Instructions for De-Ion Air® Circuit Breakers

Types DM2R, DM2F

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Special Inquiries

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General Information

Introduction

The purpose of this instruction book is to familiarize the user with the characteristics of Types DM2F & DM2R air circuit breakers. The book contains important information concerning installation, operation and maintenance.

Types DM2F & DM2R breakers differ from conventional circuit breakers in that they trip at high speed on fault current in a specific direction. The user should become thoroughly familiar with the method of operation.

Application

The DM2F & DM2R pole breakers can be applied in high power circuits which require fault current limiting to prevent damage to the equipment they are servicing. They have successfully been tested on circuits having over 200 kA peak available and limited the fault current to 140 kA in less than 6 milliseconds.
Each pole unit is equipped with a closing solenoid which is designed for intermittent operation. The control circuit must be arranged to cut off the closing current immediately after the breaker is closed.

The breaker mechanism is provided with a holding coil type latch rather than a mechanical latch which would require time to disengage and accelerate. During the closing period, the holding current can be increased temporarily by the control relays as an added precaution against having the breaker open from mechanical shock.

The breaker can be equipped with twelve pole-actuated auxiliary contacts which do not impede the opening of the pole unit.

Additional features include a bucking bar-inductive shunt combination to trip the breaker on high rates of rise of current in the desired trip direction, such as normally occur on faults; and an overcurrent contact to energize an extra tripping winding on the holding coil spool to trip the breaker on abnormal overloads. The trip coil winding has a momentarily rating of approximately 15 amps.

The bucking-bar-inductive shunt combination consists of a small bucking-bar passing through the holding magnet and a laminated iron circuit around the lower stud to force additional current through the bucking-bar on high rates of rise. The current through the bucking-bar under normal conditions is small and has very little neutralizing affect on the holding coil magnetic circuit. Adjustments are made by changing the inductive shunt air gaps or the number of laminations in the iron circuit. Reducing the air gap will reduce the rate of rise required for tripping and increasing the air gap will increase the rate of rise required for tripping. The reverse is true regarding the number of laminations in the iron circuit.

The DM2F and DM2R are physically identical. The only difference between the two is the polarity application to the coils and bus for the desired trip direction.

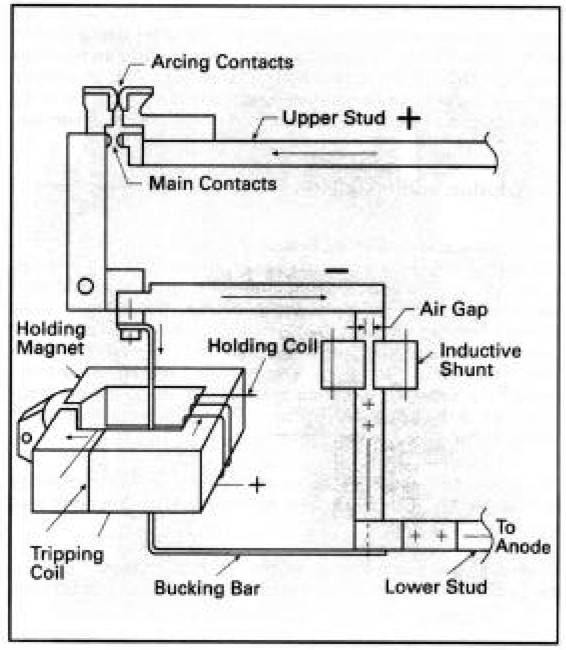


Fig. 1. *Breaker Operation with Bucking Bar*

The overcurrent contact is of the rocking beam type and mounts on the upper stud. The pick up current is adjustable within a range of plus or minus ten per cent of calibration.

The contact energizes a separate tripping winding on the holding coil spool to neutralize the holding coil magnetic circuit.

The breaker truck includes the breaker unit, a cranking mechanism, secondary contacts, a mechanical position indicator for the pole, a counter, and a mechanical interlock for cell positioning.

The breaker can also be furnished as a fixed pole unit.

Shipment and Storage

The pole units are completely assembled, inspected and tested at the factory before shipment.

Immediately after receiving, the shipment should be examined for any damage sustained after leaving the factory. If any damage is evident, or if indication of rough handling is visible, a claim for the damage should be filed with the carrier firm at once, and the factory notified immediately.

If the breaker is to be stored, it should be kept in a warm dry location, protected from water, oil, dirt, or other damage. The arc chambers must be kept covered to prevent foreign particles lodging between the ceramic arc plates. If the arc chambers have been stored under humid conditions, they must be dried by baking for 24 hours at 60°C. before being placed in service.

Description and Installation

Description and Operating Principles

For the following principles of operation, refer to Fig. 1 on page 1. Assume normal load current enters the upper stud and travels down through the pole and out through the lower stud. Current flowing through the bucking-bar in the normal direction sets up magnetic flux in the holding magnet in the direction indicated in the figure. The holding coil, which is energized by a separate direct current source, also sets up magnetic flux in the opposite direction. The holding coil flux is sufficient to hold the breaker closed.

The main terminals may be connected to opposite polarities to that shown. If they are, the holding coil connections also should be reversed.

Whenever the current through the breaker increases rapidly, the bucking-bar current increases to set up a flux through the holding magnet and armature which is opposite to the flux set up by the holding coil. As the bucking-bar current rises, the resultant flux through the armature will be reduced to a value that permits the armature to be pulled away by the spring load on the linkage, and the breaker will open.

As the breaker starts to open, the main contacts part first and cause the current to flow through the arcing contacts as shown on Fig. 2. The arcing contacts then part and an arc forms between them. The arc increases in length and rises until it impinges on the arc horns. The current then must flow through the coils of the blow-out magnet. Thus a strong magnetic field is produced between the side magnets on either side of the arc chamber. The arc, travelling through this strong magnetic field, is then forced upward into the slot of the ceramic plates of the arc chamber and is extinguished.

The general construction of the breaker is indicated in Fig. 3, which shows the moving contact arm in the position where the arcing contact tips are just touching. The closing linkage is comprised of three links which form two toggle systems. The first toggle is comprised of pin B, Fig. 3, and the links on either side. Although pin B does not go over center, the toggle cannot collapse as long as the armature, H, is held by the magnetic attraction of the holding magnet. However, if the bucking-bar current increases, or if the holding coil current is interrupted, the armature will be released and pin B will move upward which causes its toggle to collapse and the moving con-

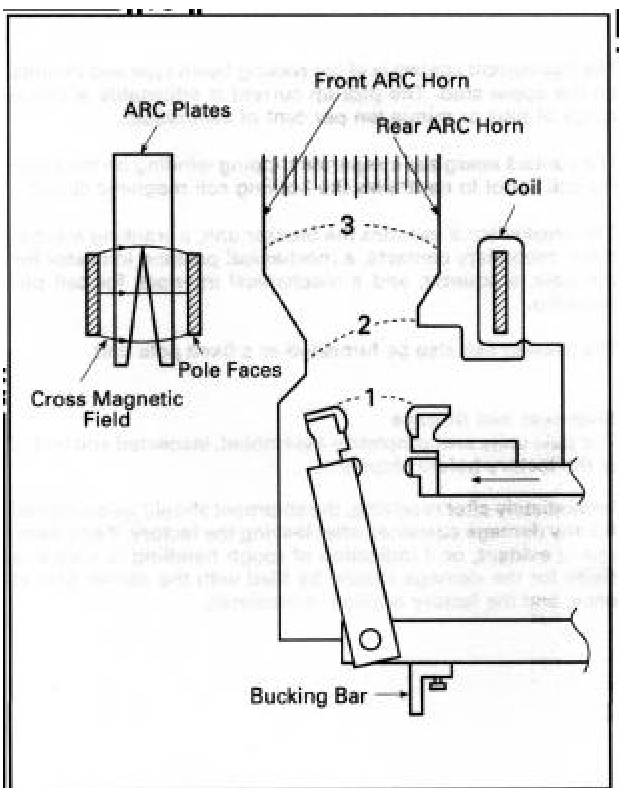


Fig. 2. *Schematic of Current Interruption*

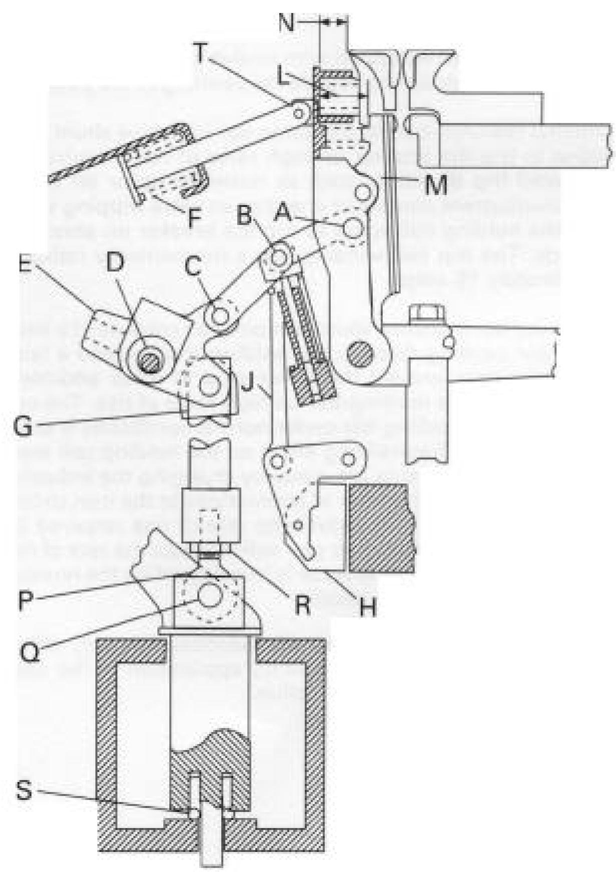


Fig. 3. *Schematic of Operating Mechanism*

tact arm will be pulled open by the spring F. Pin C remains nearly stationary until the contact arm is open, then it is moved upward by the retrieving spring, S, in the closing magnet.

The other toggle is comprised of pin C, Fig. 3, and the links on either side. In this toggle, pin C moves over center, but it is prevented from moving further by the compressive force present in the pull rod, G, when the closing solenoid plunger hits the bottom of the closing magnet. This toggle can be closed or opened manually by inserting a maintenance closing handle in the closing lever, E, and raising or lowering the handle. In order to close the breaker, the armature must be held by energizing the holding magnet coil or by means of the locking-bar illustrated in Fig. 4. If the armature is not held, the toggle nearest the moving contact arm will collapse and the breaker will open.

For either type of mounting, the pole units have been completely adjusted. No change of adjustment should be necessary and none should be made unless it is apparent that adjustments have been disturbed during shipment.

Installation
After the breaker has been uncrated, all dust and foreign particles should be wiped off with a dry cloth or vacuumed.

The polarity of the holding coil current and trip coil current should be checked carefully to insure proper tripping of the breaker. The effect of the trip coil current is always opposite that of the holding coil current. However, if the breaker is equipped with a bucking-bar-inductive shunt combination, the holding current polarity is determined by the desired tripping direction of current through the bucking-bar. (See Fig. 5.)

A preliminary check of the operation of the individual pole units should be made before installation. The holding armature should be held to the magnet surface by supplying the holding coil with 200 milliamperes. In case holding current is not available, a locking-bar for the armature may be used and is supplied with each order for breakers. Its use is shown in Fig. 5. The forcing screw of the locking-bar should hold the armature against the face of the holding magnet securely. If the armature tends to pull away from the holding magnet when the breaker is closed, then the forcing screw must be re-tightened. However, the breaker must always be in the open position when adjusting the forcing screw.

For closing tests, about 30 amperes at 125 V.D.C. should be supplied to the closing coil of each pole unit tested. The current must not be applied for more than a few seconds at a time since the closing coil is designed for intermittent duty only. The recommended control scheme provides for a momentary increase of the holding coil current to 400 milliamperes to insure positive closing.

Inspection and Maintenance

The frequency of inspection, cleaning and readjustment of contacts will depend on the duty to which the breaker is subjected and the cleanliness of the surroundings. Further inspections should be determined from accumulated operating experience for the particular installation, although inspection periods should not be longer than six months.

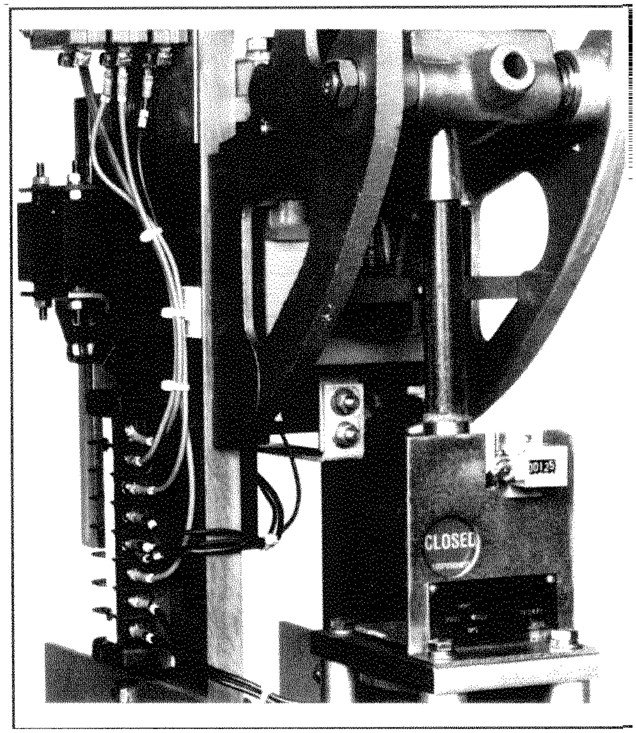


Fig. 4. Use of Locking Bar

CAUTION

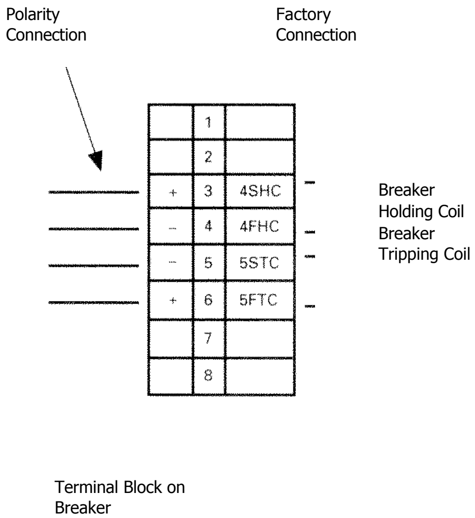
All parts of the pole unit mechanism are at line potential when the breaker is connected to an energized circuit, regardless of whether the breaker is opened or closed. The breaker should not be operated by hand while connected to an energized circuit. The closing handle, while insulated, is intended primarily for maintenance and adjustment operations.

As a safety precaution, no work should be done on the breaker while it is in the closed position. A locking-bar (Fig. 5) is provided to hold the armature on the holding magnet for adjustment purposes when holding current is not available. But even with the locking-bar in place, the breaker can still open accidentally if the toggle adjustments have not been made properly. Hence, it is advisable to keep fingers out of the mechanism at all times when the breaker is closed. Make certain that the locking-bar, tools or other loose parts are removed before the breaker is operated or put into service.

Avoid closing the breaker repeatedly when trips continue to occur shortly after the breaker is closed. When such conditions are encountered, the breaker unit should be checked to determine cause. It must be remembered that the duty imposed on the breaker pole unit will be determined by the conditions of the particular circuit application.

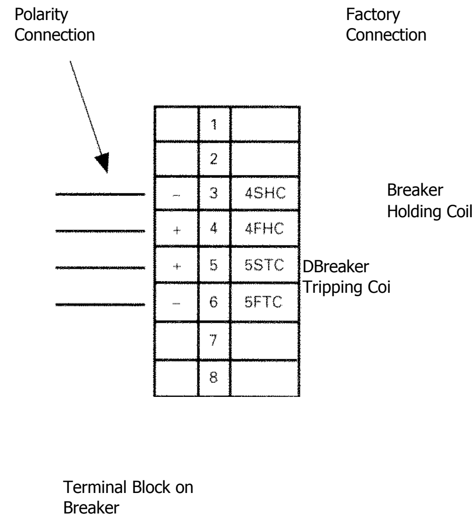
The polarity of the holding coil current and trip coil current should be checked carefully to insure proper tripping of the breaker. The effect of trip coil current is always opposite that of the holding coil current. However, if the breaker is equipped with a bucking bar-inductive shunt combination, the holding current polarity is determined by the desired tripping direction of current through the bucking bar.

DM2F Feeder Breaker with upper stud positive lower stud negative.



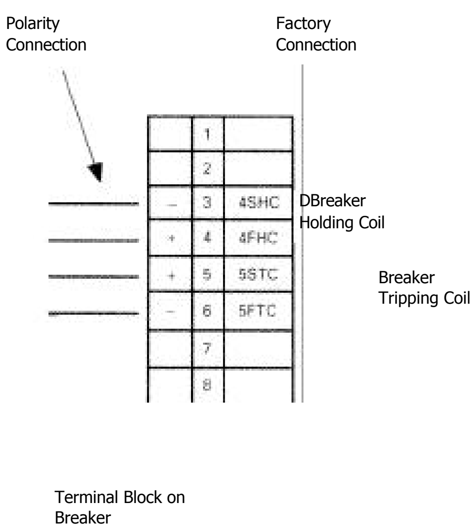
Forward Trip

DM2R Rectifier Breaker with upper stead positive lower stud negative.



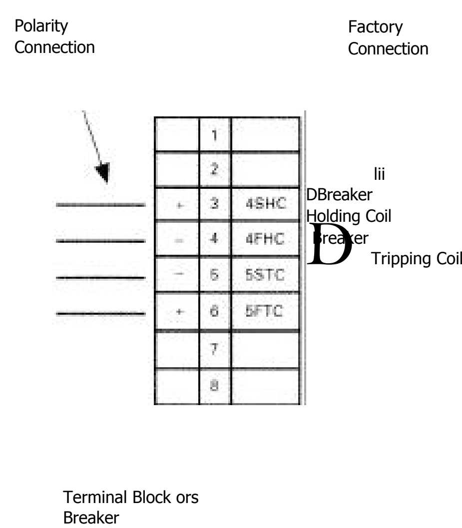
Reverse Trip

DM2F Feeder Breaker with upper stud negative lower stud positive.



Forward Trip

DM2R Rectifier Breaker with upper stud negative lower Stud positive.



Reverse Trip

Fig. 5. Polarity Hookups for **Proper Tripping of** Breaker

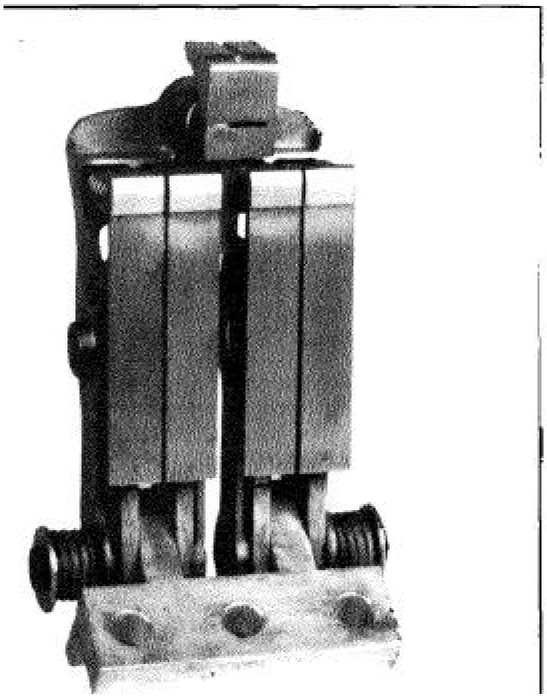


Fig. 6. *Moving Contact Assembly (4000A)*

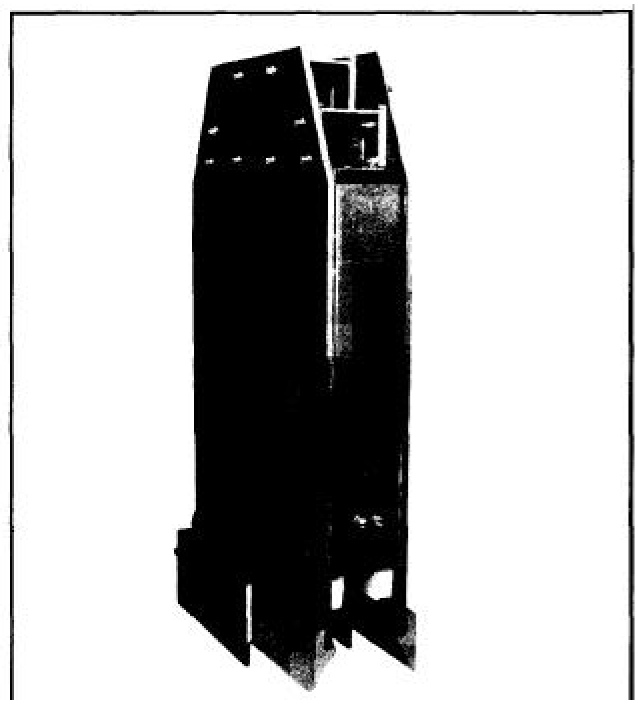


Fig. 7. *ARC Chute*

Detailed Inspection

Make sure that all bolts, nuts, terminal connections, etc. are fastened securely. Check for evidence of wear or improper adjustment and operation of the various parts.

The machined surfaces of the armature and holding magnet should be inspected carefully to make sure that they are free of dirt or magnetic particles. The surfaces should be cleaned occasionally with a clean cotton cloth dipped in kerosene. Cotton waste should be avoided since loose fibers may be left on the magnet surfaces.

After a long period of service or exposure to moist or corrosive air, the magnet surfaces may be rusted or corroded to some extent. A small amount of rust will not interfere with breaker operation. If rust or distortion occurs to the extent of interfering with proper holding, the surfaces may be trued as follows:

1. Holding magnet - use a fine grit, flat stone and carefully rub it over the surface of the magnet until flatness is restored.

2. Armature surface -remove the armature from the breaker. Lay a sheet of polishing cloth or very fine emery paper with the grit side up on a surface plate. Lay the armature on the polishing cloth and move it about carefully with a circular motion until all high spots are removed.

CAUTION

The arc chamber contains ceramic material. **Handle carefully. Do not drop, tip over or bump.**

Insulating parts of the arc chamber must withstand more than the full line potential when the breaker is interrupting. Successful breaker operation depends largely on the care given to the arc chambers. Periodically, they should be removed and inspected for worn or broken ceramic parts and for excessive metallic spray deposits.

Since fault currents vary in severity, the life of an arc chamber cannot be predicted accurately. Renewals should be determined by inspection. If the ceramic plates are eroded to sharp edges, or if the slots in the plates have increased more than 1/8 inch in width in the widest portion, the arc chamber should be replaced. If any of the ceramic plates are badly cracked, the arc chamber should be replaced.

When installing the arc chamber on the breaker, make certain that the rear arc-runner connection engages the clips on the blow-out magnet assembly, Fig. 7.

Contact Assembly
The contacts should be checked periodically for wear and adjustment. Under normal conditions, the contacts should be good for a large number of operations. A small amount of surface pitting on the main contacts will not impair the normal current carrying capacity of the breaker. Any excess roughness can be smoothed with fine aluminum oxide paper making certain that at least 70% of the line contact surface is effective.

The arcing contacts are subject to the intense heat of the arc when interrupting current. Each arc interruption will burn away some of the arcing contact metal. When they have reached the point where only 1/8 inch of contact material remains, the contact block or moving contact finger should be replaced.

The moving contact assembly is illustrated in Fig. 6. The following steps are necessary to remove the complete assembly from the breaker for servicing:

1. Remove the pin A, Fig. 3, which disconnects the toggle linkage.

2. Remove the pin fastening the opening spring guide to the top of the contact arm casting. Remove pin T, Fig. 3.

3. Remove the bolts holding the hinge block to lower stud.

4. Lift the contact assembly out of the breaker.

Adjustments

Contact Adjustment

To completely re-adjust the contacts, start by loosening the bolts holding the stationary arcing contact and backing off the jack screw so that the contact is free to slide back on the upper stud. It is best to make the following adjustments with the locking-bar in place as shown in Fig. 4. If a locking-bar is not available, then the holding coil must be energized with 200mA D.C. current.

Make certain that the armature does not pull away from the holding magnet as the breaker is closed.

Contact adjustments should be started by checking the compression of the main contact finger springs on each side of the moving contact arm assembly. This can be done by comparing the measurements of dimension L, Fig. 3, with the breaker open and with it closed. The main contact spring compression should be .063±.020 as indicated by the difference in dimension L. If these measurements are not within tolerance, open the breaker, loosen the lock nut on the eccentric pin D, Fig. 3, and ascertain that the eccentric is down and forward (closer to pole unit). The exposed right-hand side of the pin has been machined to indicate location. Turn the pin clockwise to decrease the spring compression, or counterclockwise to increase it. In general, only a few degrees of rotation will be required. Lock the eccentric pin and close the breaker to recheck the main contact finger spring compression.

The next adjustment to be checked is the length of the pull rod G, Fig. 3, which controls the amount that pin C moves over toggle. If pin C moves too far over toggle position, then the contact arm will close and then re-open slightly as the closing handle reaches its final closed position. If pin C does not move far enough, then the breaker will tend to slam open during electrical closing. The pull rod length should be adjusted so that the operator can feel a definite snap as pin C goes over toggle, but cannot notice any return motion of the moving contact support. The correct adjustment is 11/2 turns over toggle.

The pull rod length can be adjusted, if necessary, by loosening the lock nut R, removing pin Q, and rotating the universal joint P to shorten or lengthen the pull rod assembly. The universal joint has R.H. threads. After adjustment, place a screw-driver blade between the frame of the universal joint and the inside of the slot in the closing solenoid plunger to keep the universal joint centered in the slot, and tighten the lock nut R. Recheck main contact spring compression.

The stationary arcing contact should be set last. This can be done by closing the breaker by hand until a 1/8-inch shim can be placed between the main contacts at dimension M, Fig. 3, and moving the stationary arcing contact forward until it just touches the moving arcing contact. Then tighten the mounting bolts on the stationary arcing contact. Re-check the gap between the main contacts to make certain that the 1/8 shim is a snug fit when the arcing tips just touch.

As a final check, the breaker should be tested for electrical closing and for holding coil drop-out. The breaker should be capable of closing at 100 volts and as high as 140 volts without slamming out. The closing voltage figures are obtained by measuring the closing coil cold resistance and multiplying it by the measured closing coil current. This method must be used since the closing coil resistance will change due to heating and make measured closing coil voltages meaningless. The closing coil current times the cold coil resistance will give the voltage conditions corresponding to the initial operation of the breaker regardless of the present temperature of the coil. During electrical closing tests, the closing coil should be checked occasionally to make sure that it does not reach temperatures high enough to burn out the coil. This coil is intended for momentary duty only and should not have a current applied for more than a few seconds at a time.

The drop-out can be checked by connecting the holding coil to a source of variable direct current. Set the current to 200 milliamperes and close the breaker. Reduce the current slowly until the breaker opens. The measured value of current should be within the range of 32 to 100 milliamperes. If the drop-out current is not within these limits, re-check the breaker adjustments. If adjustments are properly made and the drop-out current is still not within tolerance, the factory should be consulted.

Lubrication
All pins and bearing surfaces except the moving contact hinge joint are coated at the factory with molybdenum disulphide. If the breaker linkage is dismantled, the pins and bearing surfaces should be wiped clean and coated with molybdenum disulphide dissolved in alcohol and applied with a small brush. The alcohol will evaporate rapidly and leave a deposit of molybdenum disulphide on the surface.

The moving contact hinge joint must be lubricated only with a good grade of graphite grease such as WEMCO PDS 1022= 1. Do not apply molybdenum disulphide to the moving contact hinge joint, since this lubricant is not a good electrical conductor.

Operating Irregularities
As with any equipment, the proper functioning of the apparatus will depend on the adjustment and care which it receives. Certain irregularities in operation and their possible causes are listed:

Pole Units failing to close 1. Dirt around the closing magnet plunger. 2. Poor connections to the closing coil. 3. Closing coil burned out.

Holding armature fails to hold
1. Dirt under the armature.
2. Armature or holding magnet surface is not flat.
3. Poor connection in the holding coil current.

Breaker slams open when closing
1. Improper adjustment of toggle links.
2. Faulty holding magnet or armature.

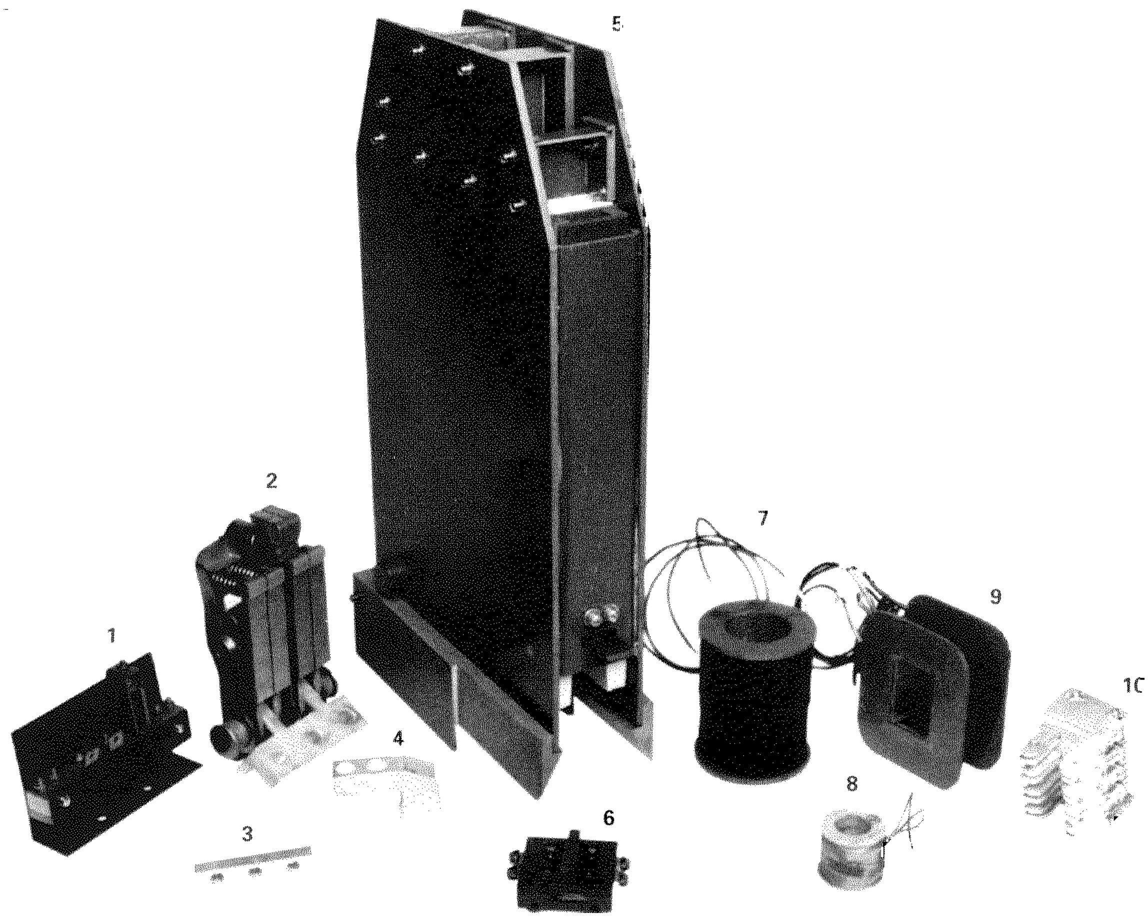


Fig. *8. Renewal Parts*

1. Overload Relay
2. Moving Contact/Assembly
3. Moving Contact/Stationary
4. Arcing Contact/Stationary
5. ARC Chambers
6. Auxiliary Switch
7. Closing Coil
8. Holding/Trip Coil
9. Shunt Trip Coil
10. Finger Clusters

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