INSTRUCTIONS AND RECOMMENDED PARTS FOR MAINTENANCE

GEK 39671A

POWER/VAC* VACUUM CIRCUIT BREAKER WITH ML-17 MECHANISM

Types:

VB-4.16-250-1200A-58 □
VB-4.16-250-1200A-78 Δ
VB-4.16-250-2000A-58
VB-4.16-250-2000A-78 Δ

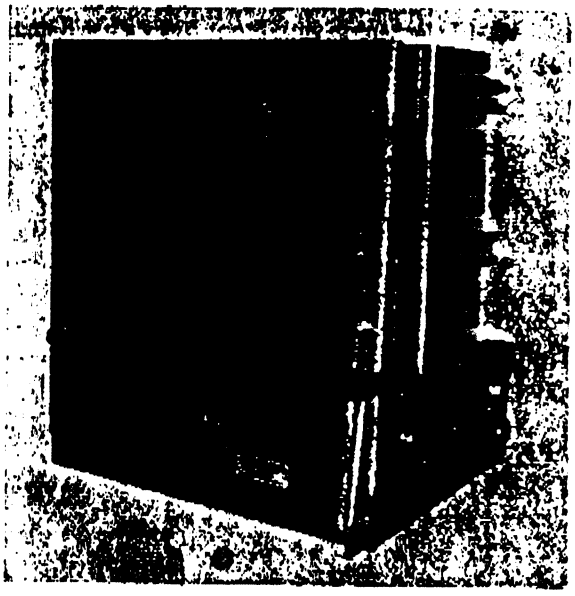
VB-4.16-350-1200A-78
VB-4.16-350-2000A-78
VB-4.16-350-3000A-78

VB-7.2-500-1200A-66
VB-7.2-500-1200A-78
VB-7.2-500-2000A-66
VB-7.2-500-2000A-78

VB-13.8-500-1200A-37
VB-13.8-500-1200A-58 Δ
VB-13.8-500-2000A-37
VB-13.8-500-2000A-58 Δ

VB-13.8-750-1200A-58
VB-13.8-750-1200A-77 Δ
VB-13.8-750-2000A-58
VB-13.8-750-2000A-77 Δ

VB-13.8-1000-1200A-77
VB-13.8-1000-2000A-77
VB-13.8-1000-3000A-77



Type Designation Means

□ Vacuum Breaker – Nominal Voltage – Nominal MVA – Continuous Current – Close and Latch Kiloamperes

Δ Non Standard High Close and Latch Ratings.

1. All personnel associated with installation, operation and maintenance of power circuit breakers should be thoroughly instructed and supervised regarding power equipment in general and, also, the particular model of equipment with which they are working. Instruction books and service advices should be closely studied and followed.

2. Maintenance programs must be well planned and carried out consistent with both customer experience and manufacturer's recommendations including service advices and instruction books. Good maintenance is essential to breaker reliability and safety.

be serviced only by skilled and knowledgeable personnel capable of releasing each spring load in a controlled manner. Particular care must be exercised to keep personnel clear of mechanisms which are to be operated or released. Information on construction of such mechanisms is provided in this instruction book.

4. Operational tests and checks should be made on a breaker after maintenance, before it is returned to service, to ensure that it is capable of operating properly. The extent of such tests and checks should be consistent with the level of maintenance performed.

DESCRIPTION

The Power/Vac* vacuum circuit breaker is a horizontal drawout removable and interchangeable interrupting element for use in metal-clad switchgear to provide protection and control of electrical apparatus and power systems.

The Power/Vac* circuit breakers are available in continuous current of 1200, 2000 and 3000 amperes in accordance with industry standards. Refer to the breaker nameplate for complete rating information of any particular breaker.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

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

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to moisture or dirt. Check all parts against the packing list to be sure that no parts have been overlooked.

HANDLING

When lifting the breaker use of the specially designed lift truck is recommended. It is necessary to use the truck when placing a breaker into or removing it from the metal-clad equipment. If it is necessary to lift the breaker with a hoist use four 1/2 inch diameter hooks rated at least 500 pounds each. Lifeing locations are provided in the side frame members. Use a spreader at least 12 inches wider than the breaker to prevent slings from contacting the interrupter supporting insulating material parts.

A front swivel wheel and two rear wheels are provided for ease of movement on flat, level floors. When unattended breakers are left on a floor or when a lift truck is used, block both rear wheels in both directions to prevent any accidental movement.

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. Unplated surfaces of rollers, latches, etc., of the operating mechanism should be coated with D6B15 grease to prevent rusting.

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

INSTALLATION

SAFETY PRECAUTIONS

This circuit breaker uses powerful springs for energy storage. Do not work on the interrupters or mechanism unless both the closing springs and opening springs are either discharged or blocked and all electrical power is removed. These precautions are required to prevent accidental operation. Anyone working on the circuit breaker should be familiar with the contents of this instruction book.

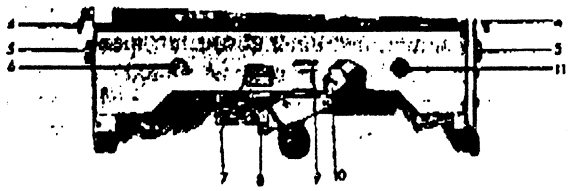
The circuit breaker has been shipped in a closed position

SHIPPING POSITION

with the mechanism trip latch blocked by a bolt through the left side frame. A yellow tag identifies this bolt. Before operation or insertion into the metal-clad equipment, this bolt must be removed and the mechanism tripped open with the manual trip push button. The close spring is shipped discharded.

After removing packing material, locate, and remove the trip latch blocking bolt indicated with a yellow tag on the

Fig. 2 (



1 – Upper Interrupter Connection
2 – Interrupter Support
3 – Operating Rod Insulator
4 – Racking Engagement Lever
5 – Pointer for Truck

of the manual wind shaft. After several rotations at no apparent load, the winding mechanism will engage the slow close pawl and begin the closing operation of the mechanism.

Slowly operate the mechanism, checking for smooth operation with lack of sticking or sudden load increases. Be sure the close toggle (Fig. 5) goes overcenter against the frame. After the one-half flywheel rotation necessary for closing, the slow close pawl is automatically disengaged and the flywheel is held by the brake.

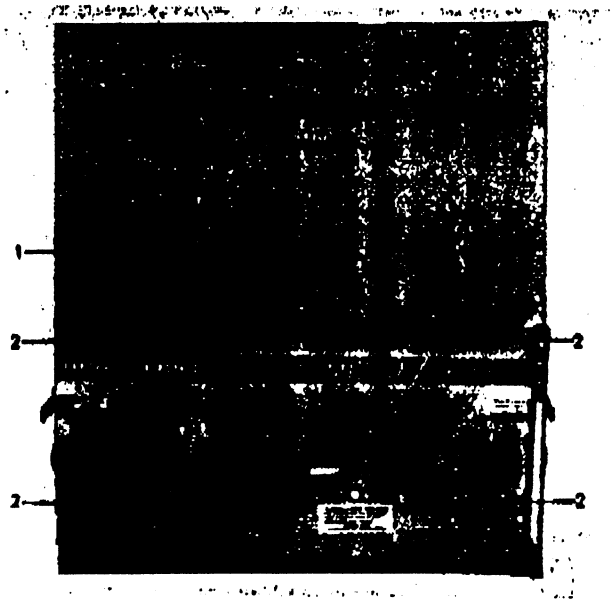


Fig. 1 (8918438M)

1 – Front Cover
2 – Cover Mounting Bolts
3 – Spring Charge Indicator

Fig. 1 Front View of Power/Vac* Breaker with Front Cover

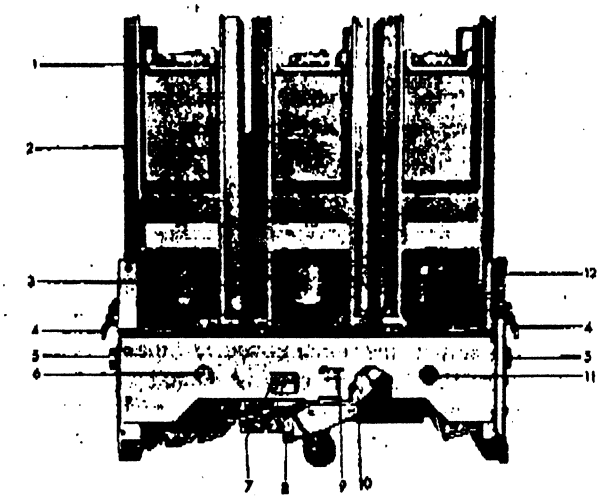


Fig. 2 (8918438K)

1 – Upper Interrupter Connection
2 – Interrupter Support
3 – Operating Rod Insulator
4 – Racking Engagement Lever
5 – Rollers for Track
6 – Manual Trip Button
7 – Open-Close Indicator
8 – Counter
9 – Spring Charge Indicator
10 – Manual Wind Shaft
11 – Manual Close Button
12 – Handle to Connect Secondary Disconnects in Test Position

Fig. 2 Front View of Power/Vac* Breaker Without Cover

left side sheet of the mechanism. Press in on the manual trip push button (Fig. 1) to trip the mechanism open, keeping hands away from moving parts.

Close and open springs are now in their discharged positions. Check this by first pressing the manual close, then the manual trip push buttons.

MECHANICAL CHECKING AND SLOW CLOSING

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

(2) Manually charge the breaker closing spring using a 5/8 inch hex socket-ratchet-type wrench for safety, and turn in the direction of the arrow as indicated on or near the end of the manual wind shaft (Fig. 2). Several rotations with no apparent load are necessary until the winding mechanism engages the spring-charging pawl.

As the manual charging shaft is rotated the trip latch will reset first with a small "click". Continued rotation will fully charge the closing spring and a louder sound will be heard. At this time the indicator (Fig. 1) will change from "Discharged" to "Charged" Stop cranking when this occurs.

(3) Insert the close spring blocking pin (Fig. 3) by carefully removing it from its storage hole, rotating the interlock lever and reinserting it in the blocking hole. Press the manual close push button to partially discharge the closing spring against the blocking pin.

(4) Pull the slow close pawl enabling pin on the flywheel (Fig. 4) and resume ratchet wrench operation of the manual wind shaft. After several rotations at no apparent load, the winding mechanism will engage the slow close pawl and begin the closing operation of the mechanism.

Slowly operate the mechanism, checking for smooth operation with lack of sticking or sudden load increases. Be sure the close toggle (Fig. 5) goes over-center against the frame. After the one-half flywheel rotation necessary for closing, the slow close pawl is automatically disengaged and the flywheel is held by the brake.

(5) In the closed position, check and record the erosion indicator dimensions and the wipe indicator dimensions (Fig. 6). Check that the position indicator shows "Closed". See section on PRIMARY CONTACT WIPE AND EROSION INDICATOR.

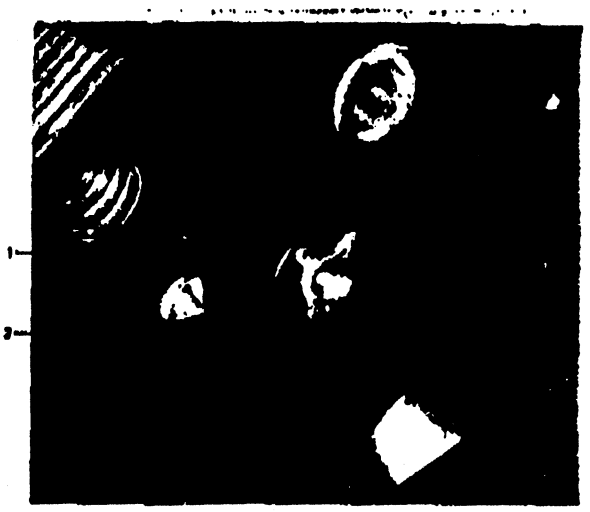
(6) Keep clear and push the manual trip push button to trip the breaker open. Check that the position indicator shows "Open" and the operation counter advances.

Fig. 4 (8918438P)

Fig. 3 (8918438Q)

1 – Close Spring Interlock Lever
2 – Blocking Hole
3 – Close Spring Blocking Pin
4 – Storage Hole
5 – Interlock Lever Return Spring

Fig. 3 Closing Spring Blocking Pin



1 – Flywheel
2 – Slow Close Pin

Fig. 4 Slow Close Pin on Flywheel

(7) Repeat (2) to put the close spring in a latched position, then press the manual close push button to partially discharge the close spring against the blocking pin.

(8) Repeat (4), (6), (7) in sequence to slow close and trip the breaker several times to insure proper operation.

(9) Repeat (2), then carefully remove the close spring blocking pin from its blocking hole, rotate the interlock coupling, and reinsert the pin in its storage hole.

(10) Close the breaker by pressing the manual close push button, then check that the close toggle is over-center onto the frame. Trip the breaker by pressing the manual trip push button. Close and open springs are now in their discharged positions.

ELECTRICAL CHECKING

Electrical checking consists of electrical breaker operation, secondary wiring high-potential testing (if required), primary current path resistance (if required) and Power/Vac® interrupter high-potential testing.

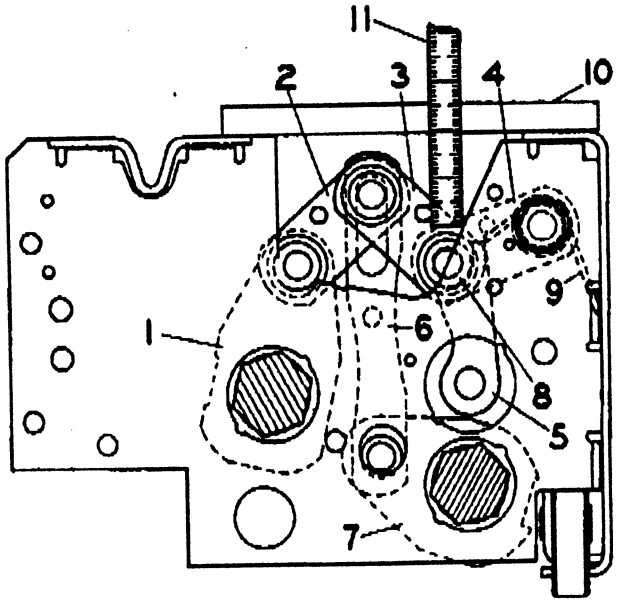
(1) To check the electrical operation attach a secondary test coupler to the circuit breaker connector, and after checking the control voltage power on the nameplate and operate the breaker several times to check the electrical operation.

(2) A secondary wiring high-potential test of 1500 rms volts, 60 hertz to ground may be made, but first disconnect both motor leads from the circuit to prevent possible winding insulation damage. Reconnect the motor leads after testing.

(3) A resistance check of the primary circuit may be made with the breaker closed. Use a low resistance measuring instrument which measures microhms. The 100 ampere reading should not exceed 100 microhoms when connected across the primary bars on the breaker side of the disconnect fingers.

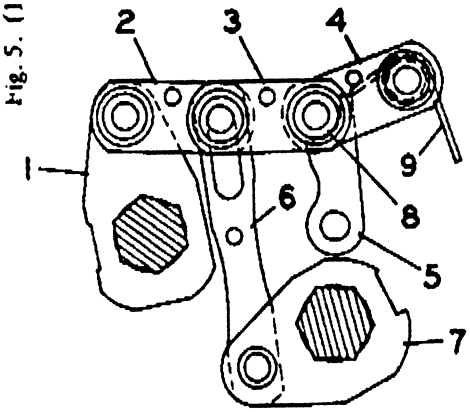
(4) Before energizing the circuit breaker, a high-potential test of the Power/Vac® interrupters should be made to verify the condition of the interrupters. See HIGH POTENTIAL TEST under MAINTENANCE for the proper procedure, precautions and appropriate voltages. Do not attempt interrupter high potential testing without first reading HIGH POTENTIAL TEST.

(5) Leave the circuit breaker in an open and spring-discharged condition after checks are complete and refer to metal-clad instruction book GEK 39672 before inserting the circuit breaker into a metal-clad unit. Reinstall the front cover if it has been removed.

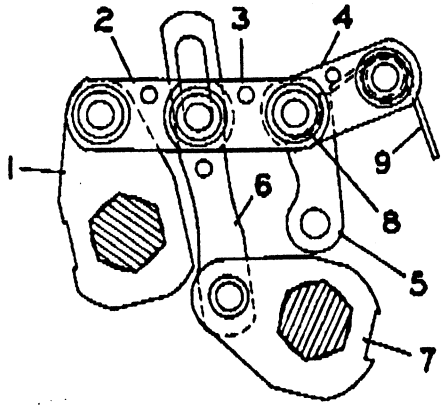


(a) Breaker Open-Close Spring Charged

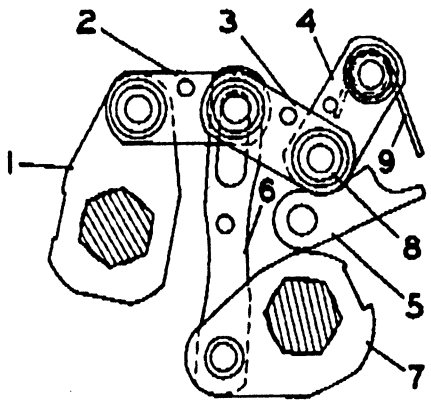
Fig. 5. (144D1405) 209B4202



(b) Breaker Closed-
Close Spring Discharged



(c) Breaker Closed-
Close Spring Charged



(d) Breaker Open-
Close Spring Discharged

1 – Output Crank
2 – Link-Output Crank to Close Toggle
3 – Link-Close Toggle to Trip Toggle
4 – Link Trip Toggle to Frame
5 – Trip Latch
6 – Slotted Link
7 – Transfer Crank
8 – Trip Roller
9 – Linkage Return Spring
10 – Straight Edge
11 – Measuring Scale for Trip Latch Clearance

Fig. 5 Toggle Linkage Positions of ML 17 Mechanism
View From Rear

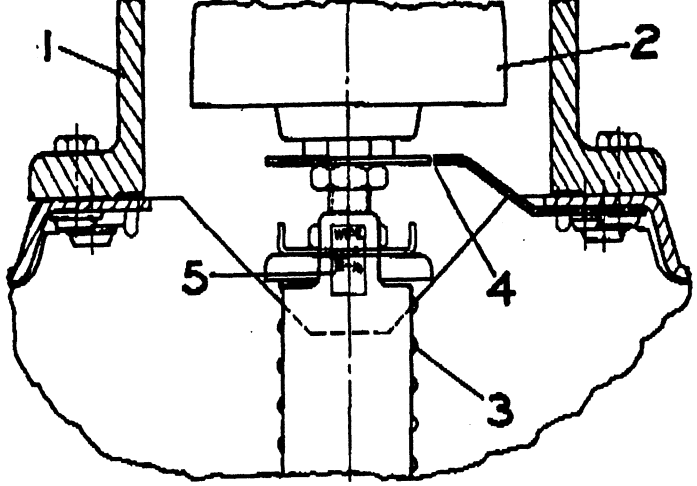


Fig. 6. 144D1403

1 – Interrupter Support
2 – Operating Rod Insulator
3 – Wipe Spring
4 – Erosion Indicator
5 – Wipe Indicator

Fig. 6 Erosion and Wipe Indicator

OPERATION

GENERAL

The Power/Vac* vacuum circuit breaker uses sealed vacuum power interrupters to establish and interrupt a primary circuit. Primary connections to the associated metal-clad switchgear are made by horizontal bars and disconnect fingers, electrically and mechanically connected to the vacuum interrupters. Molded supports, one per pole on a three-pole circuit breaker, provide interchangeable mountings for the primary bars, interrupters, current transfer fingers, and heat dissipation fins (where used). The operating mechanism provides vertical motion at each pole location in order to move the lower contact of the vacuum interrupters from an open position to a spring-loaded closed position and then back to the open position on command of the control circuit.

The ML-17 mechanism is of the stored-energy type and uses a gearmotor to charge a closing spring. During a closing operation, the energy stored in the closing spring is used to close the vacuum interrupter contacts, charge the wipe springs which load the contacts, charge the opening springs, and overcome bearing and other friction forces. The energy then stored in the wipe and opening springs will open the contacts during an opening operation.

Closing and opening operations are controlled electrically by the metal clad or remote relaying. Mechanical control is provided by manual close and trip buttons on the circuit breaker. The closing spring may be manually charged, and a method for slow-closing the primary contacts is available. The mechanism will operate at the a-c or d-c voltage indicated on the circuit breaker nameplate.

Mechanical and electrical interlocks are provided for safe operation and are described in this section under INTERLOCKS.

In order to accommodate different ratings, the basic mechanism can be adjusted to operate vacuum interrupters with varying gaps, but once adjusted for a particular rating, field readjustment is not recommended.

CLOSE SPRING CHARGING

Figure 7 rear view shows the mechanism expanded schematically in an open, closed-spring-charged condition. When the close spring is discharged, the AA flywheel eccentric would be about 180 degrees from where it is shown with respect to center pivot CC. The transfer crank BB would be rotated counterclockwise, the slotted link (17) will be holding the close toggle (20, 21) against the frame through link (19), and the trip latch (18) will be held out of latch clockwise by the trip toggle roller (11) per Fig. 5. When the closing spring is discharged lever (44) operates the motor limit switch (43). If the close-latch-checking switch (5) is made and power is available, the gearmotor (46) will drive the wind hub (11) counterclockwise. Slow-close pawl (10) will be held out of possible engagement with the wind hub notch by the action of the enabling pin (48).

After some rotation of the wind hub (11) at no load, its notch engages the wind pawl (9) and rotates the flywheel counterclockwise, compressing the close spring assembly (6), and rotating the transfer crank (BB) shaft clockwise by pushing on rod (13). As the line of action of the close spring shifts over-center on the flywheel and attempts to discharge, the close roller (3) is blocked by the close latch (4) and held until a closing operation is required. Additionally, as the close spring goes over-center, the lever (44) is spring biased into a notch on the front flywheel (2). Arm (40) moves clockwise which, through the action of the rod (41) causes a flag (42) to indicate "CHARGE". A cam (12) engages the wind pawl (9), moving it from contact with the hub (11) notch, thereby allowing the gearmotor to coast to a stop when power is removed by limit switch (43).

As the close spring is compressed, the slotted link (17) rises, and the close toggle (20,21) forms a more acute angle until, about when the closing spring is going over-center, the trip latch (18) is spring biased into place under the trip roller. When the trip latch is in place, the latch-checking limit switch (47) closes.

If control power is lost, or manual operation desired, the close spring may be manually charged by using a 5/8 inch hex socket ratchet-type wrench to rotate the manual charging wind shaft in the direction indicated by the arrow until the yellow indicator shows "CHARGED". Manual charging must then be discontinued to avoid mechanism damage.

CLOSING OPERATION (REFER TO FIG. 7)

By either energizing the close solenoid or depressing the manual close button, the close latch (4) is rotated counterclockwise and releases the close roller (3) permitting the flywheel (1,2) to rotate counterclockwise by the force of the close spring. This action, transmitted to the slotted link (17) by means of the pull rod (13), transfer crank (14,16), system pulls the close toggle (20,21) through the center against link (19) which is tied to the frame. This action rotates the output crank (22) counterclockwise. The Pole 1 bell cranks (23), on the same shaft as the output crank, also rotate counterclockwise, and by means of the horizontal connecting bar (28), rotate Pole 2 and 3 bell cranks. This rotation compresses the opening spring (29), closes the vacuum interrupters connected with each insulator (25), and compresses the wipe spring (28) on each pole when the trunnion (24) continues moving after the interrupter rod (25) stops. Rotation of an arm (34) on the output shaft changes the auxiliary switch (37) position, and the position flag (38) indicates "CLOSED". The lever (44) is moved out of the notch in the flywheel (2) and, with the close latch (4) in position to catch the close roller, the limit switch (43) energizes the gearmotor as described under CLOSE SPRING CHARGING. With the circuit breaker in the closed position, the links (17) can move up past the close toggle without disturbing it as they are slotted to accommodate a close spring charging in the breaker-closed position.

OPENING OPERATION (REFER TO FIG. 7)

By either energizing the trip solenoid or depressing the manual trip button, the trip latch (18) is rotated clockwise permitting the trip toggle (19,20) to collapse and the vacuum interrupter contacts to open under the force of the wipe springs (26) and opening spring (29). At the end of the opening stroke, a stop block (30) on the bottom of the trunnion (24) strikes set screws the horizontal connecting bar (28) which limits the over-travel. At the same time an opening stop is provided by a plate and buffer assembly (50). An opening dashpot (31) controls opening velocity and prevents excessive rebound of the interrupter contacts due to unabsorbed energy. Rotation of the output shaft from a closed to an open position operates the auxiliary switch (37) as described under CLOSING OPERATION and interrupts the trip coil circuit. If the closing spring is charged, the close toggle (20,21) can rise to the top of the slotted link (17), thereby permitting the trip toggle to reset and the trip latch to fall in place under its roller preparatory to a closing operation. If the closing spring is not charged, the trip latch is held rotated clockwise until the close spring is compressed as described in CLOSE SPRING CHARGING. Electrically initiated closing is blocked by the latch checking switch (47) when the trip latch is not reset.

TRIP-FREE OPERATION (REFER TO FIG. 7)

The linkage (19,20,21) is mechanically trip free in any location on the closing stroke, this means that energization of the trip coil while closing after the auxiliary switch contacts change position will rotate the trip latch (18) clockwise and permit the circuit breaker to open without fully completing a closing stroke. The linkage will reset as in a normal open operation, the flywheel will complete its rotation, and the closing spring will recharge as described under SPRING CHARGING. The opening speed will be slightly less than with a normal open operation due to the wipe springs not having been fully compressed, but the speed will be within the acceptable range for rated interruption.

CONTROL CIRCUIT

A typical Power/Vac* circuit breaker ML-17 mechanism wiring diagram is shown in Fig. 8. Check the wiring diagram supplied with the actual circuit breaker for its wiring.

The close spring-charging-motor circuit is established through the CL/MS switch if the close latch is reset and the SM/LS if the closing spring is discharged. When the closing spring is charged, the SM/LS interrupts the circuit.

The close circuit is established through two normally closed Y relay contacts, 52Y and the latch-checking switch LC, if the trip latch is reset. An auxiliary switch contact 52 is also in series with the close coil and that closes when the breaker is open and opens when it is closed. During a close operation, flywheel rotation closes the SM/LS contact, picking up the Y relay coil thereby opening its contacts to interrupt the close coil current and sealing it in through a normally open contact to the close signal. The sealing prevents reclosing on a sustained close command as the close signal must be removed to drop out the Y relay, and reestablish the close circuit, thereby providing an anti-pump feature.

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

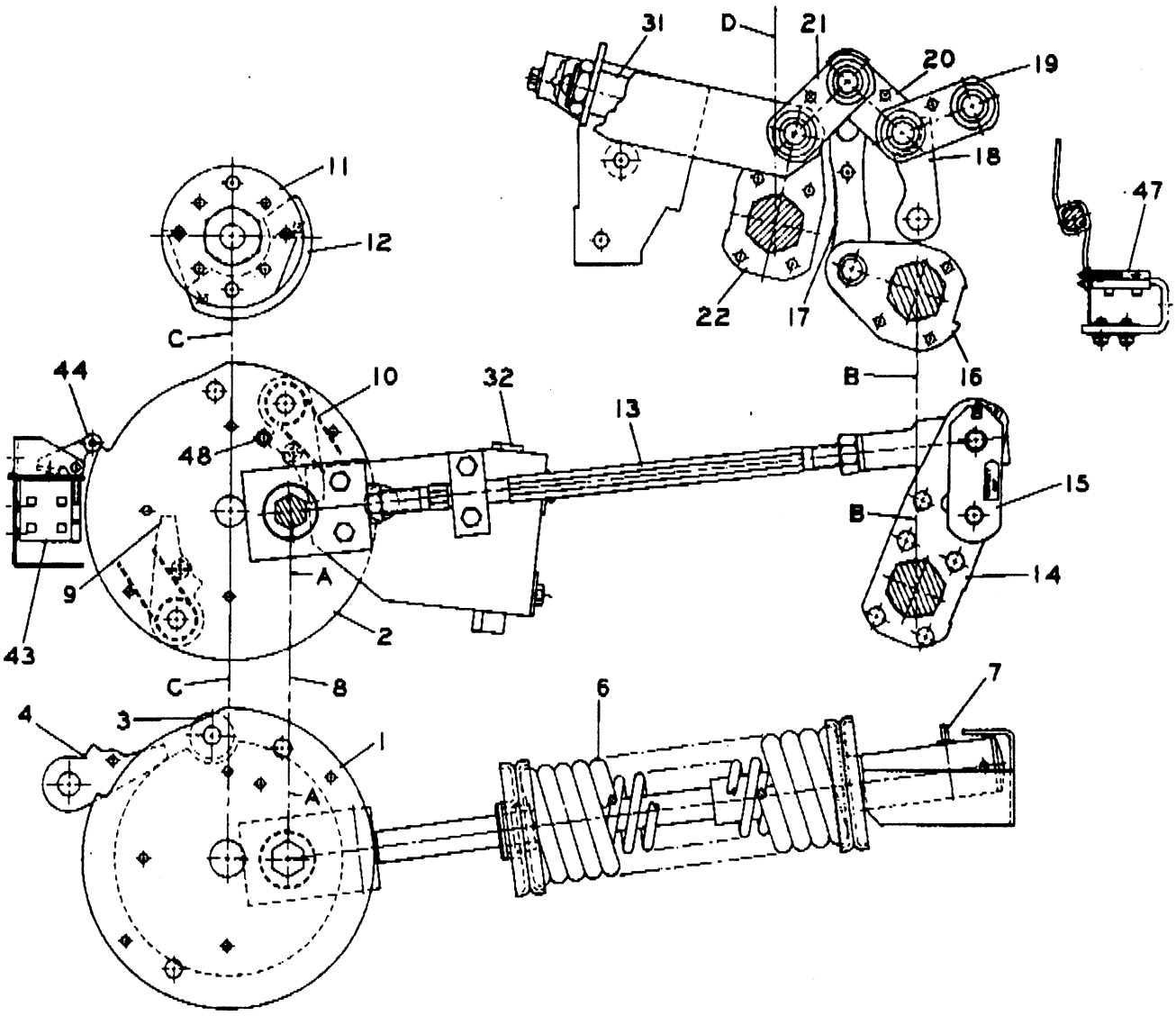


Fig. 7. (0144D1406 Sh. 1)

AA Eccentric shaft connecting flywheel halves
BB Hex shaft connecting Transfer cranks
CC Flywheel rotation axis
DD Hex shaft connecting Output cranks

1 Rear Flywheel Section
2 Front Flywheel Section
3 Close Roller
4 Close Latch
5 Close Latch Checking Switch
6 Closing Spring Assembly
7 Gag Pin in Closing Spring Assembly
8 Hex Shaft with Connection Blocks on Flywheel
9 Wind Pawl
10 Slow Close Pawl
11 Wind Hub
12 Pawl Disengagement Cam Surface – on Frame
13 Pull Rod
14 Adjustable Throw Transfer Crank
15 Adjustment Link and Indicator
16 Short Transfer Crank

Fig. 7 Exploded Schematic – Rear View ML-17 Mechanism

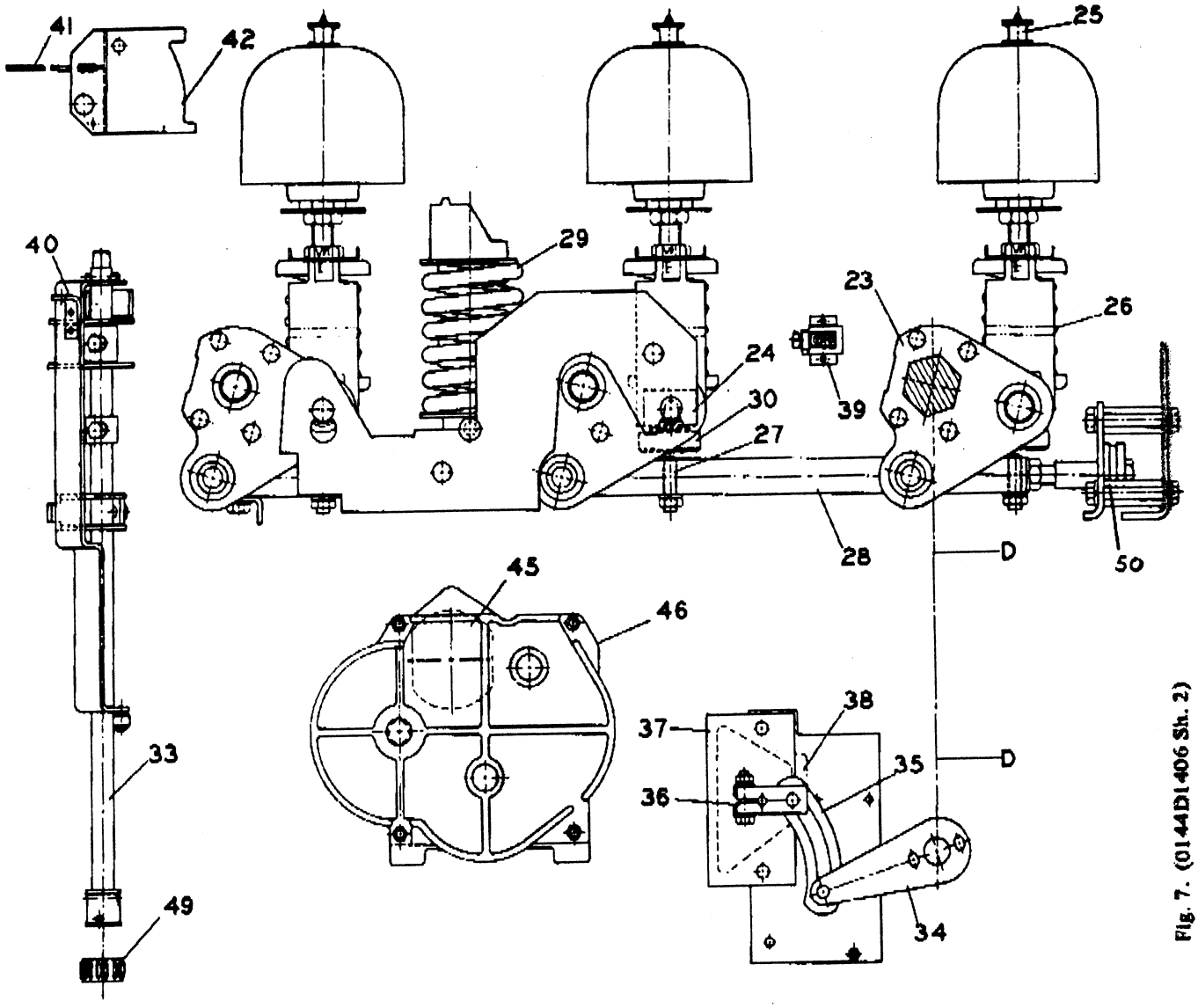


Fig. 7. (0144D1406 Sh. 2)

17 Slotted Link
18 Trip Latch
19 Link – Trip Toggle to Frame
20 Link from Close Toggle to Trip Toggle
21 Link from Output Crank to Close Toggle
22 Output Crank
23 Pole 1 Bell Cranks
24 Wipe Spring Trunnion Block
25 Interrupter Operating Rod Connection
26 Wipe Spring
27 Overtravel Stop Adjustment – on Each Pole
28 Horizontal Connecting Bar
29 Opening Spring Assembly
30 Opening Stop Block
31 Dashpot
32 Brake
33 Closing Latch Shaft
34 Auxiliary Switch Drive Arm
35 Idler Link
36 Switch Drive Arm
37 Auxiliary Switch – SB-12 – Four Stage
38 Position Indicator Flag – on Switch Shaft
39 Operation Counter
40 Spring Charge Indicator Arm
41 Rod
42 Spring Charge-Discharge Indicator Flag
43 Gear Motor Limit Switch
44 Gear Motor Limit Switch Operator
45 Reduction Gear Housing
46 Gearmotor
47 Trip Latch Checking Switch
48 Enabling Pin
49 Retaining Ring
50 Opening Stop

Fig. 7 Exploded Schematic – Rear View ML-17 Mechanism

Fig. 8 (209B3602)

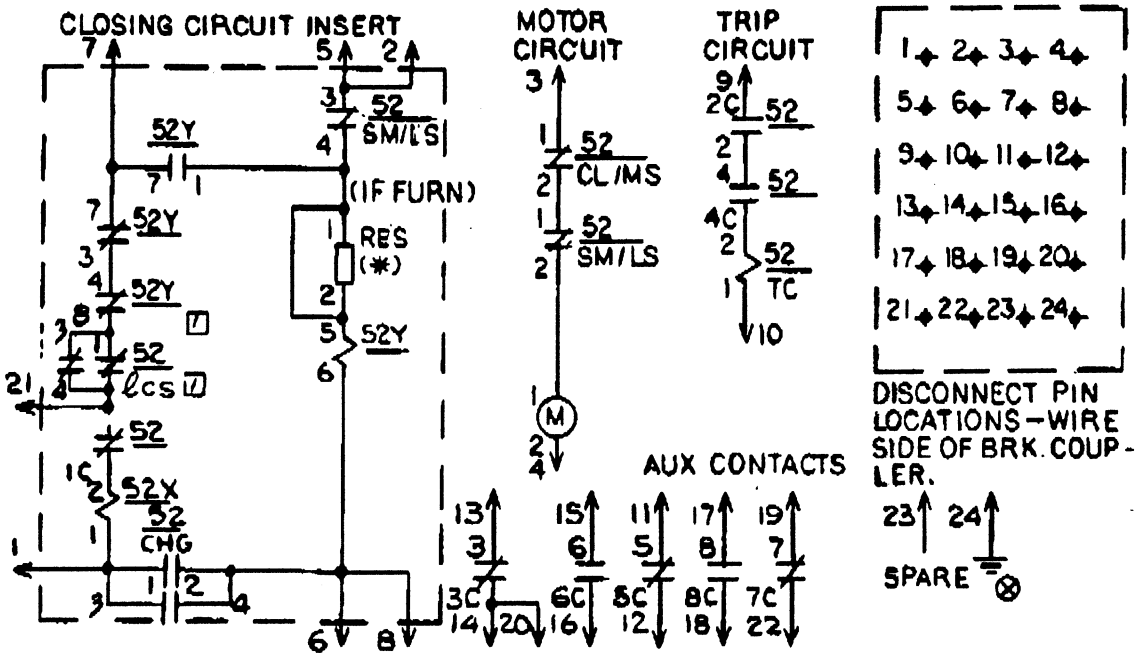
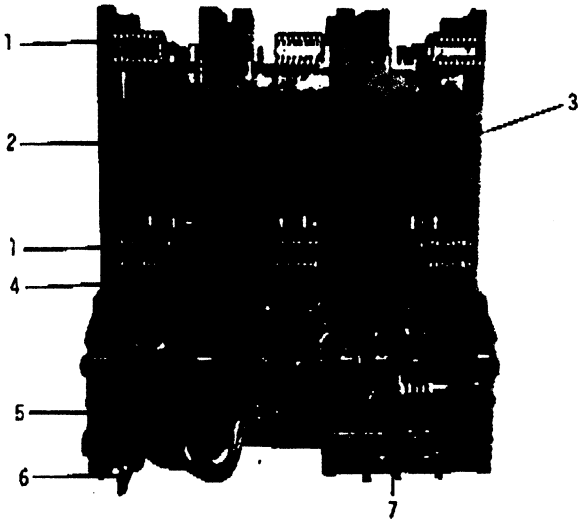


Fig. 8 Typical Wiring Diagram for ML-17 Mechanism

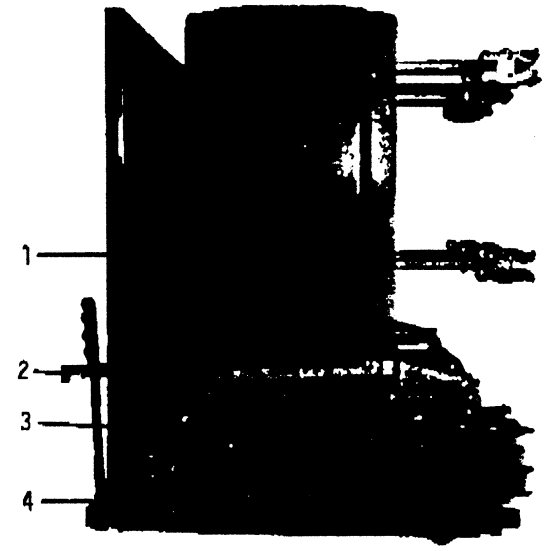
Fig. 9 (804303c)



1 – Primary Disconnect Fingers
2 – Interrupter Support
3 – Coupling Clamp
4 – Operating Rod Insulator
5 – Secondary Disconnect Coupler
6 – Ground Shoe
7 – Rating Interference Plate

Fig. 9 Rear View of Power/Vac® Breaker Showing Rating Interference Plate

Fig. 10 (8043104)



1 – Front Cover
2 – Racking Engagement Lever
3 – Rollers for Track
4 – Closing Spring Discharge Roller

Fig. 10 Closing Spring Discharge Interlock on ML-17 Mechanism

INTERLOCKS

Each Power/Vac* vacuum circuit breaker is provided with the following interlocks.

(1) Rating interference plate (Fig. 9) permits only a breaker of the matching continuous current, voltage and interrupting mva rating to be inserted into a metal-clad breaker compartment.

(2) The function of the closing spring discharge interlock is to prevent racking into the metal-clad a breaker that has the closing spring charged. This is accomplished by a roller on the right-hand side of the mechanism (Fig. 10) which contacts the racking mechanism and discharges the closing spring unless the breaker is in the "Disconnect/Test" position or the "Connect" position in the metal clad. This interlock also opens the CL/MS switch in the motor charging circuit to prevent charging the closing springs when the breaker is between the Disconnect/Test" or "Connect" position in the metal clad.

The function of the negative trip interlock (Fig. 11) is also to prevent racking a closed breaker into the

The function of the NEGATIVE TRIP INTERLOCK (5) Fig. 11 is to remove the trip latch from the trip latch roller thereby preventing a closing operation. The interlock also opens the latch checking switch in the closing circuit thereby removing the close circuit power. The negative interlock is in operation while the breaker is moving between the "Disconnect/Test" position and the "Connect" position.

(4) The positive interlock (Fig. 11) operates to prevent the racking of a breaker that is closed. A linkage connected to the horizontal connecting bar extends a detent bar (3) out from the side of the mechanism frame when it is in the closed position. If the breaker is in the "Connect" or "Disconnect/Test" position in the metal clad the detent bar locks into the racking mechanism to prevent access to the hex section of the jack screw.

(5) The closing spring gag interlock is provided on the breaker to prevent a breaker that has a gagged closing spring from entering the metal-clad unit. This is accomplished by projecting a lever (1) out of the left side of the mechanism when the closing spring is gagged. See Fig. 11.

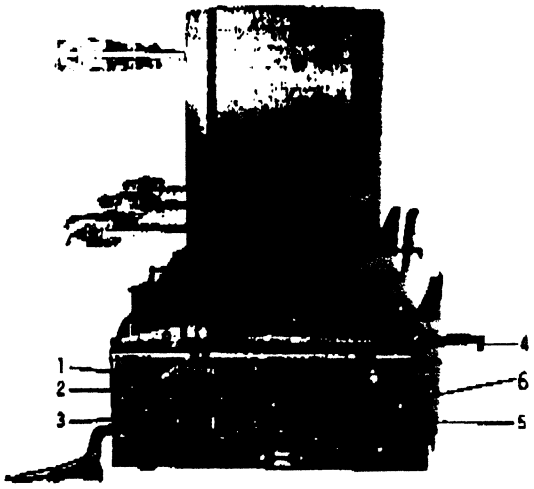


Fig. 11. (8043091)

1 – Closing Spring Gag Interlock
2 – Rollers for Track
3 – Positive Interlock Bar
4 – Racking Engagement Lever
5 – Negative Interlock Roller
6 – Trip Latch Blocking Hole

Fig. 11 Positive, Negative and Closing Spring Gag Interlocks on ML-17 Mechanism

MECHANICAL ADJUSTMENTS

GENERAL

The initial mechanical adjustments should be set up with the interrupters disconnected. After this has been completed the settings should be rechecked with the interrupters connected.

The mechanical adjustment to the mechanism and interrupters must be made in the sequence given below. If any readjustment is required, the sequence of adjustments must be repeated from the beginning. A variable radius crank (14,) Fig. 7, set at the factory is used to change the constant flywheel stroke into a variable stroke for different interrupter gaps.

PULL ROD

Refer to Fig. 7. The pull rod (13) is a turnbuckle, with a right-hand thread at the crank and a left-hand thread at the flywheel connection. Gag the close spring and slow close the mechanism as described in MECHANICAL CHECKING and SLOW CLOSING. As the flywheel and spring turn, the slotted links should have pulled the closing toggle pin over center so that the rollers on the end of the pin are resting on the mechanism frame. In this position, the slotted link should be free to move slightly from side to side.

CAUTION: If the rollers are not against the frame, the toggle links must be tapped firmly downward so that they rest

against the frame, then loosen the nuts on each end of the pull rod and adjust the rod length until the slotted link bottoms against the toggle pin. Increase the rod length by backing off about 1/4 turn so that the slotted links can move slightly from side to side.

In this position the slotted links (17) should have slight clearance to the pin in the close toggle (20, 21) (capable of being moved axially along the pin by finger pressure). Tighten the pull rod lock nuts to 20-25 foot pounds of torque.

If there is no clearance between close toggle and pin the pin may be bent by continued slow closing. The pin must be replaced if this occurs.

TRIP LATCH CLEARANCE

Refer to Items 8 and 11, Fig. 5, with the close spring still gagged, wind manual charge shaft until flywheel roller is against closing prop. Stop manual charging at once, determine the trip latch clearance by depressing the trip roller against the latch face from its spring-reset position. If no apparent motion exists, depress the manual trip push button and see if the trip roller rotates.

The acceptable range of initial latch clearance is .005 to .020 inch. The trip roller must not rotate when the latch is moved by the manual push button. The clearance may be estimated by pressing the roller down against the latch.

To adjust, loosen the locking nut (3/4 hex) under the mechanism adjacent to the interphase tie bar, and then unscrew the adjusting bolt (3/4 hex) to decrease latch clearance while pushing the manual trip push button in and out until the trip roller just starts to turn. Now, screw in on the adjusting bolt until the roller no longer turns plus an additional 1/4 turn. Torque the lock nut to 55 foot-pounds while holding the adjusting screw. This sets latch clearance at a minimum and any mechanism wear will tend to increase the clearance. When .060 inch is reached readjustment will be required.

OVERTRAVEL STOPS

With the breaker in the open position refer to Fig. 12. The horizontal connecting bar has set screws (8) threaded into the bar to provide a stop for each pole to prevent over stroking the Power/Vac* interrupters. Turn each of the six set screws (8) in toward the wipe spring assembly stop ring (14) until the bolt touches the stop ring. Back off 1/4 turn and tighten locking nut (11) to 20-25 foot-pounds.

PRIMARY CONTACT WIPE ADJUSTMENT

Contact wipe is the additional compression of a preloaded spring, used to apply force to the vacuum interrupter contacts and to provide opening kick-off force.

An indicator is provided on the wipe spring assembly with graduations given in fractions of an inch on which the wipe is indicated directly. See Fig. 6. However, to improve the accuracy of wipe measurements and settings it is recommended that the contact wipe guage tool which is furnished with the power/vac metal-clad be used.

The gauge consists of an assembly which can be slid into position on the orange erosion disc as shown in Fig. 6. The vernier screw should be positioned over the top edge of the wipe indicator. With the breaker open, slide the gauge over the erosion disc. Turn the vernier screw until it contacts the top edge of the wipe indicator. Remove the indicator without disturbing the screw and measure the length of the screw which is protruding from the gauge as accurately as possible with a micrometer or vernier caliper. Record the readings for each pole. Close the breaker and repeat the readings. The difference between the two readings is the contact wipe. The wipe should be set as follows:

Breaker Rating	Wipe (inches)
13.8 – 500	.156 – .172*
Readjust when reduced to .140	
All others	.156 – .172*
Readjust when reduced to .125	

*Do not readjust unless over .187

To adjust primary contact wipe, close the breaker and block the trip shaft against the frame to prevent accidental opening. Use a 1/40-20 bolt in trip latch blocking hole (6) Fig. 11.

(1) Loosen but do not remove the screws (3/16 hex key) holding the operating rod interrupter clamp (3), Fig. 12.

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

(3) Hold the hexagon projection at the bottom of the operating rod insulator (1 1/8 inch wrench) and loosen the adjacent locknut (15/16 inch wrench). Refer to (13), Fig. 12. Adjust by rotating the operating rod insulator. The thread is 5/8-11 and each 1/4 turn will give about 0.023 inch change in primary wipe. Screw the operating rod insulator toward the interrupter to increase wipe.

(4) After setting the contact wipes on each phase torque the operating rod locknut to 40-50 foot pounds while preventing the operating rod insulator from turning. Tighten the clamp screws (3) to 10 foot-pounds. Remove the trip shaft block and trip the breaker open. This procedure prevents accidental twisting of the operating rod of the interrupter by loading the contacts with the wipe springs and forcing relative rotation to occur at the clamp interface.

After adjustment, remeasure the wipes to check the adjustment. If the wipe settings are within the required limits, there is an adequate contact closing relationship between the poles.

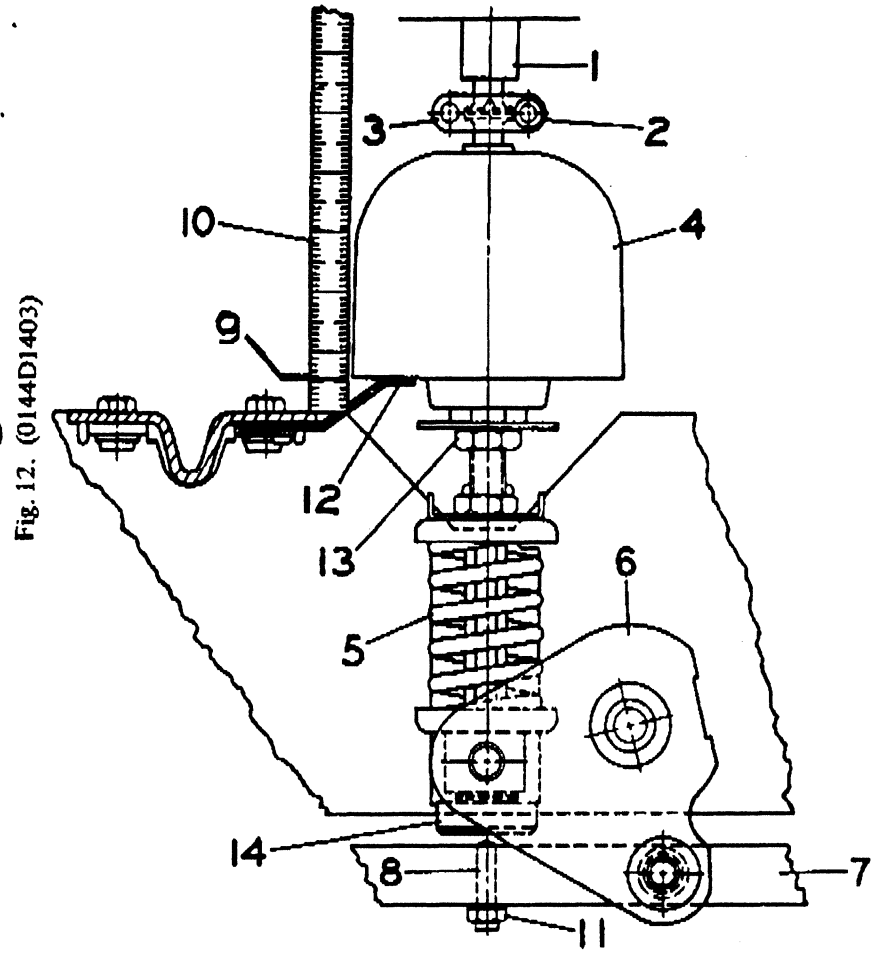


Fig. 12. (0144D1403)

1 – Power/Vac* Interrupter
2 – Coupling Clamp
3 – Clamp Screws
4 – Operating Rod Insulator
5 – Wipe Spring
6 – Bell Crank
7 – Horizontal connecting Bar
8 – Overtravel Adjusting Bolt
9 – Insulator to Frame Measurement
10 – Scale to Measure Stroke
11 – Locknut
12 – Erosion Indicator
13 – Gap Adjustment
14 – Stop Ring

Fig. 12 Primary Contact Gap and Erosion Indication

PRIMARY CONTACT GAPS AND EROSION INDICATION

Refer to items 9 and 10, Fig. 12. Measure the distance from the lower edge of the skirt on the operating rod insulator on each pole to the adjacent frame in both the open and closed positions of the breaker. The difference in open and closed readings is the primary contact gap.

Depending on the circuit breaker rating, the gap will be 1/2 inch, 5/8 inch, or 3/4 inch. A label on the variable radius crank (15), Fig. 7, indicates the nominal setting for any particular breaker. Additionally, in the closed position, an orange indicator disc below the operating rod insulator is aligned with a reference arm on new interrupters. With the breaker in the closed position, the indicator disk (12), Fig. 12, will move upward from alignment with the reference point due to contact erosion. Contact erosion will increase the contact gap which will be brought back to normal when the contact wipe is adjusted. When erosion reaches 1/8 inch, the Power/Vac* interrupters should be replaced. Do not readjust the alignment of the erosion indicator except when installing a new vacuum interrupter.

CONTROL COIL PLUNGER TRAVEL

TRIP COIL

With the breaker in the open position and the closing springs in the charged position, make certain that the trip linkage and trip shaft move freely over the full plunger travel.

CLOSE COIL

With the closing spring discharged operate the plunger in the same manner as described above for the trip coil. Make certain that the plunger moves freely over its full stroke in the coil.

CONTROL SWITCHES

There are two switch locations on the right-hand side of the mechanism and one on the left. The single switch on the right-hand side (CL/MS) is toward the front of the mechanism and monitors the closing latch position. To the rear of this switch are two switches mounted together (SM/LS) which control the spring-charging motor and anti-pump relay. Also the 52 charge switch which can be used for remote indication of the charged condition of the spring. On the left side is the (LC) latch-checking switch which monitors the position of the trip latch. Fig. 13 shows the SM/LS switches but the adjustment on the other two is similar. The switches should be adjusted in their operated positions os that there is .015 to .032 inch clearance between the operator (6) and support (7). Bolts (5) can be loosened to make this adjustment.

Fig. 14. (209B4204)

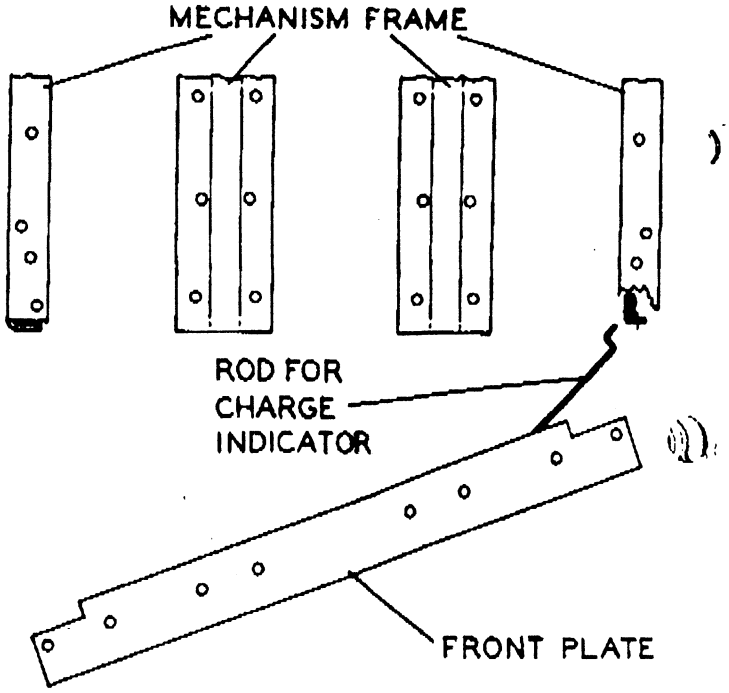
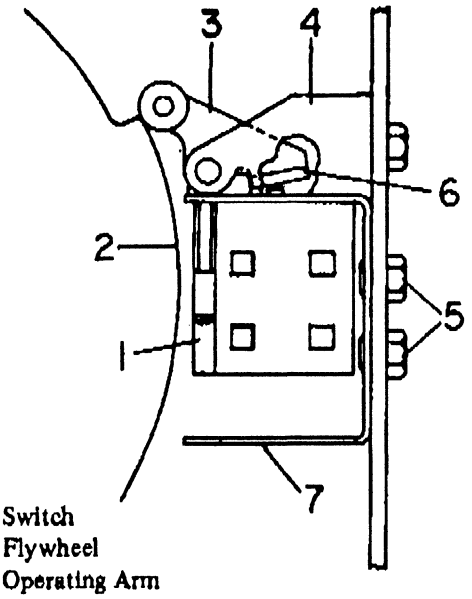


Fig. 14 Front Angle Plate

Fig. 13. (209B4204)



1 – Switch
2 – Flywheel
3 – Operating Arm
4 – Support Bracket
5 – Switch Adjusting Screws
6 – Operator
7 – Support

Fig. 13 Closing Spring Monitoring Switch

SUMMARY OF MECHANICAL ADJUSTMENTS

(1) Pull Rod – Minimum clearance of slotted links to close toggle pin (see text).

(2) Trip latch clearance 0.005 – 0.020 inch. Readjust if more than .060.

(3) Overtravel stops – 1/4 turn from touching.

(4) Primary contact gap – nominal for rating ± .032 inch

(5) Primary contact wipe –

Breaker Rating	Wipe in 64ths of an (inches)
13.8 – 500	.156 – .172*
	Readjust when reduced to .140
All Others	.156 – .172*
	Readjust when reduced to .125

(6) Control coil plunger travel – free action.

(7) Control switches – .015 – .032 inch.

ELECTRICAL CHECKS

CONTROL POWER

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

Rated Nominal Voltage	Close or Motor Circuit Min.	Max.	Trip Circuit Min.	Max.
48 DC	36	52	28	60
125 DC	90	130	70	140
250 DC	180	260	140	280
115 AC	95	125	Not available in Power/Vac*	
230 AC	190	250		

If the closed circuit voltage at the terminals of the coil or motor does not fall in the specified range, check the voltage at the source of power and line drop between the power source and 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 or motor of each breaker must fall within the specified limits.

TIMING

Timing may be checked by monitoring control circuit current and using no more than 6 volts DC and one ampere through the vacuum interrupter contact to indicate closed or open condition. Typical time ranges vary with coil voltage but nominals are:

Trip coil to contact part	35–50 milliseconds
Close coil to contact close	60–90 milliseconds

Trip-free operation may be checked by applying a trip signal through one of the vacuum interrupters and a minimum reclose operation may be checked by tripping a charged breaker open while maintaining a close signal.

Trip-free-contact, close to open	50-65 milliseconds
Reclose contact, open to close	150-165 milliseconds

MAINTENANCE

GENERAL

Safe and dependable service from electrical apparatus and power systems is contingent upon reliable performance of power circuit breakers. To obtain maximum reliability the breaker should be inspected and maintained on a regular schedule. The breakers are designed in accordance with applicable standards which require that they be capable of performing 5000 – 10,000 operations (depending on rating) before any replacement of parts should be necessary. This requirement is based on the breakers being serviced, or maintained, at least every 1000 to 2000 operations (depending on rating), or once per year, whichever comes first. If the breaker is also required to interrupt fault currents during this period of time additional maintenance and replacement of parts may be necessary.

BEFORE ANY MAINTENANCE WORK IS PERFORMED, MAKE CERTAIN THAT ALL CONTROL CIRCUITS ARE DE-ENERGIZED AND THAT THE BREAKER IS REMOVED FROM THE METAL-CLAD UNIT. DO NOT WORK ON THE BREAKER OR MECHANISM WHILE IN THE CLOSED POSITION WITHOUT TAKING PRECAUTIONS TO PREVENT ACCIDENTAL TRIPPING. DO NOT WORK ON THE BREAKER WHILE THE CLOSING SPRINGS ARE CHARGED UNLESS THEY ARE SECURED IN THAT POSITION BY THE CLOSE-SPRING-BLOCKING PIN.

PERIODIC INSPECTION

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

POWER/VAC* INTERRUPTER

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

Three checks are required on each pole unit.

CONTACT EROSION

Check in the breaker-closed position per PRIMARY CONTACT GAP AND EROSION INDICATION. When erosion reaches 1/8 inch, the interrupter should be replaced.

TRANSFER FINGER WEAR

Examine the moving contact rod projecting below the transfer fingers with the breaker open, wiping off the lubricant in order to see the metal surface condition. The finger locations should present a burnished silver contact without copper appearance at more than one location. If copper is visible at more than one location per pole or the silver plating is torn, the interrupter assembly should be replaced.

HIGH-POTENTIAL TEST

The high potential test is performed to test the vacuum integrity of the interrupter. It is a go-no go test which will confirm whether a sufficient vacuum level is present for safe interruption. If a DC high potential test is to be performed, the test equipment recommended by the Product Department should be used. Do not use the 1.414 x AC value for D.C. Hi-pot, use 40 kV DC.

When performing a high potential test, care and precautions must be taken or serious injury may result.

CAUTION: Although the procedure for Hipotting a vacuum interrupter is similar to that used for any other electrical device, there are two areas that require the exercise of extra caution.

1. During any hipotting operation the main shield inside the interrupter can acquire an electrical charge that usually will be retained even after the hipot voltage is removed. This shield is attached to the midband ring of the insulating envelope and a grounding stick should always be used to discharge the ring as well as the other metal parts of the assembly before touching the interrupter, connections, or breaker studs. A long thin extension will be required on the grounding stick in order to reach the ring through the heat dissipating fins on some ratings.

2. High voltage applied across open gaps in a vacuum can produce x-radiation that may constitute a health hazard on prolonged exposure at close range unless the source is adequately shielded. The patented internal shield of the GE vacuum interrupter contributes to x-radiation control by providing a measure of radiation shielding.

   During equipment operation in the normal current carrying mode there is no x-radiation because there is no open contacts. When the contacts are open in normal service on a maximum rated 15 kV system, the x-radiation at one meter is well below the level of concern, and the metal clad equipment enclosure provides additional shielding.

CAUTION: AS WITH ANY OPEN CONTACTS IN A VACUUM HAZARDOUS X-RADIATION CAN BE PRODUCED IF THE VOLTAGE ACROSS THE CONTACTS EXCEED A CERTAIN LEVEL, WITH A CERTAIN CONTACT GAP; THERE FORE DO NOT CONDUCT HIPOT TESTS ON THE VACUUM INTERRUPTER AT VOLTAGES HIGHER THAN THE RECOMMENDED LEVEL OF 36 kV (RMS) 60 HERTZ. DURING THE HIPOT TEST, PERSONNEL SHOULD STAND AWAY FROM AND IN FRONT OF THE BREAKER TO TAKE ADVANTAGE OF THE SHIELDING AFFORDED BY THE FRONT COVER WHICH SHOULD BE LEFT IN PLACE DURING THE HIPOT PORTION OF INSPECTION.

MECHANISM

Check all items on the check list under SUMMARY OF MECHANICAL ADJUSTMENTS readjusting or tightening as required. Lubricate as recommended under LUBRICATION.

PRIMARY INSULATION PARTS

Using dry non-linting cloth or industrial-type wipers, clean accessible insulation surfaces on the interrupter supports and operating rod insulators. In service locations where contamination is heavy or external flashovers have occurred during interrupter high-potential testing, remove the interrupter and upper primary assemblies per the procedure in REPAIR AND REPLACEMENT and clean the inside surface of the interrupter supports and the outer insulation surface of the Power/Vac* interrupters. Be sure to discharge the interrupter midband ring before removing the interrupters. Removal and reassembly of interrupters will normally not require readjustment due to the design of the interrupter operating rod insulator connection.

LUBRICATION

Proper lubrication is important for maintaining reliable circuit breaker performance. The ML-17 mechanism uses bearings have a synthetic lining in some locations. These bearings do not require lubrication to maintain low friction, but lubrication does not harm them and oiling lightly is recommended. Sleeve bearings are used in some linkage locations and needle or roller bearings are used for low friction on the flywheel, trip shaft, and close shaft.

Bearings are lubricated during factory assembly with grease and oil but, all lubricants have a tendency to deteriorate by oxidation or contamination with age. Providing a fresh lubricant supply at periodic intervals is essential to proper breaker operation, especially where frequent operation may have forced lubricant out of the bearing surfaces. On all sleeve, needle, and roller bearings. Apply a few drops of light machine oil such as Mobil 1 at each bearing. Apply a few drops on the closing spring guide rod where it enters its sleeve inside the spring.

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

(1) Metal contact surfaces such as the movable contact rod of the interrupter should be lubricated with D6B15. This grease is available packaged in 4-ounce collapsible tubes to provide cleanliness and prevent oxidation.

(2) Silvered primary contact surfaces. Wipe clean and apply a light coat of D50H47 on primary disconnect fingers. General Electric lubricant D50H47 is also available packaged in 4-ounce collapsible tubes.

(3) Pins of the secondary disconnect coupler should be lightly coated with D6B15.

METHOD OF CLEANING BEARINGS

SLEEVE BEARINGS

The non-metallic sleeve bearings used utilize Teflon surfaces

and do not require disassembly unless worn. If worn they should be pressed out and replaced. After a number of operations the surface will acquire a thin black film. Do not remove this film unless the surface of the bearing has been damaged.

Bronze sleeve bearings are not pressed into location so may move from side to side.

ROLLER AND NEEDLE BEARINGS

The trip latch roller bearing and closing latch roller bearing are pressed into the frame or parts. In order to check the bearings and relubricate them, the shafts must first be removed and then the inner race disassembled. Clean the parts with petroleum solvent and a stiff brush. Apply a light coating of machine oil until the cleaner or solvent is entirely removed. Allow this oil to drain off and then repack the bearing with G-E lubricant D6B15 being sure all metal parts are greased.

Flywheel and output crank bearings should not be removed from frame for lubrication purposes. A major disassembly is required. A few drops of Mobil #1 should be applied when required.

When cleaning the bearings 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. Precautions against the toxic effects of the alcohol must be exercised by wearing rubber gloves and by using alcohol in a well ventilated room. Excessive exposure to the fumes is sometimes unpleasant to personnel. Bearings cleaned with alcohol should be washed with a light machine oil immediately after using the alcohol. After the machine oil has drained off the bearing apply G-E lubricant D6B15.

RECOMMENDED MAINTENANCE

A Power/Vac* breaker applied to normal operations should be serviced and maintained according to the following schedule:

For all ratings other than VB 4.16-350 and VB 13.8-1000 the following should be performed every 2000 operations or every year which ever comes first.

For VB 4.16-350 and VB 13.8-1000 the following should be performed every 1,000 operations or every year which ever comes first.

1. Make a visual inspection of the breaker and remove dust and contaminants from the vacuum interrupters, and insulation.

2. A high potential test should be applied to the vacuum interrupters as outlined under MAINTENANCE OF POWER/VAC* INTERRUPTERS.

3. Check the Power/Vac* contact erosion indicator as described.

4. Check the interrupter and mechanism adjustments as summarized under MECHANICAL ADJUSTMENTS. The necessary readjustments should be made as described under MECHANICAL ADJUSTMENTS.

5. The interrupters and operating mechanism should be carefully inspected for loose nuts, bolts, damaged parts, etc. All cam latch and roller surfaces should be inspected for damage or excessive wear.

6. Lubricate the breaker operating mechanism in accordance with instructions under LUBRICATION.

7. Inspect all wiring for tightness of connections and possible damage to insulation.

8. After the breaker has been serviced, it should be slowly closed and opened, as described in INSTALLATION, to be sure there is no binding or friction and that the movable contact of the interrupter can move to the fully opened and fully closed positions. Its electrical operation should then be checked using either the test cabinet or the test couplers.

For all ratings other than VB 4.16-350 and VB 13.8-1000 the following should be performed every 10,000 operations or every five years whichever comes first.

For VB 4.16-350 and VB 13.8-1000 the following should be performed every 5,000 operations or every five years whichever comes first.

1. At this time the breaker should be given a general overhaul and all excessively worn parts in both the mechanism and on the interrupters replaced. Such wear will usually be indicated when the breaker can not be adjusted to instruction book tolerances. This overhaul and inspection is more detailed and will require disassembly of mechanism and interrupter operating parts.

2. All roller and needle bearings in the operating mechanism should be disassembled, cleaned, and repacked with G-E lubricant D6B15 as described under LUBRICATION.

3. The interrupters and operating mechanism should also be serviced as described for 2,000 operation intervals and properly adjusted before being put back into service.

GENERAL

The following information covers in detail the proper ıod 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 breaker that are most subject to damage or wear. For more detailed information on breaker repair and replacement of parts consult Service Manual GEK 39676 "Power/Vac* Vacuum Circuit Breakers with ML-17 mechanism."

IMPORTANT: UPON COMPLETION OF ANY KIND OF REPAIR WORK, ALL INTERRUPTER AND MECHANISM ADJUSTMENTS MUST BE CHECKED.

Refer to the sections on MECHANICAL AND ELECTRICAL ADJUSTMENTS.

REPLACEMENT OF INTERRUPTER

Interrupters are supplied as a complete pole unit less the primary disconnect fingers. Four bolts holding the interrupter housing and split clamp connecting the interrupter to the operating insulator need to be removed to replace the interrupter assembly.

After the new assembly is installed reconnect the operating rod by slow closing the mechanism as described in MECHANICAL CHECKING. Guide the three operating rods into place as the mechanism closes.

PRIMARY DISCONNECT FINGERS

Primary disconnect fingers can be removed by removing pins. Finger contact surfaces should be coated with D50H47 lubricant.

MECHANISM

Pin Retaining Rings – These rings are widely used in the ML 17 mechanism to retain pins. They can be installed and removed with a pair of standard pliers. Reuse is not recommended after removal. To remove, slowly squeeze the removal ears while pulling. To install, position on the pin groove and squeeze the installation ears closed to no more than 1/16 inch gap between ears.

Front Angle Plate – Most mechanism repairs require removal of the mechanism Front Angle Plate for access. It is secured by ten bolts to the frame. Disconnect the counter spring and remove the indicator rod end at the close shaft crank (2), Fig. 14 when taking the plate off. To reinstall the plate, reconnect the rod end and be sure it passes over the close manual push-button lever. Secure the bolts to 20-25 foot-pounds and reconnect the counter spring.

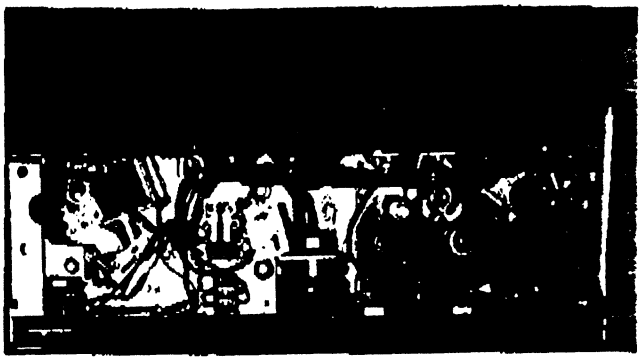


Fig. 15 (8043088)

Fig. 15 ML-17 Mechanism with Front Angle Plate Removed

The Front Angle Plate was a bearing for the Manual Wind Shaft. Great care must be exercised if the shaft is operated without this bearing. A side thrust will break the shaft.

WIND SHAFT SHEAR PIN

A flywheel wind shaft shear pin is provided to minimize the chance of gearmotor damage if a jammed flywheel should occur. After locating and correcting the jamming condition, remove the gearmotor. Remove all pieces of the old pin, align the spline coupling and shaft holes, install a new pin, and remount the gearmotor.

CONTROL SWITCHES

Control switches may be removed from their mounting brackets by disconnecting the wires and removing the two mounting screws. Use a small screwdriver to remove and replace the switch on the bracket checking that the correct type, normally open or normally closed, is used. Reinstall wire and adjust per MECHANICAL ADJUSTMENTS – CONTROL SWITCHES.

TRIP OR CLOSE COILS

To replace trip or close coils, cut wires close to the coil, loosen the coil bracket bolt closest to the plunger and remove the other bracket bolt. Pivot the bracket and remove the coil. Drive out the pole piece and install in the new coil. Slide the new coil over the plunger and into the bracket on the plunger end. Pivot the other bracket into position, locate so the plunger does not bind and torque the bolts to 20-25 foot-pounds. Butt connect the wiring, check adjustment and electrical and mechanical operation.

RENEWAL PARTS

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

Renewal parts which are furnished may not be identical to the original parts, since improvements are made from time to time. The parts which are furnished, however, will be interchangeable.

The renewal parts list covers all breakers listed on the cover.

ORDERING INSTRUCTIONS

1. Always specify the complete nameplate data of both the breaker and the mechanism.
2. Specify the quantity, catalog number (if listed), reference number (if listed), and description of each part ordered, and this bulletin number.
3. Standard hardware, such as screws, bolts, nuts, washers, etc. is not listed in this bulletin. Such items should be purchased locally.
4. For prices or information on parts not listed in the Renewal Parts List, refer to the nearest office of the General Electric Company.

RECOMMENDED RENEWAL PARTS FOR POWER/VAC * BREAKERS WITH ML-17 MECHANISM

No. Req'd	Description	Catalog No.
	Spring - Charging Motor	
1	48 V-DC	0282A2034P003
1	125 V-DC & 115 V-AC, 60 Hz	0282A2034P001
1	250 V-DC & 230 V-AC, 60 Hz	0282A2034P002
	Relay	
1	48 V-DC	0282A2008P001
1	125 V-DC	0282A2008P002
1	250 V-DC	0282A2008G001
1	115 V-AC, 60 Hz	0282A2008P003
1	230 V-AC, 60 Hz	0282A2008P004
	Potential Trip Coil	
1	48 V-DC	0282A2009P007
1	125 V-DC	0282A2009P008
1	250 V-DC	0282A2009P009
	Closing Coil	
1	48 V-DC	0282A2009P001
1	125 V-DC	0282A2009P002
1	250 V-DC	0282A2009P003
1	115 V-AC	0282A2009P004
1	230 V-AC	0282A2009P005
2	Control Switch, Normally Open	0282A2097P003
1	Control Switch, Normally Closed	0282A2097P002
1	Auxiliary Switch	0177C2114P001