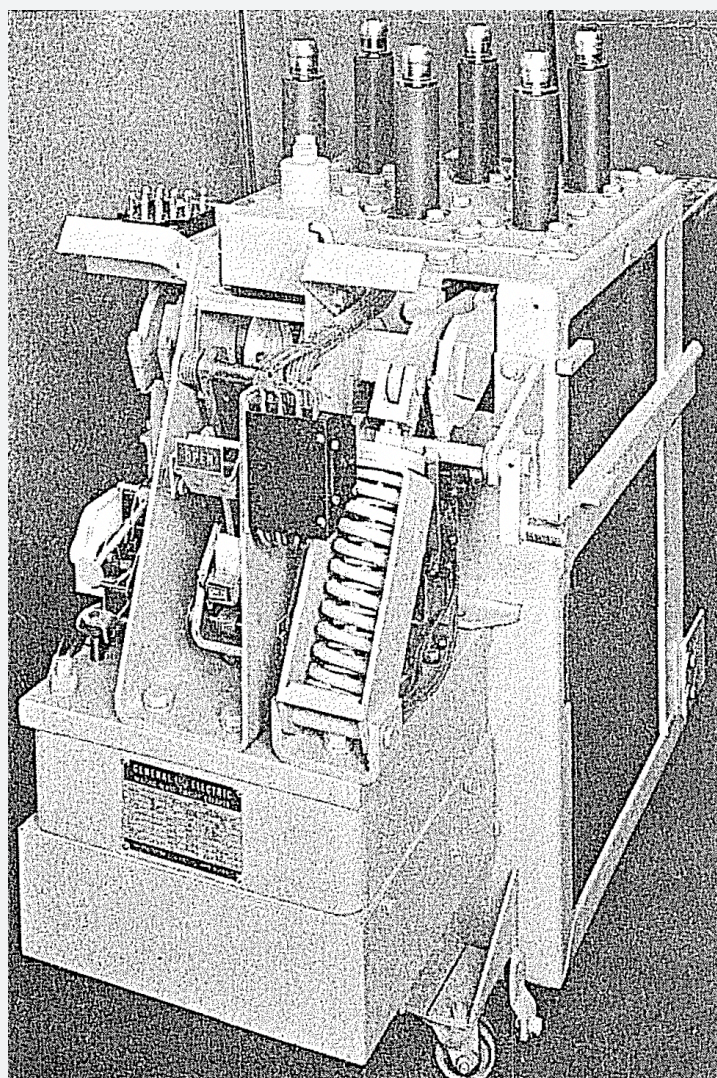


INSTALLATION AND RECOMMENDED PARTS FOR MAINTENANCE [GE LEGACY DOCUMENT]

# Magne-Blast circuit breakers

GE legacy product  
documentation



## Types

AM-4.16-150A-4, -4S, -7S, -8S

AM-4.16-250A-4, -4S, -7S, -8S

AM-4.16-150-4 and -4ML

AM-4.16-150-4S and -4SML

AM-4.16-150-7S and -8S

AM-4.16-250-4 and -4ML

AM-4.16-250-4S and -4SML

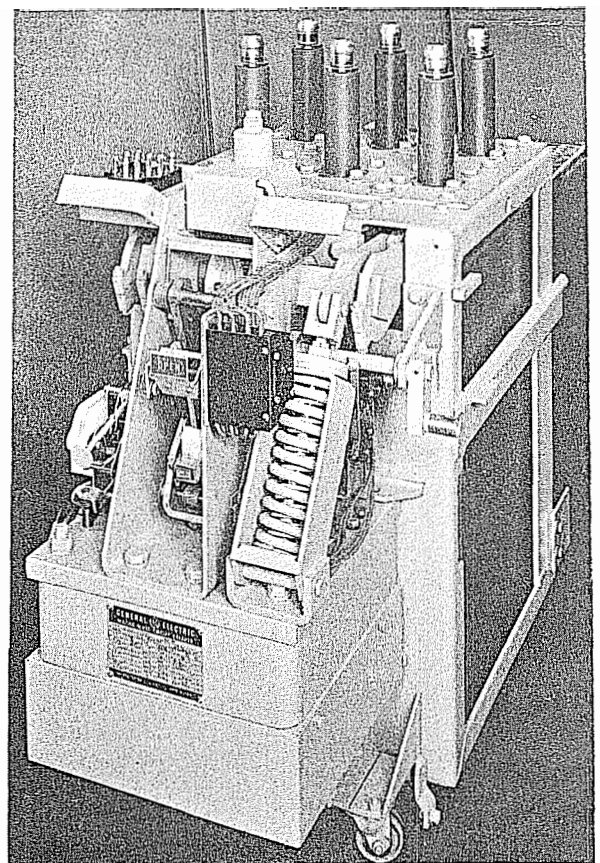
AM-4.16-250-7S and -8S

with MS-13 and ML-11

Mechanisms

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# MAGNE-BLAST CIRCUIT BREAKERS

AM-4.16-150A-4, -4S, -7S, -8S

AM-4.16-150-4,-4S,-7S,-8S AND -4ML, -4SML,

AM-4.16-250A-4, -4S, -7S, -8S

AM-4.16-250-4,-4S,-7S,-8S AND -4ML, -4SML,

INSTRUCTION BOOK GEI-50143 SUPPLEMENTS THIS BOOK FOR BREAKERS WITH ML-11 STORED ENERGY OPERATING MECHANISM (INDICATED BY ML SUBSCRIPT IN TYPE DESIGNATION).

## INTRODUCTION

The magneblast breaker is the removable and interchangeable interrupting element used in metal-clad switchgear to provide reliable control and protection of electrical apparatus and power systems.

The AM-4.16 Magneblast Breaker is available with continuous current ratings of 1200 amperes and 2000 amperes in accordance with applicable industry standards. 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 volt-

age, 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.

PROPER INSTALLATION AND MAINTENANCE ARE NECESSARY TO INSURE CONTINUED SATISFACTORY OPERATION OF THE BREAKER. The following instructions will provide complete information for placing magne-blast breakers in service and for maintaining satisfactory operation.

## RECEIVING, HANDLING AND STORAGE

### Receiving and Handling

Each breaker is carefully inspected and packed for 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 damage claim should be filed immediately with the transportation company and the nearest General Electric Sales Office should be notified.

It is expected that due care will be exercised during the unpacking and installation of the breaker so that no damage will occur from careless or rough handling, or from exposure to moisture or dirt. Check all parts against the packing list to be sure that no parts have been overlooked.

### 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 insure the proper storage of the breaker:

1. The breaker should be carefully protected

against condensation, preferably by storing it in a warm dry room, since water absorption has an adverse effect on the insulation parts. 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.

2. 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.
3. Unfinished surfaces of rollers, latches etc., of the operating mechanism should be coated with grease to prevent rusting.

If the breaker is stored for any length of time, it should be inspected periodically to see that rusting has not started and to insure good mechanical condition. Should the breaker be stored under unfavorable atmospheric conditions, it should be cleaned and dried out before being placed in service.

*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 General Electric Company.*

*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.*



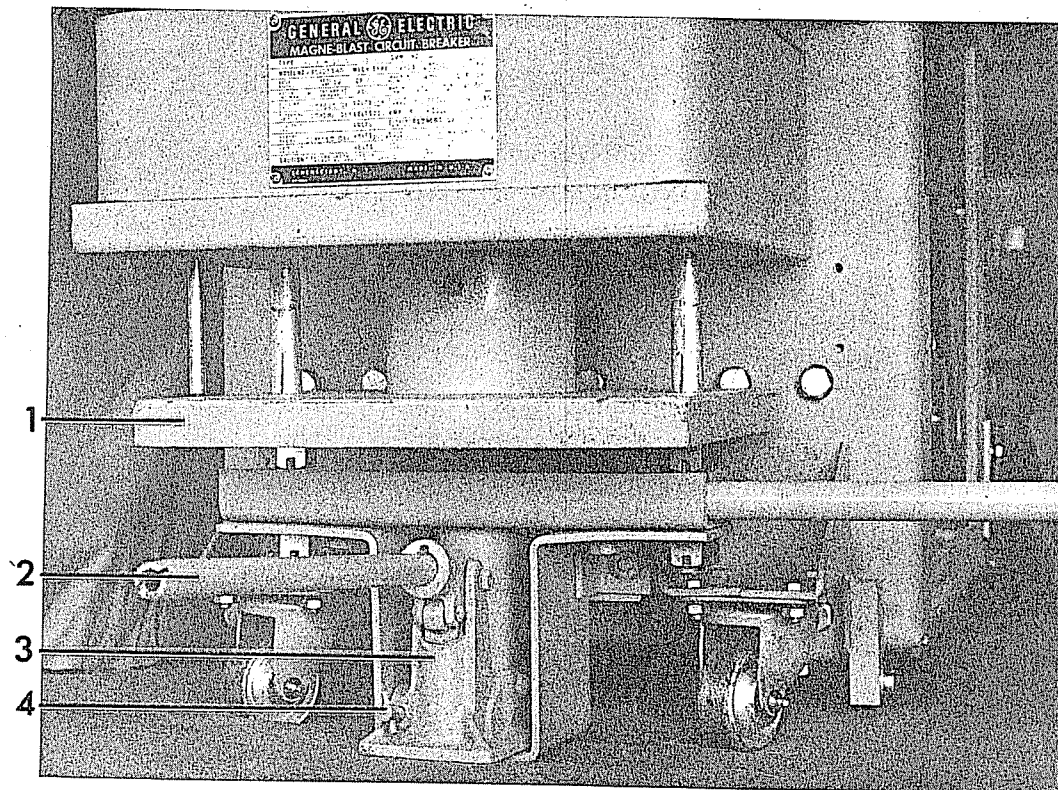


Figure 1 (8020882) Method of Mounting Maintenance Operating Device

- |                     |                                 |
|---------------------|---------------------------------|
| 1. Closing Armature | 3. Maintenance Operating Device |
| 2. Handle           | 4. Release Valve                |

## INSTALLATION

1. Remove the box barrier and mechanism cover and make a visual inspection to ascertain that the breaker and mechanism is in satisfactory condition. Check all bearing surfaces of the mechanism for lubrication. Refer to section on lubrication, page 17, and Figure 17.
2. Operate the breaker manually using the maintenance closing device provided with the breaker. Mount the device as shown in Figure 1 and turn the release valve (4) firmly to the right. To close the breaker, operate the handle (2) with a pumping motion. By turning the release valve (4) to the left, the closing armature will return to its normal position. Electrical operation must not be attempted until the breaker has been operated manually through its complete stroke several times and final installation inspection has been completed.

During the slow closing operation check to insure that the mechanism does not stick or bind during the entire stroke, that it latches securely in the closed position, and that it trips freely when the manual trip

lever is operated. At this time, also check the following adjustments:

- a. Arcing contact wipe (Refer to page 10)
  - b. Primary contact wipe (Refer to page 10)
  - c. Primary contact gap (Refer to page 10)
3. Connect the test coupler to the circuit breaker and operate it electrically several times. Check the control voltage as described under "CONTROL POWER CHECK" (Page 15).
  4. Disconnect the test coupler and replace box barrier.
  5. If the breaker has been stored for a long period of time, it is recommended that the insulation be checked with a standard 60 Hertz high potential test. Refer to Insulation Test (Page 17).
  6. Lubricate the silver portion of the ball contact at the top of the breaker bushing by applying a thin film of contact lubricant D50H47.



7. Refer to metal-clad instruction book GEH-1802 for instructions on inserting the breaker into the metal-clad unit.

## DESCRIPTION OF OPERATION

The Magneblast Breaker has two principal components; the breaker element and the operating mechanism:

The breaker element is three similar pole units, each of which includes the current carrying parts, main and arcing contacts, interrupter, and an enclosing barrier system that provides insulation between poles, or phases and to ground. The primary connections to the associated metal-clad switchgear are made through the ball contacts at the top of the breaker bushings.

The operating mechanism can be either a type MS-13 solenoid mechanism or a type ML-11 stored energy mechanism. Both mechanisms are designed to give high speed closing and opening. All secondary connections from the breaker to the metal-clad unit are made through the coupler, (1) Figure 2.

The type ML-11 mechanism will operate on a-c or d-c voltage as indicated on the breaker nameplate. Closing and opening operations are controlled either electrically from the metal-clad unit and remote location, or mechanically by the manual close and trip levers on the breaker.

Refer to GEI-50143 for complete description of operation and maintenance on the type ML-11 stored energy operating mechanism.

The closing solenoid of the type MS-13 mechanism operates on d-c voltage only as indicated on the breaker nameplate. For a-c voltage closing, rectifiers mounted in the metal-clad unit are used to supply the direct current on which the closing coil operates. Closing operations are controlled electrically from the metal-clad unit and remote location. The trip solenoid will operate on a-c or d-c voltage as indicated on the breaker nameplate. Opening operations are controlled either electrically from the metal clad unit and remote location, or mechanically by the manual trip lever (2) Figure 2 on the breaker.

A positive interlock (7) Figure 2 and interlock switch (7) Figure 10, are provided between the breaker and metal-clad unit to prevent raising or lowering of the breaker in the unit while in a closed position and to prevent a closing operation when the breaker is not in either the fully raised or lowered position.

A plunger interlock, Figure 13 can be provided

1. Secondary Coupler
2. Manual Trip
3. Control Device
4. Closing Solenoid
5. Auxiliary Switch
6. Position Indicator
7. Positive Interlock Roller
8. Opening Spring Unit
9. Operation Counter

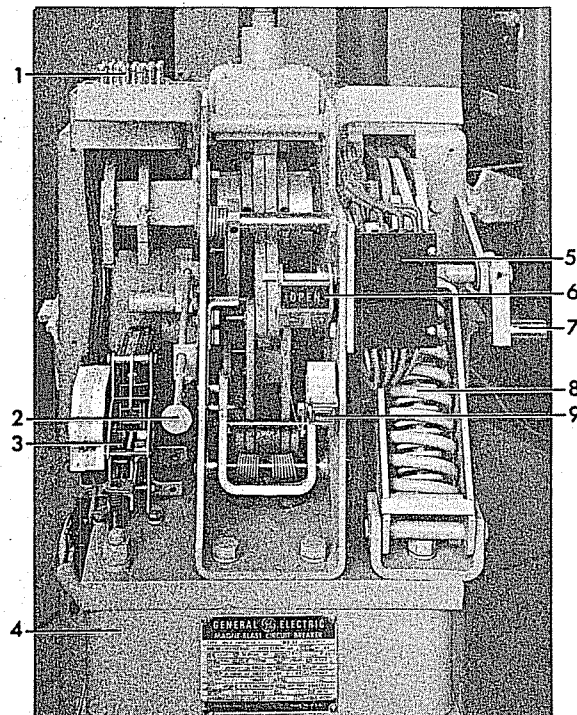


Figure 2 (8024599) MS-13 Operating Mechanism

when required to operate a stationary auxiliary switch and/or a rod interlock mounted in the metal clad unit.

The operating mechanism used on those breakers designed for MI-6 metal-clad equipment differ somewhat from those designed for M-26 equipment but its operating principal is the same. Breakers for MI-6 equipment are identified by an "A" suffix in the breaker nomenclature thus: AM-4.16-150A-4 or AM-4.16-250A-8S. In lieu of the control device mounted on the breaker the solenoid mechanism is controlled by a relay scheme located in the metal-clad unit and a cut-off switch located on the breaker. Two seven-terminal secondary couplers are used instead of the single sixteen-terminal coupler. The positive type interlock between the breaker and the metal-clad unit is replaced by a trip type interlock that trips the mechanism before raising or lowering of the breaker can be accomplished. A fork-type lever can be furnished, when required, to operate an auxiliary switch mounted in the metal-clad unit.

#### CLOSING OPERATION OF MS-13 SOLENOID OPERATED BREAKER

The closing sequence is initiated from a control switch mounted on the door of the metal-clad unit or at a remote operating station. Operation of the closing control switch energizes the pick-up coil of the control device, Figure 3, which is mounted on the operating mechanism and controls the closing operation of the breaker. As the

control device closes, seal-in contacts shunt the contacts of the closing control switch, permitting them to open without affecting the overall closing operation. Once the control device contacts are picked up, they are electrically held in the closed position until the breaker closing operation is completed. This assures complete closing of the breaker with only momentary contact of the closing control switch.

As the main contacts of the control device close, the breaker closing coil is energized. This raises the armature (6) Figure 4 which in turn lifts the closing roller (4) through plunger (14). This motion is transmitted through the mechanism linkage, and rotates the main crank (1), closing the breaker contacts. As the armature reaches the end of its travel, the prop (12) rotates beneath the pin (11) latching the breaker in the closed position. Through out the closing operation the mechanism is trip-free at all times.

During the closing operation, the opening springs (9 and 10) are compressed in readiness for an opening operation. A rubber buffer (5) above the armature absorbs the energy of the mechanism as it approaches the end of its stroke.

When the solenoid armature is near the end of its stroke the control device plunger (9) Figure 3 mechanically trips the main control device contacts, de-energizing the closing coil and allowing the armature to return by gravity to its original position. The control device plunger also mechan-

1. Trip Paddle
2. Back Auxiliary Switch
3. Mounting Screw
4. Top Auxiliary Switch
5. Plunger
6. Operating Arm
7. Trip Lever
8. Plunger Guide
9. Plunger
10. Adjusting Screw
11. Nut
12. Armature Plate

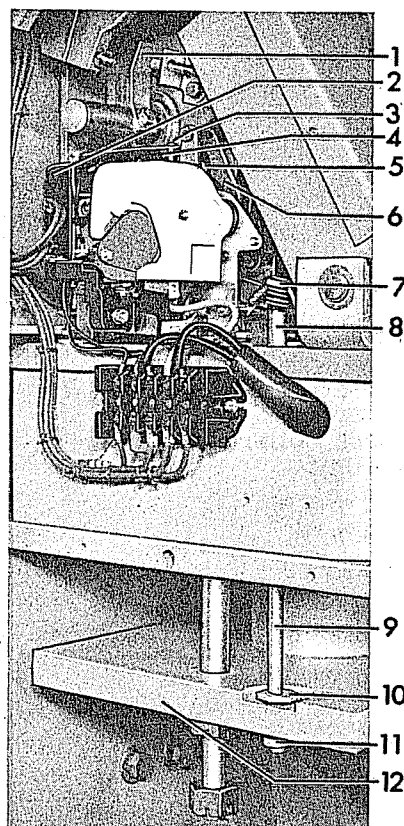


Figure 3 (8030928) Control Device

1. Main Crank
2. Trip Latch
3. Trip Roller
4. Closing Roller
5. Rubber Buffer
6. Closing Armature
7. Armature Guide Bolts
8. Spring Retainer
9. Opening Spring, Inner
10. Opening Spring Outer
11. Closing Pin
12. Prop
13. Closing Coil
14. Closing Plunger Rod

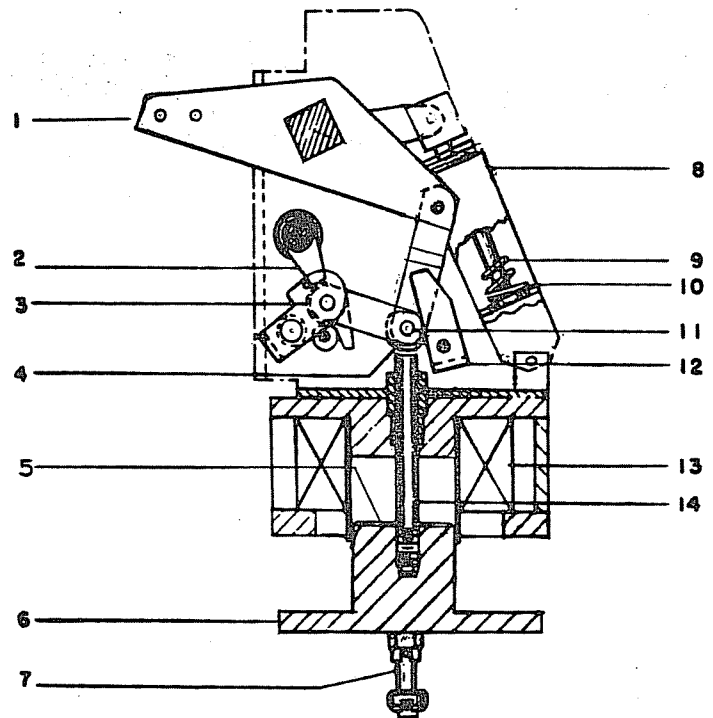


Figure 4 (0137A7682) Cross Section of MS-13 Operating Mechanism in the Open Position

ically trips the seal-in switch, de-energizing the control device coil if the closing control switch is not closed. If the closing control switch is held in the closed position throughout and after the breaker closing operation, the control device linkage will remain picked up and be unable to reset to prepare for another breaker closing operation. This arrangement insures that "pumping" of the breaker will not occur during a trip-free operation.

The operating sequence for those breakers designed for MI-6 metal-clad equipment is similar to that described above except that a relay mounted elsewhere in the metal-clad unit replaces the control device. Also, a cut-off switch (Figure 5) is used to replace the mechanical trip arrangement of the control device. The cut-off switch energizes an auxiliary relay to de-energize the main relay.

#### Opening Operation

The breaker can be opened either electrically by energizing the trip coil (1) Figure 25 or manually by pushing the trip lever (2) Figure 2. In each method the trip latch (2) Figure 4 is rotated off the trip latch roller (3) permitting the operating mechanism linkage to collapse. The energy stored in the opening springs is released to provide the required opening speed for successful interruption of the circuit. During this operation the trip coil circuit is de-energized, and upon completion of the opening operation, the operating mechanism is returned to its normal position, ready for closing.

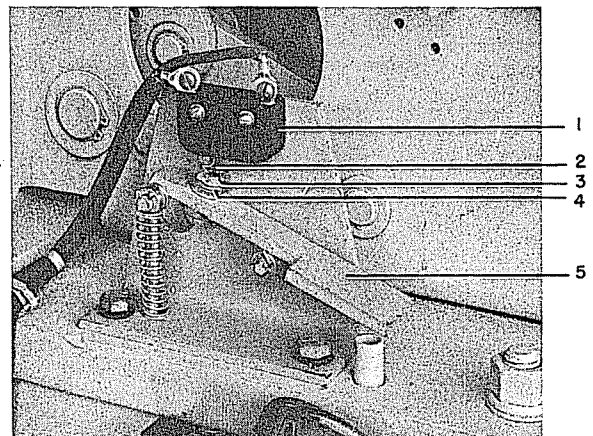


Figure 5 (8021970) Cut-off Switch

1. Cut-off Switch
2. Switch Roller
3. Striker
4. Washers
5. Lever Arm



As the breaker opens to interrupt a current, the arc first starts at the arcing contacts (6 & 27) Figure 6, transfers to the arc runner (4 & 10) and energizes the blow-out coils (3 & 11). This action introduces a magnetic field between the pole pieces (5 & 9) of the interrupter that forces the arc deeper into the arc chute (8). At the time the arcing con-

tacts part a discharge of air is expelled through the booster tube (28) across the arc. This air flow assists the arc transfer and interruption by blowing the arc away from the contacts and into the arc chute. The magnetic field forces the arc deeper into the interrupter along the diverging arc runners.

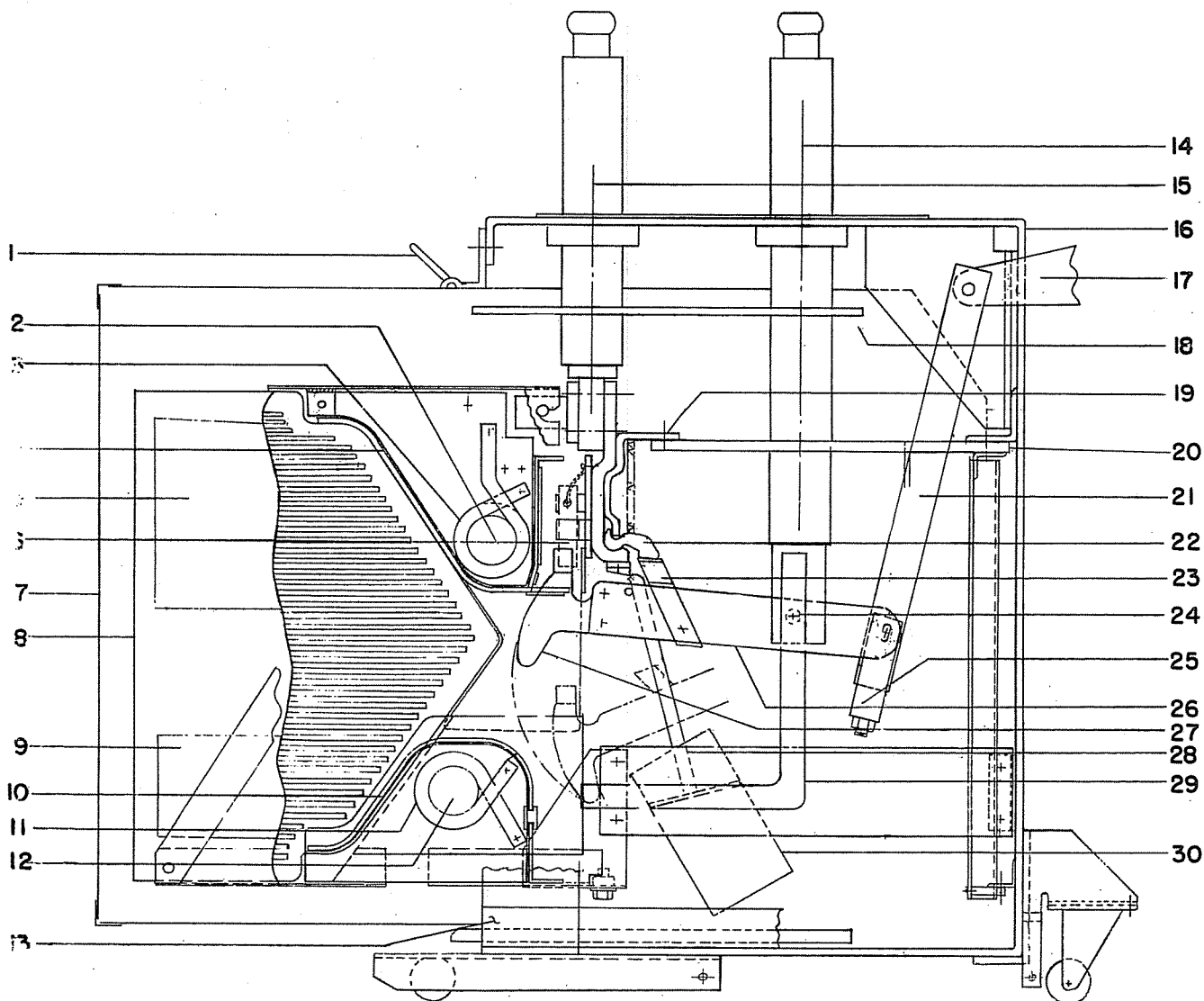


Figure 6 (0258C689) Cross Section of Breaker Pole Unit

- |                              |                                  |
|------------------------------|----------------------------------|
| 1. Box Barrier Handle        | 16. Frame                        |
| 2. Upper Blow-out Core       | 17. Main Operating Crank         |
| 3. Upper Blow-out Coil       | 18. Upper Horizontal Barrier     |
| 4. Upper Arc Runner          | 19. Spring Retainer              |
| 5. Upper Pole Piece          | 20. Lower Horizontal Barrier     |
| 6. Stationary Arcing Contact | 21. Operating Rod                |
| 7. Box Barrier               | 22. Stationary Primary Contacts  |
| 8. Arc Chute Side            | 23. Movable Primary Contacts     |
| 9. Lower Pole Piece          | 24. Cup Bearing                  |
| 10. Lower Arc Runner         | 25. Yoke                         |
| 11. Lower Blow-out Coil      | 26. Movable Contact Arm Assembly |
| 12. Lower Blow-out Core      | 27. Movable Arcing Contact       |
| 13. Lower Barrier            | 28. Booster Tube and Piston      |
| 14. Front Bushing            | 29. Connection Bar               |
| 15. Rear Bushing             | 30. Booster Cylinder             |

The arc chute has a series of interleaving ceramic fins, Figure 19. As the arc is forced into the interrupter it is lengthened in the gradually deepening serpentine path between the fins so that the electrical resistance of the arc is rapidly increased and its heat is absorbed by the ceramic material. The increased resistance reduces the magnitude and phase angle of the current and at an early current zero the arc cannot re-establish itself and interruption occurs.

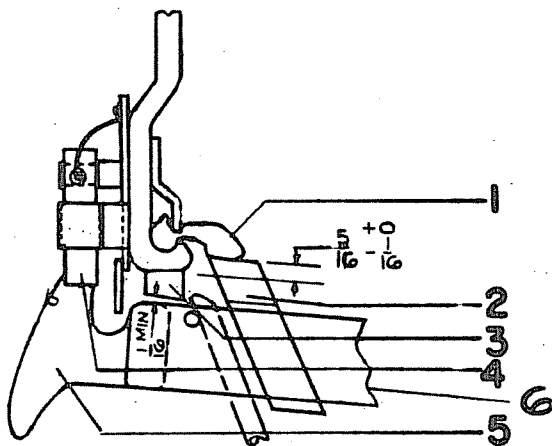
### Trip Free Operation

If the trip coil circuit is energized while the breaker is closing, the trip armature will force the trip latch (2) Figure 4 away from the trip roller (3) causing the mechanism linkage to collapse and the breaker to re-open. The closing armature (6) completes its closing stroke, the closing coil is de-energized at the end of the stroke and the armature is returned to its original position by gravity.

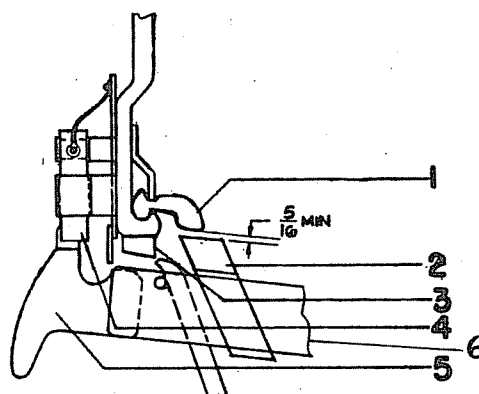
## ADJUSTMENTS

All adjustments should be checked during periodic inspections and whenever it becomes necessary to repair or replace parts that have become worn or defective while in service. The following adjustments are listed in the order in which they are to be checked after removing the box barrier and front cover from the breaker.

**DO NOT WORK ON EITHER THE BREAKER OR THE MECHANISM WHILE IN THE CLOSED POSITION UNLESS THE PROP AND TRIP LATCH HAVE BEEN SECURELY WIRED OR BLOCKED TO PREVENT ACCIDENTAL TRIPPING.**

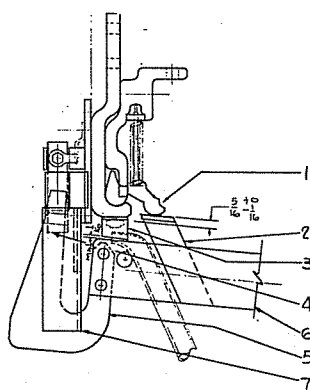


Primary Contact Wipe

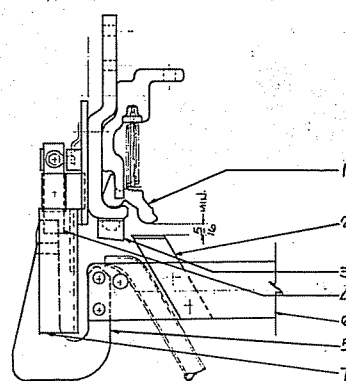


Arcing Contact Wipe

Figure 7A. "-4" & "-7" Contact Structure (0114C5320)



Primary Contact Wipe



Arcing Contact Wipe

Figure 7B. "-8" Contact Structure (0132C2709)

### Figure 7 Contact Adjustments

- |                                |                            |
|--------------------------------|----------------------------|
| 1. Stationary Primary Contacts | 5. Movable Arcing Contacts |
| 2. Movable Primary Contacts    | 6. Contact Arm             |
| 3. Buffer Block                | 7. Throat Baffle           |
| 4. Stationary Arcing Contacts  |                            |

Arcing Contact Wipe

Refer to Figure 7. Close the breaker until the arcing contacts just touch. This can be determined with the use of a circuit continuity tester such as a light indicator or bell set. In this position, the gap between the stationary primary contacts (1) and the movable primary contact (2) should be  $5/16"$  or greater. This setting has been made in the factory and no adjustment is provided. A wipe of less than  $5/16"$  is an indication that the arcing contacts need to be replaced. When making this check, see that the movable arcing contact (5) passes between the probes on the upper arc runner without touching. On the "-8" design, also check for clearance between the arcing contact (5) and the slot in the throat baffle (7) during entire stroke of the moving contact assembly.

Primary Contact Wipe

Refer to Figure 7, when the breaker is closed the stationary primary contacts (1) should rise from  $1/4"$  to  $5/16"$ . Before checking this dimension be sure the mechanism is re-set so that the prop pin (11) Figure 4 is resting on the prop. To obtain the proper contact adjustment, open the breaker and, referring to Figure 8, loosen the check nut (4) and turn the adjusting nut (3). Screwing up on the adjusting nut will decrease the primary contact wipe, down will increase it. Tighten the check nut, close the breaker and recheck the wipe. With the primary contact wipe correctly adjusted, the clearance between the contact arm (6) Figure 7 and the buffer block (3) should be  $1/16"$  or greater when the breaker is fully closed.

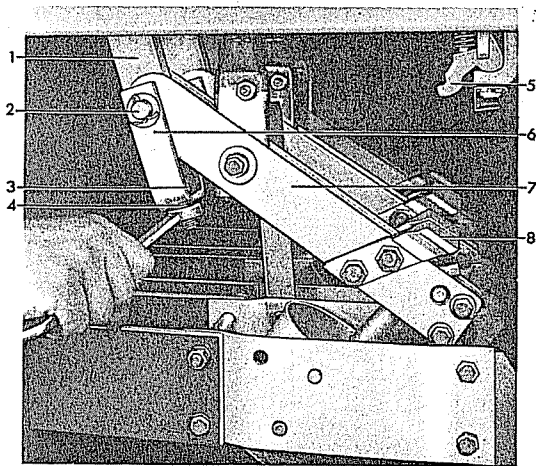


Figure 3 (8039618) Adjustable Coupling For Making Primary Contact Wipe Adjustments

1. Operating Rod
2. Operating Rod Pin
3. Adjusting Nut
4. Check Nut
5. Stationary Primary Contacts
6. Yoke
7. Contact Arm
8. Movable Primary Contacts

Primary Contact Gap

Refer to Figure 8. With the breaker closed, press the manual trip button allowing the breaker to trip open normally. Do not force the contacts open wider by hand. The gap between the stationary primary contacts (5) and the movable primary contact (8) measured between the closest points, should be  $3-5/8"$  to  $3-15/16"$ . To change this gap, loosen the check nut (25) Figure 9, and turn the adjusting nut (26) on stud (9). Screwing the adjusting nut down will decrease the primary contact gap. Tighten the check nut and re-measure the contact gap (close and trip the breaker before checking the measurement). Whenever the primary contact gap is changed, the primary contact wipe should be rechecked and, if necessary, readjusted.

WHEN WORKING ON THE MECHANISM IN THE CLOSED POSITION, KEEP FINGERS CLEAR OF THE LINKAGE, AS ACCIDENTAL TRIPPING CAN CAUSE SEVERE INJURY.

Trip Latch Wipe

Refer to Figure 9. The wipe of the trip latch (4) on the trip roller (6) should be from  $3/16"$  to  $1/4"$ . This can be measured by putting a film of grease on the latch, closing the breaker part way, and tripping. The mechanism has the proper trip latch wipe when the latch rests against the stop pin (5). No adjustment is provided and a visual inspection is usually all that is required. If this setting is not correct, look for insufficient travel of the trip shaft (3).

Prop Clearance

Refer to Figure 9. With the breaker closed as far as possible with the maintenance device, the clearance between the closing pin (10) and the prop (15) should be  $1/32"$  to  $3/32"$ . Measure the prop clearance with a feeler gauge to determine whether or not an adjustment should be made, and if so, exactly how much adjustment will be required. To make the adjustment, it will first be necessary to open the breaker and remove the maintenance operating device. Remove the stop nuts (22 and 24) being careful not to drop the armature (21). Lower the armature from the mechanism and remove the two set screws (19). Remove the closing plunger (17) from the armature and add or subtract the necessary thickness of shims (20) to give the required adjustment, then replace the closing plunger, screwing it down against the shims. Using a small drill, spot the closing plunger through the set screw hole. Replace the set screws. Remount the armature on the breaker. After reassembly, remount the maintenance closing device and check the adjustment.

Closing Plunger Clearance

Refer to Figure 9. With the breaker in the open position, the clearance between the closing plunger (17) and the closing roller (14) should be  $1/16"$  to  $3/16"$ . To obtain this clearance, the nuts (22) on the two armature guide bolts (23) may be raised



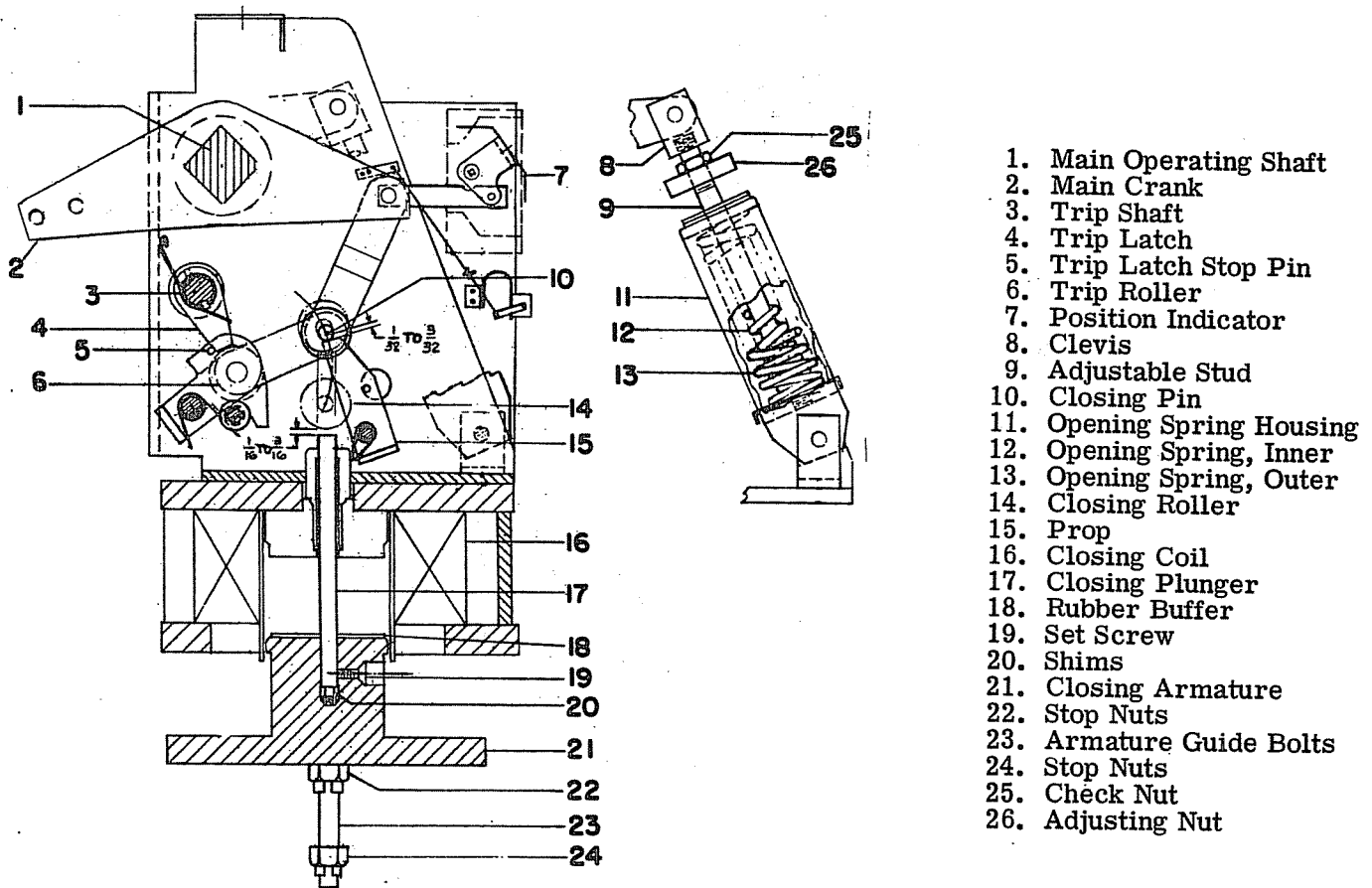


Figure 9 (0962C0772) Cross Section of MS-13 Mechanism in closed position

or lowered. Both nuts should be moved the same amount. After making an adjustment, close and open the breaker and recheck the plunger clearance.

#### Interlock Switch Adjustment

Referring to Figure 10, rotate the interlock shaft (4) manually clockwise to release the interlock switch arm (6). The point at which the contacts make can be determined with a circuit continuity tester such as a light indicator or bell set. To obtain adjustment on the interlock switch (7), bend the interlock switch arm (6). The roller and crank on the interlock switch should have  $1/32''$  to  $1/16''$  overtravel after final adjustment.

#### Control Device Adjustment

Referring to Figure 3, measure the overtravel of the two auxiliary switch plunger. Manually operate the control device by pressing the operating arm (6) the full extent of travel to the rear. With

the device in this position, further depress the plunger (5) on the top auxiliary switch (4). The gap between the plunger and operating arm should be  $1/32''$  or greater. To increase the overtravel, loosen the screws (3) and move the switch toward the rear of the mounting plate. Tighten the screws and recheck the adjustment. In a similar manner, check the overtravel on the back auxiliary switch (2).

Operate the solenoid armature plate (12) with the maintenance closing device. The control device plunger (9) should not travel more than  $3/32''$  from the point where the control device trips until the prop (15) Figure 9 falls in place. The plunger should travel a minimum of  $1/32''$  after tripping the control device. The control device arm (7) Figure 3 should have a minimum of  $1/32''$  overtravel with the plunger fully raised by the armature plate.

If adjustments are necessary, loosen nut (11) and raise or lower adjusting screw (10) the correct amount. Tighten nut after adjusting and again measure the travel of the plunger.

1. Mounting Screw
2. Latch Checking Switch
3. Latch Check Switch Arm
4. Interlock Shaft
5. Trip Shaft
6. Interlock Switch Arm
7. Interlock Switch
8. Mounting Screw

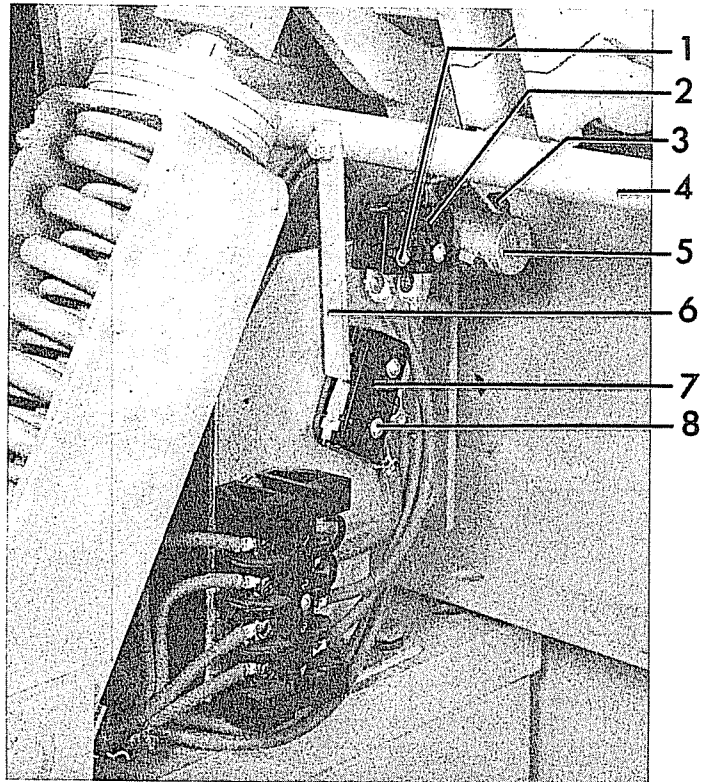


Figure 10 (8024689) Interlock Switch and Latch Checking Switch

BEFORE MANUALLY OPERATING THE CONTROL DEVICE MAKE CERTAIN THAT ALL CONTROL POWER TO THE BREAKER HAS BEEN DISCONNECTED. MANUAL OPERATION OF THE CONTROL DEVICE WITH CONTROL POWER CONNECTED WILL ENERGIZE THE CLOSING COIL AND PRODUCE A CLOSING OPERATION.

#### Cut-Off Switch Adjustments

(Breakers with "A" Suffix)

Refer to Figure 5. The lever arm (5) is set at the factory and will require no adjustment. With the breaker in the open position, depress the arm of the cut-off switch (1). There should be 1/32" to 1/16" clearance between the depressed roller of the switch and the striker (3). Washers (4) should be added or removed if necessary to correct adjustment.

### **AUXILIARY DEVICES**

#### Latch Checking Switch Adjustment

Referring to Figure 11, rotate the trip latch (4) clockwise by pressing the manual trip button to open the latch checking switch contacts and to release the latch checking switch operating arm (3). Allow the trip latch to reset slowly and determine

the point at which the contacts make by using a circuit continuity tester, such as a light indicator or bell set. The contacts of the latch checking switch should just make when the gap between the trip latch (4) and the stop pin (5) located on the crank (6) is 1/16". The roller (2) on the latch checking switch should have a minimum of 1/32" overtravel after final adjustment.

To obtain adjustment of the latch checking switch (1), bend the latch checking switch operating arm (3).

#### Auxiliary Switch Linkage

(Furnished Special on Breakers with "A" Suffix)

Refer to Figure 12. With the breaker in the open position, the distance from the center line of the front bushings (1) to the center of the slot in the fork lever (2) should be 12-9/32" as shown. To change this setting, loosen the locking bolts (3) and move the fork lever in the proper direction. Tighten the lock bolts.

#### Impact Trip, Current Trip and Undervoltage

##### Trip Devices

Figure 13 shows the necessary settings that are to be checked when these devices are fur-

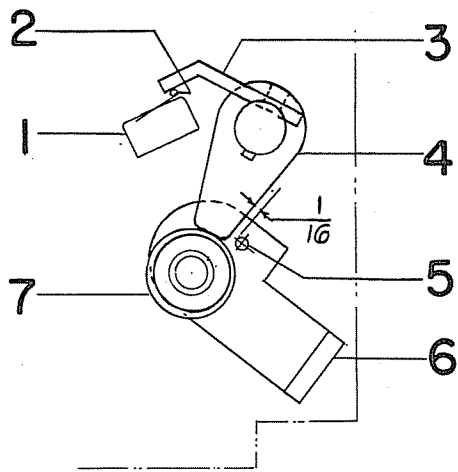


Figure 11 (0137A6038) Latch Checking Switch Adjustment

1. Latch Checking Switch
2. Latch Checking Switch Roller
3. Latch Checking Switch Operating Arm
4. Trip Latch
5. Trip Latch Stop Pin
6. Crank
7. Trip Roller

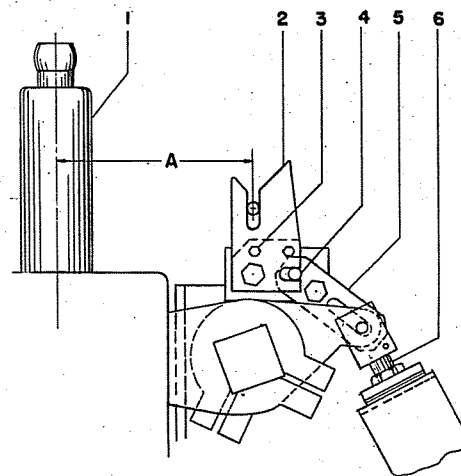


Figure 12 (006291393) Auxiliary Switch Linkage

1. Front Bushing
2. Fork Lever
3. Locking Bolts
4. Pin
5. Link
6. Rod

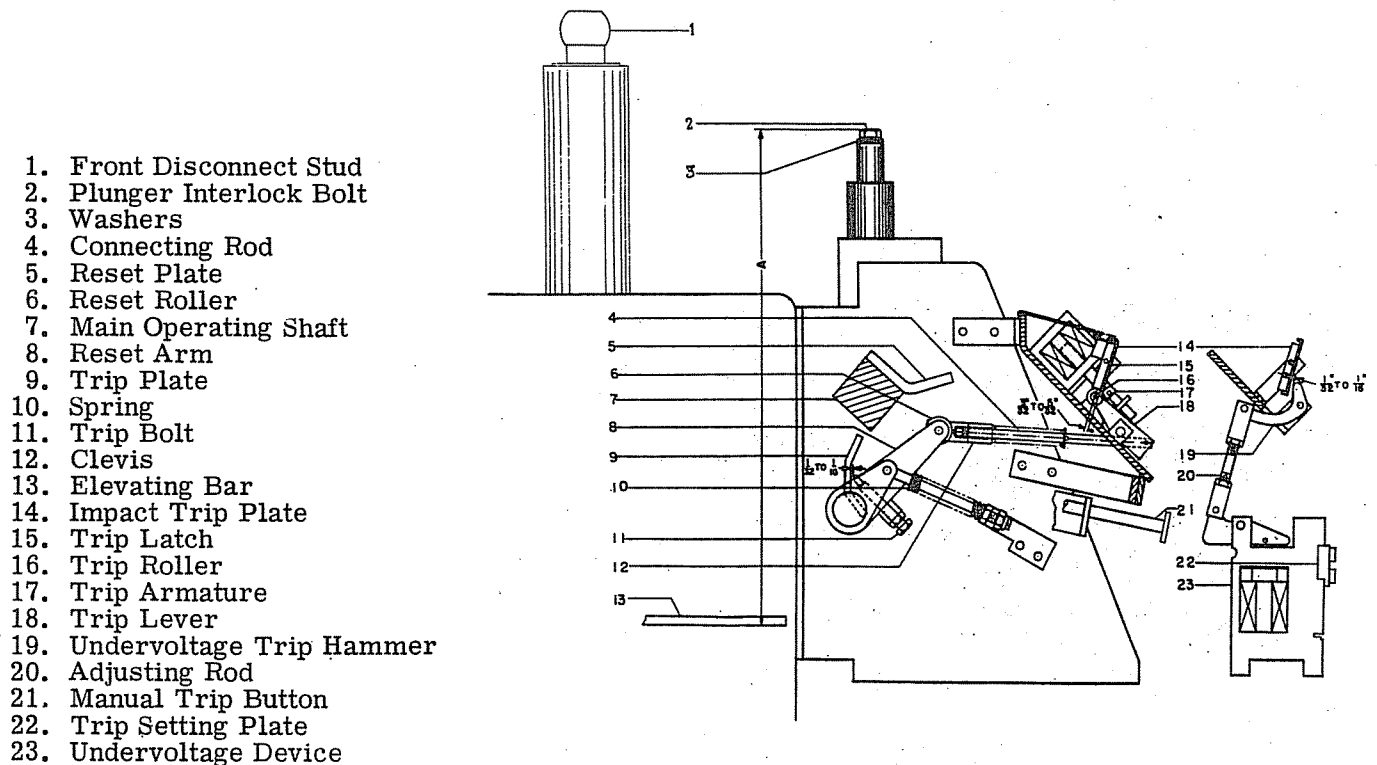


Figure 13 (0634D0336) Adjustments on Current Trip Device and Undervoltage Trip Device, Shown With The Breaker in The Closed Position



nished: The amount of wipe between the trip roller (16) and the trip latch (15) should be  $3/32''$  to  $5/32''$ . This can be altered by changing the number of shims under the block against which the trip plate (14) stops. In order to trip properly, the clearance between the trip bolt (11) and the trip plate (9) should be  $1/32''$  to  $1/16''$ . This can be altered by releasing the check nut and screwing the trip bolt (11) in or out of the reset arm (8).

When an undervoltage device is furnished check the clearance between the trip hammer (19) and the trip plate (14), with the undervoltage coil energized. This clearance should be  $1/32''$  to  $1/16''$  and can be altered by removing the connecting pin at either end of the adjusting rod assembly (20), and turning the clevis at that end.

After checking all the mechanical adjustments as outlined above, operate the devices manually to make certain that they trip and reset properly.

### Plunger Interlock

Refer to Figure 13. With the breaker in the close position, the vertical distance "A" from the top of the interlock bolt (2) to the bottom of the elevating bar (13) should be  $16-19/32''$  to  $16-23/32''$ . To change this adjustment add or remove washers (3).

### Inspection and Test

1. For ease in reviewing the adjustments the following are recapitulated:
  - a. Primary contact wipe:  $1/4''$  to  $5/16''$ .
  - b. Arcing contact wipe:  $5/16''$  or greater gap at primary contacts.
  - c. Primary contact gap:  $3-5/8''$  to  $3-15/16''$ .
  - d. Trip latch wipe:  $3/16''$  to  $1/4''$  with trip latch resting against stop pin.
  - e. Prop clearance:  $1/32''$  to  $3/32''$ .
  - f. Closing plunger clearance:  $1/16''$  to  $3/16''$ .
  - g. Interlock switch overtravel:  $1/32''$  to  $1/16''$ .
  - h. Control device switch overtravel:  $1/32''$  min.
  - i. Cut-off switch overtravel:  $1/32''$  to  $1/16''$ .
  - j. Latch checking switch contacts make when the gap between trip latch and stop pin is  $1/16''$ .
  - k. Impact trip roller wipe:  $3/32''$  to  $5/32''$ .
  - l. Impact trip bolt clearance:  $1/32''$  to  $1/16''$ .
  - m. Undervoltage trip hammer clearance:  $1/32''$  to  $1/16''$ .
  - n. Plunger interlock:  $16-19/32''$  to  $16-23/32''$ .

- o. Auxiliary switch linkage ("A" breakers only)  $12-9/32''$ .

2. Check all nuts, washers, bolts, cotter pins, and terminal connections for tightness.
3. Inspect all wiring to make sure that no damage has resulted during installation and test for possible grounds or short circuits.
4. See that all bearing surfaces of the mechanism have been lubricated. Refer to the section on LUBRICATION.
5. Operate the breaker slowly with the maintenance closing device and note that there is no excessive binding or friction and that the breaker can be moved to the fully opened and fully closed positions.
6. See that any place where the surface of the paint has been damaged is repainted immediately.

### Auxiliary Devices

On breakers that are equipped with auxiliary devices such as a current trip, undervoltage trip, or capacitor trip, the device should be checked for proper electrical operation. The current trip device should trip the breaker at 3 amperes. The undervoltage trip device should trip the breaker when the control voltage drops below 30 to 60% of rated voltage, and it should pick up at 80% of the control voltage or less. An adjustment plate is provided on the front of the undervoltage trip device as an aid in obtaining the desired setting.

NOTE: When checking the pick-up value of the undervoltage device, apply a voltage equal to 80% of normal control voltage to the undervoltage device coil. The device should pick up at this value. Do not increase the voltage gradually on this coil as it will overheat the coil, producing a false reading, and may damage the coil if excessive overheating occurs.

The capacitor trip should be capable of tripping the breaker as late as 25 seconds after the control voltage is removed. The ST-230 trip device is capable of tripping the breaker for a limited period of time after the control voltage is removed. See instruction book GEI-77015 for necessary check. If the auxiliary devices do not perform in accordance with these specifications, a careful examination should be made for defective parts.

### Opening and Closing Speed

The closing speed of the arcing contact should be 7 to 10 feet per second for the 150 MVA breakers and  $7-1/2$  to 10 feet per second for the 250 MVA breakers with rated closed circuit voltage at the closing coil terminals. These speeds represent the average speed of the movable arcing contact from a point 1" before the tip is tangent to the lower surface of the slot or probes

on the upper arc runner to the tangent position.

The opening speed of the arcing contact should be a minimum of 12 feet per second at rated control voltage. This speed represents the average speed over 3" from the point when the tip on the movable arcing contact is tangent to the lower surface of the slot or probes on the upper runner. Proper servicing and lubrication of the breaker and its operating mechanism should maintain these speeds and no adjustment is provided.

#### Control Power Check

After the breaker has been operated slowly several times with the maintenance closing device, and the mechanism adjustments checked as described above, the operating voltages should be checked at the closing coil and trip coil terminals. Control power for electrical operation of the breaker may be from either an alternating or direct current source. The operating ranges for the closing and tripping voltages as given on the breaker nameplate are as follows:

NOMINAL VOLTAGE	CLOSING RANGE	TRIPPING RANGE
125v d-c	90-130v d-c	70-140v d-c
250v d-c	180-260v d-c	140-280v d-c
230v a-c	190-250v a-c	190-250v a-c

NOTE: When repetitive operating is required from a direct current source, the closed circuit voltage at the closing coil should not exceed 115v d-c and 230v d-c at the nominal voltages of 125v d-c and 250v d-c, respectively.

To check the d-c voltage at the closing coil terminals, proceed as follows:

1. Mechanism with a control device, Figure 3. Close the breaker by manually operating the control device. Hold the contacts in the closed

position and read the d-c voltage at the closing coil terminals. To de-energize the circuit, release the control device.

2. Mechanism with cut-off switch, Figure 5. Close the breaker by manually operating the control relay located in the metal-clad unit. Hold the relay closed and read the d-c voltage at the closing coil terminals. Release the closing relay to de-energize the circuit.

If the closed circuit voltage at the terminals of the closing coil does not fall in the specified range, check the voltage at the source of power and line drop between the power source and breaker.

For A-c operation a germanium (color-black-flanged base) - or a silicon (color-blue, hex base) - rectifier bridge assembly is used, it is mounted in the metal-clad unit. These rectifiers are of the button-type and are hermetically sealed units. They have been tested and the associated resistor properly set at the factory. Unlike copper-oxide rectifiers the output of the germanium or silicon unit is affected very little by ambient temperature changes and it should not be necessary to disturb the factory setting. (See Rectifier Reference Charts, Figure 14 & 15.)

DO NOT MAINTAIN VOLTAGE ON THE CLOSING COIL ANY LONGER THAN THE TIME REQUIRED TO CLOSE THE BREAKER. (20 cycles max. at normal voltage.) Both the coils and the germanium and silicon rectifiers are designed for intermittent operation and may be damaged by prolonged current flow.

When two or more breakers, operating from the same control power source, are required to close simultaneously, the closed circuit voltage at the closing coil of each breaker must fall within the specified limits.

Electrical closing or opening is accomplished by merely energizing the closing or trip coil

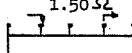
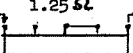
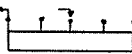
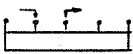
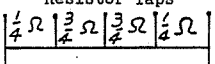
RECTIFIER REFERENCE CHART			
Closing Coil		Rectifier Resistor Setting	
Dwg. No.	Amps.	Germanium	Silicon
6375521 G-6	58.0 to 62.0	1.50Ω 	1.25Ω 
6375521 G-2	95.0 to 115.0	1.0Ω (ea. bridge) 	0.75Ω 
Resistor Taps 			

Figure 14 (0176V0946) Rectifier Reference Chart

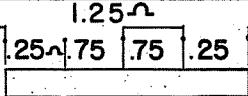
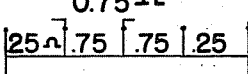
RECTIFIER REFERENCE CHART		
CLOSING COIL		RECTIFIER
DWG. NO.	AMPS.	RESISTOR SETTING
802B799 G-2	58.0 TO 62.0	1.25Ω 
802B799 G-1	95.0 TO 115.0	0.75Ω 

Figure 15 (0137A7676) Rectifier Reference Chart

circuit. Control switches are provided for this purpose on the metal-clad unit. It is also possible to trip the breaker manually by pressing the manual trip button (2) Figure 2.

NOTE: This breaker mechanism combination

is designed only for electrical closing when in use. NEVER ATTEMPT MANUAL CLOSING WITH THE BREAKER IN SERVICE, for under such conditions, sufficient closing force and speed cannot be applied.

## GENERAL MAINTENANCE

### General

Safe and dependable service from electrical apparatus and power systems is contingent upon reliable performance of power circuit breakers. To obtain maximum reliability the breaker should be inspected and maintained on a regular schedule. The breakers are designed in accordance with applicable standards which require that they be capable of performing up to 5000 operations for 1200 ampere breakers and 3000 operations for 2000 ampere breakers switching rated continuous current before any replacement of parts should be necessary. This requirement is based on the breakers being serviced, or maintained, at least every 2000 operations, or once per year, whichever comes first. If the breaker is also required to interrupt fault currents during this period of time additional maintenance and replacement of parts may be necessary.

BEFORE ANY MAINTENANCE WORK IS PERFORMED, MAKE CERTAIN THAT ALL CONTROL CIRCUITS ARE DE-ENERGIZED AND THAT THE BREAKER IS REMOVED FROM THE METAL-CLAD UNIT. DO NOT WORK ON THE BREAKER OR MECHANISM WHILE IN THE CLOSED POSITION UNLESS THE PROP AND TRIP LATCH HAVE BEEN SECURELY WIRED OR BLOCKED TO PREVENT ACCIDENTAL TRIPPING.

### Periodic Inspection

The frequency of the inspection and maintenance operations required should be determined by each operating company and will depend on the application of the breakers and the operating conditions. Factors which should be considered are: Importance to overall plant or system operation; number of operations and magnitude of currents switched by breaker; frequency of fault interruptions; and the atmospheric conditions in which the breaker normally operates. Extreme conditions of dust, moisture, corrosive gases etc., can indicate that inspection and maintenance will be required more frequently than every 2000 operations. Very clean dry operating conditions with low current switching duty can justify a longer period of time between inspections. Any time a breaker is known to have interrupted a fault at or near its rating it is recommended that the breaker be inspected and necessary maintenance be performed as soon after the interruption as is practical. The following instructions give the items that should be included in an inspection and general recommendations on the maintenance of breakers.

### Interrupters

Since there are no moving parts, the interrupters

of a magne-blast breaker will normally require little or no inspection unless there is evidence of damage to the arc chutes sides or contamination in the throat area. If either of these conditions are present the interrupters should be removed from the breaker and the following points noted:

1. The throat area of the interrupter should be cleaned with sandpaper (Do Not use emery cloth or other metallic abrasives). All flat areas on either side of the movable arcing contact travel should be sanded. Do not sand or otherwise attempt to clean the ceramic fins of the arc chute sides. Heavily contaminated parts should be replaced.
2. Cracks which have formed in the fins of the arc chute are to be expected in ceramic materials of this type when subjected to the severe heat of an arc. These cracks do not interfere with the operation of the device in any way and should be disregarded.
3. If the arc chute has suffered any mechanical injury due to dropping or accidental striking, resulting in the actual breaking off of fins, replacement will be necessary. Small broken corners on the exhaust end of the arc chute sides will not interfere with its performance and can be disregarded.
4. The plastisol flexible covering for the pole pieces (3 & 6) Figure 18 and the upper mounting support (10) should be inspected for breaks in the insulation. If there are holes or breaks in the insulation they should be repaired or the part replaced.

### Interrupter Removal and Replacement

Refer to Figure 16. To remove the interrupter loosen the two upper supporting bolts (3) and the one lower support bolt (10) using a standard 3/4" wrench. Raise the assembly approximately 3/8" and slide it toward the rear of the breaker.

To reassemble the interrupter to the breaker, rest the lower interrupter support (11) on the support bracket (9). Slide the arc chute forward, lifting it slightly to engage the supporting bolts (3) in the slots of the upper interrupter support (4). On the "-4" & "-4S" designs check the spring baffle (11) Figure 22, to assure that it closes the gap between the upper insulation (7) Figure 19, and the back surface of the contact support (4) Figure 22. On the "-8S" design check to assure that the upper insulation is properly positioned within the barrier suspended from the stationary



contact support (9) Figure 23.

Tighten the supporting bolts (3 and 10) Figure 16. These bolts serve as both the electrical and mechanical connections between the bushings and the arc runners within the interrupter. Check that the movable arcing contact (6) passes between the probes on the upper arc runner (5) Figure 19 without touching.

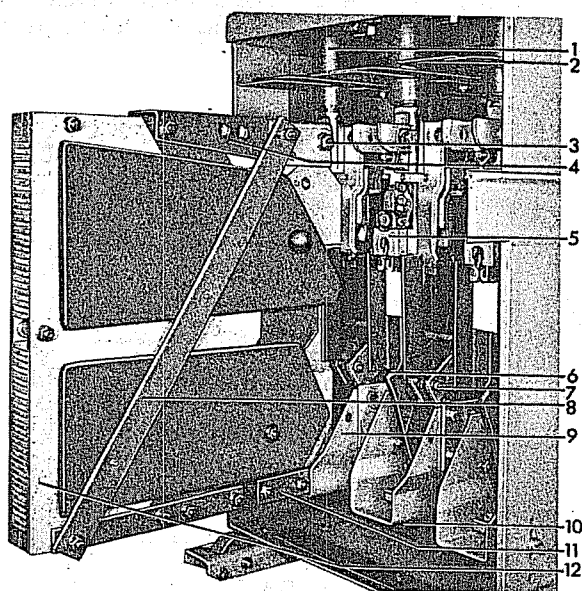


Figure 16 (8039584) Interrupter Removed Showing Accessibility of Arcing Contacts

1. Rear Bushing
2. Upper Horizontal Barriers
3. Supporting Bolt
4. Upper Interrupter Support
5. Stationary Arcing Contact
6. Movable Arcing Contact
7. Mounting Bolts
8. Arc Chute Brace
9. Support Bracket
10. Lower Supporting Bolt
11. Lower Interrupter Support
12. Interrupter

### Breaker Contacts

By removing the box barrier the movable and stationary primary contacts and the movable arcing contacts can be inspected. The stationary arcing contacts can be inspected only after removing the interrupter. If the contacts are burned or pitted, they can be made smooth with a fine file.

After completing inspection of the contacts, check the contact adjustments as specified under ADJUSTMENTS.

### Mechanism

A careful inspection should be made to check for loose nuts or bolts and broken retaining rings. All cam, roller, and latch surfaces should be inspected for any evidence of damage or excessive wear. Lubricate the mechanism as outlined below, then, using the maintenance operating device, open and close the breaker several times to make certain that the mechanism operates freely throughout its entire stroke. Check the mechanism adjustments as specified under ADJUSTMENTS. Check the control wiring for tightness of connections and damaged insulation.

### Bushings and Insulation

The surface of the bushings should be kept clean and unmarred to prevent moisture absorption. If the insulation surface should become damaged, it should be sanded and cleaned, and should be refinished with either clear varnish or clear resin. Allow to dry smooth and hard.

All other insulation parts on the breaker should be kept clean and dry. Smoke or dust collected between inspection periods should be wiped off, and if dampness is apparent, heaters should be installed in the metal clad switchgear to insure dryness.

### Insulation Test

When insulation has been repaired or replaced, or when breaker has been operating in adverse moisture conditions, it is recommended that the insulation be checked before the breaker is placed back in service. A standard 60 hertz high potential test at 14,000 volts RMS for one minute will normally indicate whether the breaker is satisfactory for service. With the breaker contacts in the fully opened position, apply the test potential to each terminal of the breaker individually with all other terminals and the breaker frame grounded. After high potential tests are made on organic insulating materials, these materials should be inspected for visible leakage current paths, and necessary action must be taken to repair or replace insulation that may have been affected by moisture absorption.

### Lubrication

In order to maintain reliable operation, it is important that all circuit breakers be properly lubricated at all times. Most of the bearings and rolling surfaces utilize a new type of dry lubrication that will require no maintenance and will last the life of the equipment. Only few bearings and surfaces listed in the chart, Figure 17, require lubrication. These have been properly lubricated during assembly at the factory, using the finest grades of lubricants available. However, even the finest oils and greases have a tendency to oxidize with age, as evidence by hardening and darkening in color. Elimination of the hardened lubricant is essential for the proper operation of circuit breakers. Also frequent operation of the breaker

causes the lubricant to be forced out from between the bearing surfaces. A simple lubrication will often clear up minor disturbances which might be mistaken for more serious trouble.

A definite lubrication schedule should be set up taking into consideration the frequency of operation of the breaker and local conditions.

It is recommended that lubrication of the breaker and its operating mechanism be a part of the periodic inspection and maintenance program, with not more than a two year period between lubrications. It is also recommended that all circuit breakers be operated at regular intervals, at least once a year, to insure the lubrication is in good condition and

the breaker is operable.

The lubrication chart, Figure 17, is divided into two methods of lubrication. The first method outlines the maintenance lubrication which should be performed at the time of periodic maintenance, and requires no disassembly. The second method outlines a lubrication procedure similar to that performed on the breaker at the factory, and should be used when a general overhaul of the breaker is necessary.

General Electric Lubricants D50H15 and D50H47 are available in 1/4 lb. collapsible tubes. It is so packaged to insure cleanliness and to prevent oxidation.

PART	LUBRICATION AT MAINTENANCE PERIOD	ALTERNATE LUBRICATION (REQUIRES DISASSEMBLY)
Sleeve Bearings - links, trip shaft, etc. (Teflon coated bearings)	No lubrication required	No lubrication required
Sleeve Bearings - main crank shaft, driving pawl lever. (Bronze or cast iron)	Light application of machine oil SAE 20 or SAE 30.	Remove bearings or links, clean per instructions and apply D50H15 lubricant liberally.
Contact Arm Hinge Assembly Cup bearing Loose rings between bushing and contact arm.	No lubrication required.	Wipe clean and apply D50H47.
Roller and Needle Bearings	Light application of machine oil SAE 20 or SAE 30.	Clean per instructions and repack with D50H15 lubricant.
Ground surfaces such as cams, ratchet teeth, etc. (Surfaces coated with MoS <sub>2</sub> )	No lubrication required.	No lubrication required.
Ground surfaces such as latches, rollers, prop, etc.	Wipe clean and apply D50H15 lubricant.	Wipe clean and apply D50H15 lubricant.
Silver plated contacts and primary disconnect studs.	Wipe clean and apply D50H47.	Wipe clean and apply D50H47.
Booster Cylinder	Do not lubricate	Do not lubricate
Arcing Contacts	Do not lubricate	Do not lubricate

Figure 17. Lubrication Chart

## METHOD OF CLEANING BEARINGS

Whenever cleaning of bearings is required, as indicated in the lubrication chart, the following procedures are recommended.

### Sleeve Bearings

The sleeve bearings used throughout the linkage utilize Teflon surfaces and do not require lubrication. After a number of operations, the surface will acquire a thin black film. Do not remove this film unless there is evidence of outside contaminants, such as dry or hardened grease. If contaminants are present they should be removed by immersing the link and bearing in clean petroleum solvent, or similar cleaner, and using a stiff brush. Do not remove the bearings from the links. **DO NOT USE CARBON TETRACHLORIDE.**

The hinge of the primary contact arm (24) Figure 6, should be disassembled, cleaned, and lubricated with G-E D50H47 lubricant at general overhaul periods.

The main shaft bearings should be removed, cleaned, and lubricated with G-E D50H15 lubricant at general overhaul periods.

### Roller and Needle Bearings

The bearings should be removed from the mechanism and the inner race disassembled. They should then be placed in a container of clean petroleum solvent or similar cleaner. **DO NOT USE CARBON TETRACHLORIDE.** If the grease in the bearings has become badly oxidized, it may be necessary to use alcohol (type used for thinning shellac) to remove it. Ordinarily, by agitating the bearings in the cleaning solution, and using a stiff brush to remove the solid particles, the bearings can be satisfactorily cleaned. Do not handle the bearings with bare hands as deposits from the skin onto the bearings are inductive to corrosion. If the bearings are touched, the contamination can be removed by washing in alcohol. After the bearings have been thoroughly cleaned, spin them in clean new light machine oil until the cleaner or solvent is entirely removed. Allow this oil to drain off and then repack them immediately with G-E lubricant D50H15 being sure all metal parts are greased. The inner races should then be assembled.

**NOTE:** If it becomes necessary to clean the bearings in alcohol (shellac thinner), be sure the alcohol is perfectly clean, and do not allow the bearings to remain in the alcohol more than a few hours. If it is desirable to leave the bearings in the alcohol for a longer time, an inhibited alcohol such as is used for anti-freeze should be used. Even then the bearings should be removed from the alcohol within twenty-four hours. Precautions against the toxic effects of the alcohol must be exercised by wearing rubber gloves and by using the alcohol in a well ventilated room; excessive

exposure to the fumes is sometimes unpleasant to personnel. Washing the bearings in the light oil, draining and repacking with lubricant D50H15 should follow immediately.

Bearings that are pressed into the frame or other members should not be removed. After removing the shaft and inner race the bearing can be cleaned satisfactorily with petroleum solvent or a similar cleaner and a stiff brush. Follow the procedure outlined above using a light machine oil and G-E lubricant D50H15 before reassembling the inner race and shaft.

## MAINTENANCE

Magne-blast breakers used for switching arc furnaces or capacitors will require more frequent and more detailed inspection and maintenance because of the repetitive nature of the applications. The following schedule is recommended for such breakers:

- A. Every 500 Operations, or Every Six Months-  
Whichever Comes First:
  1. Remove the box barriers.
  2. Wipe all insulating parts clean of smoke deposit and dust with a clean dry cloth, including the bushings, and the inside of the box barriers.
  3. All flat parts in the throat area of the interrupters should be thoroughly cleaned by using sandpaper. This cleaning should be performed any time the interrupter is removed. The fins on the arc chute sides should not be cleaned. Whenever the interrupter is removed, loose dust and dirt should be blown out before replacing arc chutes. Throat insulation which is heavily contaminated should be replaced.
- B. Every 2000 Operations, or Every Six Months  
Whichever Comes First:
  1. In addition to the servicing done each 500 operations, the following inspection should be made and work done when required.
  2. Primary Contacts (3 and 10 Figure 23). Inspect the condition of the stationary contact fingers and movable contact blocks. Badly pitted or burned contacts should be replaced. (Note: Burned primary contacts indicate the probable need for arcing contact replacement.) If the contact surfaces are only roughened or galled, they should be smoothed with crocus cloth or draw filed. After contact dressing the primary contacts should be greased lightly with D50H47.
  3. Arcing Contacts (6 and 27 Figure 6). When the arcing contact wipe is less

than the minimum specified under ADJUSTMENTS, the contacts should be replaced. The contacts should be inspected for uneven wear and/or damage using a mirror to inspect the stationary contacts. Normally it will not be necessary to remove the interrupters for this 2000 operation servicing unless inadequate wipe or contact condition indicate a need for replacement. If the interrupters are removed, the contact braids, and other parts subject to arcing should be checked for possible cleaning or replacement. Do not grease the arcing contacts under any circumstances.

4. Check the breaker and mechanism adjustments as summarized under INSPECTION AND TEST. The necessary readjustments should be made as described under ADJUSTMENTS.
5. The breaker and operating mechanism should be carefully inspected for loose nuts, bolts, retaining rings, etc., all cam, latch and roller surfaces should be inspected for damage or excessive wear. The buffer blocks and their retainers on the bottom of the stationary contact support should be inspected for possible need of replacement.
6. The contacts of the control device Figure 3, should be inspected for wear and cleaned if necessary.
7. Lubricate the breaker operating mechanism in accordance with instructions under LUBRICATION, Page 17 and the lubrication chart Figure 17.
8. Inspect all wiring for tightness of connections and possible damage of insulation.
9. After the breaker has been serviced, it should be operated manually to be sure there is no binding or friction and that the breaker contacts can move to the fully opened and fully closed positions. Its electrical operation should then be checked using either the test cabinet or the test couplers.

C. After Every 10,000 Operations:

1. In addition to the servicing done each 2000 operations, the interrupters should be removed from the breaker and disassembled to permit a detailed inspection of insulation, blow-out coils, arc runners and assemblies which can become contaminated by arc products.
2. The blow-out coils should be carefully examined and if the insulation has been cracked, shrunk or eroded from arc action and heat so that the turns of the

coils are not fully insulated from each other, the coils should be replaced. All connections should be checked for tightness.

3. The arc runners should be inspected and replaced when any part of their area has been reduced to 25% of the original metal thickness as a result of arc erosion.
4. Check the stationary arc contacts to assure that the arcing contacts are in good condition and that their connections are tight.
5. Insulating material that is carbonized and cannot be satisfactorily cleaned should be replaced.
6. Any parts damaged or severely burned and/or eroded from arc action should be replaced.

NOTE: Fine cracks may develop in the fins of the arc chute sides. This is to be expected with ceramic materials when subjected to the high heat of an arc and may be disregarded unless they are long and present a possibility of fin sections breaking completely off. Small broken corners on the exhaust end of the arc chute will not interfere with its performance and can also be disregarded.

7. The cup bearing and the contact ring at the hinge point of the contact blade should be disassembled, inspected, cleaned, and relubricated with G-E contact lubricant D50H47. The contact ring should be inspected for wear and replaced when reduced in thickness to less than 1/32". When reassembling the cup bearing, be sure the cotter pin is properly assembled in the castle nut on the hinge pin (7) Figure 23. This assures proper contact pressure at the hinge.

D. Every 20,000 operations or Approximately Every Five Years - Whichever comes first:

1. The breaker should be given a general inspection and overhaul as required. All excessively worn parts in both the mechanism and breaker should be replaced. Such wear will usually be indicated when the breaker cannot be adjusted to indicated tolerances. This overhaul and inspection is more detailed and will require disassembly of mechanism and breaker operating parts.
2. All roller and needle bearings in the operating mechanism should be disassembled, cleaned, and repacked with G. E. lubricant D50H15 as described under LUBRICATION.

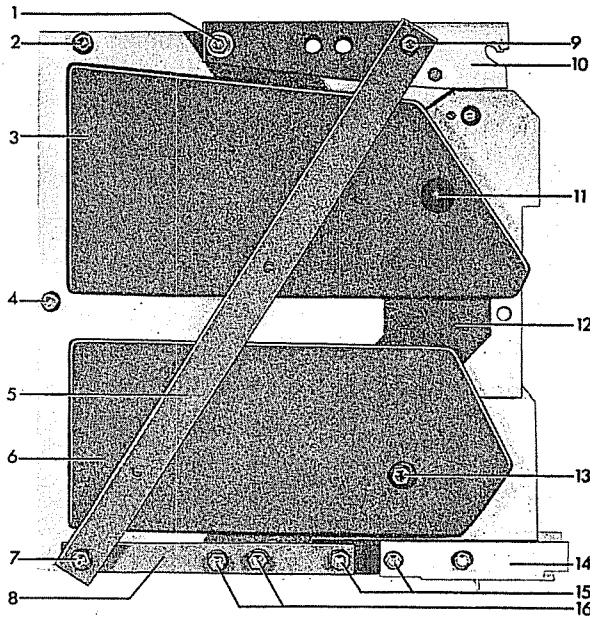


Figure 18. (8039601) Interrupter Assembly

1. Assembly Bolts and Bushing
2. Assembly Bolts
3. Upper Pole Piece
4. Assembly Bolt
5. Side Brace
6. Lower Pole Piece
7. Assembly Bolt
8. Lower Brace
9. Assembly Bolt
10. Upper Interrupter Support
11. Insulating Cap
12. Side Shield
13. Assembly Bolt
14. Lower Interrupter Support
15. Assembly Bolts
16. Assembly Bolts

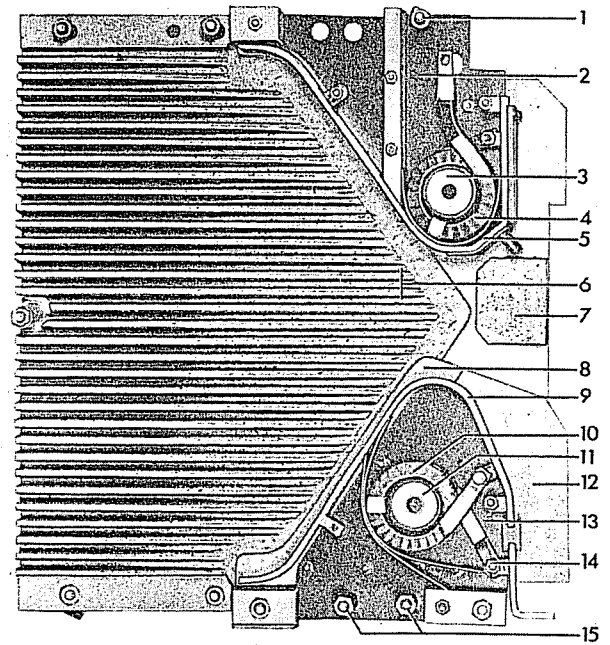


Figure 19. (8039603) Interrupter Assembly with Side Removed

1. Upper Arc Runner Spacer
2. Upper Arc Runner Assembly
3. Blowout Core
4. Blowout Coil
5. Upper Arc Runner
6. Arc Chute Side
7. Throat Insulation
8. Lower Shield
9. Lower Arc Runner
10. Blowout Coil
11. Blowout Core
12. Lower Insulation
13. Lower Arc Runner Assembly
14. Lower Coil Connection
15. Lower Arc Runner Spacers



3. The stationary primary contact fingers (3) Figure 23, should be disassembled and the silver-plated pivot area of the contact and contact support cleaned and lubricated with G-E lubricant D50H47.
4. The breaker and operating mechanism should be serviced as described for every 2,000 operations and properly adjusted before being put back into service.

#### REPAIR AND REPLACEMENT

This section covers the proper method of removing and replacing those parts of the breaker subject to damage and wear that may require repair or replacement at the installation. **IMPORTANT: UPON COMPLETION OF ANY REPAIR WORK, ALL BREAKER AND MECHANISM ADJUSTMENTS MUST BE CHECKED.** Refer to the section on INSTALLATION, paying particular attention to ADJUSTMENTS and FINAL INSPECTION.

**ARC CHUTE** (To inspect or replace blow-out coils and arc runners):

With the breaker open and the closing springs in the blocked position, remove the box barrier (7) Figure 6. The interrupter can now be removed as described under INTERRUPTER REMOVAL AND REPLACEMENT page 16.

To disassemble the interrupter after it has been removed from the breaker, proceed as follows:

**NOTE:** When disassembling the arc chute and its components some small washers, spacers, etc., will be found that cannot be identified in these instructions. Care should be taken to collect and identify these items so they can be reassembled correctly.

1. Remove the caps and assembly bolts (7, 9, 11, & 13) Figure 18.
2. Remove the side brace (5), and pole pieces (3 & 6).
3. To remove the upper interrupter support (10) remove the assembly bolt (1), and the bolted connection (2) Figure 20 between the upper interrupter support and the blowout coil.
4. Remove the assembly bolt (16) Figure 18 to remove the lower brace (8).
5. Remove the lower interrupter support (14) by removing the assembly bolts (15) and the connection nut (8) Figure 20.
6. At this point, the side shields (5) Figure 20, and the arc runner assemblies (4 & 6) can be removed.
7. Further disassembly of both the upper and

lower arc runner assemblies can be done by removing the various screws and assembly bolts (not illustrated) as shown in Figure 19.

8. The arc chute sides (6) Figure 19, can also be separated for inspection after removing assembly bolts (2 & 4) Figure 18.

Reassemble the interrupter in the reverse order. The following items should be noted during reassembly:

1. The fins of the arc chute sides should be equally spaced and aligned before bolting together. The front edge (along the runner) of the two arc chute sides should be parallel and in line.
2. The gap between the fins at the rear of the arc chute sides measured at least 1" in from the back end of the arc chute (See Figure 21) should be 1/64" to 3/32".
3. Check to insure that electrical connections to the blowout coils are tight.
4. When reassembling the arc runner assemblies, check that the spacers are correctly installed.
5. Before bolting the upper supports in place, make certain that the upper arc runner assembly is tight against the arc chute side so that the gap between the throat insulation (7) Figure 19, and the arc chute sides (6) is a minimum.
6. Make certain that the electrical connections (2 & 8) Figure 20 are tight.

Reassemble the arc chute on the breaker as described under INTERRUPTER REMOVAL AND REPLACEMENT, page 16.

#### CONTACTS

Open the breaker and remove the box barrier and interrupters as previously described. To remove the contacts, proceed as follows:

- A. Stationary Arcing Contacts (10) Figure 22.
  1. Disconnect the contact braids (7) from the contact fingers by removing two bolts and locking plates (8).
  2. Grasp the lower end of the contact fingers with pliers and pull contact assembly downward to remove from stud assembly.
  3. To disassemble braids from stud plate remove one bolt (5).
  4. To disassemble stud plate from contact

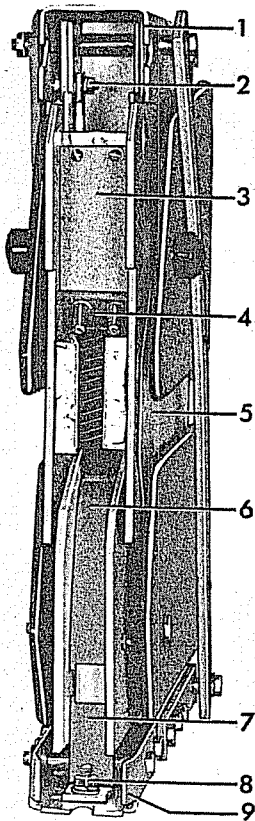


Figure 20. (8039604) Interrupter Assembly

1. Upper Mounting Support
2. Connection Bolt
3. Insulation Plate
4. Upper Arc Runner Assembly
5. Side Shield
6. Lower Arc Runner Assembly
7. Lower Coil Connection
8. Connection Nut
9. Lower Mounting Support

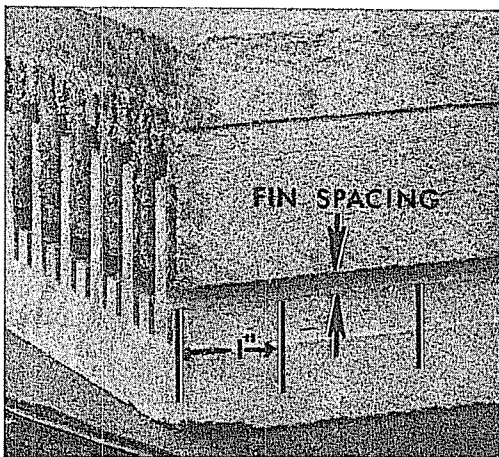


Figure 21. (8029373) Arc Chute Fin Spacing

support, remove two bolts (6).

5. Reassemble in the reverse order, make sure locking plates are properly re-assembled with bolts (8).

#### B. Movable Arcing Contact (14) Figure 23.

1. Remove the assembly bolts (12) making note of quantity and location of shims and spacers used between contacts and contact arms.
2. Reassemble in reverse order, re-using the shims and spacers.
3. Close the breaker slowly to check that the movable arcing contact is approximately centered on the stationary arcing contact and that it does not rub on either side of the throat barrier (9).

NOTE: Whenever it is found necessary to replace arcing contacts on any pole of a breaker it is recommended that both the stationary and movable contacts on that pole be replaced at the same time.

#### C. Stationary Primary Contacts (9) Figure 24.

1. Compress the contact spring (6) by use of the spring compressor.
2. Remove spring and spring guide (1).
3. Raise the contact finger to clear the primary contact stop plate (8) and lift the finger out of contact support (7). Remove one contact finger at a time.

#### To replace the Stationary Primary Contacts:

1. Apply a thin coating of D50H47 grease on the hinged edge of the finger (9) then place it on the contact support (7) so that it is retained by stop plate (8).
2. Open spring compressor (3) and assemble spring guide, spring and spring compressor (Figure 24A).
3. Turn nut (2) clockwise direction to compress contact spring (Figure 24B). Hold spring firmly in yoke on spring compressor to prevent spring from slipping out of the compressor.
4. Place washer (not shown) on guide on top of spring, place top of guide into hole in spring retainer (4) and the round end of spring guide in cutout in primary finger (Figure 24C).
5. Hold spring assembly firmly in place and remove spring compressor.

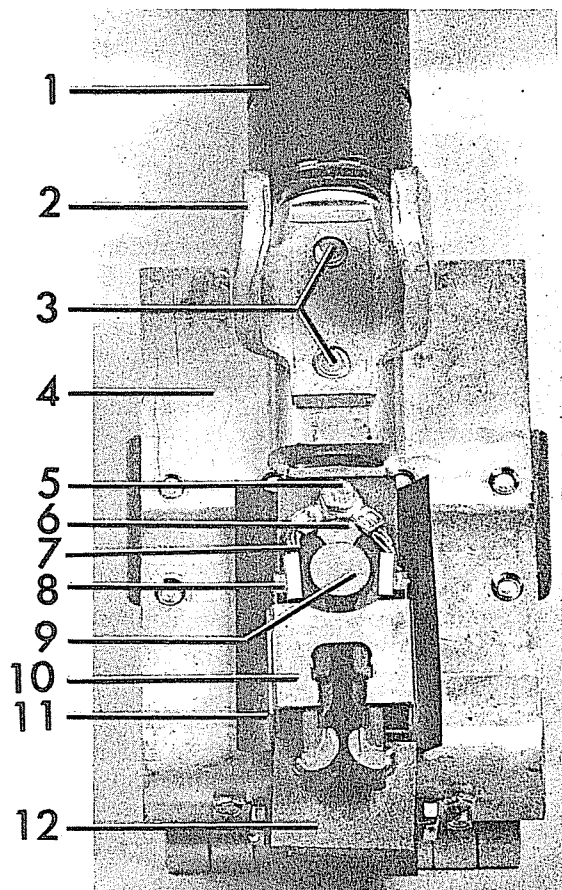


Fig. 22A (8025170) "-4" & "-7" Designs

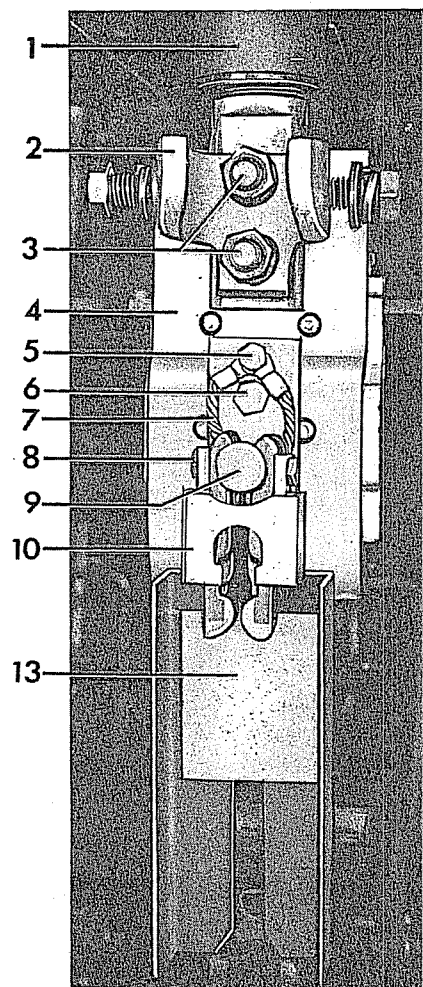


Fig. 22B (8039586) "-8" Design

Figure 22. Rear Bushing Assembly

1. Rear Bushing
2. Guide and Support for Interrupter
3. Bolts for Contact Support
4. Contact Support
5. Bolt for Flexible Braid
6. Mounting Bolt
7. Flexible Braid

8. Connection Bolt
9. Stud for Mounting Arcing Fingers
10. Stationary Arcing Contact Assembly
11. Spring Baffle
12. Insulating Plate
13. Throat Baffle

#### D. Movable Primary Contacts (10) Figure 23.

To replace the movable primary contacts on a 1200 ampere breaker proceed as follows:

1. Disassemble nuts from assembly bolts (11) and remove the movable primary contacts (10).
2. Reassemble in reverse order.

To replace the movable primary con-

tacts on a 2000 ampere breaker it is first necessary to disassemble the movable arcing contacts, then proceed as follows:

1. Disassemble operating rod pin (4), first noting quantity and location of washers in the assembly.
2. Pry contact arms (8) apart enough to disengage pivot pins of piston assembly (13) allowing piston to drop down into its booster cylinder.

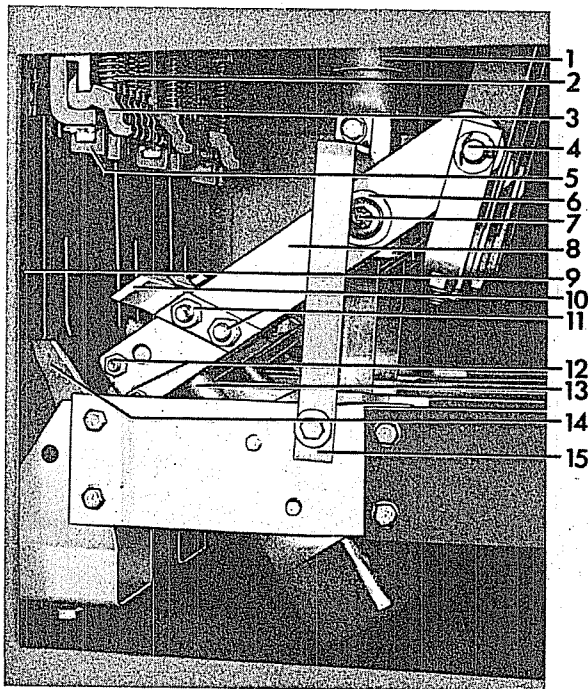


Figure 23. (8039588) Contact Assembly

1. Front Bushing
2. Contact Springs
3. Stationary Primary Contacts
4. Operating Rod Pin
5. Buffer
6. Cup Bearing
7. Hinge Pin
8. Contact Arm
9. Throat Barrier
10. Movable Primary Contacts
11. Assembly Bolts
12. Assembly Bolts
13. Piston Assembly
14. Movable Arcing Contact
15. Connection Bar

3. Rotate the two parts of the contact arm assembly away from each other so assembly bolts (11) are accessible and movable primary contacts (10) can be removed.

4. Reassemble in reverse order.

E. Contact Arm Assembly (8, 10, 12, 14, Figure 23).

1. Remove connection bar (15).
2. Disassemble hinge pin (7), cup bearing (6), and operating rod pin (4) noting quantity and location of any washers

and spacers used in assemblies.

3. The contact arm assembly including the piston assembly (13) can now be removed.
4. When reassembling, first insert piston tube assembly (13) into the booster cylinder and reassemble the cup bearing, making sure the silvered contact washers between the bushing and contact arms (both sides) are in place.
5. Reassemble operating rod pin (4) and connection bar (15).

- F. After disassembly and reassembly of any contacts, check all contact adjustments as described under ADJUSTMENTS.

### BUSHINGS

**IMPORTANT: DO NOT REMOVE ALL SIX BUSHINGS AT ONCE.** The bushings have been carefully aligned with the breaker frame, during assembly at the factory, and it is important that this alignment be maintained to insure interchangeability of the breakers in the metal-clad units. It is, therefore, recommended that the bushings be removed and reassembled one at a time. Also, before removing any one bushing, measure the distance from that particular bushing to adjacent bushings in both directions, so that it may be reinstalled in the same location.

However, it is possible to remove and reassemble three bushings at one time. If this is preferred, alignment of the bushings may be accomplished by placing the breaker in a de-energized spare metal-clad unit before tightening the bushing mounting bolts. This must be done before the interrupters are reinstalled.

To replace the bushing, proceed as follows:

#### Rear Bushing

1. Open the breaker and remove the box barrier and interrupters as already described.
2. Remove the upper and lower horizontal barriers (18 and 20) Figure 6.
3. Remove the four bolts at the mounting flange of the rear bushing being removed and lower the bushing assembly.

**NOTE:** Shims may be found between the breaker mounting plate and the bushing mounting flange on some, or all bolts. These shims are for squaring up the bushing and may be required when new bushings are assembled.

4. Referring to Figure 24, disassemble the primary contact springs (6) as previously described.

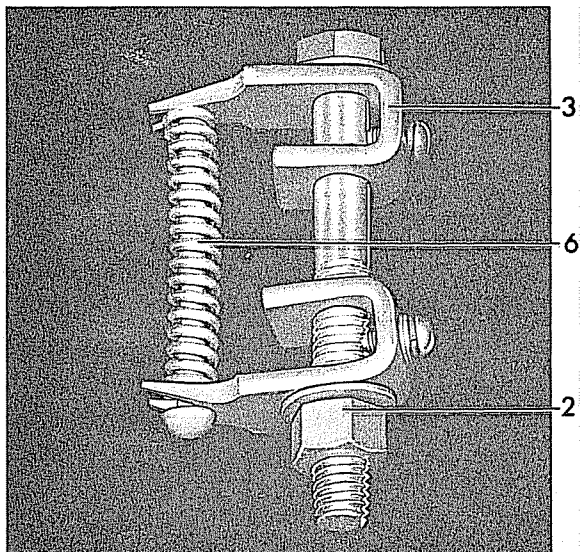


Figure 24A (8034466)

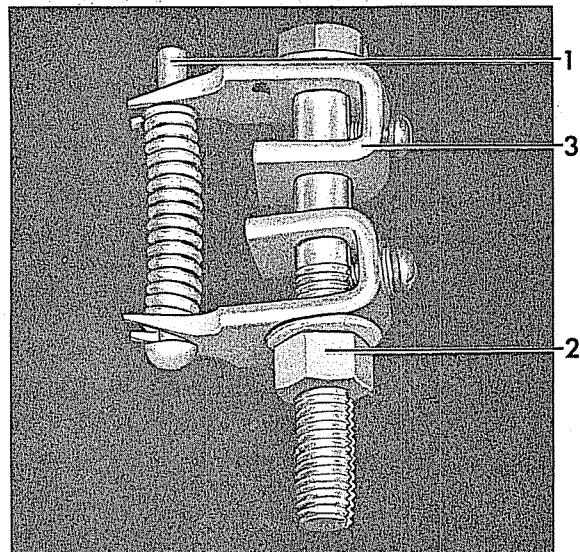


Figure 24B (8034465)

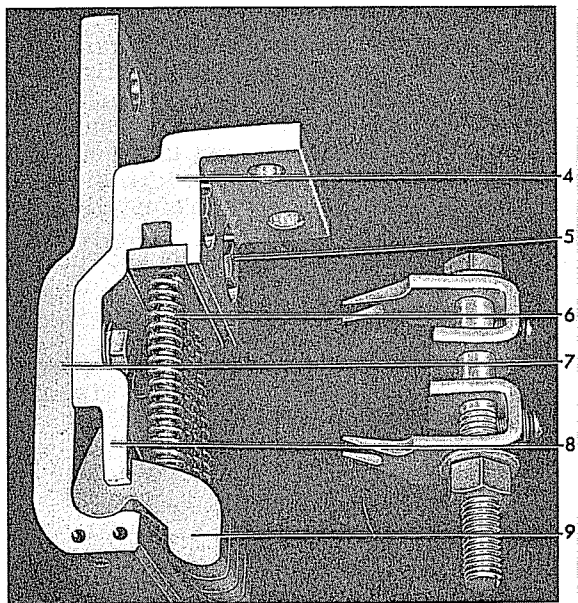


Figure 24C (8034469)

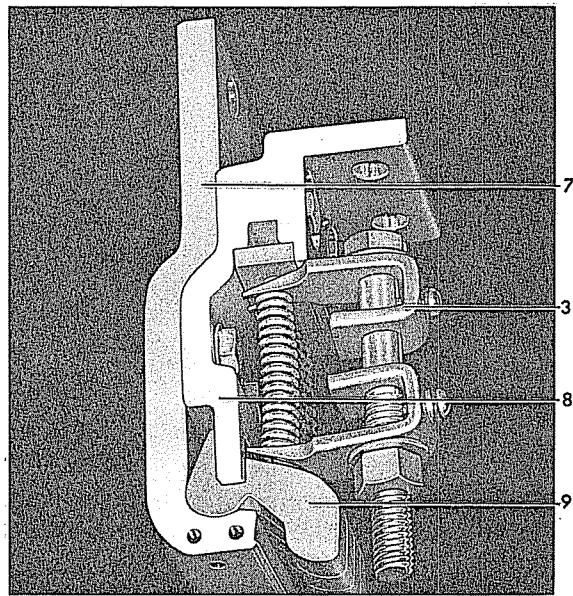


Figure 24D (8034468)

Figure 24. Method of Installing Primary Contact Springs Using a Spring Compressor

- |                      |                              |
|----------------------|------------------------------|
| 1. Spring Guide      | 6. Spring                    |
| 2. Compressor Nut    | 7. Contact Support           |
| 3. Spring Compressor | 8. Stop Plate                |
| 4. Spring Retainer   | 9. Stationary Primary Finger |
| 5. Assembly Bolts    |                              |



5. Disassemble the spring retainer (4) by removing mounting bolts (5).
6. Referring to Figure 22, disassemble the contact support (4) and interrupter mounting bracket (2) removing two bolts (3).
7. Reassemble in the reverse order. The interrupter mounting bracket (2) is not symmetrical and must be assembled correctly to orient the interrupter properly on the breaker. The longest projection of the bracket should be toward the lower end of the bushing.

#### Front Bushing

1. Open the breaker and remove the box barrier and interrupters as already described.
2. Remove the upper and lower horizontal barriers (18 and 20) Figure 6.
3. Remove the connection bar (15) Figure 23, cup bearing (6) and hinge pin (7).
4. Remove the four bolts at the mounting flange of the front bushing being removed, and lower the bushing. (See note under rear bushings concerning use of shims.)
5. When reassembling, first mount the bushing and assemble the cup bearing (6), contact arm (8), and replace pin (7) being sure the silvered contact washers between the bushing and contact arms are in place. The contact surfaces at the hinge point of the contact blade and bushing should have a thin coating of D50H47 grease.
6. Check all contact adjustments as outlined under ADJUSTMENTS.

#### TRIP SHAFT AND LATCH (3 & 4, Figure 9)

1. Remove mounting bolts for control device Figure 3, letting the control device hang free. Do not remove wiring.
2. Remove two bolts (3) Figure 25 and let the trip coil (1) and support (2) hang free.
3. Remove latch check switch bar (5) Figure 26, the trip coil plunger bracket (6), and manual trip bar (1) Figure 3.
4. Remove snap rings and washers adjacent to bearings on both sides of mechanism frame.
5. Using a 3/8" diameter brass rod approximately 15" long, drive the bearing housings out of the mechanism frame. Take the right bearing out first using the opening in the left side of the frame and then remove the left bearing using the opening made from the removal of the right bearing.

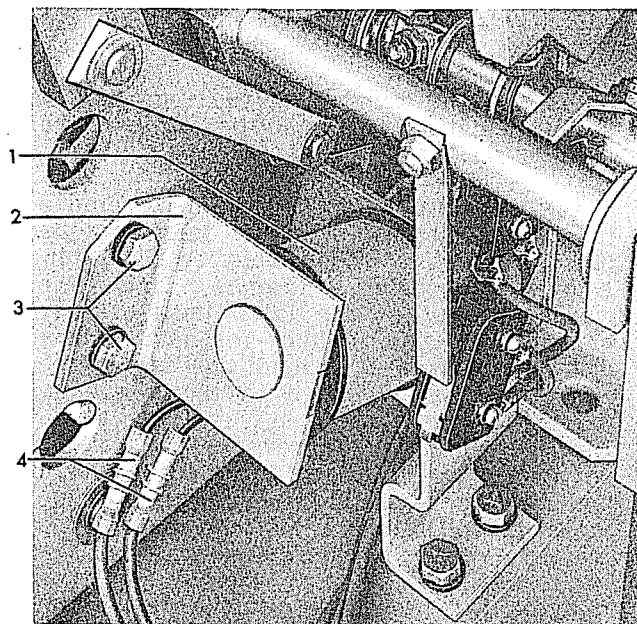


Figure 25 (8029371) Potential Trip Coil

1. Trip Coil
2. Trip Coil Support
3. Mounting Bolts
4. Trip Coil Leads

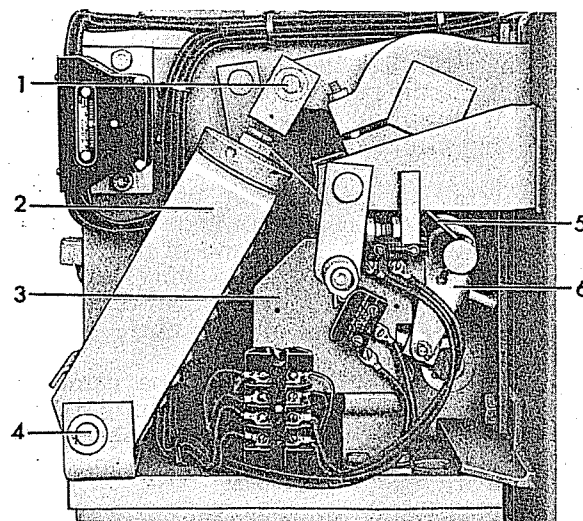


Figure 26 (8020728) Opening Spring Assembly

1. Pivot Pin
2. Opening Spring Unit
3. Trip Coil Mounting Plate
4. Pivot Pin
5. Switch Bar
6. Trip Coil Plunger Bracket

When removing the left bearing, the brass rod may require a slight bend to clear the trip latch.

NOTE: The trip shaft bearings are a self-lubricating type and do not require lubrication.

6. If the trip latch is to be replaced, remove the set screw holding the latch on the shaft. Place a block between the latch and the mechanism frame. Drive the trip shaft out of the latch until the key can be removed. Check for and remove any burrs raised around the keyway to avoid possible damage to the bearings.
7. Reassemble parts in reverse order. Be sure the spring is in the proper place and has been wound one-half turn. Also make sure the latch is in place on stop bar roller before bearings and trip shaft are reassembled. A pipe should be used to drive the bearing back into the mechanism frame so that damage does not occur to the bearing surface.

#### Trip Latch Roller Bearing

1. Remove mounting bolts on control device Figure 3, leaving control device hang free. Do not remove wiring.
2. Place block between manual trip rod (2) Figure 2, and trip paddle (1) Figure 3 on trip shaft. This holds trip shaft in trip position and allows trip linkage to be free.
3. Working through hole on left hand side of mechanism, remove snap ring and washer from trip roller pin (3) Figure 9, using snap ring pliers.
4. Slide trip roller pin just enough to the right to allow room to hook snap ring pliers on ring on other end of pin. Compress pliers to free snap ring and pry the pin to the left with screwdriver to complete the removal of snap ring.
5. Trip roller bearing can now be removed for lubrication (see section on LUBRICATION). Particular attention should be paid to the location of washers and spacers.
6. To reassemble, reverse the above procedures.

#### Closing Coil

The closing coil is contained within the solenoid pot (1) Figure 27. To remove the closing coil, proceed as follows:

1. Open the breaker.
2. Remove the two closing coil leads (11).

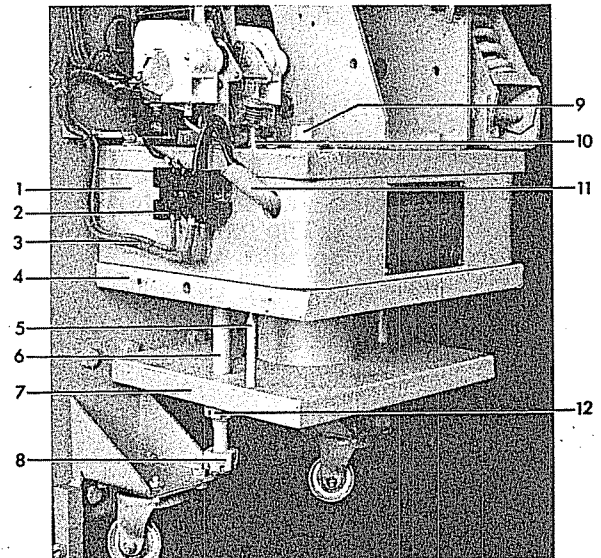


Figure 27 (8022045) Closing Solenoid Assembly

1. Solenoid Pot
2. Terminal Board
3. Wire Strap
4. Bottom Plate
5. Control Device Trip Plunger Rod
6. Guide Studs
7. Armature
8. Stop Nuts
9. Front Stud Nuts
10. Plunger Guide
11. Closing Coil Leads
12. Stop Nuts

Remove the terminal board (2) from the solenoid pot and let it hang by the wires. Also, remove the wire from strap (3).

3. Remove the stop nuts (8 and 12) on guide studs (6), lower the armature (7) and control device trip plunger (5).

NOTE: Armature rests on stop nuts (12) only. Armature should be supported during the removal of these stop nuts and then lowered.

4. Loosen the four nuts under the bottom plate (4) approximately 1/2". Support the bottom plate with a rope sling or hoist and remove the two rear nuts.
5. Remove the nuts (9) at the top of the front studs. This permits the bottom plate, closing coil, solenoid pot (1) and

and control device plunger guide (10) to be removed.

6. To reassemble, first place the closing coil and spacers on the bottom plate (4). Raise into position, inserting the control device plunger guide (10) and compressing the piston ring on the upper pole piece.
7. Tilt the bottom plate downward and replace the solenoid pot (1) and two front studs and nuts (9).
8. Tighten the four nuts under the bottom plate taking special precaution to center the closing coil around the pole piece. If the closing coil is not firmly held in place, add spacers above the closing coil.
9. Replace the control device trip plunger rod (5) and armature (7).
10. Recheck the mechanism adjustments as explained under ADJUSTMENTS.

#### Trip Coil

To replace the potential trip coil(1) Figure 25, proceed as follows:

1. Open the breaker and remove the opening spring unit (2) Figure 26, by removing the pivot pins (1 and 4).
2. Cut wires at butt connectors (4) Figure 25.

3. Remove the two mounting bolts (3) and the trip coil support (2).
4. Remove the trip coil (1).
5. After reassembling (in the reverse order) check the primary contact gap adjustment as explained under ADJUSTMENTS.

#### Interlock Switch

To remove the interlock switch (7) Figure 10 remove the two mounting screws and disconnect the lead wires. Reassemble in the reverse order and check the switch adjustments as explained under ADJUSTMENTS.

#### Latch Checking Switch

To remove the latch checking switch (2) Figure 10, (when furnished), remove the two mounting screws and disconnect the lead wires. Reassemble in the reverse order and check the switch adjustments as explained under ADJUSTMENTS.

#### Cut-off Switch

To remove the cut-off switch (1) Figure 5 remove the two mounting bolts and disconnect the lead wires. When reassembling check the cut-off switch adjustment as explained under ADJUSTMENTS.

## 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 minimize 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 since improvements are made from time to time. The parts which are furnished, however, will be interchangeable.

NOTE: The listed terms "Right" and "Left" apply when facing the mechanism end of the breaker.

#### ORDERING INSTRUCTIONS

1. Always specify the complete nameplate data 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 this bulletin number.
3. Standard hardware, such as screws, bolts, nuts, washers, etc., are not listed and should be purchased locally.
4. For prices, refer to the nearest office of the General Electric Company.

#### PARTS RECOMMENDED FOR NORMAL MAINTENANCE

In the following tabulations are listed those parts of the breaker and operating mechanism which are usually recommended for stock for normal maintenance. Other parts can be obtained by contacting the nearest office of the General Electric Company.

RECOMMENDED RENEWAL PARTS FOR  
TYPE MS-13 SOLENOID MECHANISM  
USED FOR AM-4.16-150/250-4/4S/7S/8S  
600, 1200, & 2000 AMPERE

Quan. Req.d.	Description	-4	-4S, -7S, -8S
1	Closing Coil ** #125 V-dc & 230 V-ac, 60 Hz (250 MVA) 125 V-dc & 230 V-ac, 60 Hz (150 MVA) #250 V-dc (250 MVA) 250 V-dc (150 MVA)	006375521G002 006375521G006 006375521G001 006375521G005	0802B0799G001 0802B0799G002 0802B0799G003 0802B0799G004
1	Potential Trip Coil ** 125 V-dc 250 V-dc 230 V-ac, 60 Hz 24 V-dc 48 V-dc		006174582G001 006174582G002 006174582G032 ## 006275070G001 006174582G034
1	Undervoltage Device Coil ** 125 V-dc 250 V-dc 230 V-ac, 60 Hz		006275017G019 006275017G020 006275017G033
1	Control Device Coil ** 125 V-dc 250 V-dc 230 V-ac, 60 Hz (Continuous ) 230 V-ac, 60 Hz (Intermittent)		006275017G019 006275017G020 006275017G033 006275017G034
3	Current Trip Coil 3 Amp., 60 Hz		006174599G002
1	Capacitor Trip Coil 230 V-ac, 60 Hz		006174599G006
1	Capacitor (230 V-ac, 60 Hz)		0456A0864P134

\*\* Refer to nameplate or summary for proper voltage and current rating.

# Used also on certain 150 MVA breakers with high current closing coil.

## Dash 4, 4S & some 7S used 006174582G014.

## RECOMMENDED RENEWAL PARTS FOR MAGNE-BLAST BREAKERS

TYPE AM-4.16-150/150A-4 (Δ), -7 (Δ), -8 (Δ)

AM-4.16-250/250A-4 (Δ), -7 (Δ), -8 (Δ)

(Δ SUFFIX LETTERS S, &amp; R)

Fig. No.	Ref. No.	MVA Rating	Amperè Rating	Catalog Number for Type AM-4.16-(MVA)-			No. Req'd.	Description
				-4 & -4S	-7S	-8S		
6	21	All	All	0281B0708G002	0281B0708G002	0281B0708G002	3	Operating Rod Assembly
22	7	All	All	0236C0791G001	0236C0791G001	0236C0791G001	3	Flexible Connection (Right)
22	7	All	All	0236C0791G004	0236C0791G004	0236C0791G004	3	Flexible Connection (Left)
22	12	All	All	0414A0116P004	0414A0116P004	-	3	Insulating Plate
22	13	All	All	-	-	0195A7388G002	3	Throat Barrier Assembly
22	10	All	All	0236C0790G009	0236C0790G009	0236C0790G009	3	Arcing Contact Assembly
23	2	150	600/1200	0414A0180P001	-	-	12	Primary Contact Finger Spring
		150	600/1200	-	0414A0180P001	0414A0180P001	18	
		250	1200	0121A5964P001	-	-	12	
		250	1200	-	0121A5964P001	0121A5964P001	18	
		All	2000	-	0121A5964P001	0121A5964P001	18	
		All	2000	006509787P001	-	-	24	
23	3	All	600/1200	0236C0791P008	-	-	12	Primary Contact Finger
		All	2000	0236C0791P008	-	-	24	
		All	All	-	0114C5382P002	0114C5382P002	18	
23	10	All	600/1200	0137A9164P003	-	-	3	Movable Primary Contact
		All	600/1200	0137A9164P004	-	-	3	
		All	2000	0137A9164P003	-	-	6	
		All	2000	0137A9164P004	-	-	6	
		All	All	-	0114C5382P004	0114C5382P004	6	
23	14	All	All	0802B0742G001	0802B0742G001	0227A5506G004	3	Movable Arcing Contact
23	13	All	600/1200	0213X0343G043	0213X0343G043	0213X0343G090	3	Tube And Piston Assembly
		All	2000	0213X0343G044	0213X0343G044	0213X0343G091	3	
19	7	All	All	0414A0117P001	-	-	6	Throat Insulation
		All	All	-	0108B1965G001	0195A7377G001	3	Throat Insulation (Right)
		All	All	-	0108B1965G002	0195A7377G002	3	Throat Insulation (Left)
19	8	All	All	0383A0932P001	0161A5906P001	0161A5906P001	6	Lower Runner Shield
19	12	250	All	0258C0616P006	0114C5381P001	0114C5381P010	6	Lower Insulation Barrier
19	12	150	All	0258C0616P013	0114C5381P001	0114C5381P010	6	Lower Insulation Barrier
20	3	All	All	0414A0116P002	0114C5381P004	0414A0116P002	3	Insulating Plate
18	11	All	All	000421711P001	000421711P001	000421711P001	6	Insulating Cap
18	11	All	All	000407193P001	000407193P001	000407193P001	6	Threaded Washer (For Ins. Cap)
*		All	All	0258C0616P009	0836C0197P014	0836C0197P014	6	Upper Runner Insulation

\* Not Illustrated





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**ABB Inc.**

Electrification Services  
305 Gregson Dr.  
Cary, NC 27511 USA

For further information, please visit:  
**[www.electrification.us.abb.com/services](http://www.electrification.us.abb.com/services)**

For service, call:  
1-888-434-7378 (US)  
1-540-387-8617 (International)

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