROP
- 9 CLOSING CAM
- 10 PROP SPRING
- 11 LINKAGE RETURN SPRING

NOTE: SHADING INDICATES  
 FIXED PIVOTS

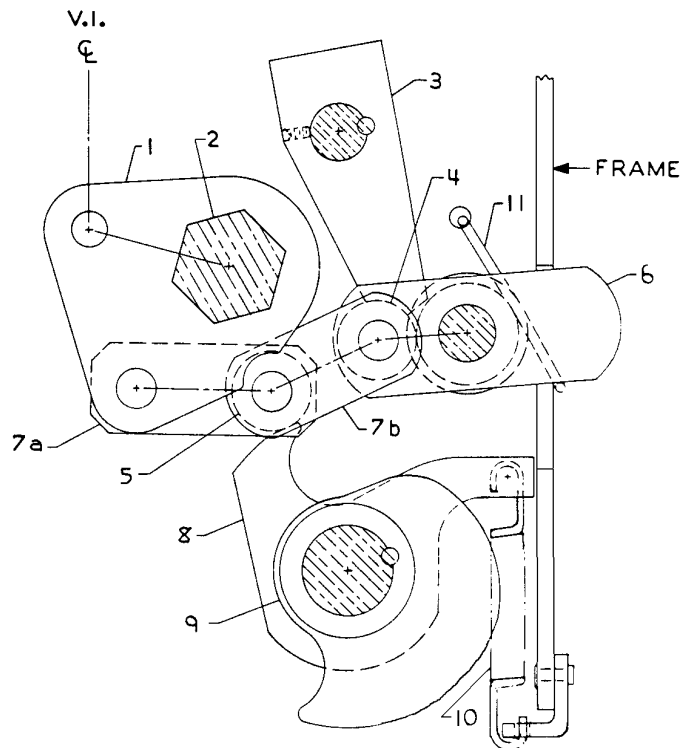


**(B) BREAKER OPEN — SPRING CHARGED**

**FIGURE 20 (Continued)**  
**TOGGLE LINKAGE POSITIONS**

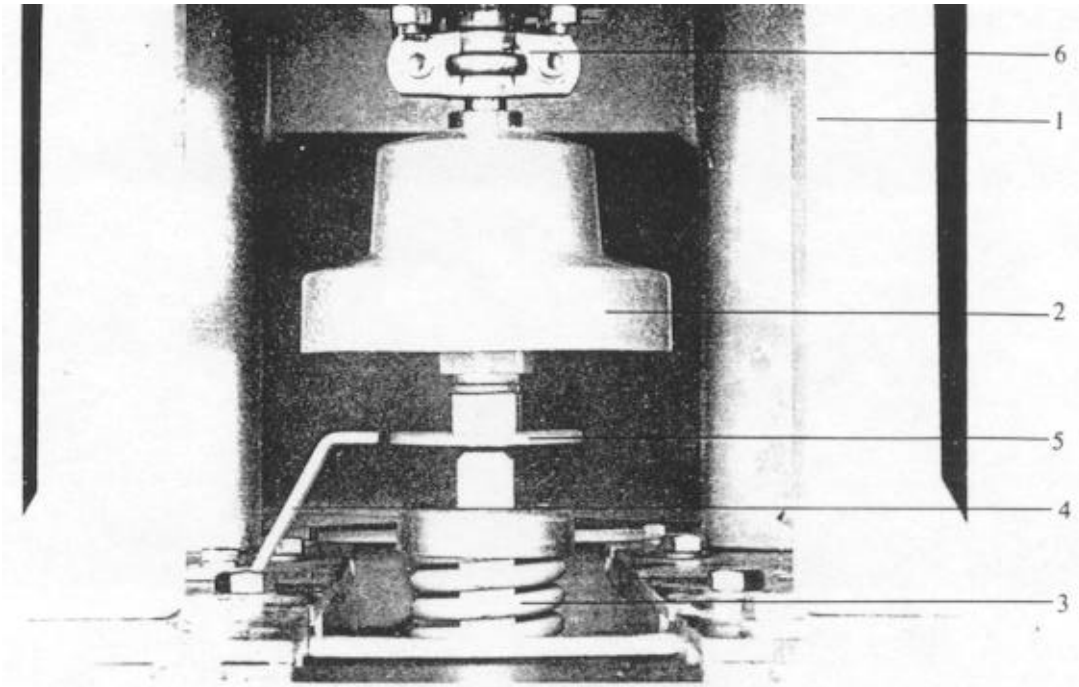


**(C) BREAKER CLOSED — SPRING DISCHARGED**

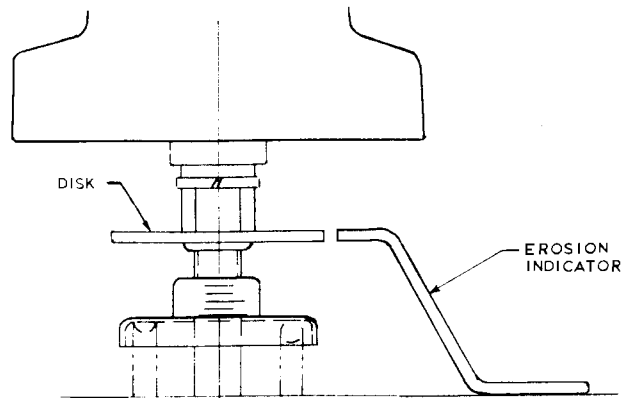


**(D) BREAKER CLOSED — SPRING CHARGED**

**FIGURE 21**  
**CONTACT EROSION INDICATOR**

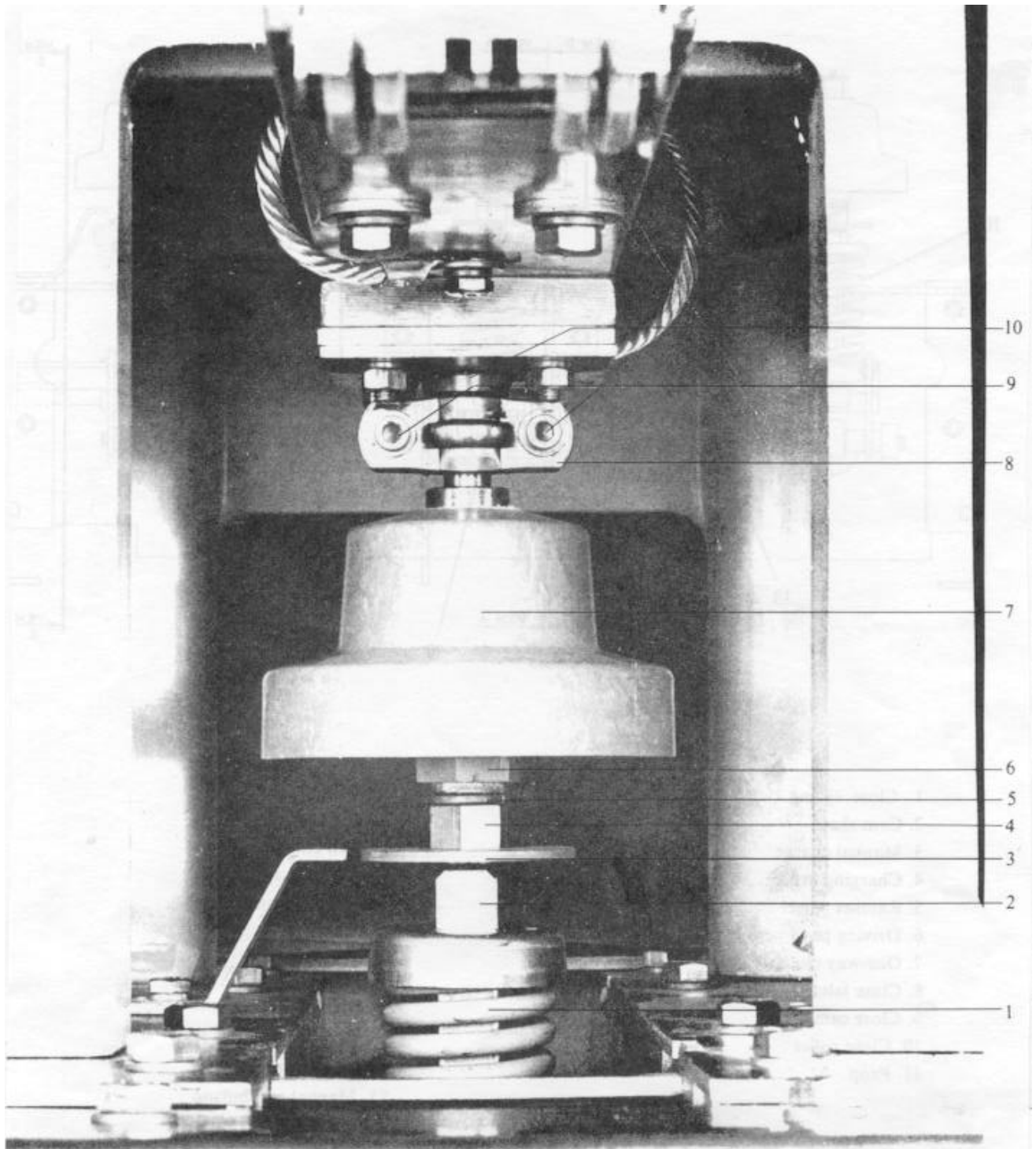


**DETAIL A**





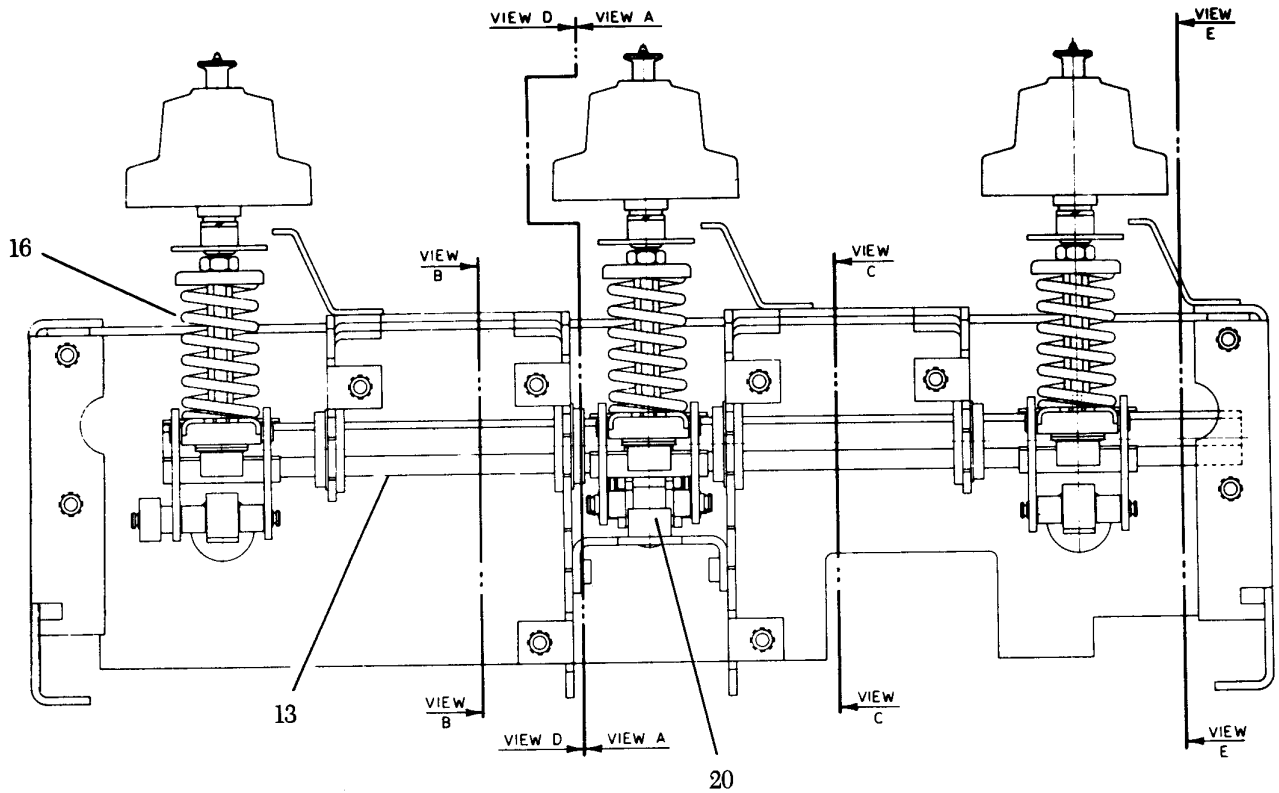
**FIGURE 22**  
**OPERATING ROD ASSEMBLY**



- 1 - Wipe Spring
- 2 - Wipe Indicator
- 3 - Erosion Disk
- 4 - Lock Nut
- 5 - Lock Washer

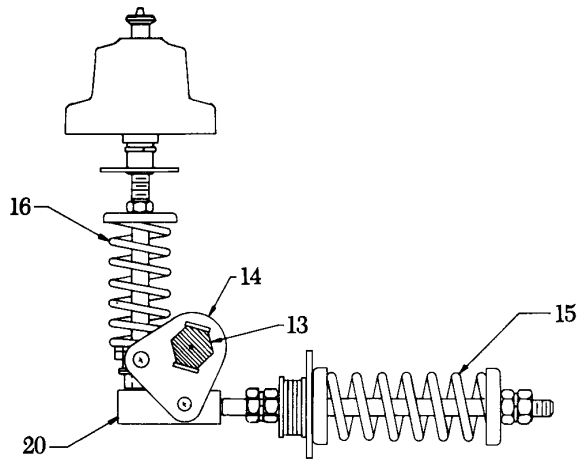
- 6 - Hexagon Projection
- 7 - Operating Rod Insulator
- 8 - Coupling Clamp
- 9 - Clamp Screws
- 10 - Interrupter Moveable Contact Rod

**FIGURE 23**  
**ML-18VL MECHANISM**

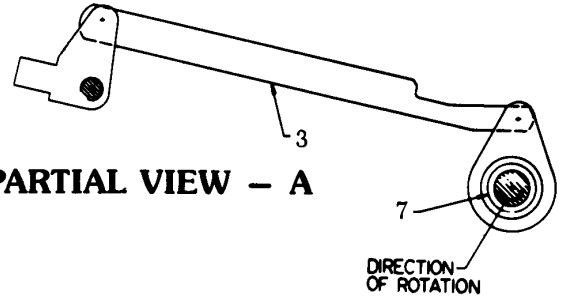


- |      |                |      |                    |
|------|----------------|------|--------------------|
| 1 -  | Close Spring   | 12 - | Output Crank       |
| 2 -  | Cam Shaft      | 13 - | Cross Shaft        |
| 3 -  | Manual Charge  | 14 - | Bell Cranks        |
| 4 -  | Charging Arms  | 15 - | Opening Springs    |
| 5 -  | Ratchet Wheel  | 16 - | Wipe Springs       |
| 6 -  | Driving Pawl   | 17 - | Auxiliary Switch   |
| 7 -  | One-way Clutch | 18 - | Trip Solenoid      |
| 8 -  | Close Latch    | 19 - | Trip Latch         |
| 9 -  | Close Cam      | 20 - | Over-travel Stop   |
| 10 - | Close Roller   | 21 - | Latch Check Switch |
| 11 - | Prop           | 22 - | Gear Motor         |
|      |                | 23 - | Manual Trip Button |

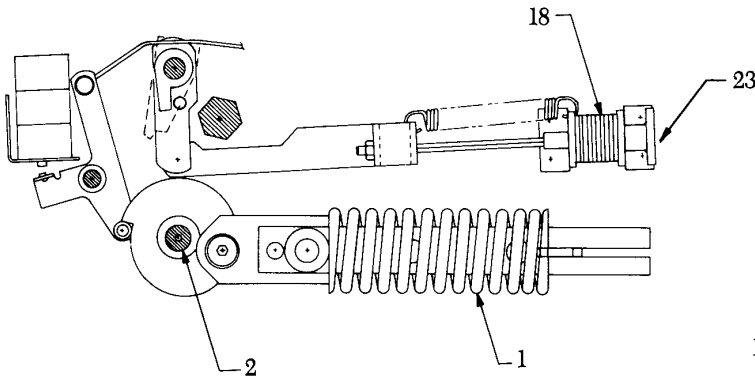
**FIGURE 23**  
**ML-18VL MECHANISM**  
**(Continued)**



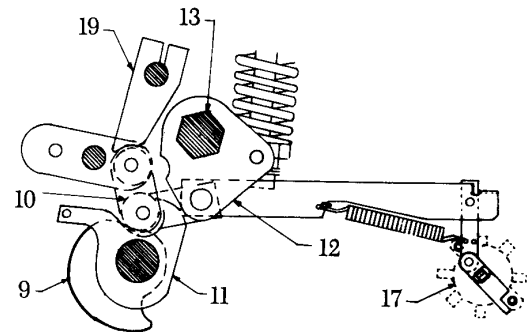
**PARTIAL VIEW - E**



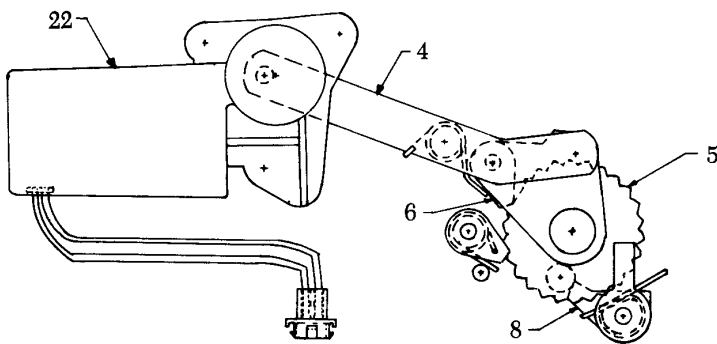
**PARTIAL VIEW - A**



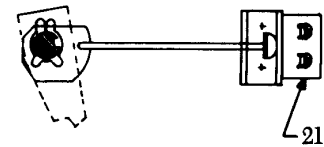
**PARTIAL VIEW - B**



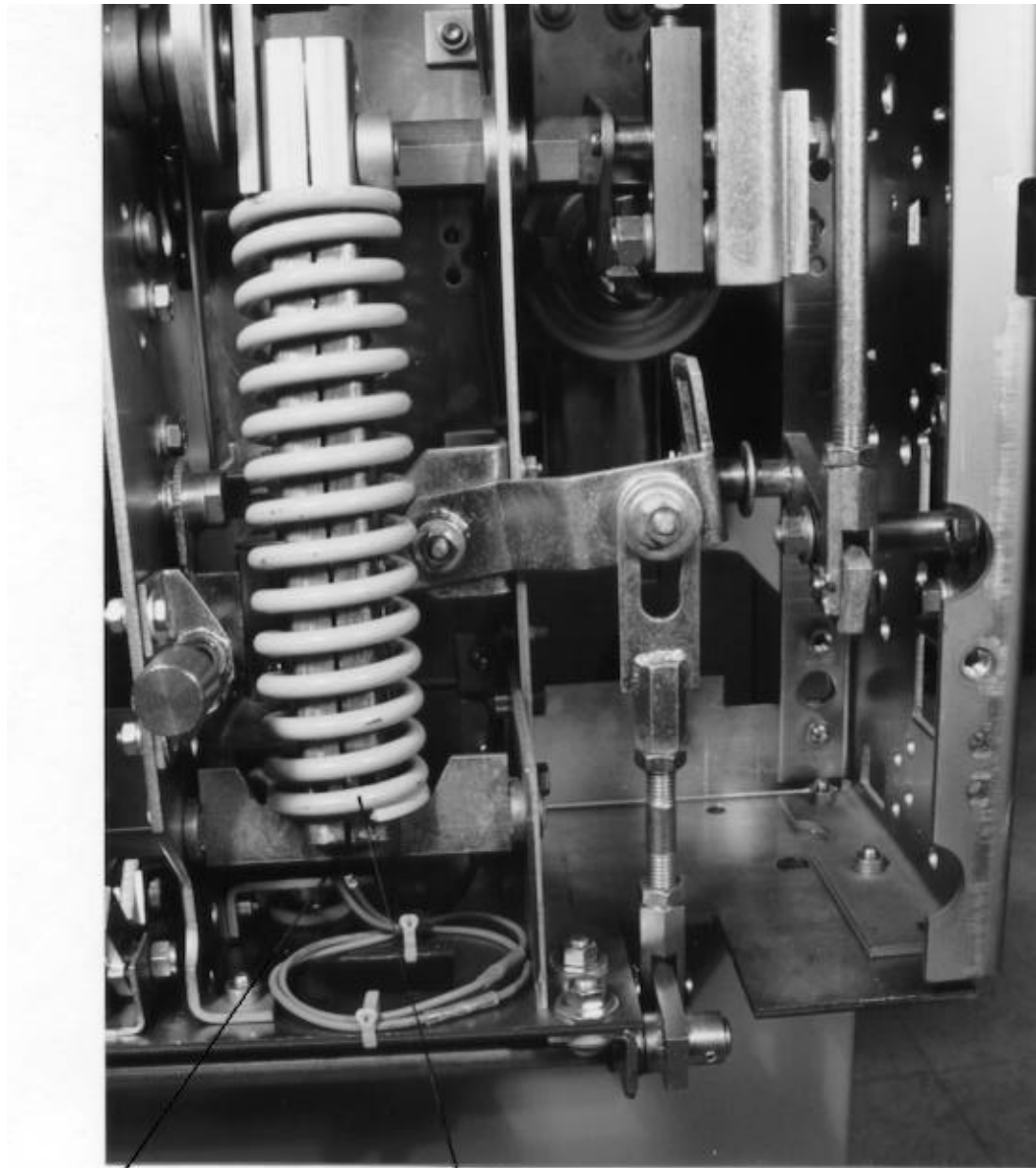
**PARTIAL VIEW - D**



**PARTIAL VIEW - C**



**FIGURE 24**  
**TRIP COIL AND LINKAGE**

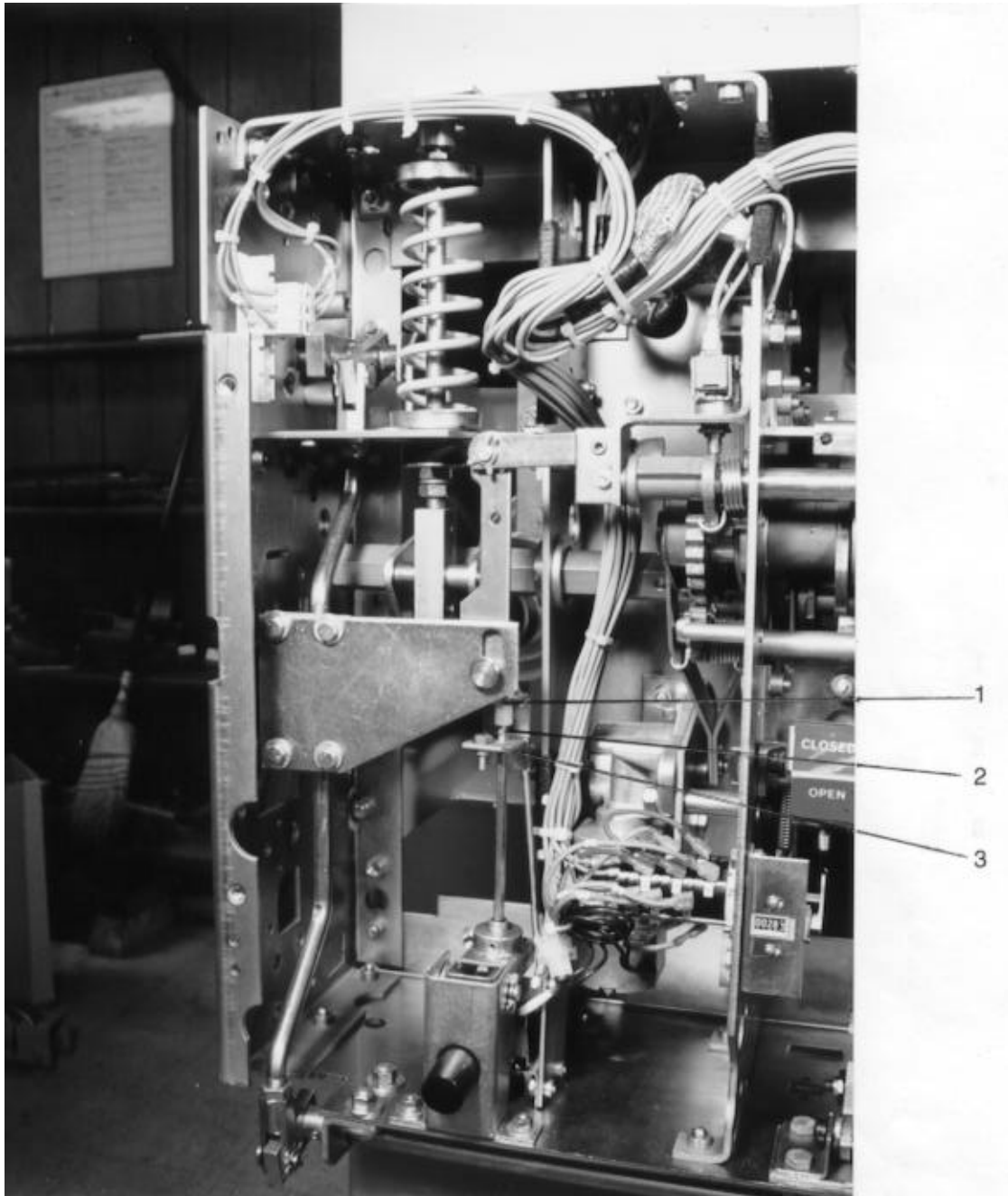


1.

2.

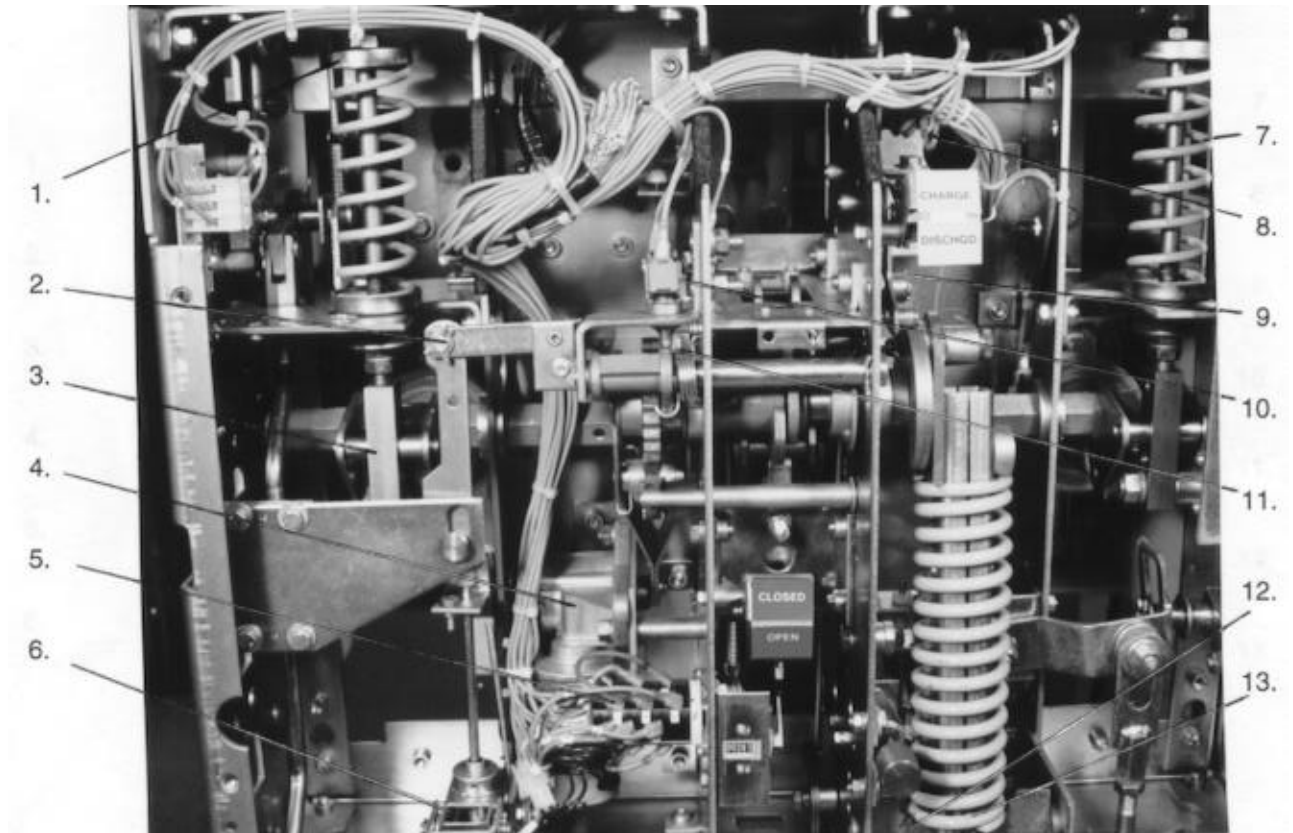
- 1 - Trip Coil
- 2 - Closing Spring

**FIGURE 25  
CLOSE COIL LINKAGE**



- 1 - Close Linkage Adjusting Nut
- 2 - Close Linkage Adjusting Rod
- 3 - Link to Close Latch Actuator

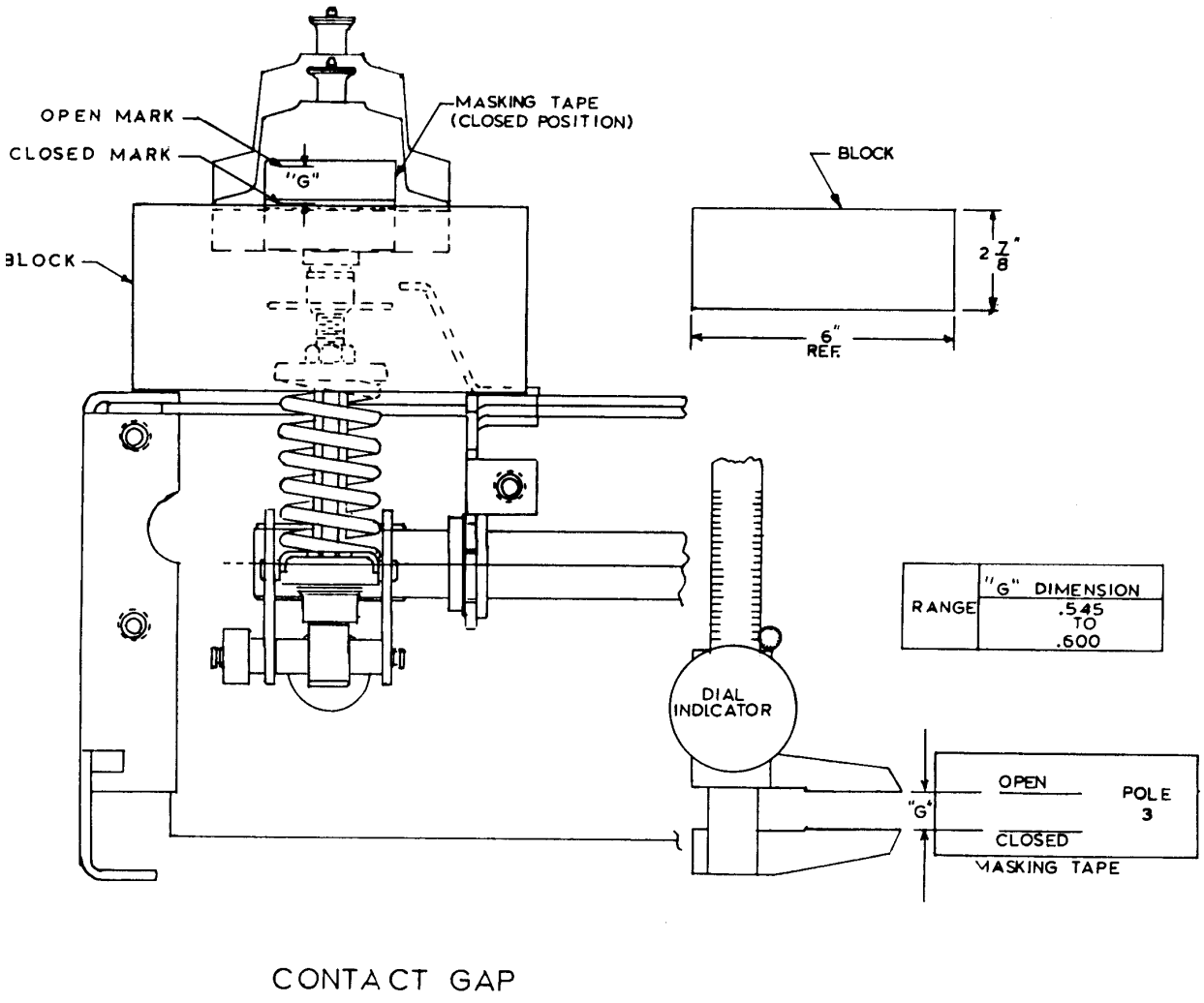
**FIGURE 26**  
**FRONT VIEW**  
**ML-18VL MECHANISM**



- 1 - Opening Spring
- 2 - Close Linkage Pivot
- 3 - Stationery Aux. Switch Operator
- 4 - Spring Charge Motor
- 5 - Auxiliary Switch
- 6 - Close Coil

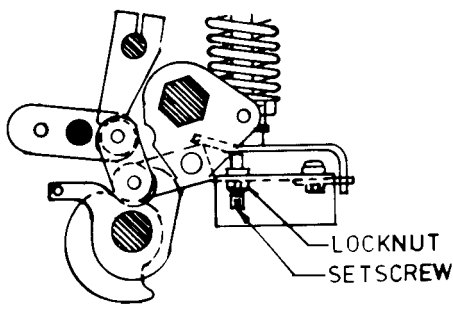
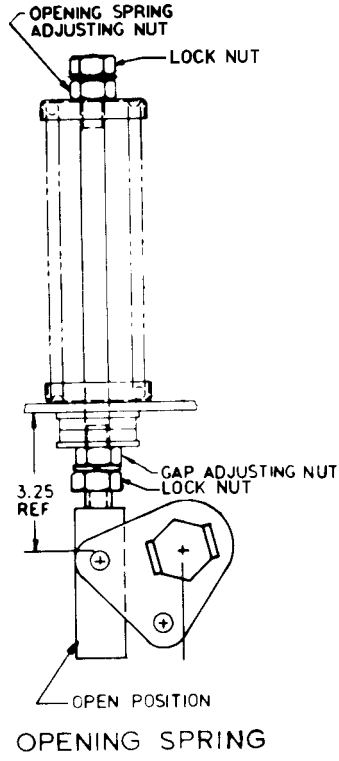
- 7 - Opening Spring
- 8 - 52Y Relay
- 9 - SM/LS Motor Control Switch
- 10 - LCS Latch Check Switch
- 11 - CL/MS Close Latch Monitor Switch
- 12 - Trip Coil
- 13 - Close Spring

**FIGURE 27  
CONTACT GAP**



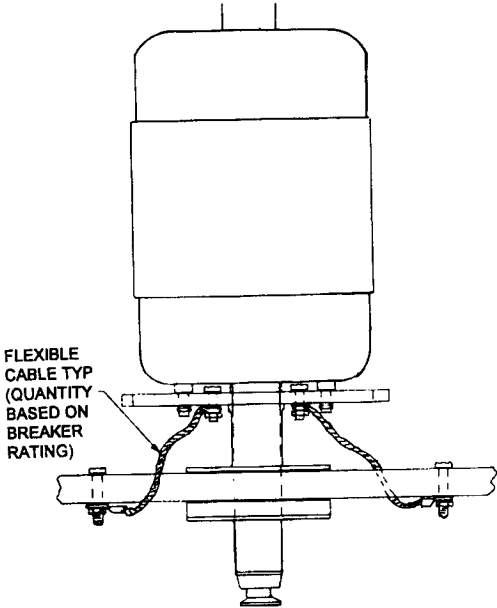
**NOTE:** The gap of the outer phase will be less than the center. The center must not exceed 0.600 inch.

**FIGURE 27a**  
**CONTACT GAP ADJUSTMENT**

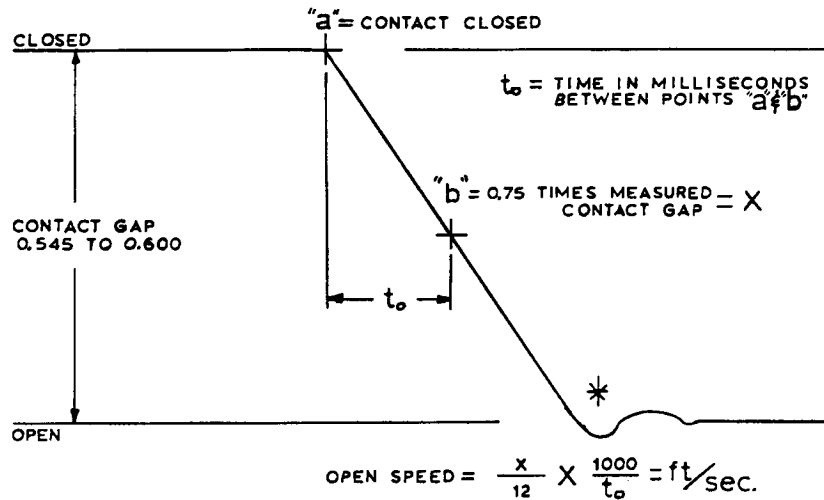
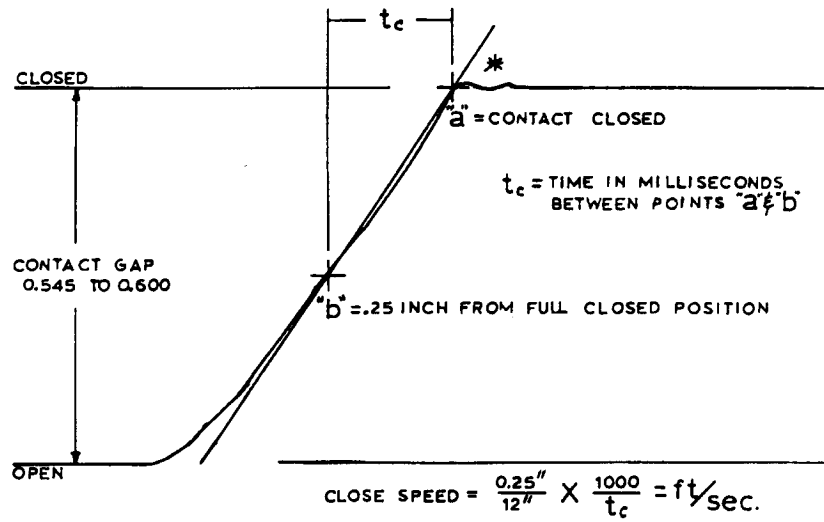




**FIGURE 28**  
**FLEX CABLE CONNECTION**



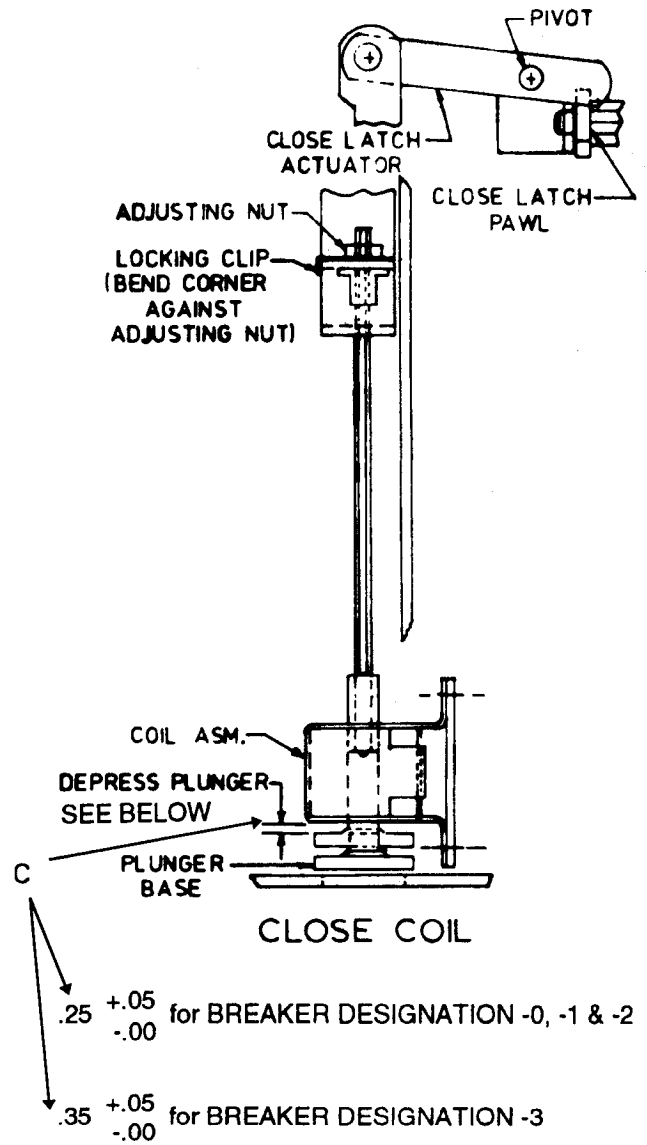
**FIGURE 29**  
**SAMPLE OPERATING SPEED GRAPHS**



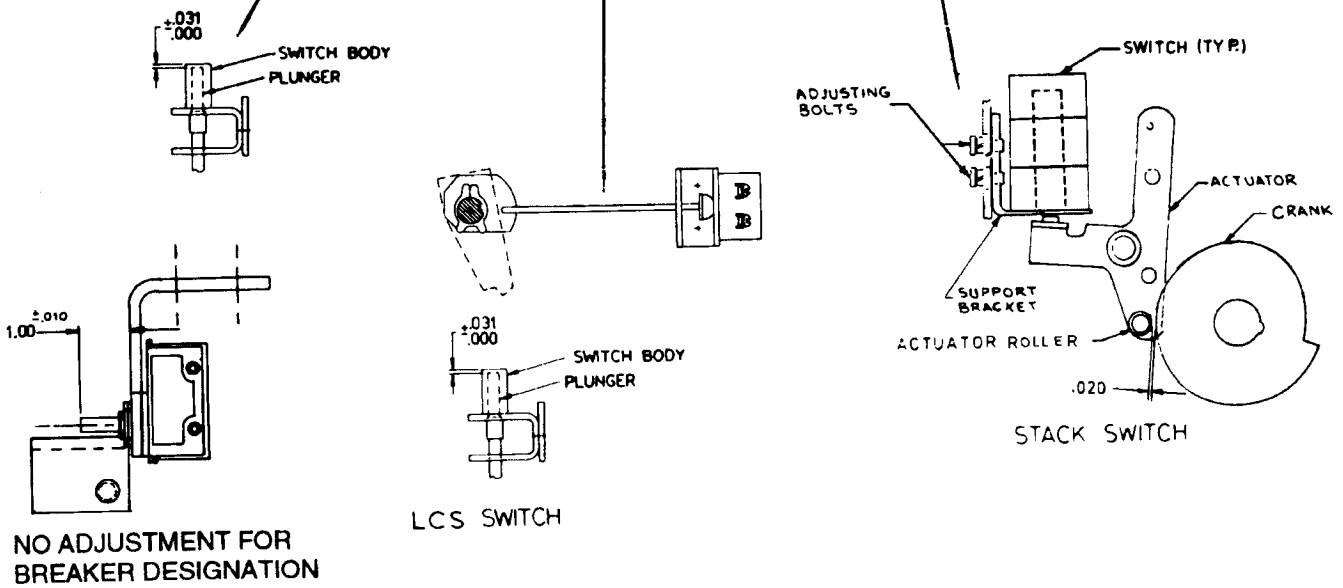
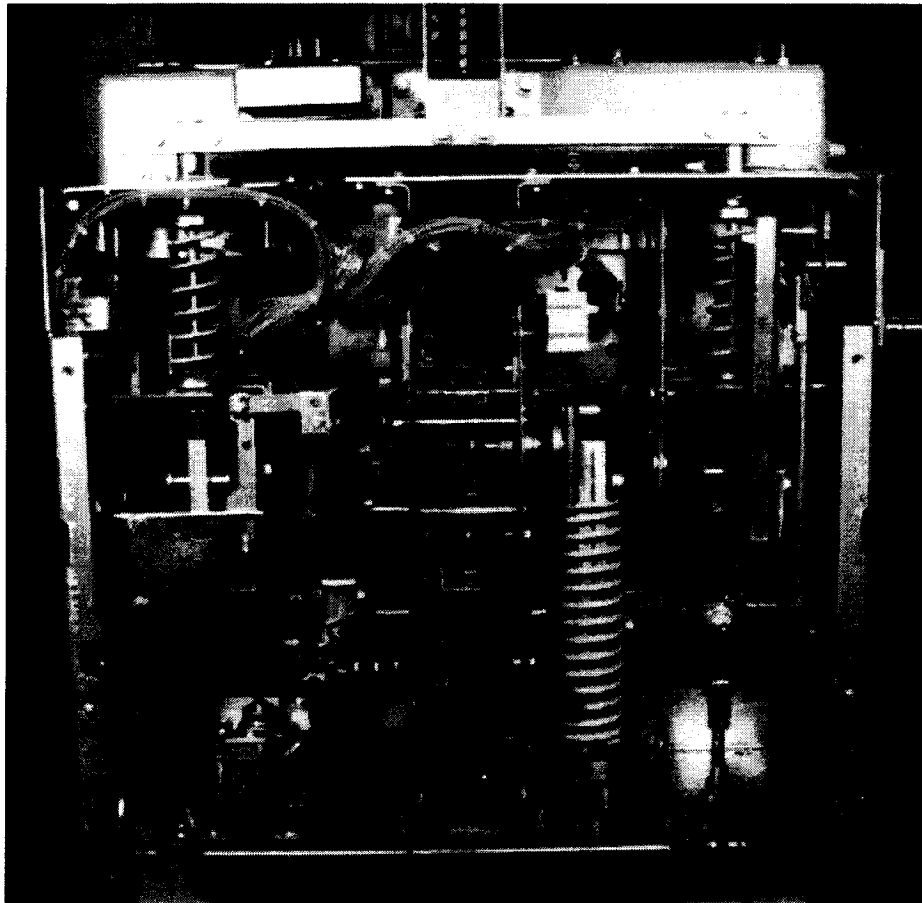
\* FOR BREAKERS EQUIPPED WITH AN OPENING DASHPOT, THERE IS VIRTUALLY NO OVERTRAVEL OR REBOUND.

**OPERATING SPEED GRAPHS**

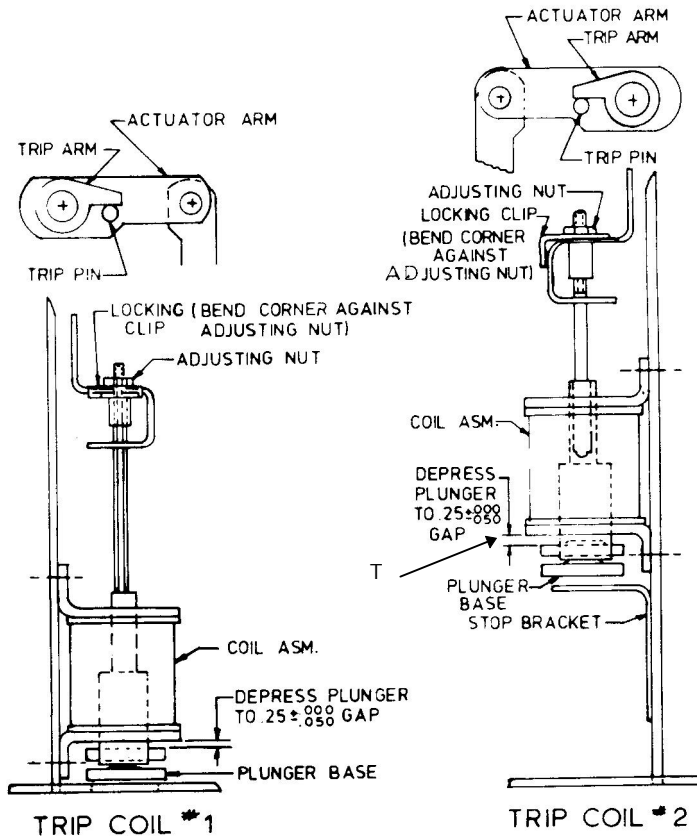
**FIGURE 30  
CLOSE COIL PLUNGER GAP**



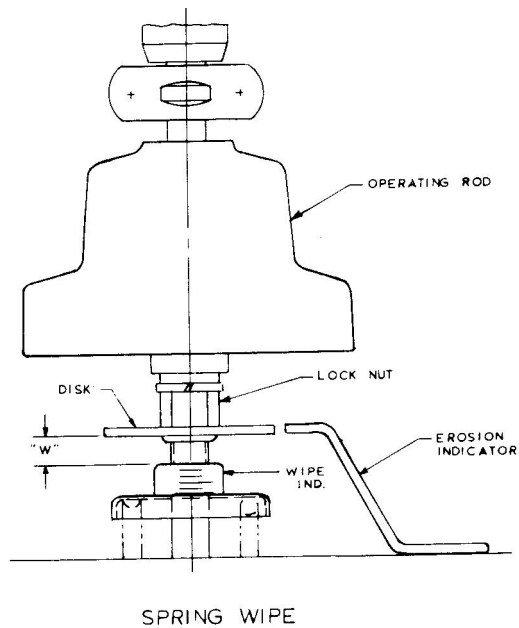
**FIGURE 31  
CONTROL SWITCHES**



**FIGURE 32**  
**TRIP COIL PLUNGER GAP**



**FIGURE 33**  
**SPRING WIPE**



## 20. STATIONARY CUBICLE SUB-ASSEMBLY

### 20.1 INTRODUCTION

The breaker cubicle sub-assembly is the stationary housing for the removable breaker unit. It contains the primary disconnects, elevating mechanism, buses, current transformers, and secondary control wiring.

### 20.2. DESCRIPTION OF MAJOR COMPONENTS

**SECONDARY ENCLOSURE** The secondary enclosure consists of a compartment with a hinged door or panel. Terminal blocks, fuse blocks, and some control devices are mounted inside the enclosure on the side sheets.

**BREAKER ELEVATING MECHANISM** The elevating mechanism is designed to raise the breaker unit into the operating position and to lower the breaker to the disconnected position. It consists of a motor, heavy duty jack screws, jack nuts, and a carriage frame. Rails are built into the breaker frame to guide it into position. By means of interlocks, the breaker cannot be lowered or raised until it has been tripped. The breaker contacts can only be closed when the breaker is in the connected position. For more detail, refer to GEH-1802.

**ELEVATING MOTOR** An optional elevating motor may have been furnished for each breaker cubicle sub-assembly. A short cable with a plug is provided and must be connected into the receptacle below the motor mounting. A selector switch is mounted on the motor for reversing the motor direction. This selector switch should not be used to start and stop the elevating gear motor.

**PRIMARY DISCONNECTS** The primary disconnect devices utilize silver to silver contacts to insure against reduction of current carrying capacity due to oxidation of the contact surfaces. These contacts are of the high pressure line contact tube and socket design, the tube being backed up by heavy garter springs to insure contact pressure.

**BUSES** The main buses are enclosed in a metal compartment with removable covers to provide

accessibility. The buses are supported by flame retardant, track resistant, glass laminate insulating material and porcelain, which is practically impervious to moisture, and an excellent dielectric. No additional coating is necessary.

The bus insulation is an extruded thermoplastic insulation sleeve, suitable for 105 degree C operating temperatures. The bus bars are inserted into the sleeves leaving only the bolted joints exposed. The bus terminates before and after the breaker unit. Current transformers may be located along the bus, on either side of the breaker, for control applications.

**BREAKER TESTING PROVISIONS** Optional provisions for testing the breaker unit after removing it from the cubicle sub-assembly can be furnished. The test equipment is located on a panel adjacent to the breaker compartment. It consists of a test coupler to provide control power to operate the breaker, and push buttons to trip and close the breaker electrically.

**CONNECTIONS** The main bus bars and other connection bars are made of copper, and the contact surfaces are silver plated. All field assembled joints in the primary conductors should be made as follows:

1. Wipe silver clean with a clean cloth and denatured alcohol. If badly tarnished, use a non-abrasive silver polish. Do not use steel wool, sandpaper, or any abrasive on the silvered surface. Avoid handling of cleaned surfaces as much as possible.
2. After cleaning, apply grease 0282A2048P009 to the silvered surfaces so that the contact area will be thoroughly sealed. Using standard washer, lock washer, and nut, together, tighten joints to the torque values shown below.

#### **BOLT CONNECTION TIGHTENING**

<b><u>Bolt Size</u></b>	<b><u>Torque</u></b>
1/2 x 13	50 - 60 foot pounds
5/8 x 11	60 - 70 foot pounds

**GROUND CONNECTION** A ground connection is made between the breaker ground shoe and the main generator accessory compartment ground bus.

**DOOR ALIGNMENT** After checking that the unit is level and plumb, check each breaker compartment door. The top of each door should be level with the adjacent doors; the sides of each door plumb; the surface of each door flush with the adjacent door; and, the space between adjacent doors equalized to permit their free swing and present a neat appearance. The door stops should be adjusted to permit a door swing of approximately 105 degrees.

If it is necessary to align the doors of the breaker compartment, the following procedure should be followed.

1. Doors may be raised or lowered vertically, or moved forward or backward horizontally, by loosening the hinge mounting nuts on the left side sheet and shifting the hinge and door assembly as allowed by the slotted holes in the hinge.
2. Doors may be shifted to the right or left by adding or removing washers or shims from between the hinge and side sheet.
3. Doors may be plumbed by slightly bending the appropriate hinges. To do this, open the door and insert a drift pin in either of the two holes in the hinge. Pulling forward on the drift pin will move the door to the right, and pushing back will move the door to the left. Adjust each hinge individually as required to plumb the door.

### 20.3. TESTING AND INSPECTION

**GENERAL** Although the equipment and devices have been completely tested at the factory, a final field test should be made to be sure that the equipment has been properly installed and that all connections are correct and have not become loose in transportation.

**WARNING:** THE PRIMARY EQUIPMENT SHOULD BE COMPLETELY DE-ENERGIZED WHILE THE TESTS ARE IN PROGRESS.

**BREAKER TESTING** The operation of the breaker with its associated devices may be tested outside the unit by use of the test coupler.

**HI-POTENTIAL TESTING** Hi-potential tests to check the integrity of the insulation are not necessary if the insulation instructions in this book are carefully followed. Should the purchaser desire to make hi-potential tests, the test voltage should not exceed 27kV AC. This voltage is 75% of factory test voltage and is in accordance with ANSI standards.

**BREAKER POSITIONING** Before proceeding to place the breaker in the operating position, the following steps must be taken. The elevating mechanism is accurately leveled and checked at the factory and should need no adjustment.

**WARNING:** DO NOT INSTALL OR REMOVE THE BREAKER OR MAKE ADJUSTMENTS UNLESS THE BREAKER IS OPEN.

1. Rub a small amount of 0282A2048P009 lubricant on the silvered portion of the breaker studs, ground shoe, and 16 secondary coupler pins, to form a thin coating for contact purposes.
2. Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered position. The breaker should then enter the housing freely. After first assuring that the breaker is in the open position, push the breaker into the unit until it rests against the rear of the front lifting saddle of the elevating mechanism.
3. The clearance between the interference block on the breaker and the interference block on the interlock mechanism should be from .063" to .125".

**WARNING:** AGAIN, BEFORE PROCEEDING WITH THIS CHECK, IT IS NECESSARY THAT THE PRIMARY CIRCUITS BE DE-ENERGIZED.

4. To elevate the breaker, operate the elevating control selector switch on the elevating motor to "RAISE". A clutch handle under the elevating motor is then pulled forward until a motor limit switch engages to raise the breaker into the unit. Carefully raise the breaker and while elevating, note that the shutter slides open and the breaker studs center with respect to the openings in the stationary disconnecting devices or damage to the contacts may result.

5. Hold the clutch handle in the forward position until a limit switch on the structure opens to stop the motor at the end of the upward travel of the breaker. The springs will charge when the clutch handle is released.

**CAUTION:** THE MOTOR RAISE/LOWER SELECTOR SWITCH MUST NOT BE USED TO ENERGIZE OR INTERRUPT MOTOR CIRCUIT AT ANY TIME.

6. When the breaker is fully elevated, the clearance between the breaker lifting rail and the upper stop bolts should not be more than .125" and not less than .094".

7. The positive interlock roller should be centered in the upper "VEE" and the interlock roller should have 1/16" clearance to the stationary plate directly under it.

8. To lower the breaker, proceed the same as for raising, except, operate the selector switch to "LOWER". The clutch must be held in the engaged position, otherwise a spring will return it to its normal position, opening the electrical circuit to the motor.

9. The breaker may be raised or lowered by an emergency hand crank which can be inserted after removing the motor. The motor is removed by unlatching the motor assembly from its support and disconnecting the motor lead plug. After removing the motor, insert the manual crank and pull the clutch forward. Rotate the crank until the coupling engages the clutch. The clutch handle will be held in the down position by a latch on the crank assembly. The breaker must be open before the crank can be inserted and held in the clutch coupling.

**WARNING:** AGAIN, BEFORE PROCEEDING WITH THIS CHECK, IT IS NECESSARY THAT THE PRIMARY CIRCUITS BE DE-ENERGIZED.

**CAUTION:** THE SPRING DISCHARGE CAM WILL DISCHARGE THE OPENING AND CLOSING SPRINGS AS THE BREAKER IS WITHDRAWN FROM THE UNIT.

10. After the breaker is lowered and withdrawn from the unit, inspect the contact surfaces of both the breaker studs and the stationary disconnecting devices.

a. Each segment of the stationary disconnecting device should make a heavy impression in the contact lubricant on the breaker studs. Contact wipe should start not less than .125" from the top of the contact ball, although each contact need not start at the same location.

b. The penetration of the breaker stud inside the stationary disconnecting device, as indicated by the contact lubricant, should be .75" to .875". This indicated that the breaker studs contacted at the full pressure center of the silver band on the stationary disconnecting device.

c. Should the inspection of the contacts show that the breaker is not being raised to the proper position, readjust the upper stop bolts and limit switches to raise or lower the breaker to the proper location. **Lock the stop bolts in the new position.**

d. If proper contacting cannot be attained by the above methods, additional adjustments may be necessary.

**CAUTION:** DO NOT MAKE THESE ADJUSTMENTS. CONTACT YOUR LOCAL GE REPRESENTATIVE FOR ADDITIONAL INFORMATION.

**POSITIVE INTERLOCK** The positive interlock functions to prevent raising or lowering a breaker except when the primary contacts are open. It also prevents closing the primary contacts when the breaker is being raised or lowered by blocking the operating mechanism mechanically and electrically.

1. Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered position. The breaker should then enter the housing freely. After first assuring that the breaker primary contacts are in the open position, insert the breaker into the unit until it rests against the rear of the front lifting saddle of the elevating mechanism.



**WARNING:** BEFORE PROCEEDING WITH THIS CHECK IT IS NECESSARY THAT THE PRIMARY CIRCUITS BE DE-ENERGIZED.

2. When entering a breaker into a unit for elevating, the spring discharge cam will discharge the opening and closing springs if they are energized.

**WARNING:** AGAIN, IT IS EMPHASIZED THAT BEFORE PROCEEDING WITH THIS CHECK IT IS NECESSARY THAT THE PRIMARY CIRCUITS BE DE-ENERGIZED.

3. Elevate the breaker to the raised position and electrically close the breaker. The positive interlock should be checked to see that the removable element is obstructed from being lowered from the operating position.

4. Snap the selector switch to "LOWER" position and pull the clutch handle forward. A definite stop should be encountered preventing the motor circuit limit switch from energizing the motor circuit and lowering the breaker.

5. A minimum of 1/16" must be maintained between the sliding clutch and the motor connector when the positive interlock is blocked by the breaker interlock roller. Trip the breaker manually and lower the breaker to the fully lowered position. The spring discharge cam will discharge the stored energy springs when the breaker is withdrawn from the unit.

**CAUTION:** IF THE INTERLOCK DOES NOT FUNCTION AS INDICATED ABOVE, DO NOT MAKE ADJUSTMENTS. CONTACT YOUR LOCAL GE REPRESENTATIVE FOR ADDITIONAL INFORMATION.

**STATIONARY AUXILIARY SWITCH** On units equipped with stationary auxiliary switches, the clearance between the end of the switch mechanism operating rod and the operating plunger on the circuit breaker should be 0 to .125" with the circuit breaker in the raised and open position.

Any adjustment in this dimension must be made on

the auxiliary switch setting. Care should be taken to prevent destroying interchangeability of the circuit breaker by excessive adjustment.

**SPRING DISCHARGE CAM** The spring discharge cam is mounted on the left hand side of the unit and operates in conjunction with a spring discharge interlock on the breaker.

When entering a breaker into a unit, to elevate to the operating position, the spring discharge cam will hold the breaker interlock trip free and the closing spring discharged until the breaker is .25" off the floor rails. At this point the positive interlock is blocking the spring charging and closing circuit open.

When lowering the breaker from the operating position the breaker must be open before the elevating mechanism can be operated. While the breaker is being lowered the springs are still charged but the positive interlock blocks the breaker from closing.

If after test operations the breaker is left closed and/or its closing spring charged, it will be automatically tripped and held trip free while the springs are discharged when it is reinserted in.

**SPACE HEATERS** Space heaters are provided in all equipment in order to keep the inside temperature several degrees higher than that outside. By maintaining a slight temperature differential, the heaters help facilitate drying and prevent condensation and the resulting corrosion and insulation deterioration which might occur.

Before energizing the heaters, be sure the power source is of the proper voltage, frequency, and phase arrangement, and is connected in accordance with the wiring diagrams furnished with the equipment. Also, be sure to remove all cartons and miscellaneous material packed inside the unit before energizing the heaters.

Heaters should be visually inspected several times a year to assure they are operating properly. It is also recommended that the heaters be energized at all times and that thermostatic control NOT be used.

## 20.4. BREAKER COMPARTMENT MAINTENANCE

**GENERAL** A regular maintenance schedule should be established to obtain the best service and reliability from the breaker compartment. Plant operating and local conditions will dictate the frequency of inspection required. For specific information regarding the maintenance of devices, relays, meters, etc., refer to the separate instruction book furnished for each device. The breaker testing device, which may be furnished as an option, provides a convenient means for maintaining the circuit breaker. Under normal conditions the protective relays do not operate, therefore, it is important to check the operation of these devices regularly.

A permanent record of all maintenance work should be kept, the degree of detail depending on the operating conditions. In any event, it will be a valuable reference for subsequent maintenance work and for station operation. It is recommended that the record include reports of tests made, the condition of equipment and repairs and adjustments that were made.

**WARNING:** BEFORE ANY COVERS ARE REMOVED OR ANY DOORS ARE OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT OR CIRCUITS BE DE-ENERGIZED AND BREAKERS BE WITHDRAWN TO A DISCONNECTED POSITION, AND TAGGED.

IF WORK IS TO BE DONE ON REMOTE EQUIPMENT CONNECTED TO A UNIT, THE BREAKER FOR THAT UNIT SHOULD BE PLACED IN THE DISCONNECTED POSITION AND TAGGED. ALSO, REMOTE EQUIPMENT SHOULD BE ISOLATED FROM ANY OTHER POWER SOURCES CONNECTED TO IT.

The primary circuits of the equipment are insulated in order to reduce the size of the equipment. However, this insulation, except in one of two instances, requires a certain amount of air gap between phases and to ground to complete the insulation. Inserting any object in this air space, when equipment is energized, whether it be a tool or a part of the body, may under certain conditions,

in effect, short circuit this air gap and may cause a breakdown in the primary circuit to ground and cause serious damage or injury or both.

Care should be exercised in the maintenance and checking procedures that accidental tripping or operation is not initiated.

The equipment and connections should be given the following overall maintenance at least annually.

1. Thoroughly clean the equipment, removing all dust and other accumulations. Wipe clean the buses and supports with a clean cloth and de-natured alcohol. Inspect the buses and connections carefully for evidence of overheating or weakening of the insulation.

2. Measure the resistance to ground and between phases of the insulation of buses and connections. Since definite limits cannot be given for satisfactory insulation resistance values, a record must be kept of the reading. Weakening of the insulation from one maintenance period to the next can be recognized from the recorded readings. The readings should be taken under similar conditions each time, and the record should include the temperature and humidity.

Hi-potential tests are not required, but if it seems advisable, based on the insulation resistance tests or after repairs, the test voltage should not exceed 27kV AC. These voltages are 75% of the factory test voltages and are in accordance with ANSI standards.

Potential transformers and control power transformers must be disconnected during high voltage testing.

3. Clean elevating mechanism and lubricate.

4. Check primary disconnecting device contacts for signs of abnormal wear or overheating. Clean contacts with de-natured alcohol.

Discoloration of the silvered surfaces is not ordinarily harmful unless atmospheric conditions cause deposits, such as sulfides, on the contacts. If necessary, the deposits can be removed with a good grade of silver polish.

Before replacing the breaker, apply a thin coat of 0282A2048P009 lubricant, to the breaker studs for lubrication.

5. Check tightness and continuity of all control connections and wiring.

6. If the equipment is equipped with heaters, check to see that all heaters are energized and operating.

# FAILURE REPORTING FORM FOR POWER CIRCUIT BREAKERS

User report No. \_\_\_\_\_

Check all appropriate blocks and provide information indicated. For major trouble provide additional information requested on next page supplemented with additional pages if necessary.

EQUIPMENT: \_\_\_\_\_ Station \_\_\_\_\_ User Ident \_\_\_\_\_ of Breaker \_\_\_\_\_

**Equipment Nameplate Information**

Mfgr. \_\_\_\_\_ Type \_\_\_\_\_ Serial # \_\_\_\_\_  
KV \_\_\_\_\_ Inter Amps/MVA \_\_\_\_\_ Continuous Amps \_\_\_\_\_ BIL \_\_\_\_\_

Breaker Background: Counter Reading: \_\_\_\_\_  
Shipped: \_\_\_\_\_, Installed: \_\_\_\_\_, Maintained: \_\_\_\_\_ Trouble Date: \_\_\_\_\_  
(Mo/Day/Yr)

Location:  Indoor  Outdoor Enclosure:  Non-metal Clad,  Metal-clad,  GIS

Interrupter:  Air Blast,  Air Magnetic,  Oil,  SF<sub>6</sub>,  Vacuum, Other: \_\_\_\_\_

**ENVIRONMENT:**

General:  Industrial,  Urban,  Suburban,  Rural,  Sea Coast,  Above 3300',  High Contamination,  
Other: \_\_\_\_\_

Weather Conditions:  Dry,  Rain,  Lightning in Area,  Snow,  Fog,  Freezing Rain,  Frost,  Condensation,  
Temperature. Trend -  Rising,  Falling,  Steady,  Extreme Cold, Temperature \_\_\_\_\_ °F,  
Wind: -  Calm,  Light,  Strong,  Steady,  Strong-Gusty

External Mechanical Stresses Involved:  Normal,  Earthquake,  Wind,  Abnormal Terminal Loading,  
Other: \_\_\_\_\_

Nominal System voltage: \_\_\_\_\_

**TROUBLE:**

When Discovered:  Installation,  In Service,  Maintenance,  Test, Other: \_\_\_\_\_

Breaker Mode at Time of Trouble:  De-energized,  Closed,  Open,  Tripping,  Closing,  Reclosing,  
 Fault Interruption,  Load Switching,  Line Switching

Breaker Response at Time of Trouble:  Not Called Upon to Operate,  Performed as Intended,  
 Unsatisfactory Operation,  Failed to Operate

Subsystem in Trouble:  External Insulation to Ground,  Internal Insulation to Ground,  Insulating Medium,  
 Isolating Contact,  Bushing,  Interrupter,  Seals-Gaskets,  Air System,  SF<sub>6</sub> System,  C.T.,  
 Resistor Sw or Aux. Int.,  Voltage Grading Device,  Line Terminals,  Compressor,  Heater,  Electrical Controls,  
 Wiring,  Operating Mechanism,  Mechanical Linkage,  Other: \_\_\_\_\_

State Specifically What Failed (With Instr. Book Ref.): \_\_\_\_\_

Has it occurred before on this type of breaker?  No,  Yes, How many times: \_\_\_\_\_

State how problem was corrected: \_\_\_\_\_

POSSIBLE CAUSE:  Design/Manufacture,  Shipping,  Storage,  Installation,  Instructions,  Maintenance,  
 Wear/Aging,  Animal/Birds,  Other,  Not Obvious

Comments and Suggestions: \_\_\_\_\_

**EFFECT:**

Breaker Down Time:  No Interruption,  30 Min or Less,  1 Hr,  2 Hr,  6 Hr,  12 Hr,  24 Hr, Other: \_\_\_\_\_

Repair Time:  Less than 30 Min,  1 Hr,  2 Hr,  6 Hr,  1 Day,  2 Days,  3 Days,  1 Week, Other: \_\_\_\_\_

Breaker Outage Status:  Immediate Forced Outage,  Outage Within 20 Min.,  Required Subsequent Outage,  
 Repair Deferred Until Regular Maintenance,  No Outage for Repair

Person Completing Report: \_\_\_\_\_ Date: \_\_\_\_\_

User Approval Name: \_\_\_\_\_ Date: \_\_\_\_\_

User Contact Name: \_\_\_\_\_ Telephone Number: \_\_\_\_\_

User Company: \_\_\_\_\_



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These instructions do not purport to cover all details or variations in equipment not 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 GE Company.

**g**

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