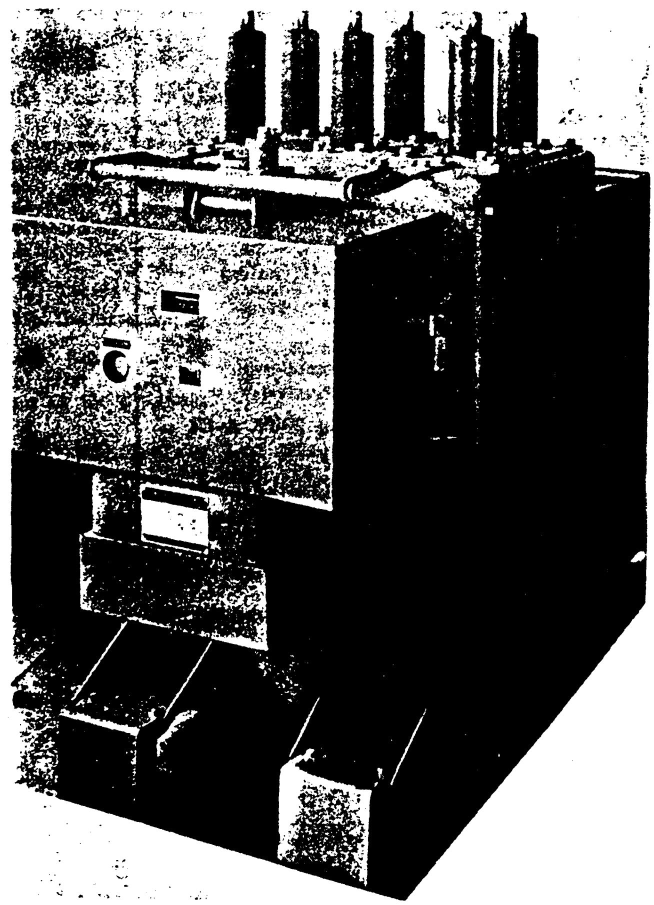
INSTRUCTIONS



# MAGNE-BLAST CIRCUIT BREAKER

## Types

AM-13.8-150-3
AM-13.8-150A-3
AM-13.8-250-3
AM-13.8-250A-3
AM-13.8-500-3
AM-13.8-500A-3
AM-13.8-500B-3
AM-13.8-500AB-3
With MS-13 Mechanism



## CONTENTS



MEDIUM VOLTAGE SWITCHGEAR DEPARTMENT
GENERAL ELECTRIC
PHILADELPHIA, PA.

## PARTS RECOMMENDED FOR NORMAL MAINTENANCE

In the tabulation below are listed the parts of those breakers which are usually recommended for stock for normal maintenance. Further information on renewal parts may be obtained from the nearest General Electric Sales Office.

| DESCRIPTION | NO. PER BKR. 1200A. EXCEPT 500B & 500AB | NO. PER BKR. ALL 2000A. & 1200A. 500B & 500AB | CAT. NO. |
|---|---|---|---|
| Booster Cylinder | 3 | 3 | 263B292 P-2 |
| Primary Contact Finger | 12 | 24 | 236C791 P-8 |
| Movable Arcing Contact | 3 | 3 | M-6496488 P-3 |
| Stationary Arcing Contact Asm. | 3 | 3 | 236C790 G-5 |
| Primary Contact Mov. | 3 | 6 | 6591644 P-7 |
| Primary Contact Mov. | 3 | 6 | 6591644 P-8 |
| Primary Contact Finger Spring | - | 24 | 6509787 P-1 |
| Primary Contact Finger Spring | 12 | - | 414A180 |
| Buffer | 3 | 3 | V-6445087 |
| Clamp for Buffer | - | 6 | K-6557243 P-2 |
| Clamp for Buffer | 6 | - | K-6557243 P-1 |
| Lower Barrier 500 MVA | 6 | 6 | 265C161 P-3 |
| Lower Barrier 150 - 250 MVA | 6 | 6 | 265C161 P-4 |
| Insulating Plate | 3 | 3 | 414A116 P-4 |
| Lower Runner Insulation (Mycalex) | 6 | 6 | 421A201 P-1 |
| Insulation Plate | 3 | 3 | 414A116 P-2 |
| Mycalex Insulation | 6 | 6 | 414A194 P-1 |
| Operating Rod | 3 | 3 | 281B708 G-1 |
| Flex. Conn. | 6 | 6 | 236C791 G-4 |
| Closing Coil (125V. D-C - 230V. A-C) | 1 | 1 | 6375522 G-2 |
| Closing Coil (250V. D-C) | 1 | 1 | 6375522 G-1 |
| Potential Trip Coil (125V. D-C) | 1 | 1 | K-6174582 G-1 |
| Potential Trip Coil (250V. D-C) | 1 | 1 | K-6174582 G-2 |
| Potential Trip Coil (230V. A-C) | 1 | 1 | K-6174582 G-14 |

Fig. A

Any other parts may be ordered by description of part, including complete nameplate data of the breaker or of the mechanism, until such time when more complete parts identification is published.

# MAGNE-BLAST CIRCUIT BREAKER TYPE AM-13.8-3 WITH MS-13 MECHANISM

## INTRODUCTION

The magne-blast circuit breaker is the removable interrupting element for use in vertical-lift metal-clad switchgear, to provide reliable control and protection of power systems. Among the many advantages of metal-clad switchgear are added protection to equipment and personnel, compactness, simplified installation and reduced maintenance. In keeping with these features the magne-blast breakers are designed for interchangeability and maneuverability, together with reliability and low maintenance requirements.

The magne-blast circuit breaker operates on the principle that an arc can be interrupted in air by sufficiently elongating and cooling it. This is accomplished by means of a strong magnetic field that lengthens the arc and forces it into intimate contact with cool dielectric material. A sturdy, reliable operating mechanism assures low maintenance and long life, and the use of Self-X insulation reduces fire hazards to a minimum.

The AM-13.8 magne-blast breaker is available in a number of current ratings. Refer to the breaker nameplate for the complete rating information of any particular breaker. The short circuit conditions to be imposed on the breaker must not exceed its rating, nor should it be called upon to operate at voltages or currents greater than those given on the nameplate. Since this book is written to cover several ratings of breakers that are of the same general design, all 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 the magne-blast breaker in service and for maintaining satisfactory operation.

## RECEIVING, HANDLING AND STORAGE

### RECEIVING AND HANDLING

Each breaker is carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment. 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. A nail puller should be used to open the crates, and care should be exercised to prevent tools from striking either the crate or any part of the breaker. Loose parts associated with the breaker are always included in the same crate. 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 absorbtion 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.

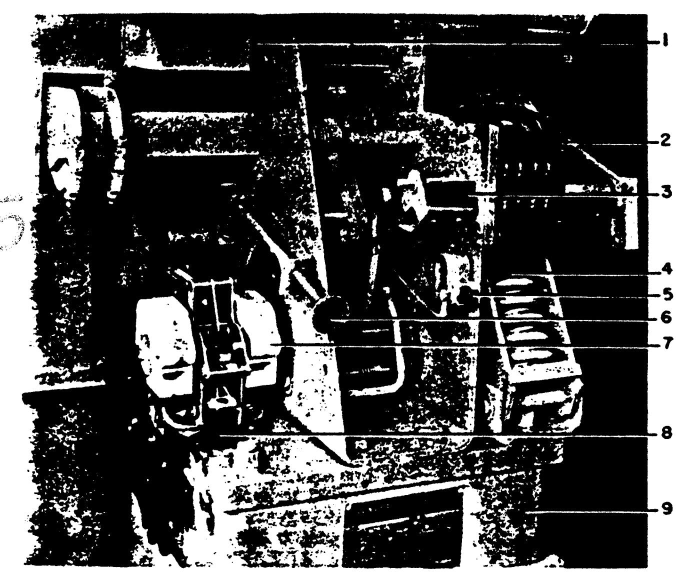
3. Machined parts of the operating mechanism, etc., should be coated with a heavy oil or grease to prevent rusting.

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, steps should be taken to dry out the breaker before it is placed in service.

## DESCRIPTION

The magne-blast breaker is composed of two major parts, the breaker element and the operating mechanism. The breaker element comprises three similar pole units, each pole unit consisting of main and arcing contacts, an interrupter, and an enclosing box barrier that segregates the interrupting units from each other to provide insulation between phases as well as from each phase to ground. The primary connections to the associated metal-clad equipment are made through the primary disconnect studs.

The MS-13 operating mechanism shown in Fig. 1 is of the solenoid type designed to give high speed closing and opening. The closing operation is controlled by the control device (7). The control device also permits trip-free operation (tripping the breaker at any time during the closing operation) and prevents solenoid pumping (reclosing) after a trip-free operation. The breaker can be opened electrically, by remote control, or manually, by means of the manual trip device (6). All secondary connections from the breaker to the metal-clad unit are made through the coupler (1).




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

Fig. 1 MS-13 Operating Mechanism

*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.*

A positive interlock and interlock switch are provided between the breaker and metal-clad unit to prevent the raising or lowering of the breaker in the unit while in the closed position and to prevent a closing operation when the breaker is not in either the fully raised or lowered position. A plunger type interlock can also be provided to prevent the closing of two adjacent breakers at the same time or to operate an additional auxiliary switch mounted in the metal-clad unit.

# INSTALLATION

The following instructions explain the necessary steps to be taken before the breaker is placed in the metal-clad unit. This includes a complete check of all of the breaker adjustments, in addition to a thorough inspecion. For final installation instructions refer to the metal-clad switchgear instruction book. Reference should also be made to the connection diagram that is furnished with each unit.

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.

## ADJUSTMENTS

Although the breaker has been completely adjusted and tested at the factory, it is possible that unusually rough handling during transportation may have caused some loosening or disturbance of parts of the apparatus. It is therefore advisable to review all adjustments before placing the breaker in service, making readjustments wherever necessary.


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

Fig. 2 Method of Mounting Maintenance Operating Device

A maintenance operating device is provided for operation of the breaker during these adjustment checks. Mount the device as shown in Fig. 2, 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.

All adjustments should be checked not only during the initial installation of the breaker but also 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. First, however, remove the breaker from the metal-clad unit and remove the box barrier and the mechanism cover.

1. Stationary Primary Contacts
2. Movable Primary Contacts
3. Buffer Block
4. Stationary Arcing Contacts
5. Movable Arcing Contacts
6. Upper Arc Runner

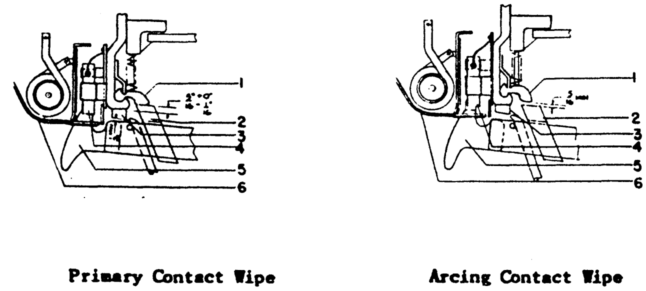



Fig. 3 Contact Adjustments

## PRIMARY CONTACT WIPE

When the breaker is closed, as shown in Fig. 3, the stationary primary contacts (1) should rise 5/16" + 0-1/16". To obtain this adjustment, open the breaker and, referring to Fig. 4, 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 (7) and the buffer block should be 1/16" or greater (as shown in Fig. 3) when the breaker is fully closed.

## ARCING CONTACT WIPE

Refer to Fig. 3. 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 usually an indication that the arcing contacts need to be replaced. When making this check, also see that the movable arcing contact (5) passes through the slot in the upper arc runner (6) without touching.

## PRIMARY CONTACT GAP

Refer to Fig. 4. 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 (6) should be 5-7/16" + 1/8" - 5/16". To change this gap, loosen the check nut (25), Fig. 5, 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 remeasure the contact gap (close and trip the breaker before checking the measurement).

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

Fig. 4 Adjustable Coupling for Making Primary Contact Wipe Adjustment

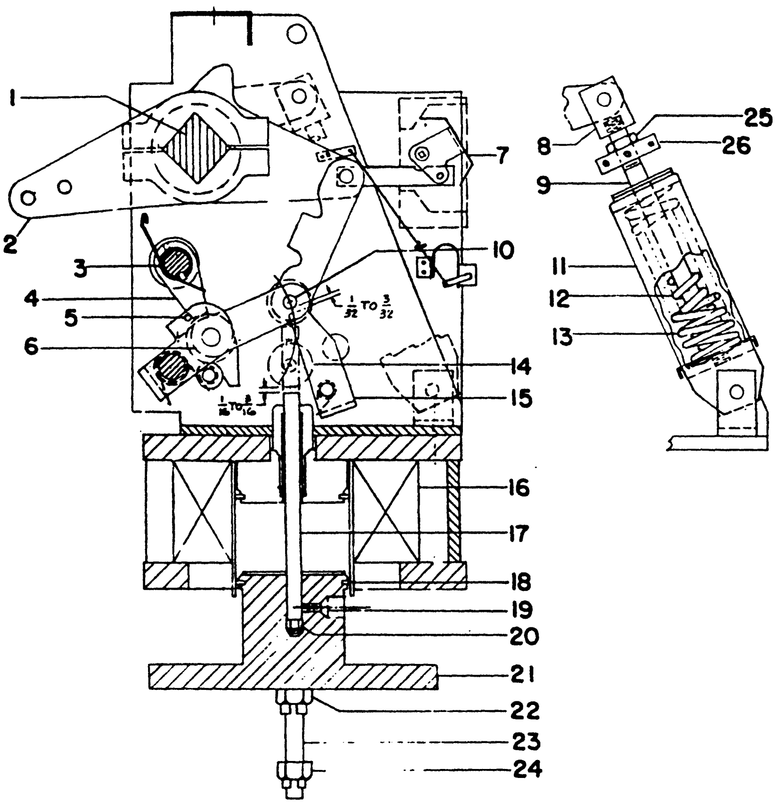
## TRIP LATCH WIPE

Refer to Fig. 5. 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 (4), 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).

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

## PROP CLEARANCE

Refer to Fig. 5. With the breaker closed as far as possible with the maintenance device, the clearance between the



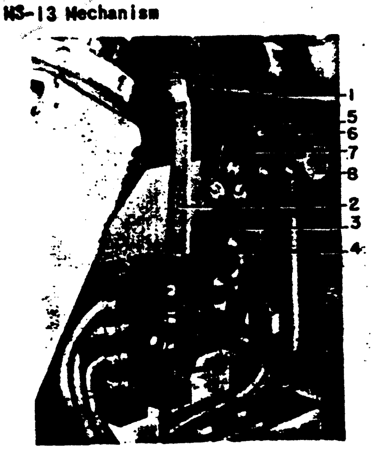

1. Main Oper. Shaft
2. Main Crank
3. Trip Shaft
4. Trip Latch
5. Trip Latch Stop
6. Trip Roller
7. Position Indicator
8. Clevis
9. Adjustable Stud
10. Closing Pin
11. Opening Spring Housing
12. Opening Spring, Inner
13. Opening Spring, Outer
14. Closing Roller
15. Prop
16. Closing Coil
17. Closing Plunger
18. Piston Ring
19. Set Screw
20. Shims
21. Closing Armature
22. Stop Nuts
23. Armature Guide Bolts
24. Stop Nuts
25. Check Nut
26. Adjusting Nut

Fig. 5 Cross Section of MS-13 Mechanism

closing pin (10) and the prop (15) should be 1/32" to 3/32". Measure the prop clearance with a feeler gage 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 subract 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. To remount the armature on the breaker, compress the piston ring (18). After reassembly, remount the maintenance closing device and check the adjustment.

CLOSING PLUNGER CLEARANCE

Refer to Fig. 5. With the breaker in the open position, the clearance between the closing plunger (17) and the closing roller



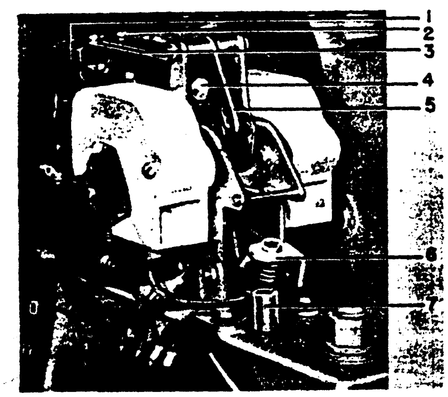
1. Interlock Shaft
2. Interlock Switch Arm
3. Roller
4. Interlock Switch
5. Latch Checking Switch Arm
6. Roller
7. Latch Checking Switch
8. Trip Shaft

Fig. 6 Interlock Switch and Latch Checking Switch

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

INTERLOCK SWITCH WIPE

Referring to Fig. 6, rotate the interlock shaft (1) manually clockwise to release the interlock switch arm (2). 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 (4), bend the interlock switch arm (2). The roller and crank on the interlock switch (4) should have 1/32 to 1/16 overtravel after final adjustment.



1. Back Auxiliary Switch
2. Mounting Screw
3. Top Auxiliary Switch
4. Plunger
5. Operating Arm
6. Trip Lever
7. Plunger Guide

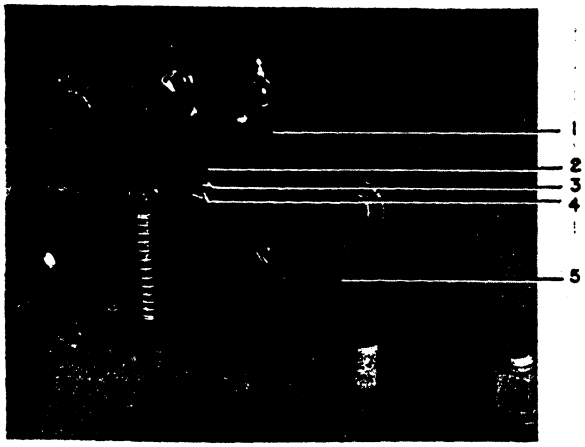
Fig. 7 Control Device

CONTROL DEVICE ADJUSTMENT

Referring to Fig. 7, measure the overtravel of the two auxiliary switch plungers. Manually operate the control device by pressing the operating arm (5) the full extent of travel to the rear. With the device in this position further depress the plunger (4) on the top auxiliary switch (3). The gap between the plunger and operating arm should be 1/32" or greater. To increase the overtravel, loosen the screws (2) 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 (1).

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.




1. Cut-off Switch
2. Switch Plunger
3. Adjustment Screw
4. Washers
5. Lever Arm

Fig. 8 Cut-off Switch Adjustments

CUT-OFF SWITCH ADJUSTMENTS
(13.8-150A-3, 250A-3, 500A-3)

Refer to Fig. 8. The operating 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 Wipe

Referring to Fig. 6, rotate the trip shaft (8) manually clockwise to release the latch checking switch arm (5). 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 latch checking switch (7), bend the latch checking switch arm (5). The roller and crank on the latch checking switch (7) should have 1/32 to 1/16 overtravel after final adjustment.

Impact Trip, Current Trip, Capacitor Trip, and Undervoltage Trip Devices

Fig. 9 shows the necessary settings that are to be checked when these devices are furnished. 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 Fig. 9. With the breaker in the open position, the vertical distance "A" from the top of the interlock bolt (2) to the bottom of the elevating bar (13) should be 10-7/32" ± 1/16". To change this adjustment, add or remove washers (3).

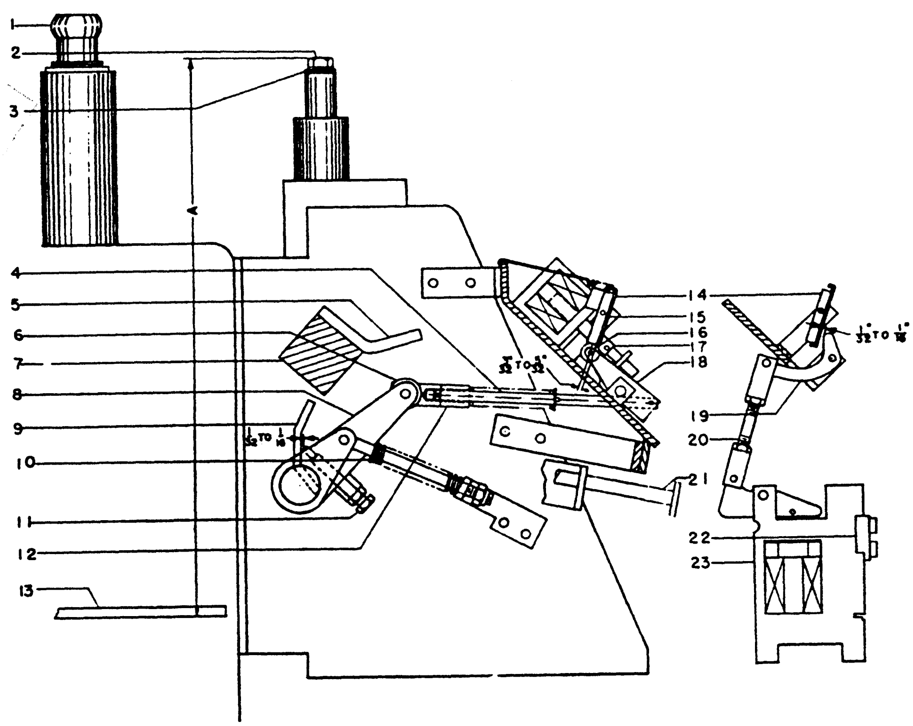
AUXILIARY SWITCH LINKAGE
(FURNISHED SPECIAL ON 13.8-150A, 250A, 500A)

Refer to Fig. 10. With the breaker in the closed position, the distance from the centerline of the front bushing (1) to the center of the switch operating pin (3) should be 13-7/32" as shown. To change this setting, loosen the locking nut (6), remove the pin (4) and turn the clevis (5). Reassemble and check adjustments.

Auxiliary Switch

The auxiliary switch is mounted on the right side of the operating mechanism (2), Fig. 1. The shaft of the position indicator operates the auxiliary switch shaft which opens and closes the "a" and "b" contacts. (The "a" contacts are open when the breaker is open and the "b" contacts are open when the breaker is closed). The "a" contacts should close when the breaker primary contacts are 1" apart. The "b" contacts need only to be checked to see that they are open when the breaker is closed.

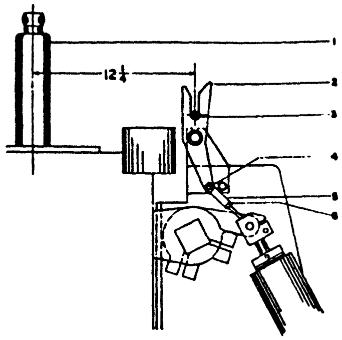
Fig. 8 (8021970)




1. Front Disconnect Stud
2. Interlock Bolt
3. Washers
4. Connecting Rod
5. Reset Plate
6. Reset Roller
7. Main Operating Shaft
8. Reset Arm
9. Trip Plate
10. Spring
11. Trip Bolt
12. Clevis
13. Elevating Bar
14. Impact Trip Plate
15. Trip Latch
16. Trip Roller
17. Trip Armature
18. Trip Lever
19. Undervoltage Trip Hammer
20. Adjusting Rod
21. Manual Trip Button
22. Trip Setting Plate
23. Undervoltage Device

Fig. 9 Adjustments On Current Trip Device And Undervoltage Trip Device, Shown With The Breaker In The Closed Position

Fig. 9 (T-6185078)




1. Front Bushing
2. Fork Lever
3. Operating Pin
4. Pin
5. Clevis
6. Check Nut

Fig. 10 Auxiliary Switch Linkage Shown With The Breaker In The Closed Position

FINAL INSPECTION AND TEST

1. For ease in reviewing the adjustments, the following are recapitulated:

   a. Primary contact wipe: 5/16" + 0 - 1/16".

   b. Arcing contact wipe: 5/16" or greater (gap at primary contacts).

   c. Primary contact gap: 5-7/16" + 1/18" - 5/16".

   d. Trip latch wipe: 3/16" to 1/4" with trip latch resting against stop pin.

   e. Prop clearance: 1/16" ± 1/32".

   f. Closing plunger clearance: 1/16" to 3/16".

   g. Interlock switch wipe: 1/32" to 1/16" overtravel.

   h. Control device switch overtravel: 1/32" min.

   i. Cut-off switch overtravel: 1/32" - 1/16" (150A, 250A, 500A).

   j. Latch checking switch wipe: 1/32" to 1/16" overtravel.

   k. Impact trip roller wipe: 1/8" ± 1/32".

   l. Impact trip bolt clearance: 3/64" ± 1/64".

   m. Undervoltage trip hammer clearance: 3/64" ± 1/64".

   n. Plunger interlock: 10-7/32" ± 1/16".

   o. Auxiliary switch linkage: (150A, 250A, 500A) 13-7/32".

   p. Auxiliary switch "a" contacts close when breaker primary contact gap is 1" or greater.

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 during installation is repainted immediately.

HI-POTENTIAL TEST

If the breaker had been stored for a long period of time, it is recommended that the insulation be checked before the breaker is placed in service. A standard 60 cycle high potential test at 27,000 volts RMS will normally indicate whether the breaker is satisfactory for service. With the breaker contacts in the fully opened position, apply the high potential to each terminal of the breaker individually for one minute 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 replace insulation that may have been affected by moisture absorption. The high potential test is also recommended for breakers which have been removed from service and stored over an extended period of time under unfavorable atmospheric conditions.

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. If the auxiliary devices do not perform in accordance with these specifications, a careful examination should be made for defective parts.

CONTROL POWER CHECK

After the breaker has been closed and opened 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. For electrical operation of the breaker, the control power may be either an alternating or direct current source. The operating ranges for the closing and tripping voltages are given on the breaker nameplate. Ordinarily, standard ranges apply which 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: Where repetitive operation 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.

For a-c operation, two copper-oxide rectifiers, mounted elsewhere in the metal-clad unit, are used. A tapped resistor is provided in each rectifier circuit to control the d-c voltage. The resistor setting should be adjusted so that the closed circuit voltage at the breaker closing coil terminals is 110 to 120 volts d-c. Where repetitive operation is required, the voltage should be set at 105 to 115 volts d-c.

| * A-C Volts (Closed Circuit) | Resistor Setting, Ohms | |
|---|---|---|
| | Summer | Winter |
| 190-196 | 1/4 | 0 |
| 194-206 | 1/2 | 0 |
| 204-216 | 1/2 | 1/4 |
| 214-226 | 3/4 | 1/4 |
| 224-236 | 1 | 1/2 |
| 234-246 | 1-1/4 | 3/4 |
| 244-250 | 1-1/4 | 1 |

* A-c volts as measured across the rectifier and a-c series resistor.

The preceding tabulation is included as a guide for adjusting the resistors for the particular combination of ambient temperature and a-c supply voltage. Summer settings are used where ambient temperatures are normally above freezing (32°F). It is necessary to use winter settings where the ambient temperature may drop to 20°F or less at any time. For a more detailed explanation of copper-oxide rectifiers for circuit breaker application, refer to Instruction Book GEI-11306.

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

Close the breaker by manually operating the control device, Fig. 9. 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.

DO NOT MAINTAIN VOLTAGE ON THE CLOSING COIL ANY LONGER THAN THE FEW SECONDS REQUIRED TO READ THE VOLTMETER. These coils are designed for intermittent operation and will be damaged by prolonged current flow.

If the closed circuit voltage at the terminals of the closing coil does not fall in the specified range, proceed as follows:

1. A-c control power source - Decrease the series resistance to increase the d-c voltage, or increase the series resistance to decrease the d-c voltage. Recheck voltage at the closing coil.
2. D-c control power source - Check voltage at the source of power and line drop between the power source and the breaker.

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 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 (6), Fig. 1.

When all the foregoing inspection details have been checked, the breaker may be safely placed in service. Before the breaker is finally raised into position in the metal-clad unit, rub a small amount of G.E. Contact Lubricant D50H28 on the silvered portion of the breaker studs to form a thin coating for contacting purposes.

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.

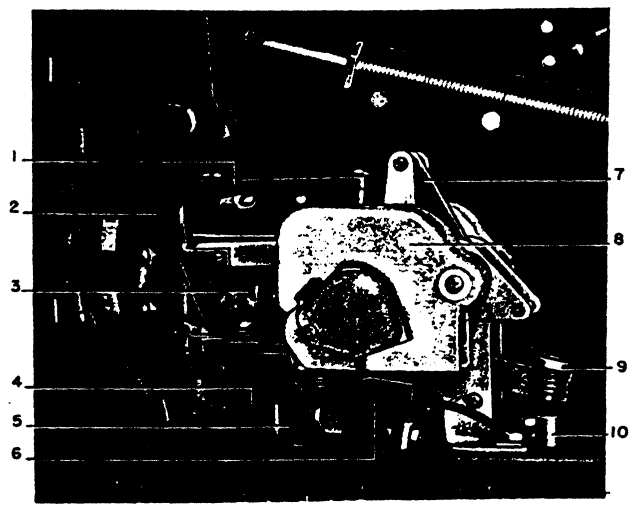
# OPERATION

## CLOSING OPERATION

The closing operation of the breaker is primarily controlled by the control device, Fig. 11, mounted on the operating mechanism. 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 pickup coil of the control device. As the control device closes, seal-in contacts shunt the closing control switch to allow the opening of the closing control switch contacts without affecting the overall closing operation. This type of arrangement assures complete closing of the breaker with only momentary contact of the closing control switch.

Operation of the control device energizes the breaker closing coil by closing the main control device contacts (5 and 6), Fig. 11. Once the control device contacts are picked up, they are electricaly held in the closed position until the breaker closing operation is completed. Energizing the breaker closing coil raises the armature (6), Fig. 12, 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. During the closing operation, the opening springs (9 and 10) are compressed in readiness for an opening operation. Air trapped above the armature acts as a dash pot to absorb the energy of the mechanism as it approaches the end of its stroke.

Slightly before the mechanism latches, the control device plunger (5), Fig. 22, 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 mechanically 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 through 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.




1. Shunting and Anti-pump Switch
2. Seal-in Switch
3. Operating Coil
4. Crank
5. Stationary Contact Assembly
6. Movable Contact Assembly
7. Arm
8. Arc Chute
9. Trip Lever
10. Plunger Guide

Fig. 11 Control Device

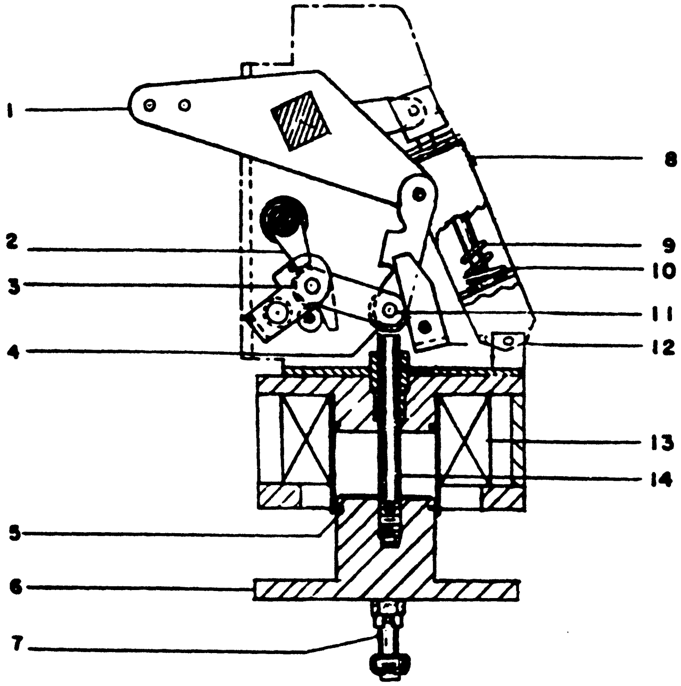
The operating sequence for those breakers designed for MI-6 metal-clad equipment is similar to that described above except that a relay mounted elsewhere in the metal-clad unit replaces the control device. Also, a cut-off switch (Fig. 8) is used to replace the mechanical trip arrangement of the control device. The cut-off switch energizes an auxiliary relay to de-energize the main relay.

The closing speed of the arcing contact should be 7 to 10 feet per second for the 150,250 MVA breakers and 9 to 13 feet per second for the 500 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 upper arc runner to the tangent position.

## OPENING OPERATION

An electrical opening operation is initiated by energizing the trip coil. This is accomplished either by actuating the opening control switch on the metal-clad unit or by a combination of relays and current devices used to detect a fault on the load side of the breaker. By energizing the trip coil, the trip plunger rotates the trip latch (2), Fig. 12, causing the operating mechanism linkage to collapse. The energy stored in the opening springs (9 and 10) is thus released, opening the breaker. 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.

As the breaker opens, the main contacts part first, shunting the current through the arcing contacts. An arc forms as the arcing contacts part (see Fig. 13). As the movable arcing contact (27) is with-




1. Main Crank
2. Trip Latch
3. Trip Roller
4. Closing Roller
5. Piston Ring
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

Fig. 12 Cross Section of MS-13 Operating Mechanism in the Open Position

drawn through the slot in the arc runner, the upper end of the arc is transferred to the upper arc runner (4). To assist the interruption at this point, a stream of air is emitted from the booster tube (28) and forces the arc onto the lower arc runner (10). Establishment of the arc on the runners automatically inserts the first blowout coil into the circuit, introducing a magnetic field between the pole pieces which tends to draw the arc away from the arcing contacts. The 150 and 250 MVA interrupter contains three upper magnetic blowout coils and one lower blowout coil each individually connected in series with its respective section of arc runner. The 500 MVA interrupter contains three upper blowout coils and three lower blowout coils each individually connected in series with its respective section of arc runner. As the arc is forced outward along the diverging arc runners, the magnetic field is progressively increased with the addition of each coil in the circuit.

At the same time, the arc is being forced into the arc chute (8) which is composed of a series of gradually interleaving insulating fins. These fins, which project alternately from the two opposite inner surfaces of the chute, elongate the arc into a gradually deepening serpentine path, so that the electrical resistance in the path of the arc is rapidly increased and the heat from the arc is absorbed. The increased resistance reduces both the magnitude and the phase angle of the current, and at an early current zero the arc path is so long and the gases produced by the arc so cooled that the arc cannot re-establish itself, and interruption occurs.

Manual tripping follows the same procedure except that instead of energizing the trip circuit, the manual trip (6), Fig. 1, is used.

The opening speed of the arcing contact should be 10 to 15 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 upper runner.

### TRIP-FREE OPERATION

If the trip coil circuit is energized while the breaker is closing, the trip plunger will force the trip latch (2). Fig. 12, 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, but the closing coil is de-energized at the end of the stroke, and the armature is returned to its original position by gravity.

## MAINTENANCE

Dependable service and safer power equipment are contingent upon the unfailing performance of the power circuit breaker. To maintain such service, it is recommended that a definite inspection and maintenance schedule be set up and followed, as serious shutdowns can often be avoided by locating potential sources of trouble in an early stage. A periodic lubrication of parts subject to wear is also vitally important for the successful operation of the breaker.

**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 periodic inspection should be determined by each operating company on the basis of the number of operations (including switching), the magnitude of currents interrupted, and any unusual operations which occur from time to time. Operating experience will soon establish a maintenance schedule which will give assurance of proper breaker condition. On installations where a combination of fault duty and repetitive operation is encountered, an inspection is recommended after any severe fault operation. The following instructions list the main points to be included in an inspection, and a number of general recommendations.

### ARC CHUTES

It is not necessary to inspect the arc chutes unless there is evidence of damage or if the arc chutes are removed for any reason. When inspecting an arc chute, it should be disassembled and the following points noted:

1. Scale formed over the surface of the arc chute must not be removed, but loose particles collected in the chute should be blown out.
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 of the chute will be necessary.

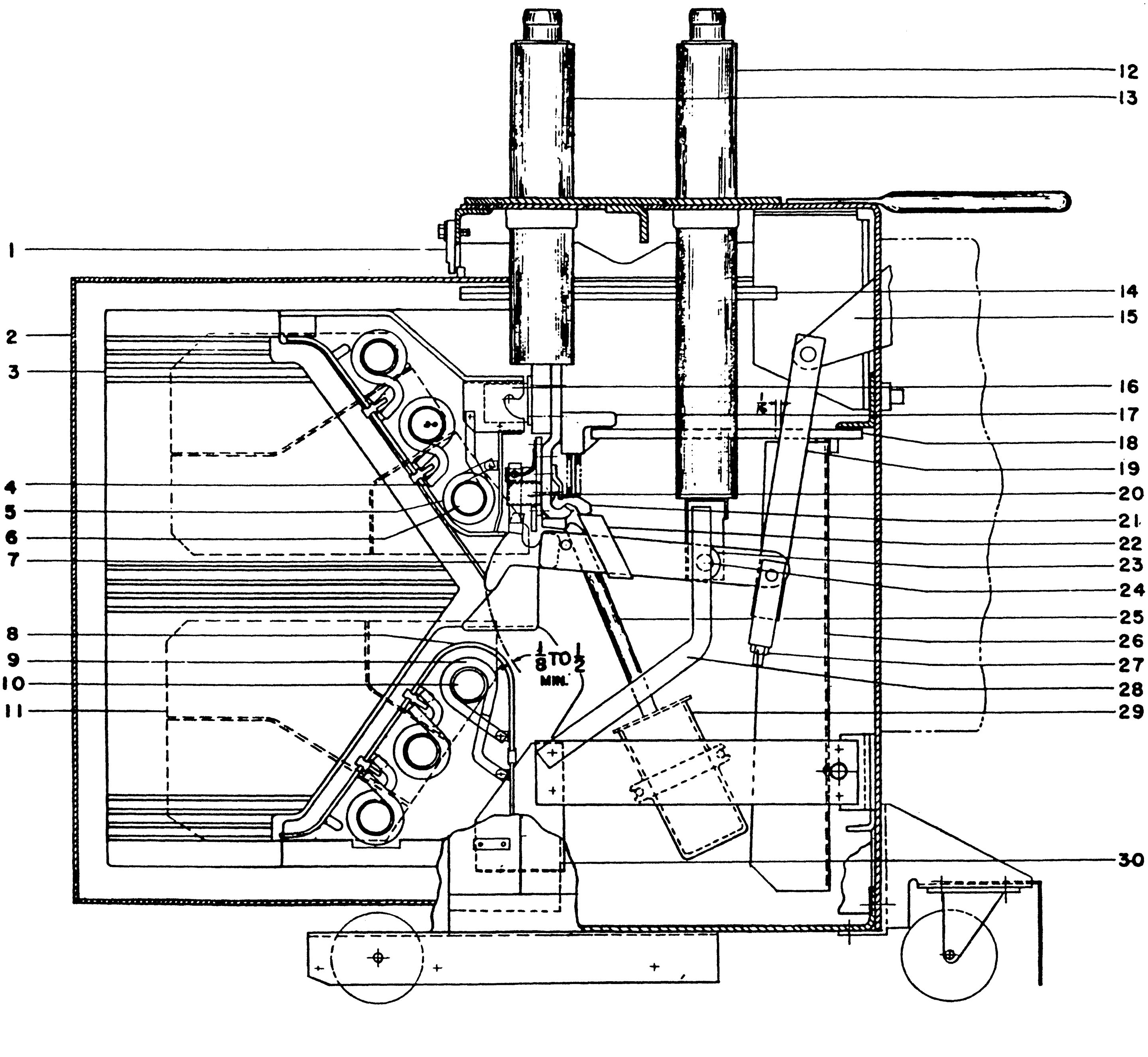
### BREAKER CONTACTS

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 arc chute assembly, as explained under REPAIR AND REPLACEMENT. If the contacts are burned or pitted, they should be made smooth with a fine file.

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

### MECHANISM

A careful inspection should be made to check for loose nuts or bolts and broken retaining rings. All cam, roller, and




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

Fig. 13 Cross Section of Breaker Pole Unit 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 INSTALLATION, ADJUSTMENTS. Check all terminal connections.

BUSHINGS AND INSULATION

The surface of the Self-X 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 (GE-1170) or clear Glyptal* resin (GE-1202). 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 to insure dryness.

LUBRICATION

In order to maintain reliable operation, it is important that all circuit breakers be properly lubricated at all times. During assembly at the factory, all bearing surfaces, machined surfaces, and all other parts of the breaker and mechanism subject to wear have been properly lubricated using the finest grade of lubricants available. However, even the finest oils and greases have a tendency to oxidize with age, as evidenced 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. Until such a schedule is worked out, the breaker should be lubricated at each periodic inspection and also whenever it is overhauled, in accordance with the lubrication chart, Fig. 14. It is also recommended that all circuit breakers be operated at regular intervals to insure the user that the equipment is operating freely.

The lubrication chart 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, but should be used only in case of a general overhaul or disassembly for other reasons, or if the operation of the breaker becomes slower.

General Electric Lubricants D50H15 and D50H28 are available in 1/4# collapsible tubes. It is so packaged to insure cleanliness and to prevent oxidation.

METHOD OF CLEANING BEARINGS

Wherever cleaning is required, as indicated in the lubrication chart, the following procedures are recommended:

| Part | Lubrication at Maintenance Period | Alternative Lubrication (Requires Disassembly) |
|---|---|---|
| Ground surfaces such as cams, rollers, latches, etc. | Wipe clean and apply D50H15. | Wipe clean and apply D50H15. |
| Sleeve Bearings (Mechanism and Breaker Linkage) | Very light application of light machine oil SAE-20 or -30. | Remove pins and links and clean as per cleaning instructions below. Apply D50H15 liberally. |
| Removable Seal and Open Type Ball, Roller and Needle Bearings | Light application of light machine oil SAE-20 or -30. | Clean as per cleaning instructions below and repack with D50H15. |
| Silver Plated Contacts and Primary Disconnect Studs | Wipe clean and apply D50H28. | Wipe clean and apply D50H28. |
| CONTACT ARM HINGE ASSEMBLY | | |
| 1. Cup Bearing | No lubrication required. | Wipe clean and apply D50H15. |
| 2. Loose rings between bushing and contact arm. | No lubrication required. | Replace rings showing evidence of excessive wear. |
| Booster Cylinders | No lubrication required. | No lubrication required. |

Fig. 14 Lubrication Chart

Sleeve Bearings

The pins should be removed and all old oxidized grease removed by immersion in clean petroleum solvent or similar cleaner. DO NOT USE CARBON TETRACHLORIDE. Wipe the bearing clean. Apply a small amount of G.E. Lubricant D50H15 to the entire surface of the bearing and pin just before reassembling.

Removable Seal and Open Type Ball, Roller and Needle Bearings

The bearings should be first removed from the mechanism and disassembled by the removal of the seals or inner race in the case of needle bearings. 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 inducive 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 removable seals should then be replaced.

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 anit-freeze should be used. Even then the bearings should be removed from the alcohol within twenty-four hours. Esso Anti-Freeze and Du Pont Zerone are satisfactory for this purpose. 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 light oil and draining should follow immediately, then apply the lubricant.

TROUBLE SHOOTING

Failure of a breaker to operate properly will generally fall within three general classes; failure to trip, failure to close or latch closed, and overheating. The following is a brief outline showing particular types of distress that might be encountered, together with suggestions for remedying the trouble:

FAILURE TO TRIP

1. Mechanism binding or sticking caused by lack of lubrication.
   REMEDY: Lubricate complete mechanism.
2. Mechanism binding or sticking caused by being out of adjustment.
   REMEDY: Check all mechanism adjustments, latches, stops, auxiliary devices, etc., in accordance with INSTALLATION, ADJUSTMENTS. Examine latch and roller surfaces for corrosion.
3. Damaged trip coil.
   REMEDY: Replace damaged coil.
4. Blown fuse in trip circuit.
   REMEDY: Replace blown fuse after determining cause of failure.
5. Faulty connections in trip circuit.
   REMEDY: Repair broken or loose wires and see that all binding screws are tight.

* Registered Trade-Mark of General Electric Company

6. Damaged or dirty contacts in trip circuit.
   REMEDY: Recondition or replace contacts.

FAILURE TO CLOSE OR LATCH CLOSED

1. Mechanism binding or sticking caused by lack of lubrication.
   REMEDY: Lubricate complete mechanism.
2. Mechanism binding or sticking caused by being out of adjustment.
   REMEDY: Check all mechanism adjustments, latches, stops, auxiliary devices, etc., in accordance with INSTALLATION, ADJUSTMENTS. Examine latch and roller surfaces for corrosion.
3. Control device sticking or not operating properly.
   REMEDY: Check and adjust control device, or replace.
4. Damaged or dirty contacts in control circuit, including control device.
   REMEDY: Recondition or replace contacts.
5. Damaged control device coil.
   REMEDY: Replace damaged coil.
6. Damaged closing coil.
   REMEDY: Replace damaged coil.
7. Defective cut-off switch, latch-checking switch, or interlock switch.
   REMEDY: Replace defective switch.
8. Blown fuse in closing circuit.
   REMEDY: Replace blown fuse after determining cause of failure.
9. Faulty connections in closing circuit.
   REMEDY: Repair broken or loose wires and see that all binding screws are tight.
10. Insufficient control voltage caused by excessive drop in leads.
    REMEDY: Install larger wires and improve electrical contact at connections.
11. Insufficient control voltage caused by poor regulation (a-c control).
    REMEDY: Install larger control transformer. Check rectifier to be sure it is delivering adequate d-c supply.

OVERHEATING

1. Poor condition of contacts due to lack of attention after severe duty or too frequent operation.
   REMEDY: Recondition or replace burned and pitted contacts. (Contacts should be reconditioned very carefully and only when absolutely necessary).
2. Contacts not properly aligned or adjusted.
   REMEDY: Check all adjustments in accordance with INSTALLATION, ADJUSTMENTS.
3. Breaker kept closed or open for too long a period.
   REMEDY: Operate breaker more often to wipe contacts clean. Replace contacts if necessary.
4. Overloading.
   REMEDY: Replace breaker with one of adequate rating for present or future load, or re-arrange circuits so as to remove excess load.
5. Primary connections of inadequate capacity.
   REMEDY: Increase size or number of conductors or remove excess current.
6. Loose connections or terminal connectors.
   REMEDY: Tighten.
7. Ambient temperature too high.
   REMEDY: Relocate in a cooler place, or arrange some means of cooling.

REPAIR AND REPLACEMENT

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 on parts of the breakers that are most subject to damage or wear.

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 remove an arc chute, first open the breaker and remove the box barrier (2), Fig. 13. Loosen the two upper supporting bolts (2), Fig. 15, and the one lower supporting bolt (9), Fig. 15, using a 3/4" wrench. By raising the complete arc chute assembly about 1/2" and sliding it toward the rear of the breaker, it can be removed. This operation may be accomplished with the aid of an arc chute remover and transporter (not shown).

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

1. Remove the assembly bolts (2, 7, 9, 10, 12, and 15), Fig. 16.
2. Remove the side brace (14), the rear brace (5), the upper pole pieces (3), and the lower pole pieces (4), Fig. 16.
3. To remove the upper mounting support (13), Fig. 16, remove the assembly bolts (1 & 11), Fig. 16, and the connection bolt (2), Fig. 18.
4. Remove the assembly bolts (18) to remove the lower brace (8), Fig. 16.
5. Remove the lower mounting support (16) by removing the assembly bolts (17), Fig. 16, and the connection nut (8), Fig. 18.
6. At this point, the fiber side shields (5), Fig. 18, and the upper arc runner assembly (3) can be removed.
7. Further disassembly of both the upper and low arc runner assemblies can be done by removing the various screws and 1/4" assembly bolts (not illustrated) as shown in Fig. 17.
8. The arc chute sides (6), Fig. 17, can be separated by removal of the assembly bolt (6), Fig. 16.

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

1. Equally space the fins of the arc chute sides before bolting together.
2. Check to insure that electrical connections to the blowout coils are tight.
3. When reassembling the arc runner assemblies, check that the spacers (1 and 10), Fig. 17, are correctly installed.
4. Before bolting the upper mounting support in place, make certain that the upper arc runner assembly is tight against the arc chute side so that the gap between the upper insulation (7), Fig. 17, and the arc chute side (6) is a minimum.
5. Make certain that the electrical connections (2 and 8), Fig. 18, are tight.

To reassemble the arc chute to the breaker, proceed as follows:

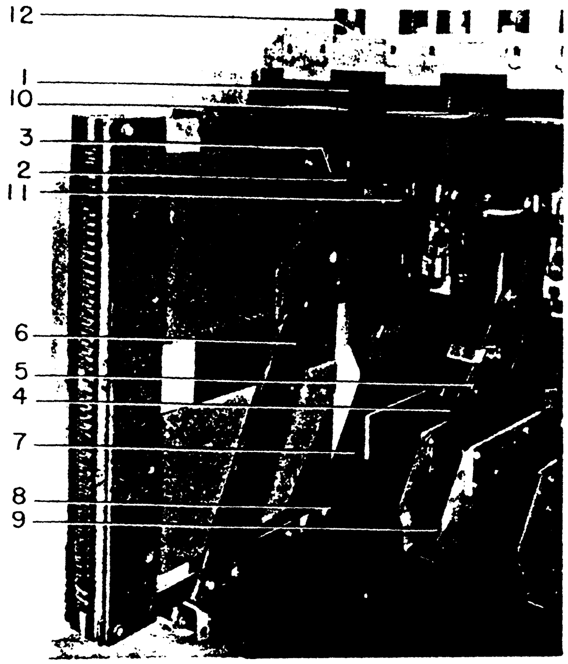
1. Rest the lower mounting support (8) on the arc chute mounting bracket (7) as shown in Fig. 15.
2. Slide the arc chute forward and lift it slightly to engage the supporting bolts (2), Fig. 15, in the slots of the upper mounting support (3).
3. Tighten the supporting bolts (2 and 9), Fig. 15. These bolts serve as both the electrical and mechanical connections between the bushing and the arc runners.
4. Check that the movable arcing contact (4), Fig. 15, passes through the slot in the upper arc runner (6) without touching.

CONTACTS

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

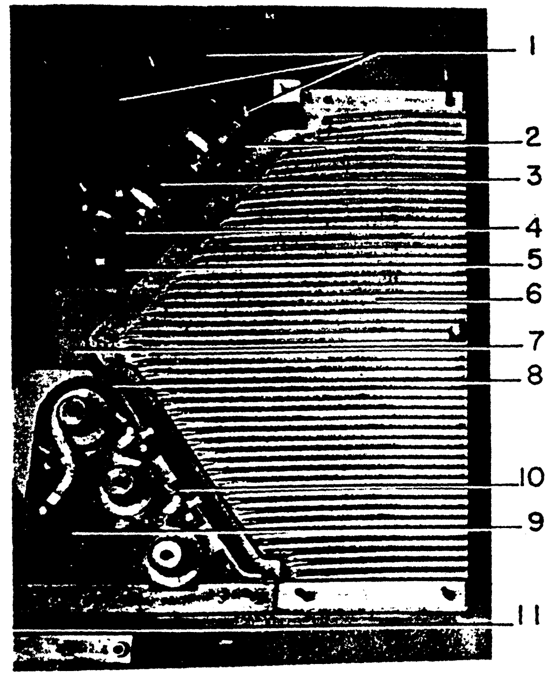
A. Stationary Arcing Contacts (10), Fig. 19

1. Disconnect the contact braids from contact fingers by removing two bolts (8), Fig. 19.
2. Grasp the lower end of the contact fingers with pliers and pull contact assembly downward to remove from stud assembly.



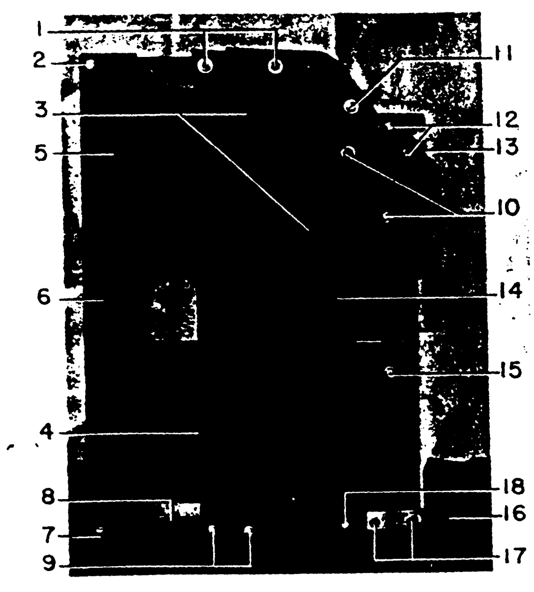
1. Rear Bushing
2. Supporting Bolt
3. Upper Mounting Support
4. Movable Arcing Contact
5. Assembly Bolts
6. Side Brace for Arc Chute
7. Arc Chute Mounting Bracket
8. Lower Mounting Support
9. Lower Supporting Bolt
10. Upper Horizontal Barrier
11. Lower Horizontal Barrier

Fig. 15 Removal of Arc Chute Assembly



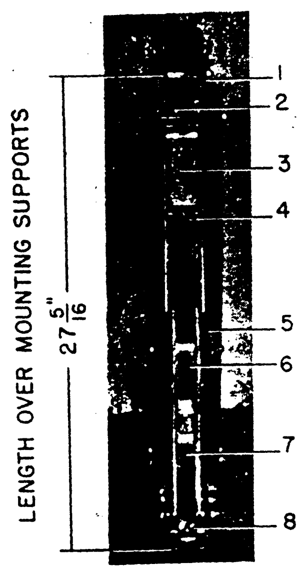
1. Upper Arc Runner Spacers
2. Upper Arc Runner Assembly
3. Blowout Core
4. Blowout Coil
5. Upper Arc Runner
6. Arc Chute Side
7. Upper Insulation
8. Lower Arc Runner
9. Lower Arc Runner Assembly
10. Lower Arc Runner Spacers
11. Lower Coil Connection

Fig. 17 Arc Chute Assembly with Sides Removed



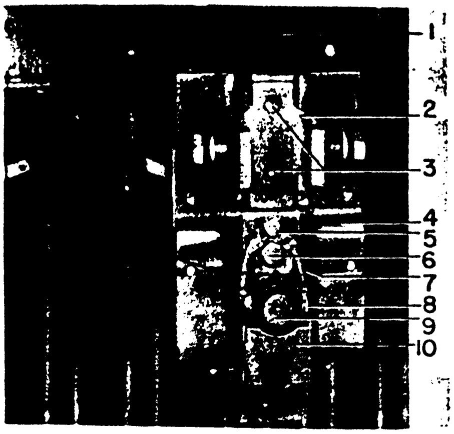
1. Assembly Bolts
2. Assembly Bolts
3. Upper Pole Pieces
4. Lower Pole Pieces
5. Rear Brace
6. Assembly Bolt
7. Assembly Bolt
8. Lower Brace
9. Assembly Bolts
10. Assembly Bolts
11. Assembly Bolts
12. Assembly Bolts
13. Upper Mounting Support
14. Side Brace
15. Assembly Bolts
16. Lower Mounting Support
17. Assembly Bolts
18. Assembly Bolts

Fig. 16 Arc Chute Assembly Complete



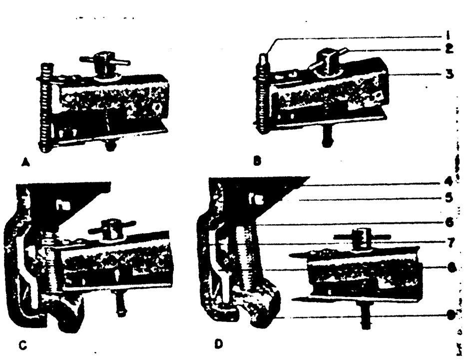

1. Upper Mounting Support
2. Connection Bolt
3. Upper Arc Runner Assembly
4. Upper Arc Runner
5. Side Shield
6. Lower Arc Runner Assembly
7. Lower Coil Connection
8. Connection Nut

Fig. 18 Front View - Arc Chute Assembly



1. Rear Bushing
2. Guide and Support for Arc Chute
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

Fig. 19 Rear Bushing Assembly



1. Spring Guide
2. Handle for Spring Compressor
3. Spring Compressor
4. Spring Retainer
5. Assembly Bolt for Spring Retainer
6. Spring
7. Contact Support
8. Stop Plate
9. Stationary Primary Contact Fingers

Fig. 20 Method of Installing Primary Contact Springs Using a Spring Compressor

3. To disassemble braids from stud assembly, remove one bolt (5).
4. To disassemble stud assembly from contact support, remove two bolts (6).
5. Reassemble in the reverse order.

B. Stationary Primary Contacts (9), Fig. 20

1. Compress the contact spring (6).
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. Place the finger (9) on contact support (7) so that it is retained by stop plate (8).
2. Open spring compressor (3) and assemble spring guide, spring and spring compression (Fig. 20A).
3. Turn handle (2) in clockwise direction to compress contact spring (Fig. 18B). Hold spring firmly in yoke on spring compressor to prevent the 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 cut-out in primary finger (Fig. 20C).
5. Hold spring assembly firmly in place and remove spring compressor.

C. Movable Arcing Contact (7), Fig. 21

1. Remove the assembly bolts (8).
2. Reassemble in reverse order.

D. Movable Primary Contacts (5), Fig. 21 (1200 Amp. Breaker)

1. Remove the nuts from assembly bolts (6).
2. Remove the primary contacts and spacers (not illustrated).
3. Reassemble in reverse order.

(2000 Amp. Breaker)

1. Remove the nuts from assembly bolts (6).
2. Remove the connection bar (9).
3. Remove the cup bearing (3).
4. Spread the contact arms (4) and remove the primary contacts (5).
5. Reassemble in the reverse order.

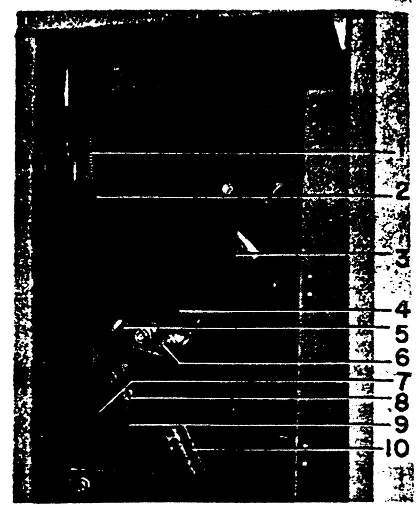
E. Contact Blade Assembly (4,5,7) Fig. 21

1. Remove the connection bar (9).
2. Remove the cup bearing (3) and the pin (2), Fig. 4.
3. When reassembling, first insert the piston assembly (10), Fig. 21, into the booster cylinder and reassemble the cup bearing (3).
4. Replace pin (2), Fig. 4, and connection bar (9), Fig. 21.

F. After disassembly and reassembly of any contacts, check all contact adjustments as described under INSTALLATION, 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 facilitate installation of the breaker in the metal-clad unit. 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.



1. Contact Springs
2. Stationary Primary Contacts
3. Cup Bearing
4. Contact Arm
5. Movable Primary Contacts
6. Assembly Bolts
7. Movable Arcing Contact
8. Assembly Bolts
9. Connection Bar
10. Piston Assembly

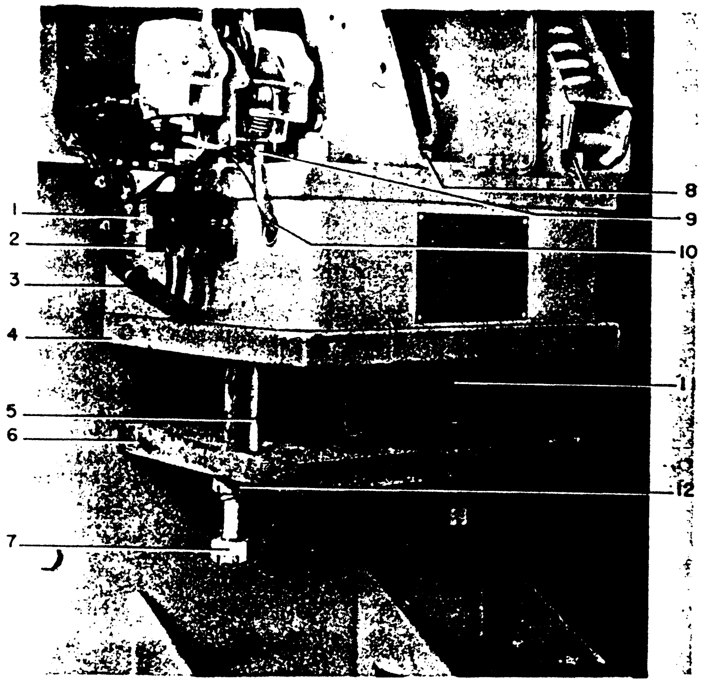
Fig. 21 Removal of Contacts

It is also 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 arc chutes are reinstalled.

To replace the bushing, proceed as follows:

Rear Bushing

1. Open the breaker and remove the box barrier and arc chutes as already described.
2. Remove the upper and lower horizontal barriers (10 and 11), Fig. 15.
3. Remove the four bolts (12) at the mounting flange of the rear bushing being removed and lower the bushing assembly.
4. Referring to Fig. 20, disassemble the primary contact springs (6) as previously described.
5. Disassemble the spring retainer (4) by removing mounting bolts (5).
6. Referring to Fig. 19, disassemble the contact support (4) and arc chute mounting bracket (2) by removing two bolts (3).
7. Reassemble in the reverse order. The arc chute mounting bracket (2) is not symmetrical and must be assembled correctly to orient the arc chute properly on the breaker. The longest projection of the bracket should be toward the lower end of the bushing.




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

Fig. 22 Closing Solenoid Assembly

Front Bushing

1. Open the breaker and remove the box barrier and arc chutes as already described.

2. Remove the upper and lower horizontal barriers (10 and 11), Fig. 15.

3. Remove the connection bar (9), Fig. 21, and cup bearing (3).

4. Remove the four bolts at the mounting flange of the front bushing being removed, and lower the bushing.

5. When reassembling, first mount the bushing and assemble the cup bearing (3) and contact arm (4), Fig. 21.

6. Check all contact adjustments as outlined under INSTALLATION, ADJUSTMENTS.

CLOSING COIL

The closing coil is contained within the solenoid pot (1), Fig. 22. To remove the closing coil, proceed as follows:

1. Open the breaker.

2. Remove the two closing coil leads (10). Remove the terminal board


1. Pivot Pin
2. Opening Spring Unit
3. Pivot Pin

Fig. 23 Opening Spring Assembly

(2) from the solenoid pot and let it hand by the wires. Also, remove the wire cleat band (3).

3. Remove the stop nuts (7 and 12) on guide studs (11), lower the armature plate (6) and control device trip plunger (5).

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 (8) at the top of the front studs. This permits the bottom plate, closing coil, solenoid pot (1) and control device plunger guide (9) to be removed.

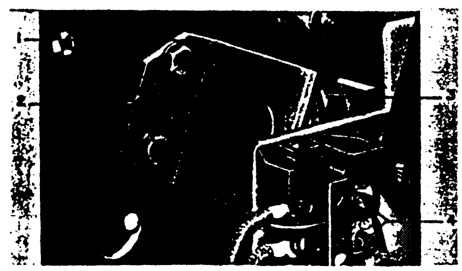
6. To reassemble, first place the closing coil and spacers on the bottom plate (4). Raise into position, inserting the control device plunger guide (9) and compressing the piston ring on the uppr pole piece.

7. Tilt the bottom plate downward and replace the solenoid pot (1) and two front studs and nuts (8).

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 (5) and armature (6).

10. Recheck the mechanism adjustments as explained under INSTALLATION, ADJUSTMENTS.



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

Fig. 24 Potential Trip Coil

TRIP COIL

To replace the potential trip coil (3), Fig. 24, proceed as follows:

1. Open the breaker and remove the opening spring unit (2), Fig. 23, by removing the pivot pins (1 and 3).

2. Disconnect the two trip coil lead wires (4), Fig. 24.

3. Remove the two mounting bolts (2) and the trip coil support (1).

4. Remove the trip coil (3).

5. After reassembling (in the reverse order) check the primary contact gap adjustment as explained under INSTALLATION, ADJUSTMENTS.

INTERLOCK SWITCH

To remove the interlock switch (4), Fig. 6, remove the two mounting screws and disconnect the lead wires. Reassemble in the reverse order and check the switch adjustments as explained under INSTALLATION, ADJUSTMENTS.

LATCH CHECKING SWITCH

To remove the latch checking switch (7), Fig. 6, (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 INSTALLATION, ADJUSTMENTS.

CUT-OFF SWITCH

To remove the cut-off switch (1), Fig. 8, remove the two mounting bolts and disconnect the lead wires. When reassembling, check the cut-off switch adjustment as explained under INSTALLATION, ADJUSTMENTS.

# RENEWAL PARTS

RECOMMENDATIONS

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. Refer to Fig. A for Parts Recommended for Normal Maintenance.

ORDERING INSTRUCTIONS

When ordering renewal parts, address the nearest General Electric Sales Office, specifying the quantity required, and describing each part by the catalog number obtained from the Renewal Parts Bulletin.

It is also suggested that complete identification of the breaker be furnished by supplying the information found on the breaker nameplate and, if possible, the number of the requisition on which the breaker was originally furnished.

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.

**GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.**

9-56