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**GENERAL  
ELECTRIC**

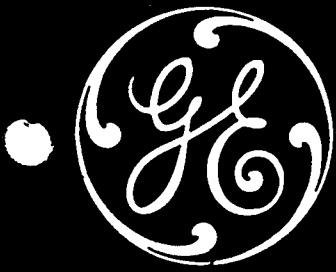


# 13

## GENERAL ELECTRIC

1. GEK-7302B INSTALLATION AND OPERATIONAL  
MANUAL FOR TYPES AK-15, AK-25, AK-50, AK-75,  
AK-100, AKT-50, AKU-25, AKU-50, AKF-25 AND  
AKF-2C/2D/2E
2. GEI-50299E MAINTENANCE INSTRUCTIONS FOR  
TYPES AK-2/2A-15, AK-2/3/2A/3A-25 AND  
AKU-2/3/2A/3A-25
3. GEF-4149G RENEWAL PARTS FOR TYPES  
AK-2/2A-15, AK-2/2A3/3A-25, AKU-2/2A/3/3A-25 AND  
AKF-2/2A-25





## INSTRUCTIONS

GEK-7302B  
Supersedes GEH-2021D

# LOW-VOLTAGE POWER CIRCUIT BREAKERS

## INSTALLATION AND OPERATION MANUAL

### TYPES

AK-2/3/2A/3A-15	AKT-2/3/50/50S
AK-2/3/2A/3A-25	AKU-2/3/2A/3A-25
AK-2/3/4/5/2A/3A/4A/5A-50/50S	AKU-2/3/4/5/2A/3A/4A/5A-50/50S
AK-2/3/2A/3A-75/75S	AKF-2/2A-25
AK-2/3/2A/3A-100/100S	AKF-2C/2D/2E

GENERAL ELECTRIC

AUXILIARY DEVICES SPECIFICATIONS

TYPE LOAD OR P. F.	VOLTAGE		INTERRUPTING RATING (AMPS)		
	Nominal	Range	Auxiliary Switch	Bell Alarm Switch	EC-1 Switchette
Resistance	48 DC	41-56	25.00	-	-
	125 DC	106-140	11.00	2.5	0.30
	250 DC	210-280	2.00	0.9	0.15
	600 DC	508-672	0.45	0.3	-
Electro- Magnet	48 DC	41-56	15.00	-	-
	125 DC	106-140	6.25	2.5	0.30
	250 DC	210-280	1.75	0.9	0.15
	600 DC	508-672	0.35	0.3	-
75 - 85% Lagging	120 AC	104-127	75.0	30.0	-
	240 AC	208-254	50.0	15.0	10.0
	480 AC	416-508	25.0	7.0	10.0
	600 AC	520-635	12.0	5.0	-
30 - 35% Lagging	120 AC	104-127	50.0	30.0	-
	240 AC	208-254	25.0	15.0	10.0
	480 AC	416-508	12.0	7.0	10.0
	600 AC	520-635	8.0	5.0	-
Continuous Rating (Amps)			* 20.0	* 10.0	* 10.0
Closing Rating (Amps) <sup>30-35% P.F.</sup> or resistive			50.0	30.0	**

\* Limited to 5.0 A continuous rating of #16 GA. wire on Drawout Breakers.

\*\* Adequate for use with AK Breaker Shunt Trip Coils of the voltage ratings listed in above table. (Maximum current of 12.3A for the 120 V. AC coil)

# INSTALLATION AND OPERATION

## OF TYPE AK POWER CIRCUIT BREAKER

### RECEIVING, HANDLING AND STORAGE

Before installing, or operating these circuit breakers, make a careful reading of the sections of these instructions which are pertinent to the anticipated work.

Upon receipt of a circuit breaker, immediately make an examination for any damage or loss sustained in shipment. If injury, loss or rough handling is evident, file a damage claim at once with the trans-

portation company and notify the nearest General Electric Sales Office.

Unpack the circuit breaker as soon as possible after it has been received. Exercise care in the unpacking to avoid damage to the breaker parts. Be sure that no loose parts are missing or left in the packaging material. Blow out any dirt or loose particles of packaging material remaining on/or in the breaker.

If the circuit breaker is not to be placed in service at once, store it in a clean, dry location in an upright position. Support it to prevent bending of the studs or damage to any of the breaker parts. Do not cover the breaker with any packing or other material which absorbs moisture, that may cause corrosion of breaker parts. A covering of kraft or other non-absorbent paper will prevent dust from settling on the breaker.

## INSTALLATION

### LOCATION

In choosing a location for the installation of an AK Circuit Breaker, there are two factors to be considered. The first of these is the effect of the location on the breaker itself. Much better performance and longer life may be expected if the area is clean, dry, dust-free, and well ventilated, than if the opposites to these conditions exist. The second consideration is convenience for operation and maintenance. The breaker should be easily accessible to the operator, and there should be sufficient space allowed for maintenance work to be done if this becomes necessary.

### MOUNTING

AK Circuit Breakers are designed to be mounted in any one of three ways. These are dead front mounting, individual mounting with the enclosure being provided, and drawout mounting in which the breaker is designed for insertion into a cubicle in drawout equipment such as a substation or control board.

### DEAD FRONT BREAKERS

These breakers are designed for mounting in a switchboard or enclosing case of the customer's design and construction. Mounting in this instance consists of bolting the breaker frame to a supporting structure within the switchboard or enclosure, connecting the power buses or cables, and making any necessary control connections. The front cover of the breaker enclosure may be a hinged door or a plate bolted to the panel. In either case, it should have a section cut out, through which the front escutcheon of the breaker may protrude. Outline drawing numbers giving the dimensions needed for preparing a suitable enclosure or cubicle for the various types of AK breakers are given below. These are for standard 2 or 3 pole breakers.

Breaker	Typical Outline Drawing No.
AK-2-15 and 25	695C116
AK-3-15 and 25	121C7570
AK-2-50 Man. Oper.	845C281
AK-2-50 Elec. Oper.	238C123
AK-3-50 Man. Oper.	121C7553
AK-3-50 Elec. Oper.	121C7555
AKT-2-50 Man. Oper.	102C3650
AKT-2-50 Elec. Oper.	102C3651
AKT-3-50 Man. Oper.	121C7589
AKT-3-50 Elec. Oper.	121C7590
AK-2-75 Man. Oper.	845C284
AK-2-75 Elec. Oper.	269C225
AK-3-75 Man. Oper.	121C7583
AK-3-75 Elec. Oper.	121C7557
AK-2-100 Man. Oper.	845C290
AK-2-100 Elec. Oper.	269C227
AK-3-100 Man. Oper.	121C7585
AK-3-100 Elec. Oper.	121C7559
AK-4-50 Man. Oper.	134C2600
AK-4-50 Elec. Oper.	134C2601
AK-5-50 Man. Oper.	134C2610
AK-5-50 Elec. Oper.	134C2611

The surface on which the breaker is mounted must be flat throughout in order not to impose any internal distortion on the breaker unit. The supporting structure must be rigid enough to avoid any possibility of the breaker studs supporting the weight of the breaker. Minimum cutout dimensions, as given by the appropriate outline drawing, must be maintained to provide adequate electrical clearance.

### INDIVIDUALLY ENCLOSED BREAKERS

Individually enclosed breakers are supplied with several types of enclosures, most common is the general purpose type or the weather resistant type. The former is used for favorable indoor locations and the latter for outdoor locations or indoor locations that may be subject to unfavorable conditions. All of the enclosures are provided with suitable means for mounting on walls or supporting framework. Removable cover plates are supplied with the enclosures which may be drilled or machined to accommodate the entrance of bus ducts,

conduits or cables. Steps in the procedure for installing enclosed breakers follow:

1. If the breaker is an AK-15, AK-25 or an AK-50, remove it from the enclosure. With AK-50 breakers, a handle and cam arrangement is used for that part of the breaker movement that involves the disengagement or engagement of the primary disconnect. AK-75 and AK-100 breakers are bolted solidly to the enclosure frame and need not be removed from the enclosure.
2. Remove cover plates of enclosure and prepare them to accommodate whatever power entrance means is used.
3. Mount enclosing case to supporting structure.
4. Replace cover plate and make power connections to stationary terminals in enclosure.
5. If the breaker is a type AK-15, AK-25 or AK-50 and has been removed from the enclosure, it may now be replaced. Control power connections to the terminal board should be made as required. (See CONNECTIONS).
6. Before energizing the power circuit, operate the breaker several times to be sure that it is functioning properly. (See OPERATION).

AK-4/5-50 breakers which are individually enclosed will have enclosures of the AKD5 drawout type. These breakers will be straight drawout breakers, types AK-4A-50 and AK-5A-50. (See instructions in this book under the heading, "Drawout Breakers AKD5 Equipment")

### DRAWOUT BREAKERS AKD EQUIPMENT

Mounting drawout breakers consists of simply placing the breaker in the proper position with respect to its enclosure, sliding or rolling it to a stop position, and, by means of a racking handle and mechanism, racking it through the last part of its movement during which the stationary and movable halves of the disconnects engage.

*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.*

Large drawout breakers are fastened to a telescoping tray which extends out from the enclosure to receive the breaker. Small breakers have guides on their side plates which slide in channels in the enclosures. Both large and small breakers have a test position in which the secondary disconnects are engaged, but the primary disconnects are not. In this position, the breaker may be operated electrically without energizing the load cable or bus.

Use D50H47 lubricant on the disconnect terminals to reduce the force required to insert the breaker.

#### Inserting Breaker AK-15 and 25

##### 1. Trip the breaker.

2. Raise the breaker until the guides on the sides of the breaker are level with their mating supporting channels in the enclosure, and slide the breaker part way into its enclosure. (Note - The breaker will be obstructed by a position stop at the bottom of the enclosure after the breaker has traveled only a short distance into the cubicle. Lift the position stop handle, located at the bottom right of the enclosure, which will release the position stop and allow the breaker to travel further into the cubicle).

3. Raise the rackout handle forward and up as far as its travel will permit and push the breaker into the enclosure until the rackout pins on the handle assembly bear against the housing rackout cams on the side of the enclosing case.

4. Push downward on the rackout handle forcing the pins on the handle up into the slot in the stationary cam plate. This action forces the breaker through a final short portion of its movement into the enclosure and allows the operator to provide the force necessary to make the primary disconnects engage the stationary studs in the enclosure. In performing this operation, make sure that the handle is rotated downwards as far as its free travel will permit and then pull the racking handle down to be sure the trip interlock is released. (Note - When the racking handle is in any position other than completely down, the breaker cannot be operated and is held trip-free by the trip interlock. This applies to the "fully in" and "test" positions.)

#### Withdrawing Breaker AK-15 and 25

1. Trip the breaker open. If the breaker is not open, the interlock lever of the drawout mechanism will not permit operation of the rackout handle.

2. Pull the racking handle up and forward as far as it will travel, disengaging the primary disconnects.

3. Slide the breaker out until the position stop engages in the front slot in the bottom of the breaker carriage. The breaker is now in the "test" position, where its primary disconnects are safely disconnected from the line and load terminals of the enclosure. (Note - Refer to section describing "Test Position" in these instructions.)

4. To remove the breaker from its enclosure, lift the position stop handle and slide the breaker forward until the position stop engages the rear slot in the bottom of

the breaker carriage. This is the safety position stop where both the primary and secondary contacts are disengaged. Again lift the position stop handle. Slide the breaker slightly forward to remove it from the enclosure.

#### Inserting Breaker AK-50, 75 and 100

1. Lift the breaker to a position approximately six inches above the height of the compartment tray.

2. Pull the drawout tray out under the breaker as far as the tray will travel. NOTE - When installing an individual skeleton housing for a drawout AK-50 or 75, locate a bolt head over the two front bottom mounting holes of the housing to provide a limit stop for the drawout tray.

3. Lower the breaker about 1/2" above the dowel pins on the tray and push the breaker back into its compartment so that the rear bottom angle of the breaker is against the guides on the tray directly back of the dowel pins.

4. Slowly lower the breaker onto the tray and at the same time guide it so that the holes in the rear angle of the breaker fit over the two dowel pins on the tray. If the breaker is correctly positioned on the dowels, its rear and side bottom frame angles will all sit firmly on the tray.

5. Insert two 3/8 inch hex. head screws through the holes in the front of the side angles on the breaker and thread them part way into the tapped holes in the tray. Do not tighten screws firmly. This provides better alignment of the primary stationary studs and the primary disconnects for the subsequent racking operation.

6. Push the breaker into the compartment until the "test" position stop engages to prevent further travel. (Note - Refer to section describing "Test Position" in these instructions.)

7. Release the test position stop by depressing its lever and push the breaker back into the compartment until the racking pins on the housing butt against the outer surface of the racking cam. In this position, the racking pin has lifted the locking arm on the cam which allows the racking handle to be lifted enough to allow the pawl to engage the first notch on the cam.

8. When the pawl engages the first notch on the cam, push the handle down again to its normal position. This causes the cam to rotate about the racking pin. Repeat this operation five times to rack the breaker into its final operating position. Interlocks hold the breaker trip free until it is racked into the fully contacted position. The fifth stroke of the handle is only a partial stroke and does not result in any further movement of the breaker. It does serve three useful purposes: it positions the cam so that it cannot rotate and allow the breaker to back out under short circuit stresses; the partial stroke signals that the racking operation is complete, and it releases the trip interlock which was engaged by the racking pin during the previous four pumps of the racking arm. NOTE: Once a racking operation has been started, it must be completed, as the breaker cannot be reversed until the racking operation is completed.

9. After completing the fifth racking stroke, lift the handle as high as it will go and allow it to drop to its normal position. NOTE: Any strokes beyond this point will cause the breaker to be trip free. Tighten the 3/8 inch hex head screws inserted in the front holes of the drawout tray during step 5 of this operation. The breaker is now in the operating position.

cause the breaker to be trip free. Tighten the 3/8 inch hex head screws inserted in the front holes of the drawout tray during step 5 of this operation. The breaker is now in the operating position.

#### Withdrawing Breaker AK-50, 75 and 100

1. Trip the breaker to release the positive racking interlock.

2. Lift the racking handle as far as it will go.

This operation will re-engage the trip interlock to hold the breaker trip-free for the remainder of the racking operation. Note that here the cam is rotated by lifting the handle, whereas in racking the breaker in, the operation is performed as a result of pushing the handle down.

3. Reset the handle to its lowered position and lift it again. This operation must be performed 5 times to completely disengage the cams from their racking pins. After the fifth lifting stroke let the handle drop to its normal position.

4. Pull the breaker out of its compartment until the test position stop engages to hold the breaker in the "test" position.

5. Depress the test position stop handle and pull the breaker out of its compartment as far as the drawout tray will travel.

6. Remove the two 3/8 hex. head screws which hold the breaker on the tray.

7. Attach a lifting device to the top frame of the breaker.

8. Lift the breaker approximately 1/2 inch off the dowel pins on the tray and then pull the breaker forward until its primary contacts clear the compartment.

9. Push the tray all the way back into its compartment. The breaker is now free from its compartment.

#### TEST POSITION

The "Test Position", as referred to in the previous instructions, is that breaker position where the primary power disconnect contacts are safely disengaged but the secondary control disconnects are engaged. In this position, the breaker may be tested or operated, manually or electrically without energizing the primary power circuit, provided the racking handle has been moved to the completely down position, thus releasing the trip interlock.

For a more complete description of drawout mechanisms and enclosures see AKD DRAWOUT EQUIPMENT INSTRUCTIONS, GEH-1830 and AKD5 Drawout Equipment Instructions GEI-90890.

#### DRAWOUT BREAKERS AKD5 EQUIPMENT

NOTE: AKD5 breakers are identified by letter "A" appearing after breaker number - example, "AK-2A-15".

Drawout Mechanism Operation - There are four positions of the drawout mechanism:

1. The Connected Position - the breaker in the operating position, both primary and secondary contacts made and the door may be closed.
2. The Test Position - the primary (power) contacts not made but the secondary (control) contacts are made. Any breaker test not involving power may be made in this position. The door may be closed in this position.
3. Disconnect Position - neither the primary nor the secondary contacts made. The door may be closed.
4. Fully Withdrawn Position - the breaker completely out of its compartment ready for removal from the inner housing. The door must be open in this position.

Breaker Insertion AK-2A/3A - With the inner housing in the connected position proceed as follows:

1. Insert handle on jackscrew shaft located on left hand side of compartment right above indicator.
2. Rotate handle counter clockwise until jackscrew is stopped. (Indicator should read DISC).
3. Remove handle and open compartment door.
4. Rotate the two track lock links and pull the right track to the limit of its travel.
5. Using a lifting device, raise the breaker until the breakers mounting pins are approximately one inch above the tracks.
6. Pull the remaining track out to the limit of its travel and lower breaker so the breaker mounting pins drop into the slots in the track. Remove the lifting device.

NOTE: TERMINAL BOARD LOCATED ON RIGHT SIDE OF BREAKER FOR AK-15/25 WITH EXTERNAL CONNECTIONS MADE TO RIGHT SIDE OF BOARD. FOR AK-50/75/100 TERMINAL BOARD LOCATED ON LEFT SIDE WITH EXTERNAL CONNECTIONS MADE TO LEFT SIDE OF BOARD.

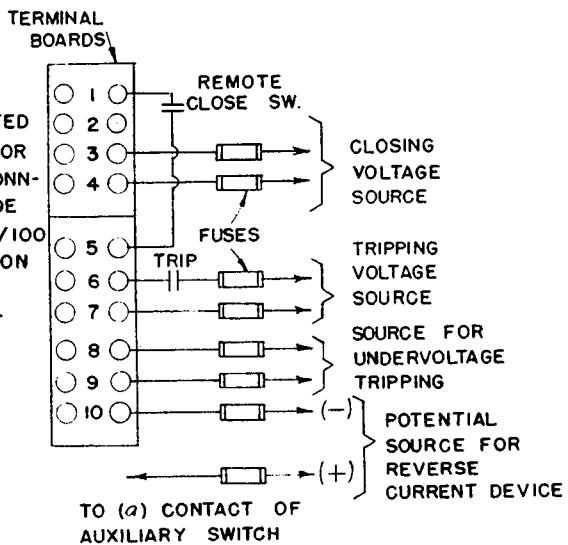


Fig. 1 (Front View)

7. Push the breaker in against the track stops. Rotate the two track lock links to lock the breaker in place. Close the compartment door.
- NOTE: When moving a breaker from one position to another, be sure breaker is tripped open.
8. Insert handle on jackscrew shaft and rotate clockwise to move breaker into the compartment. Breaker is in connected position when jackscrew can no

longer be rotated. (Indicator should read CONN.).

Breaker Insertion AK-4A/5A - With the inner housing in the connected position, proceed as follows:

1. Open door and remove wooden wedge in the lower guide slot of the inner housing.
2. Pull inner housing forward as far as possible.

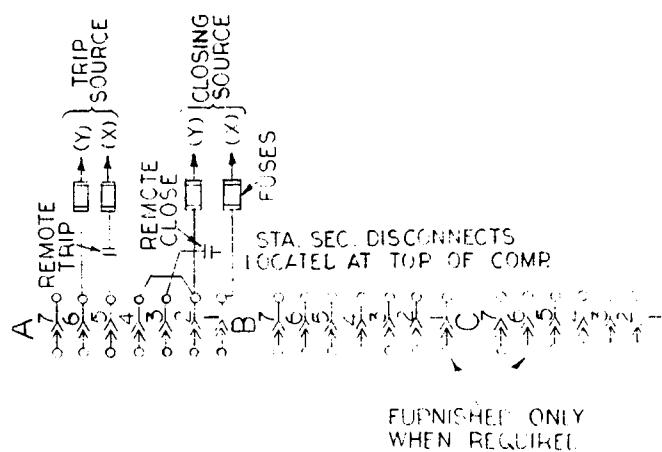
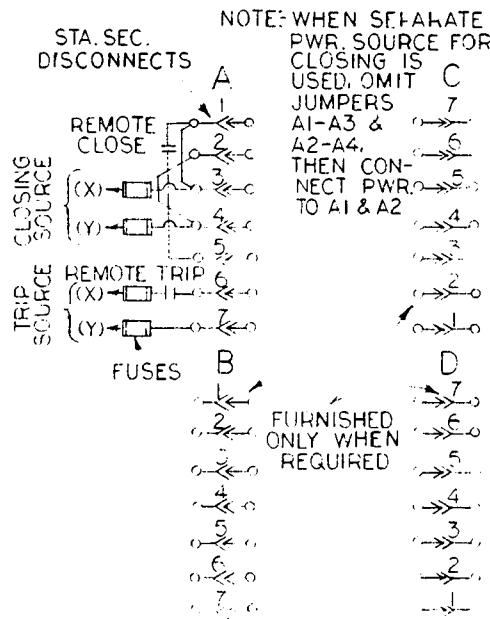


Fig. 3 Front View AK-50, 75, 100 Breaker Compartment

GEK-7302 Installation and Operation of Type AK Power Circuit Breakers

3. Rotate the two track lock links, and pull the right track all the way forward.
4. Using a lifting device and the spreader provided for these breakers, raise the breaker and position it so that the mounting pins on the side of the breaker line up with the slots in the track and are about 2 inches above the track.
5. Pull the left track out and lower the breaker so that the mounting pins engage the slots in the tracks.
6. Engage the racking handle. This is done by pushing the trip button in the breaker escutcheon, sliding the cover below it to the right, and inserting the handle on the jackshaft.
7. Turn the handle counterclockwise as far as it will go, (if it will move in that direction) and remove the handle.
8. Push the breaker in against the track stops, and lock the track links.
9. Close the compartment door. Again engage the handle as in step 6, and rotate the handle clockwise as far as it will go. Towards the end, a high force requirement will be felt as the disconnect fingers on the breaker engage the stationary studs. A couple of turns later, and the stop will be encountered. The position indicator will now show "CONN."

Breaker Removal AK-2A/3A

1. Trip the breaker.

2. Move the breaker and inner housing to the fully withdrawn position. (See Breaker Insertion, Steps 1, 2 and 3).

3. Rotate the two track lock links and pull the breaker out to the limit of the track travel. Attach lifting device and lift breaker up and away from compartment until primary disconnects clear the compartment.
4. Move the inner housing to the connected position by pushing the tracks back against the track stops and then follow Steps 7 and 8 under Breaker Insertion. The inner housing is now in the connected position and the breaker is free from its compartment.

Breaker Removal AK-4A/5A

1. Trip the breaker.
2. Engage the handle and rotate it counterclockwise. If the breaker closing spring is fully charged, it will be discharged automatically a couple of turns before the end of the action.
3. Open the door, unlock the track locks, and pull the breaker all the way forward. The breaker may now be lifted from the tracks.

NOTE: The installation of AK-2/3-50S/75S/100S/AKF2C/2D and breakers equipped with the quick-closing mechanism is the same as the other breakers described in this book. The only difference occurs with drawout breakers. The compartments that house the quick-close breakers will be equipped with an interlock that prevents the manual discharging of the closing springs while the

breaker is in the racked in (connected position). This interlock, when requested, will be provided with both AKD and AKD5 equipment that require quick close breakers

CONNECTIONS

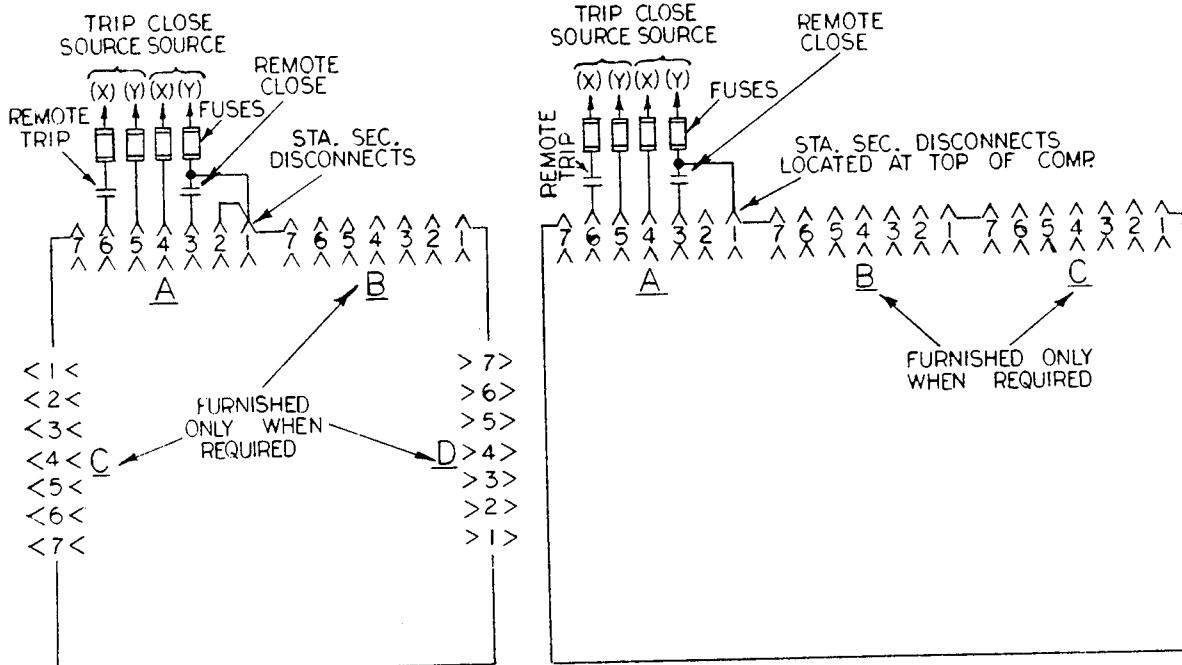
All electrical connections should be made to assure good conductivity. Mating surfaces should be parallel and firmly bolted or clamped together. Contact surfaces should be clean and have a smooth finish. The bus or cable connecting to the breaker should have adequate current-carrying capacity to prevent excessive heating. Control circuit connections should be made according to the wiring diagram which applies to each breaker specifically. Depending on the breaker type, those connections are made either to a terminal board on the breaker or to the stationary parts of the secondary disconnects.

INDIVIDUALLY ENCLOSED AND STATIONARY BREAKERS

The customers external connections for operation of breaker control components and accessories are shown in Fig. 1.

DRAWOUT BREAKERS

The customers external control connections to these breakers are made to the stationary secondary disconnected located in the breaker compartment as shown in Figs. 2 and 3, AKD Equipment and Figs. 4 and 5 AKD5 Equipment. (Note - If the breaker is used in a General Electric Company, Drawout Switchgear Equipment, all external connections must be made to terminal blocks located in the rear vertical wiring trough of the equipment.)



FRONT VIEW AK-1A-15, 25 & AK-2A-15, 25  
BREAKER COMPARTMENT

FRONT VIEW AK-2A-50, 75, 100  
BREAKER COMPARTMENT

TYPICAL WIRING DIAGRAMS

## **OPERATION**

## **MANUAL CLOSING**

AK-15/25 manually operated breakers are closed by turning the handle 90 degrees counterclockwise and then clockwise 90 degrees back to the original position. The initial counterclockwise movement resets the closing mechanism. The clockwise movement closes the breaker.

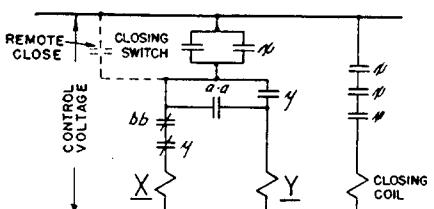
The closing mechanism of the AK-2/3-50/75/100 manual breakers is a spring charged mechanism similar to the one used on AK-2/3-50/75/100 electrically operated breakers. AK-2/3-50/75/100 manual breakers are closed by rotating the closing handle counterclockwise through approximately 120 degrees, and then clockwise back through 120 degrees to the normal handle position. Four such complete movements of the handle are required to close the breaker. During the four counterclockwise movements and the first three clockwise movements of the handle, the springs are charged. After approximately 70 degrees travel of the fourth clockwise handle movement, the spring charged mechanism is driven over-center and the breaker closes. A charge-indicator, numbered 1 to 4, viewed through the breaker front escutcheon, moves with each complete handle movement and indicates the number of complete handle movements that have been performed.

AK-4/5-50 manual breakers are also closed by means of energy released through the discharge of a closing spring. The charging of the spring is done by a single stroke of the breaker handle. This involves raising the handle counterclockwise from the vertical position until a stop is encountered after about 140 degrees of rotation. The spring is then extended to its fully charged position as the handle is returned to its normal vertical position. Release of the spring, and resultant closing of the breaker, occurs when the "close" button in the escutcheon is pushed. (The breaker will close only if the racking mechanism is in the "CONN" or "TEST" position.)

## ELECTRICAL CLOSING (Figures 6 and 7)

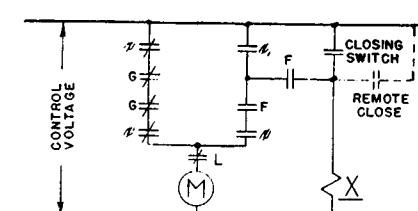
## **STANDARD BREAKERS**

AK-15 and AK-25 electrically operated



LEGEND  
X = X RELAY COIL  
N = X RELAY CONTACT  
Y = Y RELAY COIL  
Y = Y RELAY CONTACT  
aa-bb = MECHANICALLY OPERATED SWITCHES  
 $\frac{1}{+}$  = NORMALLY OPEN SWITCH CONTACTS  
 $\frac{1}{-}$  = NORMALLY CLOSED SWITCH CONTACTS

Fig. 15. Simplified Elementary Diagrams  
Internal Wiring AK-15 and 25



**LEGEND**

- (M) CLOSING MOTOR
- (X) RELAY COIL
- (C) RELAY CONTACT

**F&G = MECHANICALLY OPERATED SWITCHES**

- (+) = NORMALLY OPEN SWITCH CONTACTS
- (-) = NORMALLY CLOSED SWITCH CONTACTS

L = AUXILIARY SWITCH CONTACT

Fig. 7 Simplified Elementary Diagram  
Internal Wiring AK-50, 75 and 100

**LEGEND**

- CC - CLOSING RELAY COIL
- G - CLOSING RELAY CONTACTS
- X - ANTI-PUMP RELAY CONTACTS
- F - MECHANICALLY OPERATED SWITCHES
- L - AUXILIARY SWITCH CONTACTS
- (M) - CLOSING MOTOR
- W - ANTI-PUMP RELAY COIL
- X - CONTROL RELAY CONTACTS
- - CONTROL RELAY COIL
- +— NORMALLY OPEN SWITCH CONTACTS
- +— NORMALLY CLOSED SWITCH CONTACTS

Fig. 8

energized, operating the X contacts. This seals in the X relay and energizes the motor once again and the closing operation takes place.

**QUICK CLOSE BREAKERS  
(Figure 8)**

Functionally, the quick close mechanism differs from the standard electrical mechanism in that the pre-charge operation is extended to completely charge the closing springs. At the end of the charging operation, which takes approximately 5 seconds, (2 seconds for AK-4/5-50 breakers) a latch plate engages the prop roller to prevent the closing springs from discharging.

With the closing springs fully charged the breaker is ready for a closing operation upon release of the prop roller. This may be accomplished either manually, by depressing the closing lever on the breaker, or electrically by closing the remote closing switch. Upon the release of the prop roller the closing springs discharge and close the breaker in the same manner as on the standard electrical breaker. AK-4/5-50 breakers are closed through a remote switch or the close button in the escutcheon, (if the breaker is equipped with a push button closing switch).

With control voltage applied, the motor is energized through the G switch contacts, and charges the closing springs. When the springs reach the fully charged position, the mechanically operated switches operate, reversing their contacts. Upon operation of these switches the motor is stopped by the opening of the G switch. The closing of the F switch prepares the breaker for a closing operation.

A closing signal now given energizes the control relay X whose contacts close and complete the circuit through the closing relay coil. With the closing relay coil energized the breaker closes as described above. At the same time the closing relay contact closes to energize the anti-pump relay causing its contacts to reverse providing the anti-pump feature.

When the breaker closes, the mechanical operated G switches close to energize the motor again and the F switches open and de-energize the control relay. The auxiliary switch contact opens preventing the control relay from being energized until the breaker is tripped open. With the G switches closed, the motor charges the closing springs ready for the next closing operation.

#### MANUAL OR MAINTENANCE CLOSING OF ELECTRICAL BREAKERS

All electrical breakers may be closed manually by means of the maintenance handle furnished with the breaker or switchgear.

To close AK-15/25 breakers:

1. Place the two small hooks of the handle into the two slots located in the lower portion of the front escutcheon.
2. Rotation of the long end of the handle downwards forces the shorter end of the handle upwards against the bottom of the solenoid armature, and closes the breaker's contacts.

To close AK-2/3-50/75/100 breakers:

1. Place the ratchet type maintenance handle on the shaft that protrudes from the gear reduction unit.
2. Operate handle until the spring charge indicator reads charged.
3. Continue to operate handle until the closing springs discharge and close the contacts.

To close AK-50S/75S/100S, AKF2C, 2D breakers and breakers equipped with the quick closing mechanism:

NOTE: All AKD, or AKD-5 drawout type breakers equipped with the quick closing mechanism cannot normally be closed manually when in the racked in (connected

position), due to mechanical designed interference between the enclosure and the spring discharge lever on the breaker. If manual closing is desired with the breaker racked in, the interference feature must be removed, otherwise the breaker can be manually closed in the test position or fully racked out position only.

1. With the ratchet type maintenance handle applied to the gear box shaft, operate the handle until the springs are fully charged. The fully charged position is indicated by the spring charge indicator and by solid resistance to any further handle operation.
2. Push down on the push to close lever to release the energy stored in the closing springs which closes the breaker's contacts.

To close AK-4/5-50 breakers:

NOTE: AK-4A and AK-5A drawout breakers will be "trip-free" if the racking mechanism is in any position other than the "TEST" or "CONN" position. If the breaker is on a workbench or on the extended rails, and it is to be closed with the maintenance handle, operate the drawout mechanism as far as it will go in a clockwise direction. This will put the mechanism in the "connected" position, and the breaker may be closed. If this is done, the mechanism will have to be reset to the "disconnected" position before it can be reinserted into the breaker compartment in the enclosure.

1. Place the maintenance handle on the end of the camshaft below the motor.

2. Operate the handle until the closing spring goes over center and the breaker closes. If the breaker is a "quick-close" breaker, type AK-4/5-50S, the spring will not release upon going over center, but will be held off by a blocking link. This can be released by pulling forward on the closing solenoid armature located beneath the mechanism. This can be done safely, since no moving parts are located in this space.

#### TRIPPING

The breaker is tripped open by the displacement of a mechanism latch, which allows a toggle linkage supporting the movable contacts in the closed position to collapse. This trip latch is fastened rigidly to a trip shaft which runs horizontally from left to right through the

breaker. All of the means provided for tripping the breaker operate through striker arms which displace the mechanism trip latch by moving against trip paddles fastened on the trip shaft. Looking at the breaker from the right, counterclockwise rotation of the trip shaft causes the breaker to trip; clockwise movement resets the mechanism latch. The manual trip button, overload devices, shunt trip, undervoltage tripping device, and reverse current trip all operate in this fashion to trip the breaker. The movement of the striker arms of all of these, when activated, should move from 1/32 to 1/16 inch beyond the point at which tripping occurs. This is what is meant by the expression, "positive tripping".

NOTE: BEFORE MAKING ANY ADJUSTMENTS TO TRIP DEVICE SETTINGS, THE BREAKER SHOULD BE IN THE OPEN POSITION AND CONTROL POWER REMOVED.

Most AK-2 and AK-4 air circuit breakers are equipped with series overcurrent trip devices either of the dual magnetic type (instantaneous and time delay tripping) or instantaneous alone. Breakers are designed to carry up to 100% of the continuous current rating of their trip devices. Any attempt to carry higher currents for a prolonged period will cause overheating and possible damage.

All AK-3 and AK-5 type air circuit breakers will be equipped with Power Sensor\* overcurrent trip devices. The time current band as well as the pickup settings of this device are adjustable. A single captive thumb screw adjusts all three phases for any particular characteristic or setting. Should a thumb screw be inadvertently left loose the Power Sensor\* will revert to the "minimum" pickup settings or "maximum" time delay bands accordingly. If after installation, nuisance tripping occurs, check the Power Sensor\* for proper settings as required for the specific application and tighten all the thumb screws on the Power Sensor\*.

For a more detailed discussion of the construction, operation, and application of overcurrent trip devices refer to the following publications:

1. Maintenance manual for specific breaker involved (see "Maintenance").
2. "Selection and Application of Power Circuit Breakers" GET-1113.

## TYPE AKU AND BREAKERS WITH FUSE-BREAKER COMBINATIONS

#### Open Fuse Lockout Device

This device may be furnished with any of the above type breakers. The open fuse lockout device consists of 3 separately operated devices (one per breaker pole) each wired in parallel to corresponding breaker fuses. These devices are mounted on the

left hand side of the breaker (looking from front). The purpose of this device is to trip the breaker upon the blowing of any one of the breaker fuses. This energizes the coil of the device causing the armature to engage the trip paddle, thereby tripping the breaker. Once operated, the armature is

latched in the closed air gap position allowing the reset button to extend forward indicating which fuse has blown, and simultaneously holding the breaker in the trip-free position until the latch closed armature is released by the operating of the manual reset button.

## MAINTENANCE INSTRUCTIONS

### INSPECTION

BEFORE INSPECTION OR ANY MAINTENANCE WORK IS DONE, BE SURE THAT THE BREAKER IS IN THE OPEN POSITION. ALL ELECTRICAL POWER, BOTH PRIMARY AND CONTROL SOURCES SHOULD ALSO BE DISCONNECTED.

Periodic inspection of the circuit breaker is recommended at least once a year. More frequent inspections are recommended, if severe load conditions, dust, moisture, or other unfavorable conditions exist.

Always inspect the breaker after a short circuit current has been interrupted.

At the time of inspection, the following checks should be made after the breaker has been de-energized.

1. Manually operate the breaker several times, checking for obstructions or excessive friction.

2. Electrically operate the breaker several times (if breaker has electrical control) to ascertain whether the electrical attachments are functioning properly.

3. Remove the arc quenchers by removing the channel shaped retaining bar.

4. Inspect arc quenchers and contacts for breakage or excessive burning.

Should arc quencher barriers or contacts be eroded to half their original thickness they should be replaced.

### LUBRICATION

In general, the circuit breaker requires moderate lubrication. Bearing points and sliding surfaces should be lubricated at the regular inspection periods with a thin film of GE Lubricant D50H15. Before lubricating remove any hardened grease and dirt from latch and bearing surfaces with kerosene. ALL EXCESS LUBRICANT SHOULD BE REMOVED WITH A CLEAN CLOTH TO AVOID ANY ACCUMULATION OF DIRT OR DUST.

On drawout breakers, the contact surface of the disconnect studs should be cleaned and greased with GE Grease Specification D50H47.

These instructions have as their purpose the imparting of information of a general nature concerning the installation and operation of Type AK power circuit breakers. If more complete and specific information is required, such as might be needed for overhauling the breaker, trouble

shorting, or replacing parts of the breaker, refer to the complete instruction for the particular breaker type involved. These are:

Maintenance Manual	Breaker Type
GEI-50299	AK-2/2A/3/3A-15125, AK U-2/2A/3/3A-25
GEI-93863	AKF-2/2A-25
GEK-7303	AK-2/2A/3/3A-50/75/100, AKU-2/2A/3/3A-50
GEK-7301	AK-2/2A/3/3A-50S/75S/100S, AKF-2C/2D/2E Power Sensor Solid State Test Instructions
GEK-7310	AK/AKU-4/5-50/50S
GEK-7309	Test Instructions for Installation or service of Power Sensor Equipped AK breakers
Renewal parts bulletins for the various types of breakers are:	
Bulletin	Breaker Type
GEF-4149	AK-2-15/25
GEF-4150	AK-2-50
GEF-4395	AK-2/2A/3/3A-75
GEF-4396	AK-2/2A/3/3A-100
GEF-4527	AK-4/5-50

GENERAL ELECTRIC COMPANY  
CIRCUIT PROTECTIVE DEVICES DEPARTMENT  
PLAINVILLE, CONNECTICUT 06062

GENERAL  ELECTRIC





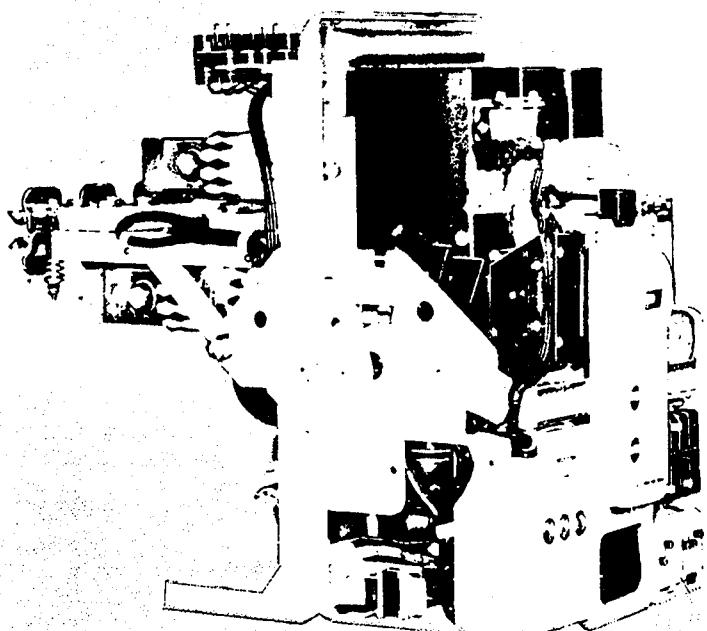
Maintenance  
Instructions



# Power Circuit Breakers

Types AK-2/2A-15  
AK-2/3/2A/3A-25  
AKU-2/3/2A/3A-25

\*Includes Supplement GEI-86153



GENERAL ELECTRIC

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shaped section which is easily accessible to a small, open end, 1/4 inch wrench. Two cantilever springs, which bear on each end against a portion of the hexagon section of the pin, lock the adjusting pin in place and provide index stops for the process of adjustment. The right hand hexagon shaped end of the pin is numbered from 1 to 6, which provides a reference for making wipe adjustments.

When contacts are to be adjusted, the recommended procedure is as follows:

1. With the breaker in the open position and using the numbers on the right end of each adjusting pin as a reference, set each pin in the same position. In many cases, the number 3 is a good beginning point. The proper view of the number on the adjusting pin is obtained by viewing the breaker from the front and the adjusting pin from approximately a 15 degree angle with respect to the movable contacts. Note that the numbers on the pin are not in numerical sequence as the pin is rotated.
2. By measurement, establish the position of the front surfaces of the stationary contacts with reference to the steel arc runners above and behind the contacts.
3. Close the breaker, and establish the amount of wipe by again measuring as in step two, and comparing the measurements with those taken with the breaker open.
4. If any set of contacts lead or lag the others, open the breaker and advance or retard the adjusting pin to the next higher or lower number. Moving the adjusting pin to a higher number will increase the contact wipe and moving to a lower number will decrease the contact wipe.

NOTE: No attempt should be made to move the adjusting pin when the breaker is closed. Besides being more difficult, the additional force required to move the pin will tend to round off the flats of the hex section of the pin.

5. When all the contacts have the recommended wipe of 3/32 to 5/32 of an inch, the contact adjustments are complete.

#### CONTACT REPLACEMENT

Figure 3

The normal situation that will exist in the matter of contact replacement will call for replacement of all the movable and stationary contacts at the same time. This will be the case

where long use of the breaker in service has resulted in extensive wear or erosion of the silver alloy contact tips. A commonly used "rule of thumb" is that contact replacement is indicated if less than one-half of the original thickness (1/8 of an inch) of the contact tip material remains.

#### GENERAL PREPARATION

1. Remove arc quencher retainer (1), Figure 5 by loosening the two captured nuts with a 7/16" wrench.
2. Lift off the three arc quenchers.
3. Remove the U shaped insulation (5) Figure 3 from each pole by lifting it and disengaging the rivet heads thru the keyholed slots in the insulation.
4. As an aid to future reassembly of the movable contacts, note the position of all stationary insulation barriers with respect to barriers mounted on the cross bar.

#### REMOVAL OF MOVABLE CONTACTS (18) Figure 3.

1. Screw the threaded end of the steel rod lightly into pivot pin (11) on the right pole.
2. With a pair of long nosed pliers, unhook safety pin type spring clip (9) and extract pin (11) and remove spring clip (9).
3. Grasp movable contact assembly and remove it from its seat on the cross bar.
4. Repeat procedure 1, 2, and 3 above on the left pole.
5. Move the cross bar downward to disengage it from the contact wipe adjusting pin (15) on the center pole, then move the cross bar toward the front of the breaker.
6. Remove the split pin retaining the center pole pivot pin.
7. Remove the pivot pin and movable contact assembly.

#### REMOVAL OF STATIONARY CONTACTS (21) Figure 3.

1. Slip the blade of a heavy screw driver between the two upper contacts and force the contacts toward their pivot point sufficiently far to disengage the contact stop surface from the pin.
2. The contact can then be removed by disengaging the end of the contact from its spring.
3. The two lower contacts can be similarly removed.

#### REPLACEMENT OF STATIONARY CONTACTS (21) Figure 3.

1. Coat the contact pivot area only of each of the four contacts with a thin coat of D50H47 grease. Use only D50H47 grease.
2. Note the difference between the two types of

stationary contacts and be sure to locate them in the breaker with the upper and lower contacts having their stop projecting surfaces as shown in the section AA, Figure 3. The upper left and lower right contacts are identical as are the lower left and upper right contacts.

3. By placing the hook on the end of the contact through the loop of the contact spring, the contact can be pushed toward the pivot surface and slipped behind the stop pin. Install all stationary contacts in all poles.

#### REPLACEMENT OF MOVABLE CONTACTS (18) Figure 3.

1. Coat the pivot area only of the new movable contacts with a thin coat of D50H47 grease.
2. Assemble the center pole movable contacts, align the pivot pin holes with the bullet nosed rod, and install the pivot pin and split pin.
3. Move the cross bar assembly into position and insert the eccentric contact wipe adjust-

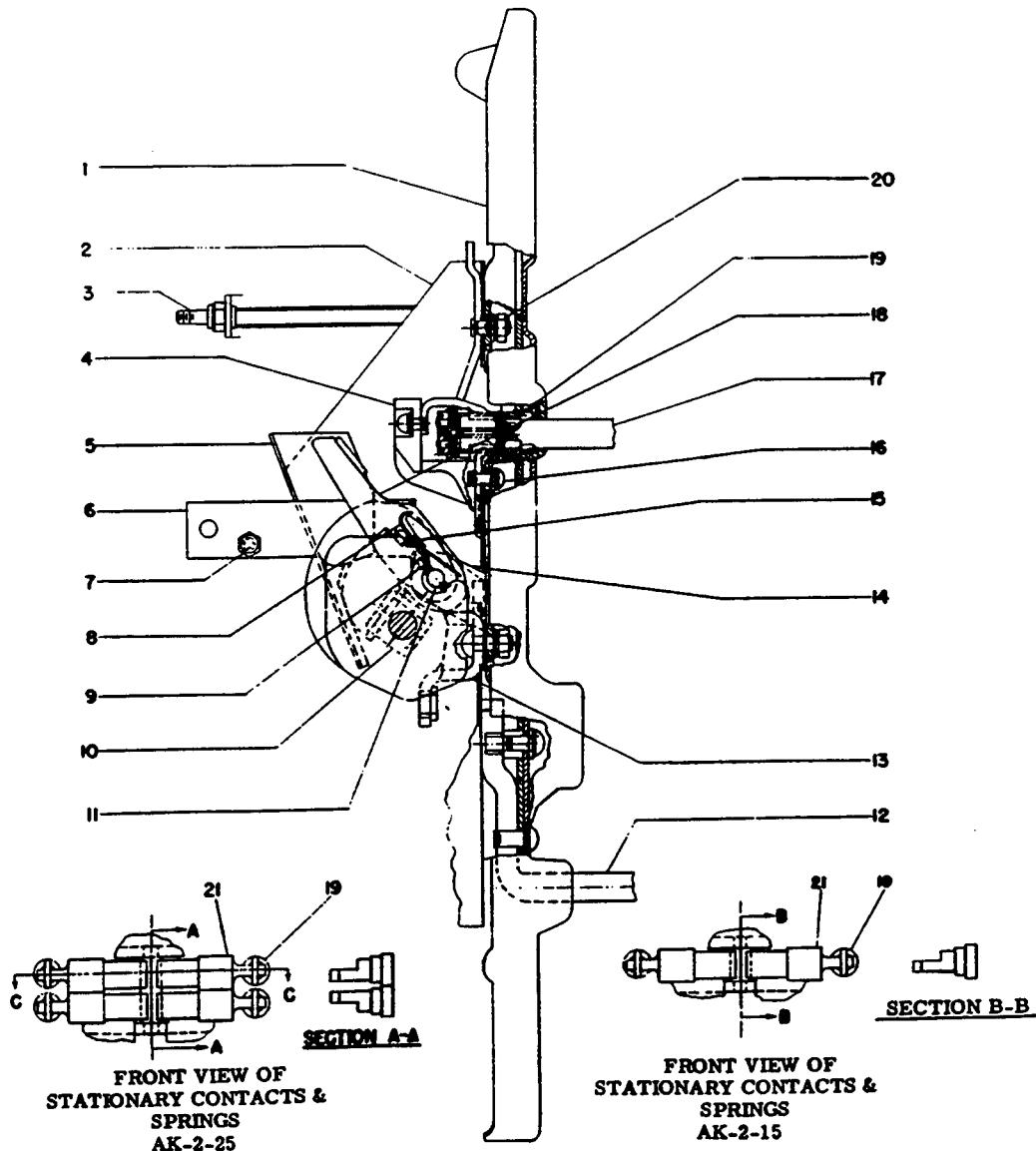


Figure 3. (549D409-2) Contact Assembly

1. Breaker Base	8. Spring	15. Contact Wipe Adjustment Pin
2. Insulation	9. Spring Clip (Retainer)	16. Screw
3. Insulated Stud	10. Cross Bar	17. Upper Stud & Arc Runner
4. Upper Stud Barrier	11. Pivot Pin	18. Movable Contact
5. Insulation	12. Lower Stud	19. Spring
6. Links (Insulated)	13. Contact Pivot Support	20. Nut
7. Tie Bolt	14. Spring	21. Stationary Contacts

ment pin (15) on the center pole into position. Be sure the stationary insulation barriers are correctly located.

4. Align the cross bar with the left and right pole pivot supports and install the left and right pole movable contacts. Use the bullet nosed steel pin to aid in aligning the holes in the cross bar, the contacts and the pivot supports.
5. Install the left and right pole pivot pins while threading them through the spring clips and lock the spring clips (9). Be sure the pivot pins are fully inserted.
6. Adjust the contact wipe to  $1/8" \pm 1/32"$  by adjusting the eccentric contact wipe adjusting pin (15). The breaker must be open to adjust the wipe. In the event acceptable wipe cannot be obtained by moving the contact wipe adjusting pin (15), from the movable contact forward or backward as necessary to bring the wipe within the range of the contact wipe adjusting pin (15). Do not exceed the recommended settings for wipe; otherwise the breaker may not close completely. When viewed from the top with the breaker closed, the movable contact should be centrally located with respect to the stationary contacts. If the movable contacts are not centrally located as shown in section CC, form the movable contacts until they are nominally centered.

If the moving contacts are not centered with  $1/8"$  separation when closed against the fixed contacts, they should be bent laterally (after opening the breaker contacts). To do this without squeezing the two movable contact arms together, a  $1/8"$  spacer plate should be inserted between them; then the pair can be grasped with pliers and bent in the desired direction for centering.

New contacts should be adjustable using eccentric numbers 1, 2, or 3. These numbers are the ones visible when viewing the breaker from the front, not from above. (The higher numbers should be reserved for tightening at future maintenance readjustments after wear.) Also, if higher numbers are used, where adequate wipe is obtainable at settings 1, 2, or 3, it is possible that the stationary contacts will bottom, producing excessive back force on the breaker closing mechanism so that the toggle link will not pass center. As a result, the breaker will not complete its stroke, and inadequate pressure and wipe will result; burn-up of contacts from just load current will follow.

If the required wipe of new contacts cannot be obtained with eccentric number of 3 or lower, bending of the contact arms toward the closed position is required. This should be done individually, using an 8" Crescent or 1/2 - 5/8" tapered open end wrench to grasp the contact and a 10" Crescent or the 1" - 1-1/8" tapered

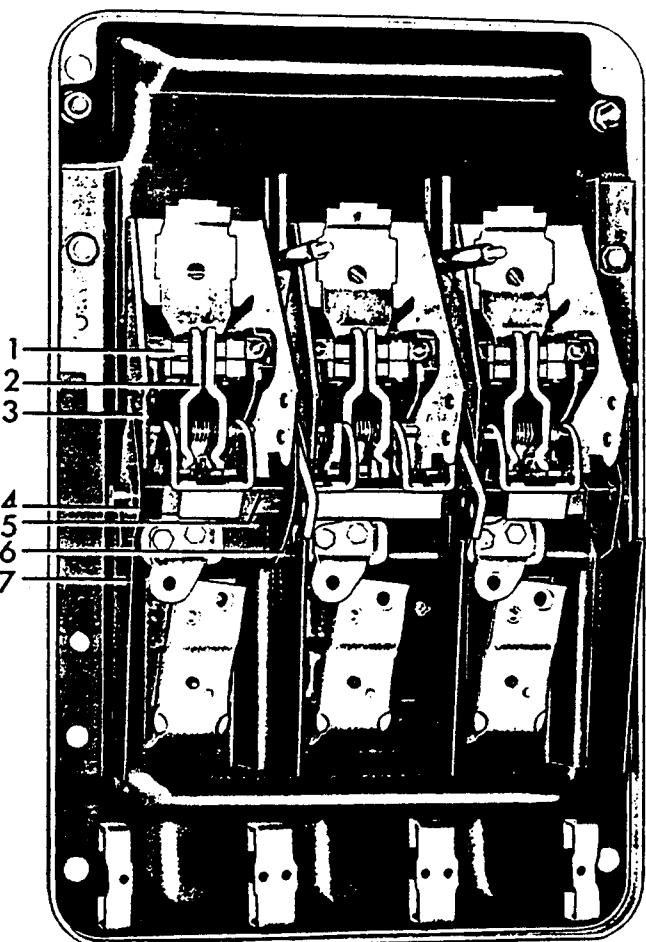


Figure 4. (8039851) AK-2-25 Back Frame - Location of Crossbar and Pole Shields

1. Stationary Contacts
2. Movable Contacts
3. Upper Stud Asbestos Shield
4. Crossbar Plastic End Shield
5. Crossbar Assembly
6. Crossbar Asbestos Inner Shield
7. Lower Stud Asbestos Shield

open-end wrench to grasp the pivot portion of the arm. The soft copper arm will bend with little difficulty. Both arms should be bent identically.

Operate breaker several times, and recheck wipe to make sure bending of movable arms did not occur in these operations.

7. Operate the breaker manually several times to assure proper functioning occurs, then replace the U shaped insulation (5) Figure 3 and arc quenchers. When replacing the arc quenchers be sure the quencher is seated downward completely and that the quencher clamp covers the knobs protruding through the arc quencher insulation.

## CONTACT SPRINGS (19) Figure 3

A minimum force of 5 lbs and a maximum force of 9 lbs. should be required to begin movement of a single stationary contact from the open position towards the closed position. This may be checked by using a push scale applied at the point at which the movable contact touches the stationary contact. If these pressures are not obtained or if the spring is damaged, replacement is required.

In order to replace the contact spring the upper stud (17) must be removed. The hardware which fastens the stud to the breaker base consists of two screws (16), and nut (20). When these are removed, the stud may be withdrawn from the base in a forward direction. After the stud has been removed, it is a simple matter to disconnect the two ends of the spring (19) and replace it with a new one.

## MECHANISM

The breaker mechanism is a spring actuated, over-center toggle type of mechanism. As the closing force is applied, either by movement of the operating handle or the closing solenoid armature, energy is stored in the operating springs. After the springs have gone over center, movement of the output crank of the mechanism is still blocked for a time by a cam arrangement. As the springs are further extended, the blocking cam moves away from the output crank, and the springs are allowed to discharge part of their stored energy, closing the breaker contacts.

This assures a fast-snapping closing action regardless of the speed at which the closing handle is operated.

The breaker mechanism is tripped by the displacement of the trip latch (7), Figure 6. Looking at the breaker from the right hand side as in Figure 5, the tripping movement of the latch is counter-clockwise. Operation of any of the automatic trip devices or the trip push button causes the latch to move in the tripping direction. When the latch moves off the trip latch roller (7), the remaining force in the operating spring causes the mechanism toggle to collapse, resulting in the opening of the breaker contacts.

## ADJUSTMENT

Since all the mechanism adjustments are carefully set by experienced factory personnel after assembly at the factory, it should normally not be necessary to make any adjustments in the field. At the time of installation, and also in the course of a maintenance inspection, if the breaker functions properly through several repeated operations, it is best to assume that adjustments are satisfactory.

If the breaker mechanism does not function properly, it is best to first perform the available remedial measures listed in the "Trouble Shooting" chart of these instructions. One of the remedies

listed is that of proper mechanism latch engagement, the amount of engagement between the latch (7) and latch roller (5), Figure 6. This is the only adjustment that is required on the breaker mechanism, and proper latch engagement is obtained in the following manner:

(NOTE - Before making latch adjustments, check to make sure that the buffer paddle which stops against the end of the latch adjustment screw is rigidly fastened to the trip shaft. Hold the trip shaft (8), Figure 5, steady and attempt to move the buffer paddle. If any relative movement between the two is noted, tighten the fasteners holding the buffer paddle to the trip shaft.)

### Latch Adjustment - Manual Breaker

1. Locate the latch adjustment screw on the lower, outer side of the right-hand mechanism side frame. This screw is threaded through a nylon insert locknut which, in turn, is welded to a projecting bracket on the side frame.
2. Rotate the closing handle 90 degrees counter-clockwise, setting the closing mechanism in the reset position. Turn the adjusting screw into the locknut until the closing mechanism trips open, the closing handle returning to its normal vertical position. NOTE: KEEP HANDS CLEAR OF THE CLOSING HANDLE WHEN MAKING THIS ADJUSTMENT.
3. Withdraw the adjusting screw from the locknut 1/4 turn at a time, attempting to close the breaker after each 1/4 turn, and observing whether the contacts move toward closing before tripping occurs. If the contacts move before tripping occurs, you have established the position of the adjusting screw where the latch and latch roller begin to engage. In some cases, it may be necessary to turn the adjusting screw less than 1/4 turn in order to establish the position where the contacts begin to move before tripping occurs. When this position is established, note the position of the slot in the head of the adjusting screw.
4. Withdraw the adjusting screw three and one-half turns from the position noted in step 3. This sets the proper amount of latch engagement.

### Latch Adjustment - Electrical Breaker

1. Locate the latch adjustment screw on the lower, outer side of the right mechanism side frame. This screw is threaded through a nylon insert locknut which, in turn, is welded to a projecting bracket on the side frame.
2. With the breaker in the open position turn the adjusting screw into the locknut one complete turn at a time, closing the breaker after each complete turn of the adjusting screw, until

the breaker will not close. Use the maintenance closing handle whenever closing or attempting to close the breaker during this entire operation.

3. Withdraw the adjusting screw from the locknut  $\frac{1}{4}$  turn at a time, attempting to close the breaker after each  $\frac{1}{4}$  turn, and observing whether the contacts move toward closing before tripping occurs. If the contacts move toward closing before tripping occurs, you have established the position of the adjusting screw

where the latch and latch roller begin to engage. In some cases, it may be necessary to turn the adjusting screw less than  $\frac{1}{4}$  turn to establish the position where the contacts move before tripping occurs. When this position is established, note the position of the slot in the head of the adjusting screw.

4. Withdraw the adjusting screw three and one-half turns from the position noted in step 3. This sets the proper amount of latch engagement.

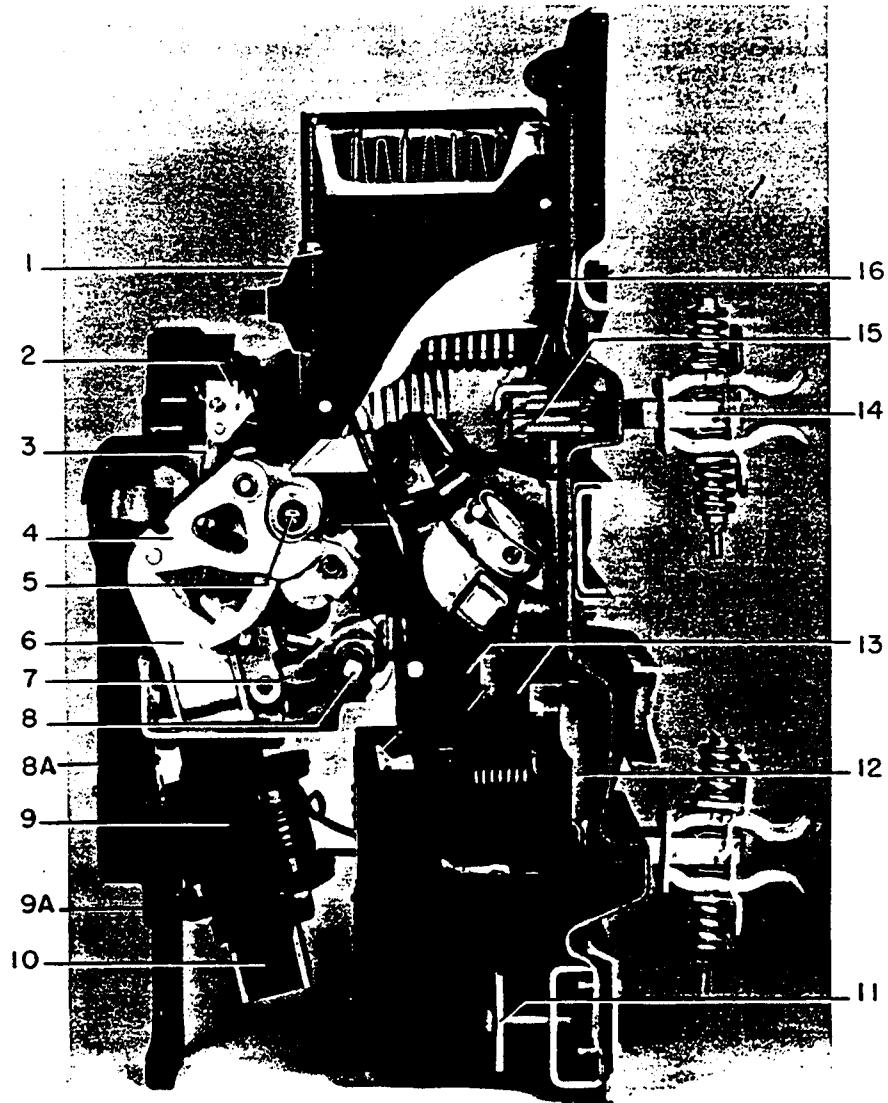


Figure 5. (8024457) Cut Away Model of Electrically Operated AK-2 Breaker

- |                            |   |  |
|----------------------------|---|--|
| 1. Arc Quencher Retainer   | 8. Trip Shaft                                   | 12. Lower Stud                         |
| 2. Cut off Switch          | 8A. Front Escutcheon                            | 13. Socket Head Screws                 |
| 3. Cut off Switch Actuator | 9. Closing Solenoid                             | 14. Upper Stud                         |
| 4. Spring Carrier          | 9A. Location of Slots for<br>Maintenance Handle | 15. Stationary Contacts<br>and Springs |
| 5. Shoulder Pin            | 10. Closing Solenoid Armature                   | 16. Arc Runner                         |
| 6. Connecting Link         | 11. Cover Retainer of Overload Device           |  |
| 7. Trip Latch Roller       |   |  |

Should the mechanism continue to function improperly after the proper latch engagement has been set and the corrective measures listed in the "Trouble Shooting" chart carried out, it is generally recommended that no attempt be made to repair the mechanism interior but that a replacement mechanism assembly be obtained from the factory.

#### REPLACEMENT

- If the breaker is electrically operated, remove the front escutcheon by taking four screws from flange. If the breaker is a drawout type, two small round head screws must also be removed from the bottom edge of the escutcheon. (For removal of front escutcheon from

manually operated breakers, see procedure described below.)

- Remove arc quenchers (See "Arc Quencher").
- Disconnect the two insulated connecting links between the mechanism and the contacts as in step 2 of the procedure for "Separation of Front and Back Frames".
- Remove the two elastic stop nuts, which fasten the upper extensions of mechanism frame to studs connecting with rear frame.
- Remove four screws which fasten the bottom of the mechanism frame to the horizontal cross member of the front frame.

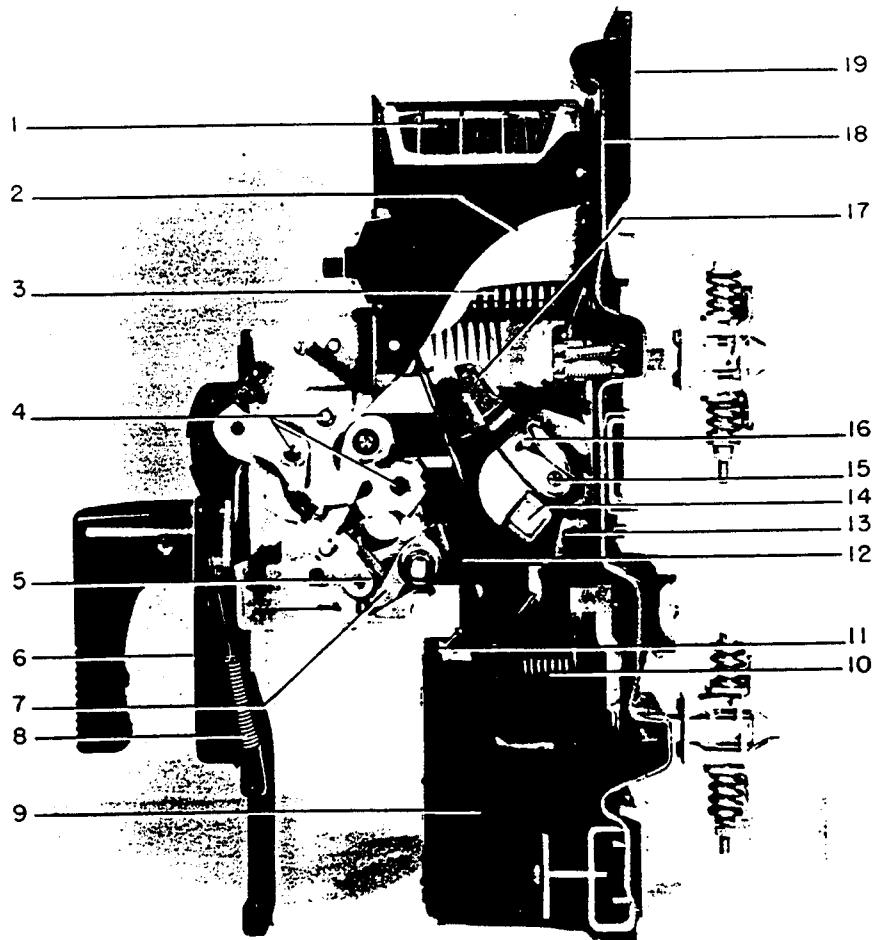


Figure 6. (8024516) Cut Away Model of Manually Operated AK-2 Breaker

1. Arc Quencher Muffler	8. Handle Return Spring	15. Movable Contact Pivot
2. Ceramic Side Plates	9. Overload Device	16. Contact Wipe Adjustment Pin
3. Steel Plates	10. Series Coil of Overload Device	17. Movable Contact
4. Fixed Centers in Mechanism	11. Trip Arm of Overload Device	18. Moulded Compound Bar
5. Latch Roller	12. Trip Paddle	19. Steel Back Plate
6. Escutcheon	13. Movable Contact Pivot Support	
7. Trip Latch	14. Crossbar	

6. If the breaker is manually operated, and has no auxiliary switch, it is now free to be lifted clear of the breaker. If it has an auxiliary switch, this may be disconnected from the mechanism as described under "Auxiliary Switch - Replacement, elsewhere in these instructions.
7. If the breaker is electrically operated, it will be necessary to disconnect the mechanism from the solenoid armature. In order to do this, raise the mechanism as far as the travel of the armature will permit and remove the screw which binds together the two extensions of the armature. After this is removed, the armature extensions must be spread apart to release them from the link connecting with the mechanism. This can be done by threading a #10-32 screw at least 1-3/4 inches long into the top hole of the armature extension. This hole is just above the one from which the binding screw has been removed. As the end of the screw butts against the far extension, the two extensions will be spread open, releasing the mechanism link.
8. The replacement mechanism may be installed by reversing the order of procedure for disassembly. After reassembly, check the operation of the breaker and, if necessary, adjust the latch engagement.

#### **REMOVAL OF FRONT ESCUTCHEON OF MANUAL BREAKERS**

1. Remove set screw fastening the plastic handle to steel operating shaft and remove the operating
2. Open and remove annealed (soft) retainer and two flat washers from shaft.
3. Remove four screws from flange of escutcheon. If the breaker is a drawout type, two small round head screws must also be removed from the bottom edge of the escutcheon.
4. Push steel operating shaft through escutcheon bushing.
5. Remove handle reset spring (8) Figure 6, and escutcheon is free of breaker.
6. Handle and escutcheon assembly can be assembled most easily by exactly reversing the procedure for disassembly. In replacing the escutcheon it may be necessary to use pliers to pull the operating shaft fully into the escutcheon in order to have space enough to replace the flat washers and the soft retainer. The latter may be closed on its groove in the shaft by ordinary gas pliers. After replacement, check operation of breaker.

#### **AUXILIARY SWITCH**

The auxiliary switch is mounted on the left side of the operating mechanism frame. Its operating shaft is linked to the output crank of the breaker mechanism. Through a cam arrangement, the operating shaft of the switch controls the open and closed positions of the individual contact pairs. Each stage of the switch, which is usually two-stage or five-stage, contains one "a" and one "b" set of contacts. An "a" pair of contacts is always in the same position as the main breaker contacts. That is, open when the breaker contacts are open, and closed when the breaker contacts are closed. Just the opposite is true of the "b" contacts. The terminals of the switch are covered by a sheet of insulating material held in place by two screws fastened along its left edge. When this is removed, the terminals are exposed. The upper pairs of terminals are those which connect to "a" switches. The lower terminals connect to "b" switches.

#### **REPLACEMENT**

1. Remove auxiliary switch cover.
2. Disconnect leads to switch terminals.
3. Remove two screws which fasten switch to side of mechanism frame.
4. Remove switch by moving towards left.
5. Before mounting replacement switch, turn the crank end of the switch operating shaft in position to engage the hole in the link connecting with the breaker mechanism. Be sure the bearing washer is in place between the mechanism link and the switch operating shaft.
6. Complete mounting by following disassembly steps in reverse order.

#### **ELECTRICAL CONTROL COMPONENTS**

These consist of the following:

1. Closing solenoid
2. "X" contactor (relay)
3. "Y" permissive relay
4. Cut-off switch
5. Closing switch
6. Shunt-trip device

The last two of these components may or may not be present in the control arrangement.

## CLOSING SOLENOID

The closing solenoid consists of a magnet, armature and coil. This assembly is located directly beneath the breaker mechanism to which it is connected by a link which ties the upper end of the armature to the spring carrier of the mechanism. (See Figure 5.)

When voltage is applied to the coil, the magnetic force generated pulls the armature up into the coil and magnet assembly. This, in turn, rotates the spring carrier about its pivot, extending the mechanism spring and causing its line of action to move "over center", resulting in a closing operation.

### **REPLACEMENT**

The only replacement operation that might conceivably be required on this assembly is that of the solenoid coil. To replace this, proceed as follows:

1. Remove escutcheon by unfastening four flat head screws in flange.
2. Remove closing switch. (See "Closing switch".)
3. Cut off or disconnect the coil leads.
4. Remove four screws which fasten lower section of magnet to upper section.
5. Allow lower section of magnet and coil to slide downward until clear of armature.
6. Reassemble with new coil by reversing order of procedure.

## "X" CONTACTOR

The "X" contactor is a heavy-duty relay which performs the function of closing the circuit of the breaker solenoid during electrical operations. Three of the four sets of contact of the device are arranged in series to minimize the duty required of any one contact. As explained under "Operation", the fourth contact is used to "seal-in" the "X" coil.

The "X" contactor is located on the right beneath the horizontal front frame member. It is mounted on three studs which fasten it to a mounting bracket which is suspended from the frame. Rubber bushings on the mounting studs provide anti-vibration and anti-shock protection for the relay. The relay contacts and their terminals are covered by a molded piece of insulation which fits over spring clips that hold the cover in place.

### **REPLACEMENT**

Removal of the complete device is accomplished by removing the cover, disconnecting the leads from the terminals, and removing the nuts from the three mounting studs. If the replacement unit includes the mounting bracket, the relay

need not be removed from the old bracket. This can be taken off the breaker simply by removing the two screws which fasten it to the breaker frame. If the breaker is a drawout type, the supporting bracket of the "Y" relay may be temporarily displaced to provide access to the screws.

Since the expendable parts of the "X" contactor are the contacts and the coil, ease of replacement of these parts has been designed into the relay. Methods of procedure are as follows:

### Contacts

1. Remove relay cover.
2. Remove terminal binding screw of stationary contact to be replaced.
3. Lightly pinch with pliers (pointed end) the split section of the contact which enters the hole in the compound body of the device and lift out the stationary contact.
4. With the fingers, pull forward on the spring guide of the movable contact, compressing the contact spring as far as possible.
5. With the spring thus held, grip the end of the contact strip with pointed pliers, turn it through 90 degrees on its long axis, and withdraw it.
6. Replace new contacts by reversing the procedure.

### Coil

1. Remove relay cover.
2. Turn the two retaining spring clips on the ends of the device through 90 degrees about their pivots.
3. Pull out the two halves of the body of the device which carry the stationary contacts. When these are clear of the frame, the armature and movable contact assembly will move aside, exposing the coil.
4. Remove the terminal screws of the coil and pull it free of its retaining spring clips.
5. Place new coil on pole piece inside of the spring clips and fasten terminals to leads.
6. Just start the replacement of one of the compound blocks which hold the stationary contacts into its groove in the frame.
7. Position the armature and movable contact assembly to allow the entrance of the second stationary contact block.
8. When these parts are all properly aligned, with the stationary contacts under the movable contacts, push them into their guiding grooves in the frame until they bottom.

9. Rotate the retaining spring clips to the locked position, making sure that each clip is in its proper recess, and replace the device cover.

### "Y" RELAY

As described under "Operation", the "Y" relay is a permissive relay which limits to one the number of breaker closures possible on one closing signal.

On drawout breakers, the "Y" relay mounting bracket is fastened to the right hand side member of the breaker frame by two mounting screws. On terminal board breakers, it is fastened to the rear side of the terminal board support. The relay itself is fastened to an intermediate bracket which is detachable from the main support. The junctures between the relay and the intermediate bracket and between the two brackets are rubber cushioned against vibration and shock.

### REPLACEMENT

If replacement of the "Y" relay becomes necessary, it may be detached from its supporting brackets by removal of the fastening hardware. The leads to the relay should be cut off as closely as possible to the soldered connections so that enough wire will remain for connection to the new relay. Sufficient original wire is allowed for this purpose.

After the old relay has been removed, the wire leads to the relay should be stripped of insulation to about 1/4 of an inch from the ends. A good mechanical connection should be made before soldering.

After all connections are completed, the relay may should again be mounted to the breaker by means of its supporting brackets and hardware.

After replacement has been completed, the relay may be checked electrically in the following manner:

1. Apply closing voltage to terminal board or secondary disconnects.
2. Push button of closing switch and hold closed.
3. Continuing to hold push button in closed position, manually trip the breaker open.
4. If the breaker stays open, and makes no attempt to close, the "Y" relay is functioning properly.
5. While releasing the close button, observe the "Y" relay. It should open as the closing switch is released.

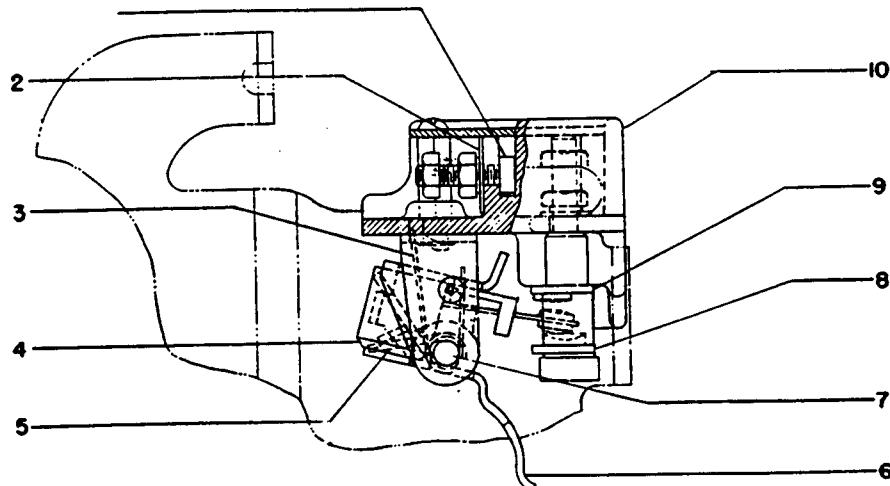


Figure 7. (695C162) Cut-Off Switch

- |                             |                 |                 |
|-----------------------------|-----------------|-----------------|
| 1. Screw                    | 5. Spring       | 9. Contact (AA) |
| 2. Washer                   | 6. Actuator     | 10. Support     |
| 3. Spring                   | 7. Pivot Pin    |                 |
| 4. Movable Contact Assembly | 8. Contact (BB) |                 |

CUT-OFF SWITCH

Figure 7.

As explained under "Operation", the function of the cut-off switch is to de-energize the "X" contactor coil and energize the "Y" relay coil as the breaker mechanism moves from the opened to the closed position.

The switch is operated by the movement of a mechanism link against the switch actuator (6). This causes the actuator and movable contact assembly (4) to rotate counterclockwise about pin (7), opening the "bb" contacts (8) and closing the "aa" contacts at (9). Overtravel of the actuator (6) beyond the point of making contact at (9) is absorbed by spring (5) which couples the movable contact (4) to the actuator. Spring (3) resets the switch after the breaker contacts open and the breaker mechanism resets.

The point at which the cutoff switch operates during the breaker closing cycle is after the spring charged mechanism has been driven over-center. This assures that the cutoff switch cannot operate too early in the breaker closing cycle, thus the X and Y relays are de-energized and energized, respectively, at the proper time and the circuits anti-pump feature is maintained. When the closing mechanism is driven over-center, the force of the previously charged closing springs is released, closing the breaker.

## REPLACEMENT

The cut-off switch is located above the breaker mechanism. It is fitted between the upper portions of the steel side plates that make up the mechanism frame. A raised horizontal ridge on each side of the molded body of the switch fits into a corresponding groove in each of the steel side plates. A round head screw on each side fastens the switch and side plate together. Replacement of the switch is accomplished by the following procedure:

1. Remove the cover on the top of the switch by taking out the two screws which hold it in place.
2. After taking careful note of the connection arrangements, disconnect the leads from the switch terminals.
3. Remove the two screws, one on each side, which fasten the switch to the mechanism side plates. Note that the one on the right hand side also holds a wiring cleat and spacer which serves to hold the wires clear of the link connecting the mechanism and the breaker position indicator.
4. Remove the front escutcheon from the breaker.
5. Slide the cut-off switch out from between the steel side plates by pulling straight forward.

6. Mount the replacement switch by reversing the order of procedure.

CLOSING SWITCH

Figure 8.

The closing switch is mounted on the upper flange of the closing solenoid coil. A hole in the escutcheon (3) permits access to the switch button (4). When the button is pressed, movable contact (5) deflects and impinges upon stationary contact (2). This energizes the "X" relay coil which seals itself in, and, in turn, energizes the closing solenoid.

## REPLACEMENT

1. Remove escutcheon (3).
2. Disconnect leads from switch terminals.
3. Deflect the left end of hinge (7) to the left so that the movable contact (5) may be disengaged from the switch assembly.
4. Removal of the two screws (10) from speed-nuts (9) completes the disassembly of the switch.
5. Reassembly with new parts is a matter of reversing the described procedure. In reassembling, be sure the tab on the left end of hinge (7) is bent to the right far enough to avoid any possibility that movable contact (5) might become free of the assembly.

SHUNT TRIP DEVICE

Figure 9.

The shunt trip device is mounted underneath the horizontal cross frame member, just to the left of the front escutcheon. It is composed of a magnet, coil and armature. The armature has an extended arm or striker (11) which bears against the trip paddle (12) on the trip shaft when the coil (8) is energized. This displaces the trip latch in the breaker mechanism, opening the breaker contacts.

The trip device is generally activated by a remote switch or relay which closes the shunt trip coil circuit.

In order to avoid unnecessary heating of the coil of the device, an auxiliary switch "a" contact is wired in series with the coil. This prevents the energization of the coil if the breaker is open.

## REPLACEMENT

The entire shunt trip device may be dismounted by disconnecting the coil leads and removing nuts (1). However, the only part of the device that might conceivably need replacement during the life of the breaker is the coil (8). This

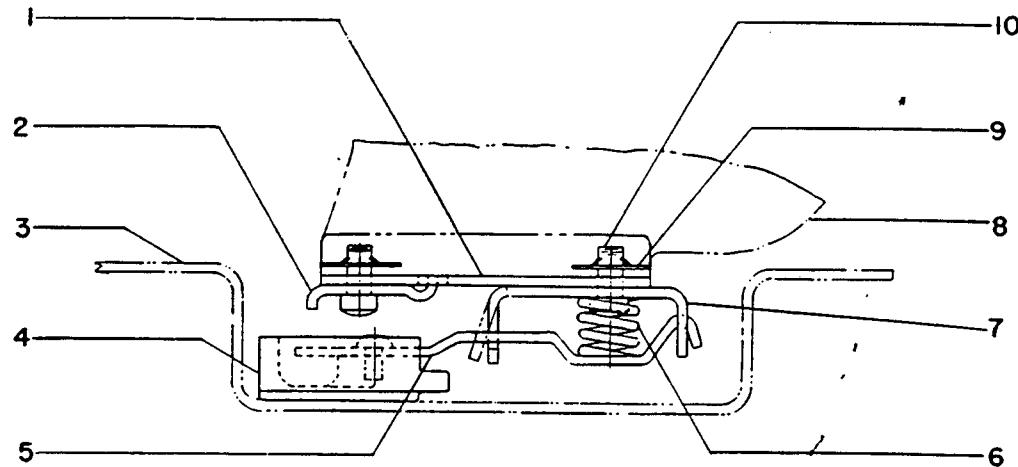


Figure 8. (805B905) Closing Switch (Top View)

- |                       |                     |              |
|-----------------------|---------------------|--------------|
| 1. Insulation         | 5. Movable Contact  | 9. Speed Nut |
| 2. Stationary Contact | 6. Spring           | 10. Screw    |
| 3. Front Escutcheon   | 7. Hinge            |              |
| 4. Push Button        | 8. Closing Solenoid |              |

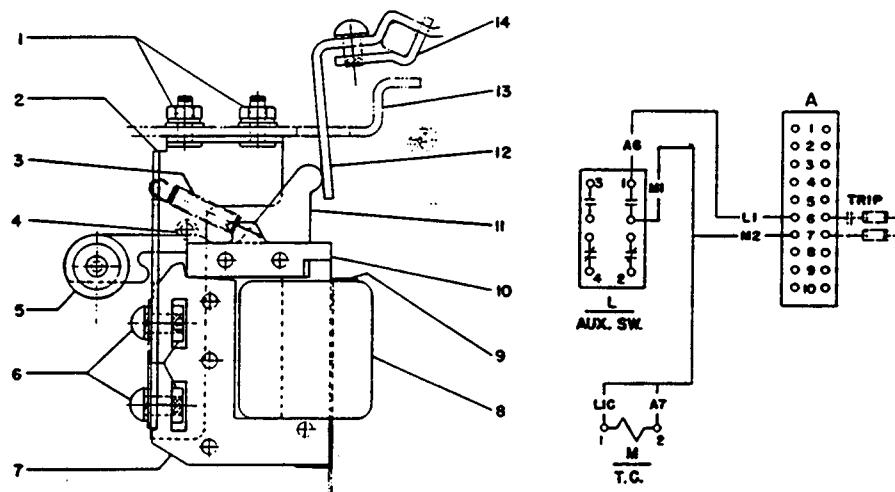


Figure 9. (695C161) Shunt Trip Device

- |           |              |                      |
|-----------|--------------|----------------------|
| 1. Nut    | 6. Screws    | 11. Armature Arm     |
| 2. Frame  | 7. Magnet    | 12. Trip Paddle      |
| 3. Spring | 8. Coil      | 13. Mechanism Frame  |
| 4. Rivet  | 9. Clamp     | 14. Trip Shaft Clamp |
| 5. Weight | 10. Armature |                      |

may be replaced without removing the device from the breaker by proceeding as follows:

1. Disconnect leads of coil (8).
2. Remove two screws (6) which fasten magnet (7) and coil to the frame (2).
3. Having removed the magnet from the device, straighten the end of clamp (9).
4. Remove the coil from the magnet.
5. Install new coil, again forming end of clamp (9) as shown.
6. Reassemble to frame.

## 7. Connect coil leads.

### ADJUSTMENT

The only adjustment required on the shunt trip device is that which ensures positively that the breaker will trip when the device is activated. In order to be sure of this, armature arm (11) must travel from 1/32 to 1/16 of an inch beyond the point at which the breaker trips. A good method of checking this is to hold a 1/32nd shim between the magnet and armature at (10), and with the breaker closed, push upwards at (5), closing the armature against the magnet. If the breaker trips, there is sufficient overtravel. If adjustment is necessary, trip paddle (12) may be formed towards or away from armature arm (11).

## PROTECTIVE DEVICES

An AK-2/3 breaker may be equipped with the following protective devices:

1. Overcurrent trip (Magnetic) AK-2
2. Power Sensor Trip (Static) AK-3
3. Reverse Current Trip AK-2
4. Under Voltage Trip & Lockout Device
5. Bell Alarm and/or Lockout device
6. Open Fuse lockout device.
7. AKD-5 Interlock AK-2A/AK-3A

### OVERCURRENT TRIP DEVICE (Magnetic)

The typical overcurrent trip device consists of a magnetic structure, a series current coil, and a pivoted armature.

When current flow through the series coil generates a magnetic field strong enough, the armature overcomes the restraining force of a calibration spring attached to it, and closes against the magnet. This trips the breaker by means of an extension on the armature which strikes against a trip paddle on the trip shaft.

Depending on the type of individual device, the movement of the armature may be delayed for a time by a timing device. If a relatively long time-delay (seconds or minutes) is desired, the velocity of armature movement is governed by a piston moving through an oil dashpot. If only a short-time delay (cycles or milli-seconds) is required, movement is controlled by an escape-movement gear and pallets arrangement.

An AK-2-15/25 breaker may be equipped with either the EC-2 or EC-1 overcurrent trip device. The majority of applications will require the use of the EC-2 device. The EC-1 device is normally

used when the short-time delay feature is required, or when the trip device is used to operate a special over-current alarm switch.

Most circuit breakers are equipped with series overcurrent trip devices either of the dual magnetic type (instantaneous and time delay tripping) or instantaneous alone. Breakers are designed to carry up to 100% of the continuous current rating of their trip devices. Any attempt to carry higher currents for a prolonged period will cause overheating and possible damage.

### EC-2 OVERCURRENT TRIP DEVICE

The Type EC-2 overcurrent tripping device is available in three forms:

1. Dual overcurrent trip, with long-time delay and high-set instantaneous tripping.
2. Low-set instantaneous tripping.
3. High-set instantaneous tripping.

The dual trip has adjustable long-time and instantaneous pick-up settings and adjustable time settings. Both forms of instantaneous trips have adjustable pick-up settings.

### DUAL OVERCURRENT TRIP, WITH LONG-TIME DELAY AND HIGH-SET INSTANTANEOUS TRIPPING.

By means of the adjustment knob (5), Figure 10, which can be manipulated by hand, the current pick-up point can be varied from 80 to 160 percent of the series coil rating. The indicator and a calibration plate (4), Figure 10, on the front of the case provide a means of indicating the pick-up point setting in terms of percentage of coil rating. The calibration plate is indexed at percentage settings of 80, 100, 120, 140 and 160.

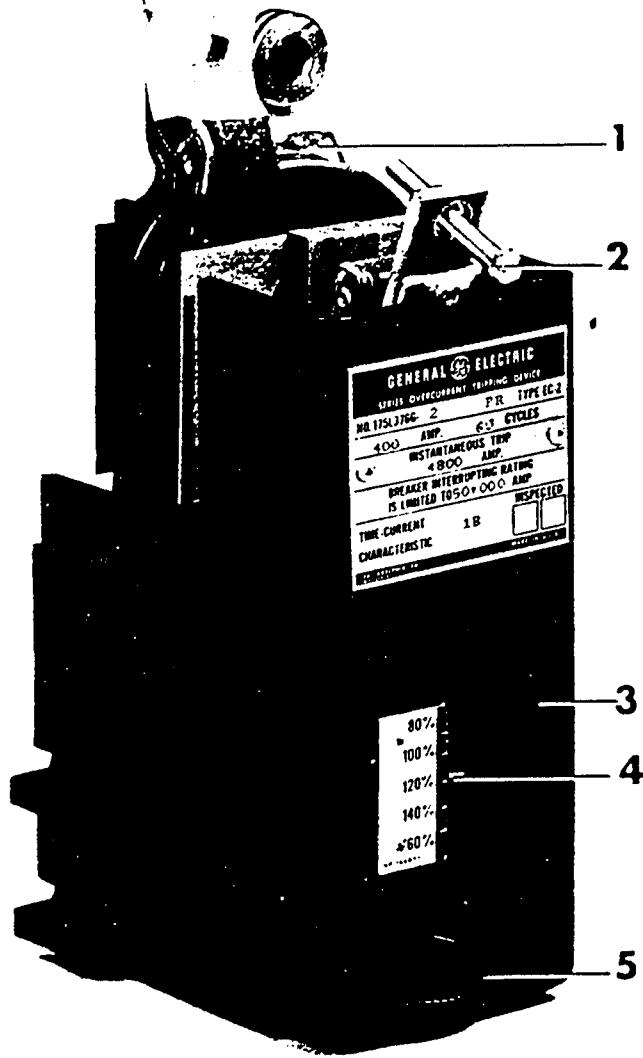


Figure 10. (8024842) EC-2 Overcurrent Trip

1. Series Coil
2. Trip Adjustment Screw
3. Opening for Time Adjustment
4. Pickup Indicator & Calib. Plate
5. Pickup Adjustment Knob

The long-time delay tripping feature can be supplied with any one of three time-current characteristics which correspond to the NEMA standards maximum, intermediate and minimum long-time delay operating bands. These are identified as 1A, 1B and 1C characteristics, respectively. Approximate tripping time for each of these, in the same order are 30, 15 and 5 seconds at 600% of the pick-up value of current. (See time-current characteristic curves 286B201A, B, and C).

The tripping time may be varied within the limits shown on the characteristic curves by turning the time adjustment screw (5), Figure 11. Turning in a clockwise direction increases the tripping time;

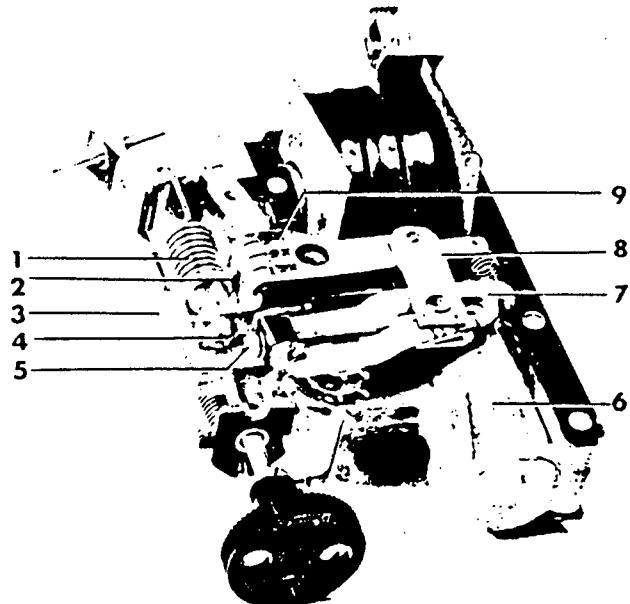


Figure 11. (8024843) EC-2 Overcurrent Trip With Cover Removed.

1. Instantaneous Calibration Spring
2. Movable Nut (Index Pointer)
3. Time-Delay Calibration Spring
4. Instantaneous Pickup Adjustment Screw
5. Time-Delay Adjustment Screw
6. Oil Dashpot
7. Dashpot Arm
8. Connecting Link
9. Instantaneous Pickup Calibration Marks

counter-clockwise motion decreases it. The dashpot arm (7), Figure 11 is indexed at four points, maximum - 2/3 - 1/3 - minimum from the left, as viewed in Figure 11. When the index mark on the connecting link (8), Figure 11, lines up with a mark on the dashpot arm, the approximate tripping time as shown by the characteristic curve is indicated. The 1A and 1B characteristic devices are shipped with this setting at the 2/3 mark and the 1C characteristic at the 1/3 mark. The standard characteristic curves are plotted at the same settings.

Time values are inversely proportional to the effective length of the dashpot arm. Therefore, the linkage setting that gives the shortest time value is the one at which dimension "A" Figure 11, is greatest. The time adjustment screw (5), Figure 11, may be turned by inserting a Phillips head screwdriver through the hole in the front of the case, but if it is desired to relate the linkage setting to the index marks on the linkage it will be necessary to remove the case. This may be done by removing the two mounting screws, one on each side of the case, which may be taken off without disturbing the trip unit itself.

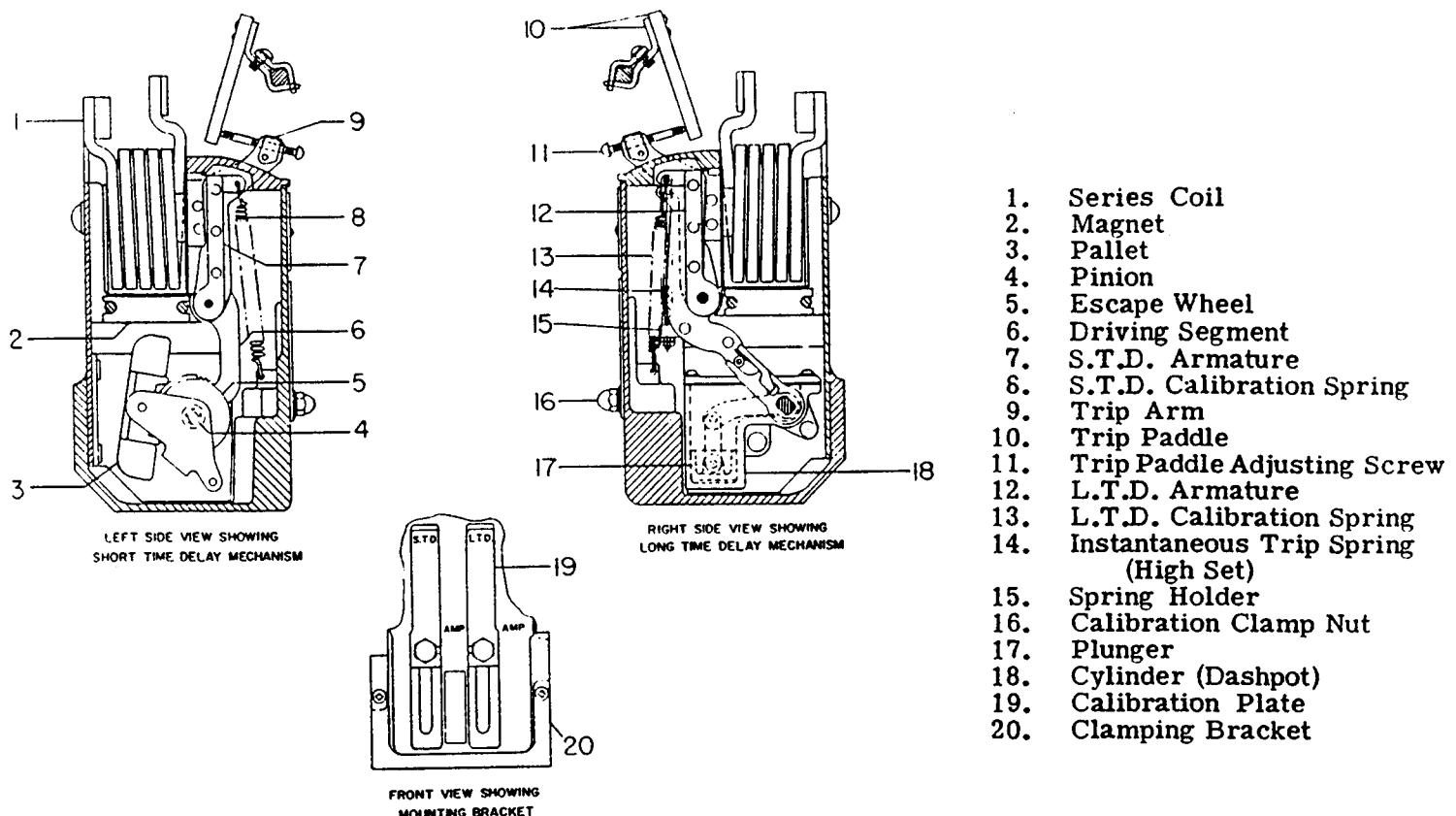


Figure 12. (695C189) EC-1 Type Overcurrent Trip Device

NOTE: Forcing the adjusting screw to either extreme position may cause binding of the device and should be avoided.

#### INSTANTANEOUS LOW-SET TRIPPING

The low-set instantaneous pick-up point may be varied by the adjustment knob (5), Figure 10. The calibration in this case usually ranges from 80% to 250% of the series coil rating, the calibration plate being indexed at values of 80%, 100%, 200% and 250% of the rating.

#### INSTANTANEOUS HIGH-SET TRIPPING

The high set instantaneous pick-up value may have one of the following three ranges: 4 to 9 times coil rating; 6 to 12 times coil rating or 9 to 15 times coil rating. The pick-up setting may be varied by turning the instantaneous trip adjusting screw (4), Figure 11.

Three standard calibration marks will appear on the operating arm at (9), Figure 11, and the value of these calibration marks will be indicated

by stampings on the arm as follows:

4X	or	6X	or	9X
6X		9X		12X
9X		12X		15X

At the factory, the pick-up point has been set at the nameplate value of the instantaneous trip current. (Usually expressed in times the ampere rating of the trip coil.) The variation in pick-up setting is accomplished by varying the tensile force on the instantaneous spring. Turning the adjustment screw changes the position of the movable nut (2), Figure 11, on the screw. The spring is anchored to this movable nut so that when the position of the nut is changed, there is a corresponding change in the spring load. As the spring is tightened, the pick-up point is increased. The top edge of the movable nut (2), Figure 11 serves as an index pointer and should be lined up with the center of the desired calibration mark, punched slots on operating arm, to obtain the proper instantaneous trip setting.

EC-1 OVERCURRENT TRIP DEVICE

The EC-1 device can be provided with the following tripping combination

1. Long time delay, short time delay and instantaneous -tripping.
2. Long time and short time delay tripping only.
3. Long time delay and instantaneous tripping.
4. Short time delay and instantaneous tripping.
5. Short time delay tripping only.
6. Instantaneous tripping only.
  - a. Adjustable (Low set)  
or  
Non-adjustable (High set)

**SHORT TIME DELAY TRIPPING, Figure 12.**

The armature (7) is retained by calibrating spring (8). After the magnetic force, produced by an overcurrent condition, overcomes this restraining force, the armature movement is further retarded by an escapement mechanism which produces an inverse time delay characteristic. The mechanism is shown in the left side view of Figure -12.

The pickup for this device can be field set between limits having a ratio of 2-1/2 to 1 in the range of 200 to 1000% of the coil rating.

**LONG TIME DELAY TRIPPING, Figure 12**

The armature (12), is retained by the calibration spring (13). After the magnetic force, produced by an overcurrent condition, overcomes this restraining force, the armature movement is further retarded by the flow of silicone oil in a dashpot, which produces an inverse time delay characteristic. The mechanism is shown in the right side view of Figure 12.

**INSTANTANEOUS TRIPPING, Figure 12.**

- a. Adjustable instantaneous tripping takes place after the magnetic force produced by an overcurrent condition, overcomes the restraining force of the adjustable calibration spring (13).
- b. Nonadjustable instantaneous tripping takes place after the magnetic force produced by an overcurrent condition overcomes the restraining force of a nonadjustable spring (14).

**ADJUSTMENTS, EC-1 AND EC-2**

In addition to the pick-up settings and time-delay adjustments already described, overcurrent trip devices must be adjusted for positive tripping. This adjustment is made at the factory on new breakers, but must be made in the field when the

breaker mechanism or the overcurrent trip devices have been replaced.

Positive tripping is achieved when adjustment screw (2), Figure 10, is in such a position that it will always carry the trip paddle on the trip shaft beyond the point of tripping the mechanism, when the armature closes against the magnet.

In order to make the adjustment, first unscrew trip screw (2), Figure 10, until it will not trip the breaker even though the armature is pushed against the magnet. Then, holding the armature in the closed position, advance the screw until it just trips the breaker. After this point has been reached, advance the screw two additional full turns. This will give an overtravel of 1/16 of an inch and will make sure that activation of the device will always trip the breaker.

Adjustment screw (2), Figure 10, can best be manipulated by an extended 1/4 inch hex socket wrench.

In order to gain access to the adjustment screw on the center pole overload device, it will be necessary to remove the nameplate from the front escutcheon of the breaker. This will reveal a hole, centrally located in the escutcheon, by means of which the extended socket wrench can engage the adjustment screw.

**REPLACEMENT, EC-1 and EC-2**

Replacement of either the EC-1 or EC-2 overcurrent trip device is accomplished by the following procedure:

1. Separate the breaker's front and back frames as described in the section under "Maintenance".
2. Remove the steel clamps which fasten the cover of the device to the back of the breaker. NOTE: Pickup settings on the cover of each device are calibrated for the specific device. When replacing covers, replace on associated device.
3. Remove the 3/8 inch hexagon headed bolts which fasten the coil of the overload device to the breaker copper.
4. Remove the round head screw which fastens the frame of the overload to the breaker base.
5. After reassembling breaker with new overload device, adjust for "positive trip" as described under "Adjustments" of this section.

REVERSE CURRENT TRIP DEVICE

Figure 13.

The reverse current trip device sometimes used with d-c breakers will trip the breaker open if the direction of current flow is reversed.

This device is similar in appearance and is mounted in the same way as the overcurrent trip.

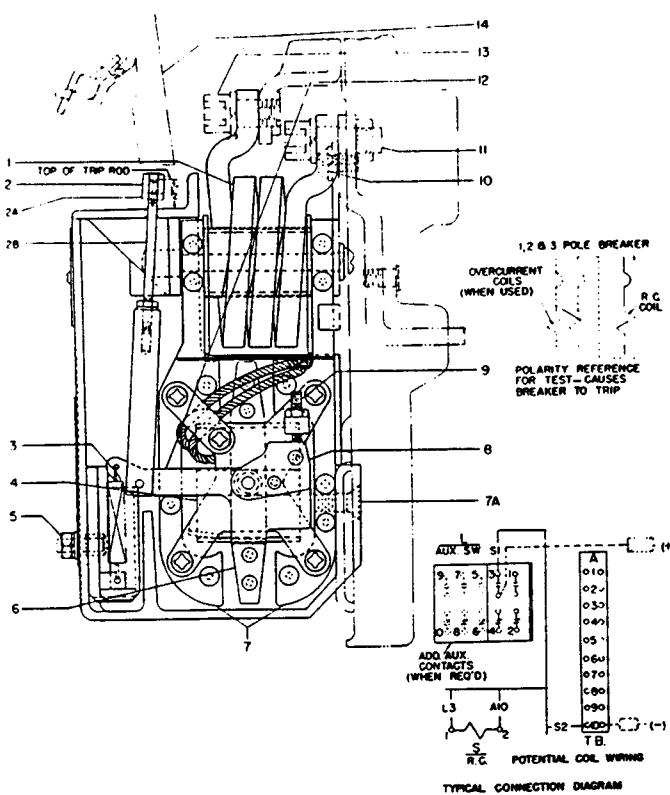


Figure 13. (286B209) Reverse Current Tripping Device

- |                    |                        |
|--------------------|------------------------|
| 1. Series Coil     | 7A. Screws             |
| 2. Adjusting Nut   | 8. Counterweight       |
| 2A. Locking Nut    | 9. Stop Screw          |
| 2B. Trip Rod       | 10. Mounting Screw     |
| 3. Spring          | 11. Screw (Lower Stud) |
| 4. Potential Coil  | 12. Trip Crank         |
| 5. Calibration Nut | 13. Screw (Lower Stud) |
| 6. Armature        | 14. Trip Paddle        |
| 7. Pole Pieces     |                        |

The device consists of a series coil (1), with an iron core mounted between two pole pieces (7) and a potential coil connected across a constant source of voltage and mounted around a rotary type armature (6). Calibration spring (3) determines the armature pick-up value when a reversal of current occurs.

As long as the flow of current through the breaker is in the normal direction, the magnetic flux of the series coil and the magnetic flux of the potential coil produce a torque which tends to rotate the armature counterclockwise. The calibration spring (3) also tends to rotate the armature in the same direction. This torque causes the

armature to rest against stop screw (9) attached to a bearing plate on the right side of the device.

If the current through the series coil (1) is reversed, armature (6) tends to move in a clockwise direction against the restraint of calibration spring (3). When the current reversal exceeds the calibration setting, the armature will move in a clockwise direction. This causes trip rod (2B) to move upwards against trip paddle (14), tripping the breaker open.

### ADJUSTMENTS

The only adjustment to be made on the reverse current device is to make sure that the trip rod has a minimum overtravel of  $1/32$  of an inch beyond the point of tripping the breaker. The only occasion this adjustment should have to be made is when an old device is being replaced by a new one.

The new device will be factory adjusted so that the top end of the trip rod (2B) will extend  $1/2$  inch above the top of the device case, and no additional adjustments of the trip rod should be required. To obtain the proper  $1/32$  of an inch overtravel, close the breaker and proceed as follows:

1. Loosen the locking nut (2A).
2. Manually lift the trip rod and vary the position of the adjusting nut (2), thus establishing the position of the adjusting nut where the breaker is just tripped. (NOTE - Be sure that all parts of the person are kept clear of moving breaker parts when tripping the breaker.)
3. With this position of the adjusting nut established, advance the adjusting nut upward one and one half turns.
4. Tighten the locking nut and the minimum  $1/32$  of an inch overtravel of the trip rod should be obtained.

### REPLACEMENT

Replacement of the ED-1 Reverse Current Device is accomplished by means of the same procedure as that followed in the case of the EC Overcurrent Trip Devices. There is, however, one additional step to be taken. This consists of disconnecting the leads of the potential coil. These are connected to a small two point terminal board mounted between two of the phases on the breaker base. After the new device has been installed, adjust for overtravel of the trip rod as described above.

## POWER SENSOR TRIP

### GENERAL DESCRIPTION

All AK-3 Type Air Circuit Breakers contain Power Sensor Overcurrent Trip Devices. The Power Sensor Trip functions with solid state components with the exception of the Magnetic Trip Device which is used to trip the breaker on signal from the Power Sensor Unit. The Power Sensor Overcurrent Trip Device consists of four major components.

1. The magnetic coils around the breaker conductors (Figure 14).
2. The Power Supply which provides both the tripping energy and the comparison basis for overcurrent detection (Figure 15).
3. The Power Sensor Unit with the various pick-up settings and time delay selection taps (Figure 16).
4. The Magnetic Trip Device which physically trips the breaker (Figure 17).

In addition to the phase overcurrent protection, a ground fault sensing feature may be provided.

The Ground Sensing Device works on the principle that the instantaneous value of current flowing in the three conductors (or; in four conductors on four wire systems) must add to zero unless ground current is flowing. Therefore, if the electrical system is a four wire wye system with the neutral grounded at the transformer, the fourth sensing coil (Figure 18) must be included on the neutral conductor with its secondary combined with the secondaries of the three phase sensors which are mounted on the breaker. On Draw-out breakers, the output of the external neutral sensor must enter the breaker by a control disconnect (Figure 19) which is mounted low and on the center-line on the back of the breaker. Refer to Figure 20 for Power Sensor Cabling diagram.

### MAINTENANCE

When mal-functioning of the Power Sensor Trip is indicated the trouble should be traced to one or more of these four components involved, and that component should be replaced as a unit. The following steps should be taken to detect a mal-functioning unit.

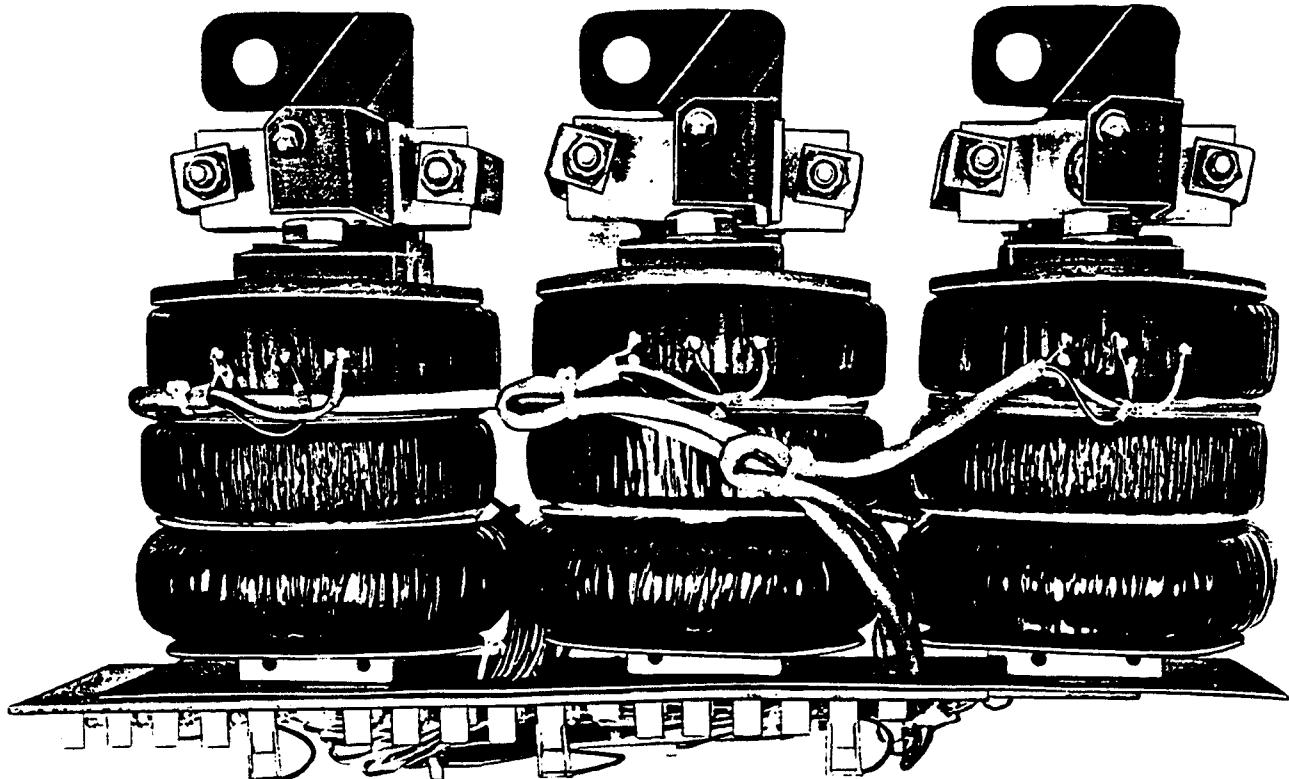


Figure 14. (8041866) Magnetic Coils

**NOTE:** No adjustment to the taps controlling pick-up or timing should be made with the breaker carrying current.

In the event the Power Sensor Device must be made non-operative to allow the breaker to continue carrying current without overcurrent protection, it is recommended that the leads to the tripping solenoid be removed to completely eliminate the possibility of the breaker tripping. Do not close breaker with power on the main contacts while the disconnect plug to the magnetic coils is disconnected.

1. Check for the existence of overcurrent or ground fault conditions that may be causing

the breaker to trip as a proper response to these abnormal circuit conditions.

2. The possibility of the breaker being trip free by mechanical interferences along the trip shaft or inadvertent shunt trip operations should be positively eliminated before investigating the Power Sensor. Successful operations in the test position should be obtained before proceeding with the Power Sensor trouble shooting.
3. A PST-1 Power Sensor Test Kit must be available. (Figure 21). Check the Power Sensor Unit for correct function for each pick-up setting and one point on each time delay characteristic. Then check for the correct operation of each phase of the Power Supply Unit. This procedure is described in the instruction manual (GEK-7301) for the PST-1 Test Kit, and GEK-7309 Power Sensor Instructions. If the test results for this test do not deviate more than 10% from the published curves, proceed to step 4. If the deviation is more than 10% contact the factory for possible replacement of the Power Sensor Unit.
4. If the breaker is equipped with ground fault protection, determine whether the false tripping is the result of falsely answering an overcurrent trip or a ground trip signal. This may be determined by temporarily eliminating the ground trip signal by shorting out the ground signal points 1 and 5 at the ground signal terminal board on the back frame bottom of the breaker. Terminals 1 and 5 can be identified by the 0.15UF capacitor connected

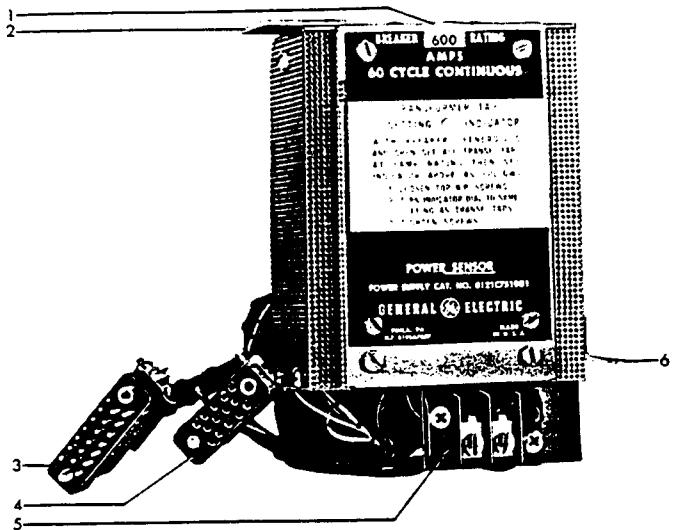


Fig. 15. (8039850) Power Supply

- |                         |                           |
|-------------------------|---------------------------|
| 1. Rating Disc          | 4. Female Disconnect Plug |
| 2. Mounting Bracket     | 5. Terminal Block         |
| 3. Male Disconnect Plug | 6. Mounting Bracket       |

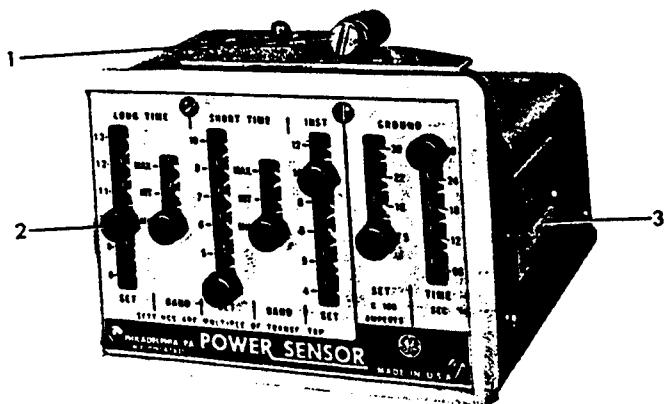


Figure 16. (8041864) Power Sensor Unit

1. Mounting Screw
2. Captive Thumb Screw
3. Name Plate

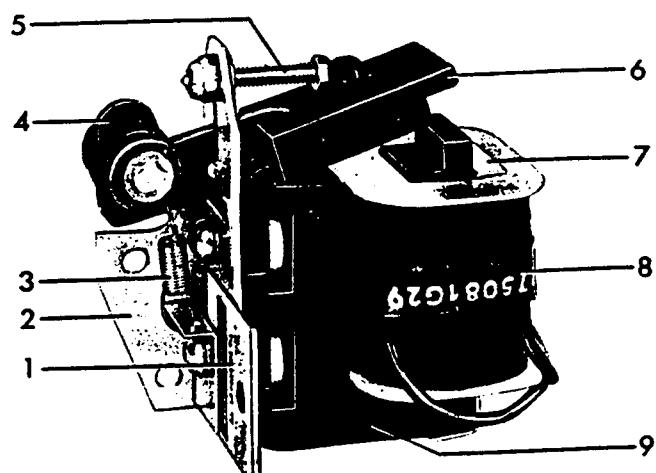


Figure 17. (8041863) Magnetic Trip Device

1. Name Plate
2. Mounting Bracket
3. Spring
4. Trip Arm
5. Adjuster
6. Clamp
7. Coil
8. Magnet
9. Magnet

between them. See drawing 138B2454 (Figure 22) with the breaker restored to service with the ground fault detector deactivated, establish whether there is false tripping due to overcurrent.

#### FALSE TRIPPING CAUSED BY FAULTY GROUND FAULT DETECTION

If the breaker is equipped for four wire service (fourth C.T. remotely mounted, Figure 18) it is important that the shielding be effective by having continuity from the disconnect plug at the Power Sensor Unit to the external C.T. and further, that this shield be isolated from the signal conductors. It is also important that continuity exists through the ground signal circuit. Check these conditions as follows; referring to Figure 22.

1. Remove connection plug at Power Sensor Unit and check continuity between A and C (Signal). Letters are located on end of plug.

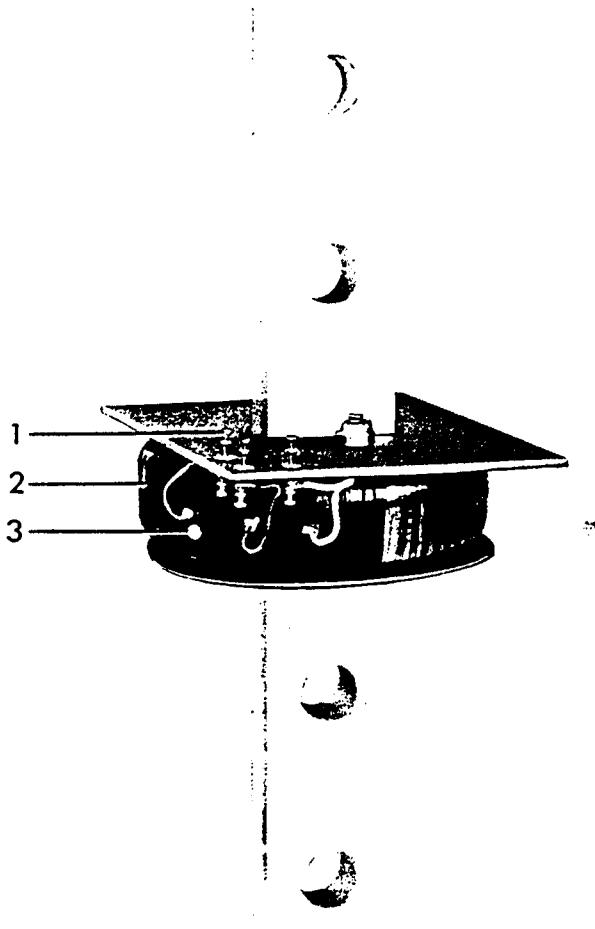


Figure 18. (8041867) Ground Sensor Coil (Remotely Located)

1. Terminal
2. External Ground Sensor Coil
3. White Polarity Dot

2. Check to be sure no continuity exists between R and A, or between R and C.
3. Temporarily connect jumper from shield to either terminal at remote C.T. and check to assure the shield is continuous from Power Sensor Plug to remote C.T. by checking for continuity between R and A. If continuity does not now exist, shield is not continuous and point of discontinuity must be found. Check the control disconnect as the possible point of discontinuity. Remove jumper at remote C.T. after shield continuity is established.

Note the polarity marks on the ground sensors. Be sure the external ground C.T. senses the neutral current associated with the particular breaker load current and that polarity marks are in accordance with 138B2454 (Figure 22). If the breaker bottom studs connect to the source, the external C.T. must also have its polarity mark toward the source.

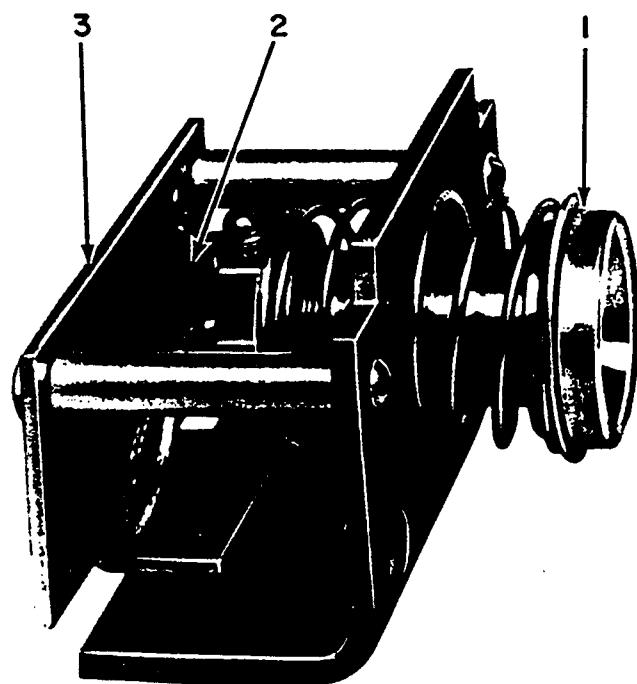


Figure 19. (8918380A) Control Disconnect Plug

1. Female Disconnect Plug
2. Terminal Board
3. Mounting Bracket

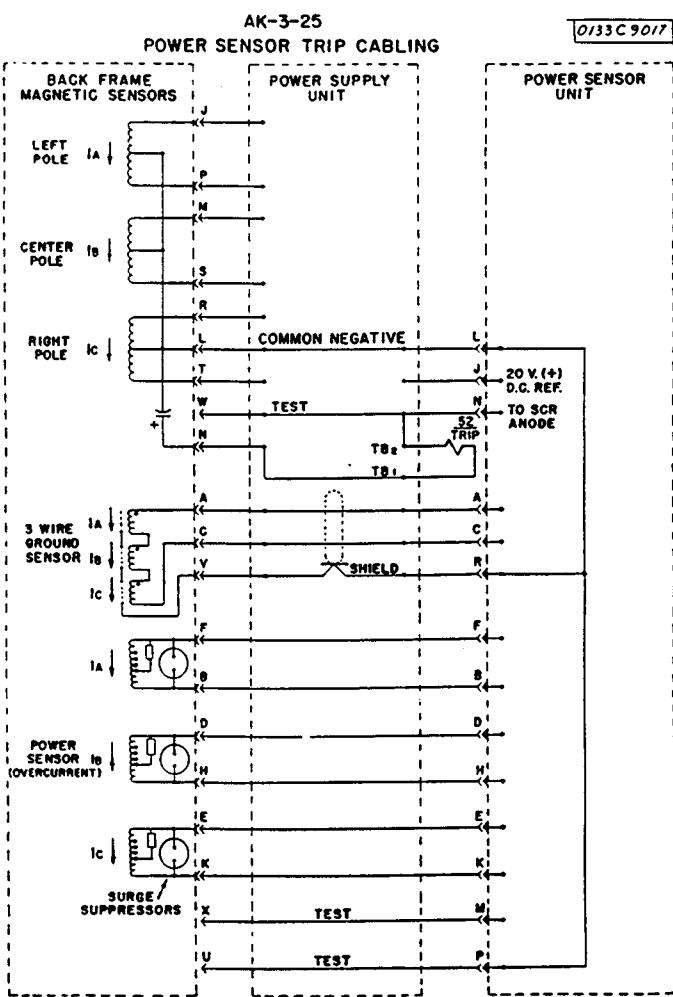


Figure 20. (0133C9017) Power Sensor Cabling Diagram



Figure 21. (8039962) Power Sensor Test Kit

## TESTING MAGNETIC COILS

After the PST-1 Test Kit has been used to determine the adequacy of performance of the Power Sensor Unit, it may be advisable or required to test the magnetic coils by the use of a hi-current Low voltage type test set. In this event, only one test per phase need be made. This test should be made at some convenient multiple of pick-up setting such as 300% for comparison with published time-current curves.

In the event the breaker is equipped with ground sensor, the ground sensor will cause tripping on single phase testing unless the signal is shorted at the terminal board (Figure 22). Jumper points 1 and 5 during overcurrent test.

The above considerations should indicate which of the four major components is faulty and in need of replacement.

## REPLACEMENT OF POWER SENSOR COMPONENTS

### POWER SENSOR UNIT (Figure 16).

1. Loosen screw connecting the unit to the front frame.
2. Slide unit forward.
3. Remove control plug by alternately loosening the two retaining screws.
4. Replace in reverse order.

### MAGNETIC TRIP DEVICE (Figure 17).

1. Remove trip solenoid wires from the terminal board on power supply.
2. Remove four screws holding power supply to breaker frame.
3. Pull power supply forward until restricted by wiring.
4. Remove two bolts holding trip device to breaker frame.
5. Lift out trip device.
6. Replace in reverse order.

### POWER SUPPLY (Figure 15).

1. Remove magnetic trip wires from the terminal board on POWER SUPPLY
2. Remove four screws holding power supply to breaker frame.

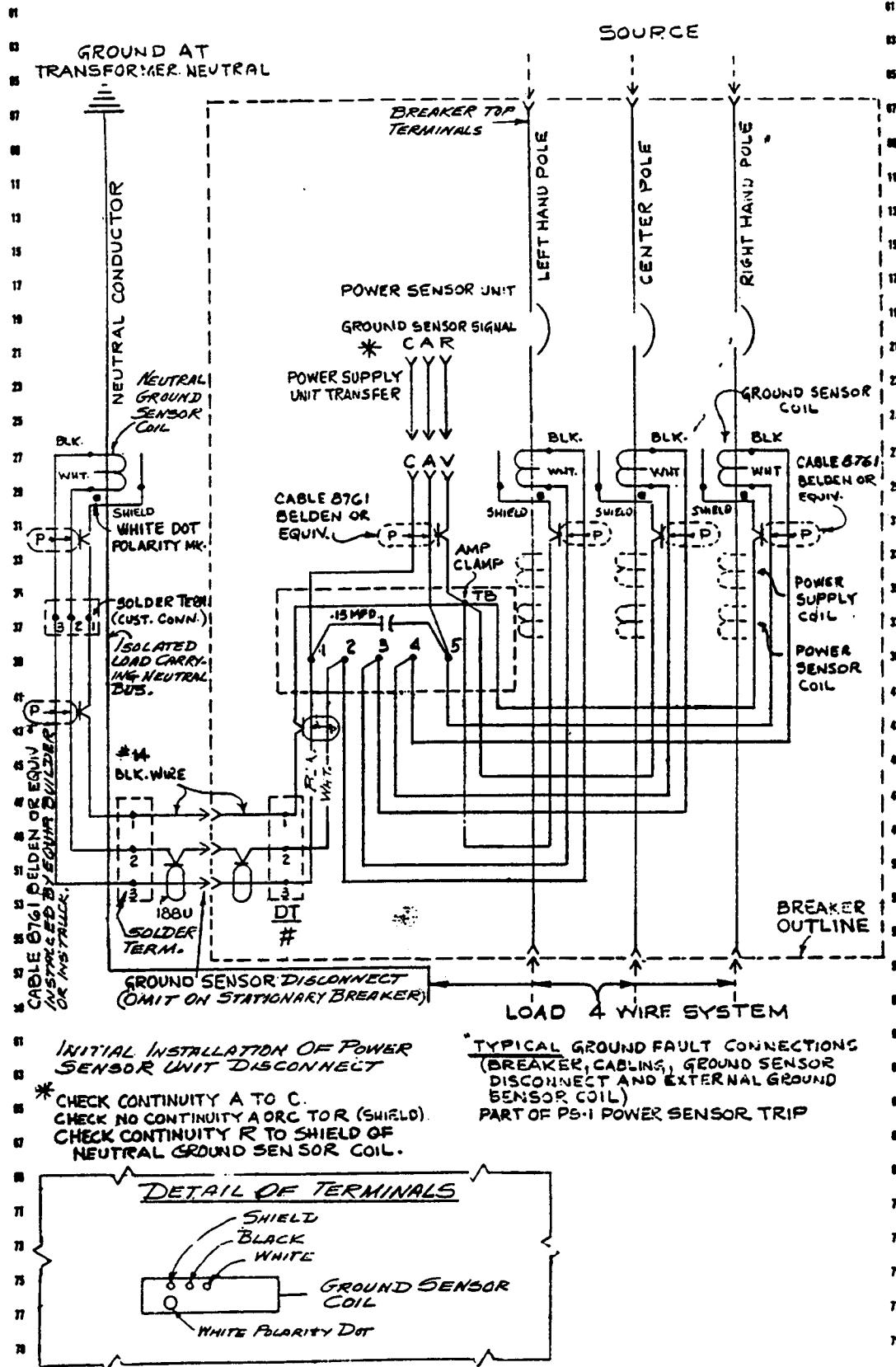


Figure 22. (138B2454) Ground Fault Wiring Diagram

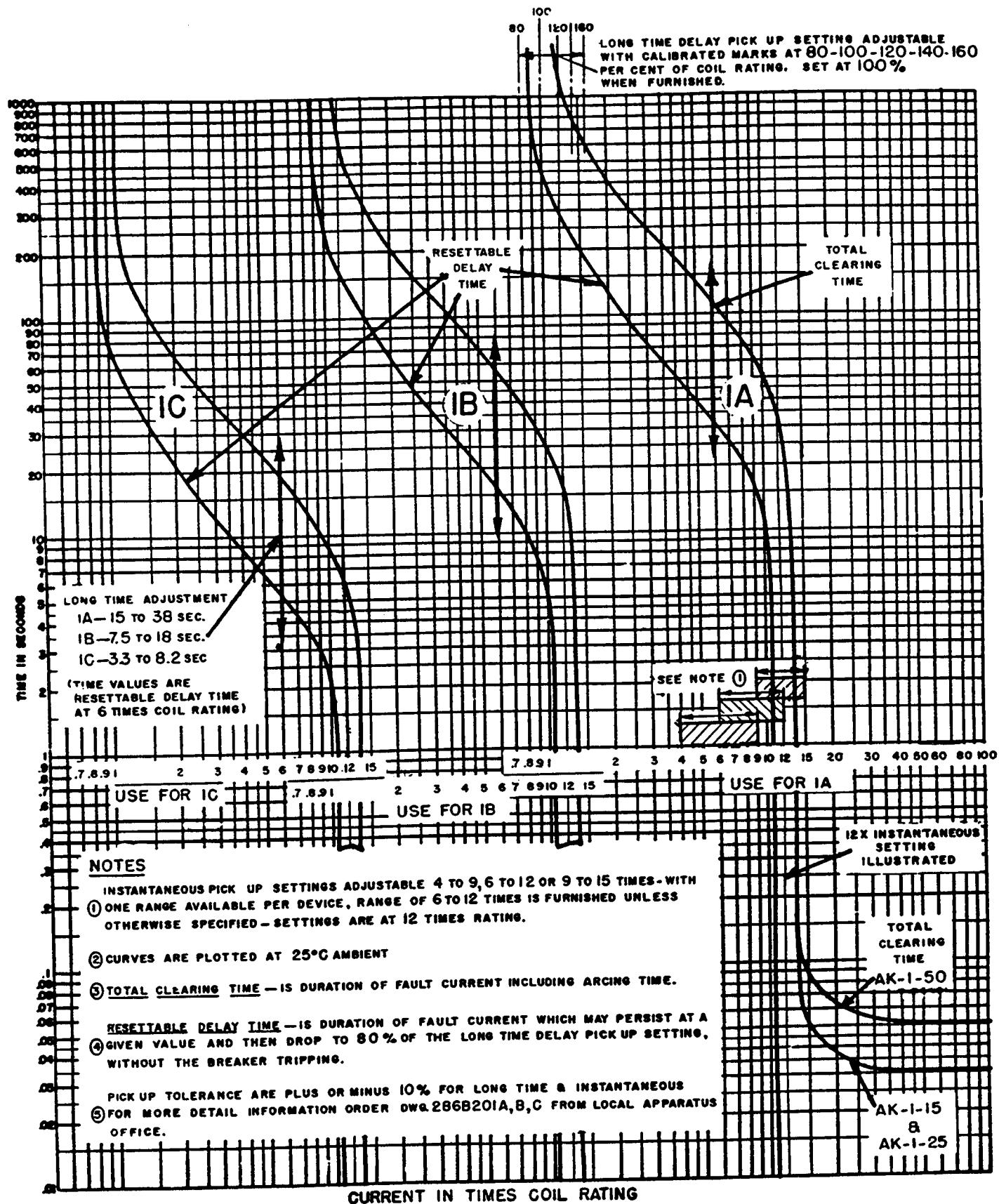


Figure 23. (286B209) Time-Current Characteristic - EC Devices

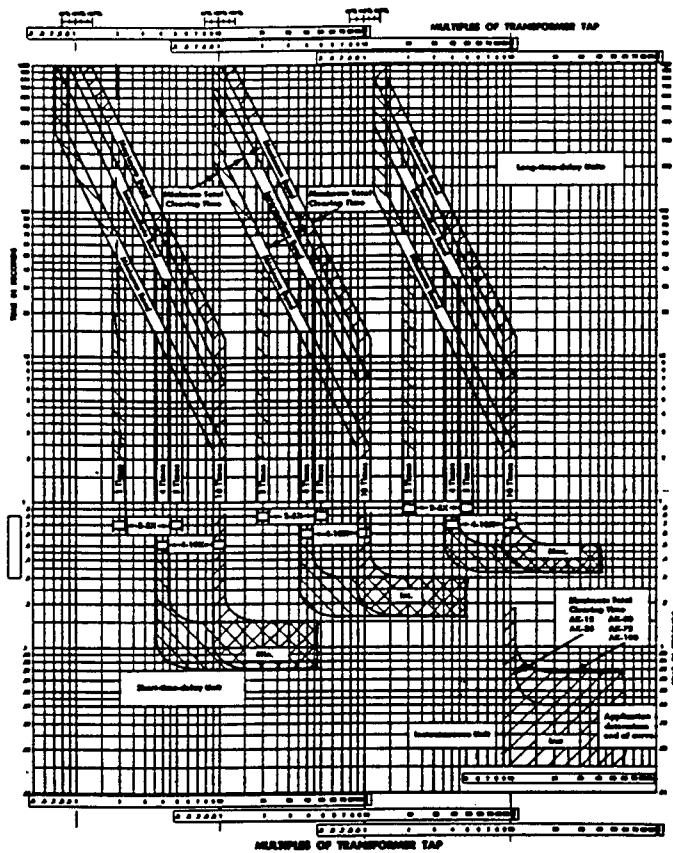


Figure 24. (109HL687) Time Curve

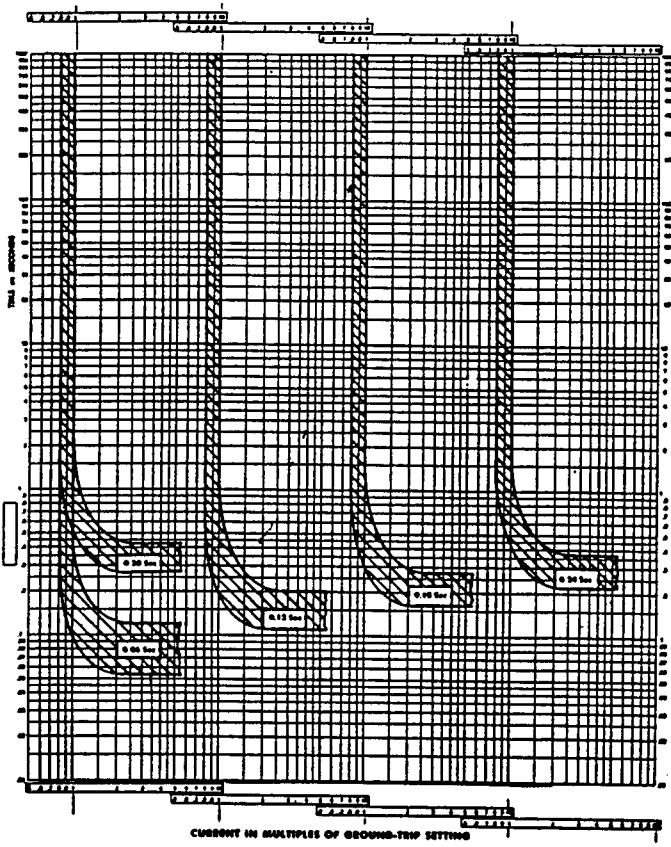
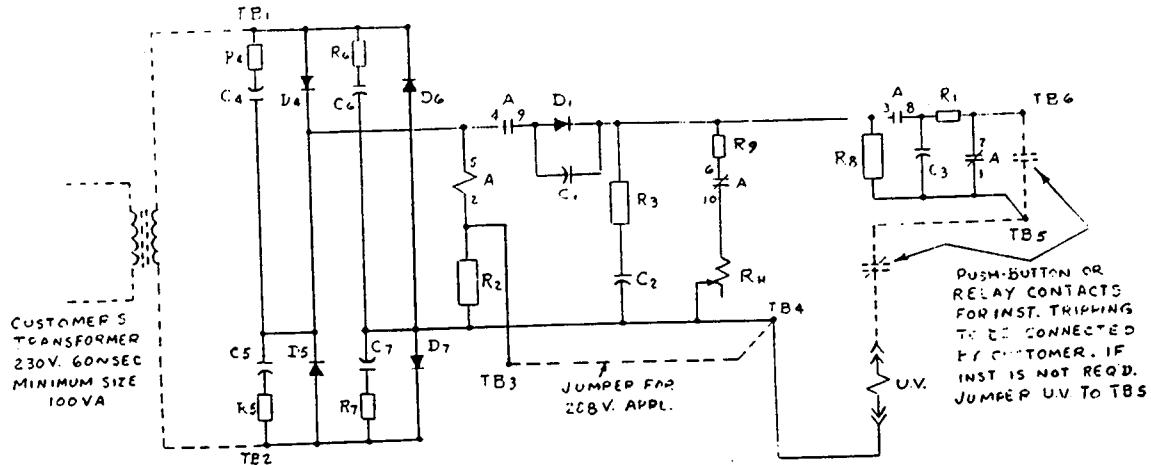


Figure 25. (109HL689) Time Curve

1. Separate the breaker front and back frame as described in the section under "Maintenance".
2. Remove two screws holding sensor coil disconnect plug bracket to back frame.
3. Remove bolt holding resistor bracket to back frame.
4. Remove 2 screws holding capacitor bracket to back frame.

### SELECTIVE TRIPPING

Selective overcurrent tripping is the application of circuit breakers in series so that only the circuit breaker nearest the fault opens. Any one or combination of two or more of the preceding over-current devices may be used in a selective system. The breaker having the shorter time setting and lower pickup will trip before the



A - 250V DC RELAY

C<sub>1</sub>, C<sub>4</sub>, C<sub>5</sub>, C<sub>6</sub>, C<sub>7</sub> - 10μF ±10% 600 WVDC.

C<sub>2</sub> - 550μF 350 WVDC

C<sub>3</sub> - 1000 μF 200 WVDC

D<sub>1</sub>, D<sub>4</sub>, D<sub>5</sub>, D<sub>6</sub>, D<sub>7</sub> - IN560 - 600 mA @ 30°C

R<sub>1</sub> - 15 Ω 2W ±5%

R<sub>2</sub> - 1500 Ω 5W ±5%

R<sub>3</sub> - 75 Ω 5W ±5%

R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, R<sub>7</sub> - 10 Ω ½W

R<sub>8</sub> - 2750 Ω 20W ±5%

R<sub>H</sub> - 0.25,000 Ω 25 W

R<sub>9</sub> - 500 Ω 3W ±5%

breaker having the longer setting and higher pickup, provided the fault is on the part of the line protected by the breaker having the lower setting.

For the exact characteristics and setting of each breaker in a selective system, reference should be made to a coordination chart for the particular system. (Figures 23, 24, and 25)

#### STATIC TIME DELAY UNDERVOLTAGE TRIPPING DEVICE

The Static Time Delay Undervoltage Tripping Device consists of an undervoltage device mounted on the breaker, a static time delay box mounted separately from the breaker and a control power transformer which is also mounted separately from the breaker when the reference voltage is other than DC., 208V AC or 230V AC. Refer to wiring diagram 0102C3698 (Figure 26).

The voltage 208V AC or 230V AC, to be monitored is connected to terminals #1 and #2 of the time delay box. The undervoltage device

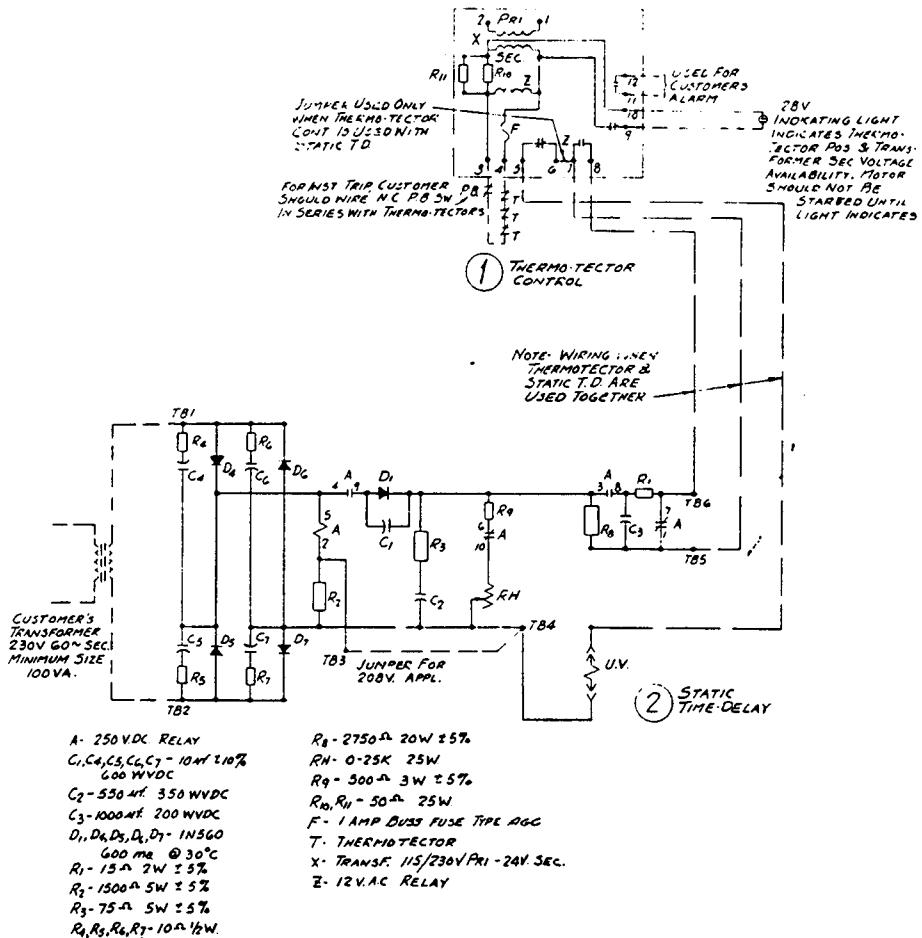
on the breaker is always connected through either its secondary disconnects or terminal board, to terminals #4 and #5 of the time delay box.

The undervoltage device is set to pickup at approximately 80% of bus voltage and drop out between 30% and 60%.

The undervoltage device coil circuit is continuously rated and will remain picked up as long as the voltage remains above the predetermined drop out voltage. The time delay is field adjustable between 1 and 5 seconds, it is factory set at the minimum setting, and once the time delay is established, it is consistent.

No more than one undervoltage device should be connected to a static time delay box.

The Static Time Delay Undervoltage can also be furnished in conjunction with the termotector control package, as shown on wiring diagram 0102C3699 (Figure 27). Overheating of the motor windings causes the termotector, imbedded in the motor windings, to open and allow the "Z" relay of the control box to instantaneously trip the



breaker through a normally closed "Z" contact in series with the undervoltage device mounted on the breaker.

**WARNING** - Do not use bell set to check continuity of bridge circuit in static time delay box, only a volt-ohm meter or vacuum tube volt meter should be used.

In the event the device fails to pick-up, the following checks are recommended to determine whether the magnetic device on the breaker or the static time delay unit is the faulty component.

A. Check input voltages across terminals 1 & 2 on static box. These voltages should be as follows:

1. Device 177L316 G-12-208 or 230 volts A.C.
2. Device 177L316 G-14-125 volts D.C.
3. Device 177L316 G-15-250 volts D.C.

B. Check output voltages on terminals 4 & 5 with the under voltage device connected. The

approximate voltages are as follows:

1. 208 Volt A.C. 177L316 G-12-110 volts D.C. 230 Volt A.C. 177L316 G-12-120 volts D.C.
  2. 125 Volt D.C. 177L316 G-14 50 volts D.C.
  3. 250 Volt D.C. 177L316 G-15-100 volts D.C.
- C. The resistance of the under-voltage coils are as follows:

1. 6275080 G-59 - 1830 Ohms.
2. 6275081 G-61 - 440 Ohms.

#### REPLACEMENT

The entire device may be dismounted by disconnecting the coil leads and removing screw (1) and nuts 16. Normally, only the coil (12) will ever need replacement. This may be removed from the device by taking out screws (11) which will free both the magnet (10) and the coil. Straight-

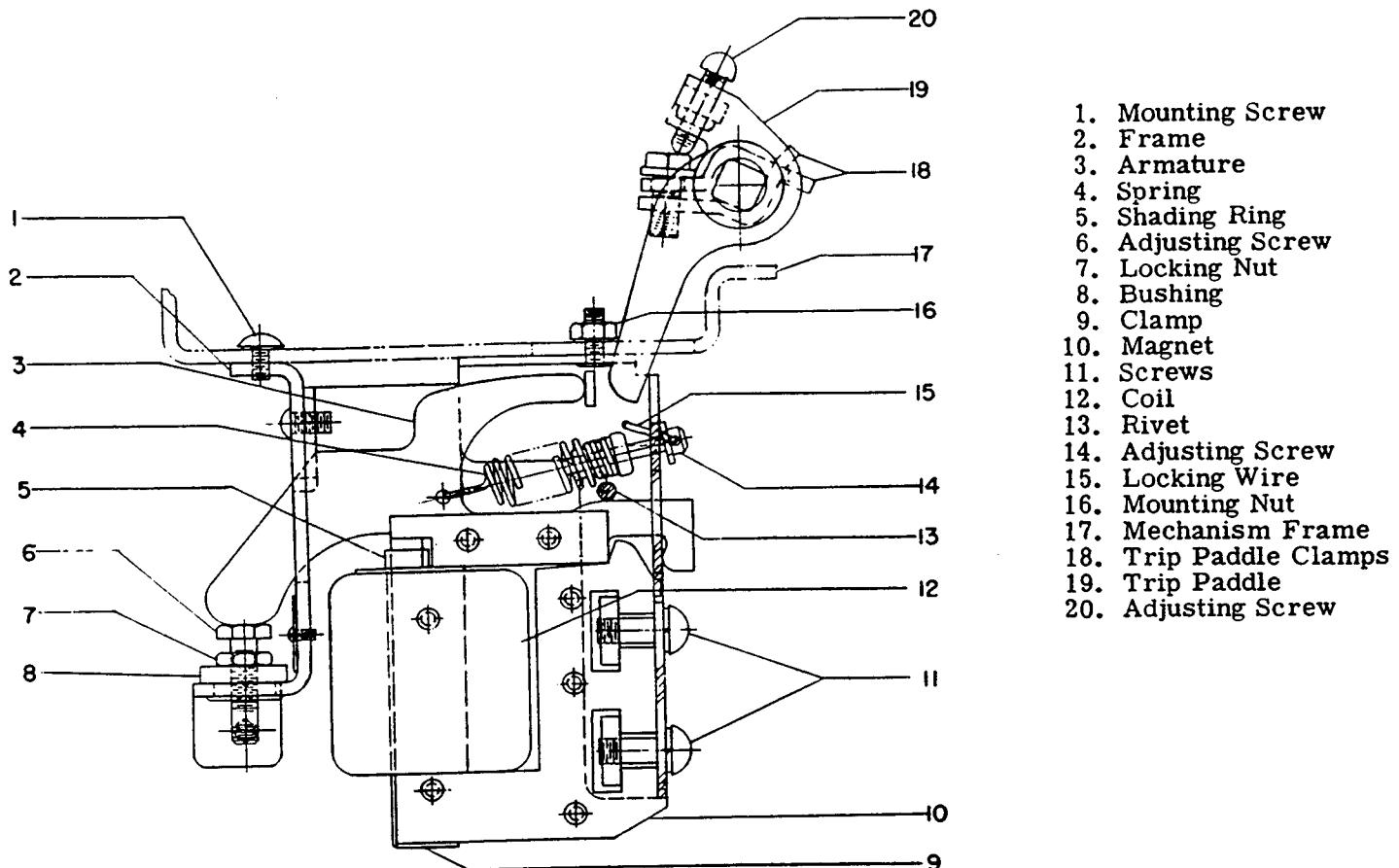


Figure 28. (0152C9206) Undervoltage Tripping Device

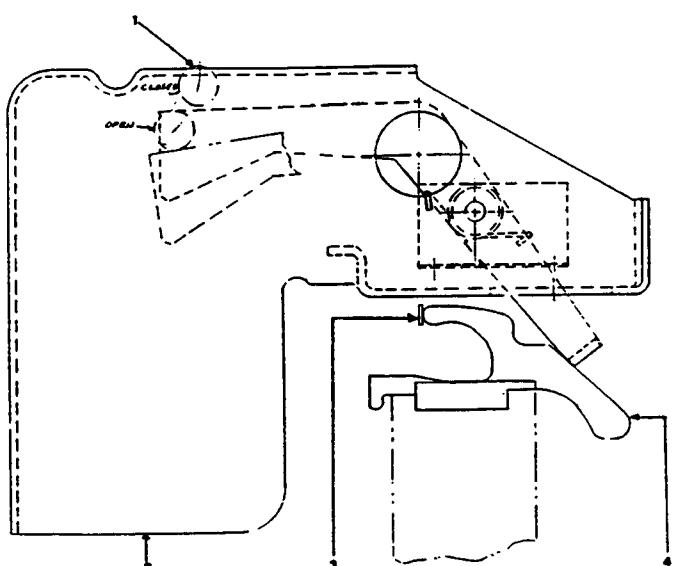


Figure 29. (0101C7842) Undervoltage Lockout Device

1. Cross Bar
2. Left Side Frame
3. Trip Paddle
4. Undervoltage Armature

ening of the bend in clamp (9) will separate the coil from the magnet. The coil leads, of course, must be disconnected.

#### INSTANTANEOUS UNDERVOLTAGE TRIPPING DEVICE

The instantaneous undervoltage device is mounted in the same location and manner as the static time-delay device and its construction is similar.

The adjustments and replacement of this device are the same as those described above for the static time-delay undervoltage device.

#### UNDERVOLTAGE LOCKOUT DEVICE (Figure 29)

The undervoltage lockout device holds an open breaker trip-free when the coil of the device is deenergized. When the breaker is in the closed position, linkage operated by the breaker mechanism cam positions itself to mechanically hold the undervoltage device armature in the closed air gap position to prevent tripping the breaker in the event the undervoltage device coil is deenergized. This feature when used in conjunction with normally-closed auxiliary contacts of an

alternate breaker presents a convenient method of mechanically interlocking two or more breakers to assure that no two breakers may be closed at the same time.

#### BELL ALARM SWITCH AND/OR LOCKOUT ATTACHMENTS

(Figure 30)

The bell alarm device is mounted on top of the horizontal cross frame member just to the left of the mechanism frame when the breaker is viewed from the front. This device operates a switch with two sets of contacts, one normally open, the other normally closed. The switch may be used to open or close an external circuit, giving a bell or light indication of a protective trip device operation.

If the breaker is tripped open by any means other than the manual trip button or the shunt trip device, the bell alarm mechanism is activated. The alarm is shut off and the bell alarm and lockout mechanism is reset by operation of the manual trip button or shunt trip device. If the device is a bell alarm only, the bell alarm mechanism is also reset simply by closing the breaker.

#### OPERATION

Lever (2) is connected to the breaker mechanism so that when the breaker opens lever (2) rotates counterclockwise about pin (14). The motion is transmitted through links (1) and (13) to paddle (12) which operates bell alarm switch (11). If the device has the lockout feature, the movement of link (13) also causes lockout link (8) to slide in a direction that results in its striking trip paddle (5) which, by displacement of the breaker mechanism trip latch, makes it impossible to reset the breaker mechanism until the bell alarm mechanism is reset.

Link (6) serves as a latch in the bell alarm mechanism. If it is displaced, link (10) is free to rotate about its lower pin. This deprives the linkage of its normally fixed center of rotation about pin (15) and defeats both the bell alarm and the lockout operation. Operation of either the manual trip button or the shunt trip device will displace latch (6) and have this effect. Thus if the breaker is tripped by either of these means, the bell alarm and/or lockout will not operate. Also, operation of either of these devices will reset the switch and inactivate the lockout.

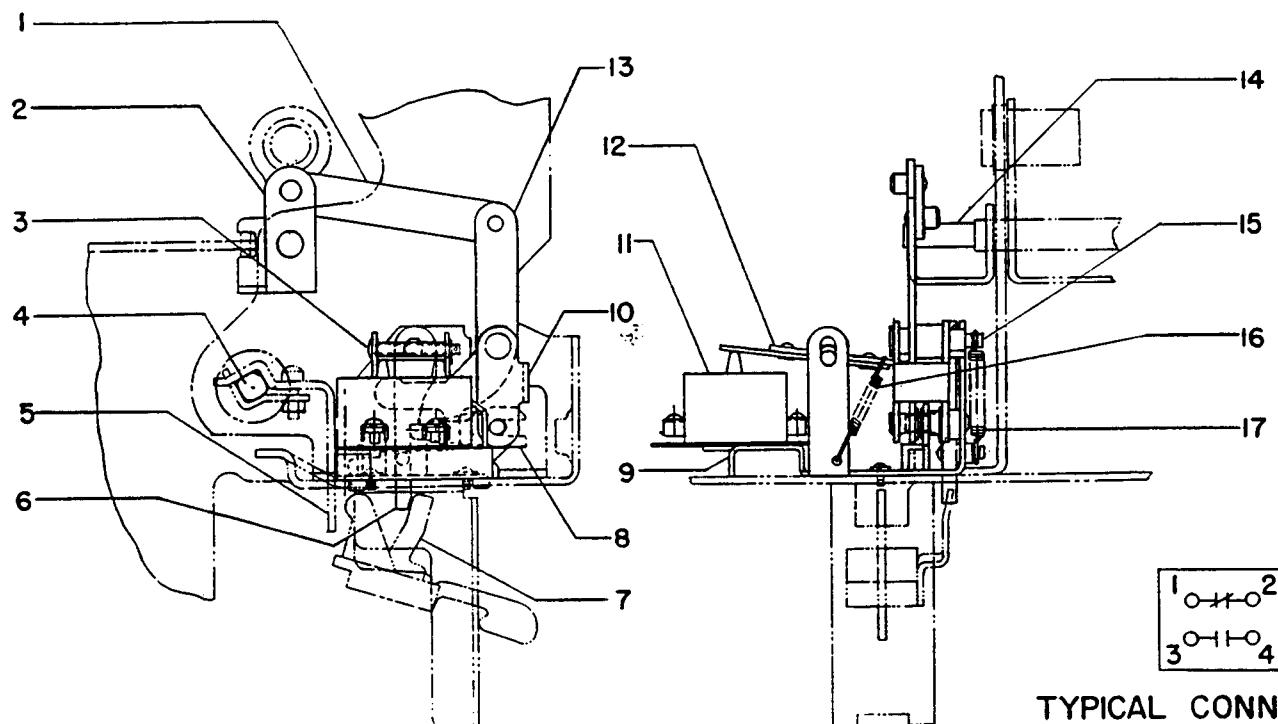
TYPICAL CONNECTION  
DIAGRAM

Figure 30. (695C158) Bell Alarm and Lockout Device

- |                |                 |             |
|----------------|-----------------|-------------|
| 1. Link        | 7. Trip Arm     | 13. Link    |
| 2. Lever       | 8. Lockout Link | 14. Pin     |
| 3. Pin         | 9. Frame        | 15. Pin     |
| 4. Trip Shaft  | 10. Link        | 16. Springs |
| 5. Trip Paddle | 11. Switch      | 17. Spring  |
| 6. Link        | 12. Paddle      |             |

### OPEN FUSE LOCKOUT DEVICE

(Figure 31)

The Open Fuse Lockout Device consists of two or three separately operated devices (one per phase). Each wired in parallel to corresponding breaker fuses. This device is furnished on all AKU breakers. The purpose of this device is to trip the breaker upon the blowing of any one of the breaker fuses and render the breaker trip free until the blown fuse is replaced and the associated coil assembly reset.

#### OPERATION, Figure 31.

When any one of the breaker fuses blow, the coil (6) in that phase is energized and the armature (5) closes. With the armature closed, lever (2) slips under the armature and latches it in the closed position. The latched closed armature holds the breaker in the trip free position until it is released by pushing the associated reset button (1). The coil is deenergized as soon as the breaker opens.

#### ADJUSTMENTS

1. Set top cylindrical collar (not shown) to engage the trip shaft paddle in the tripped position.

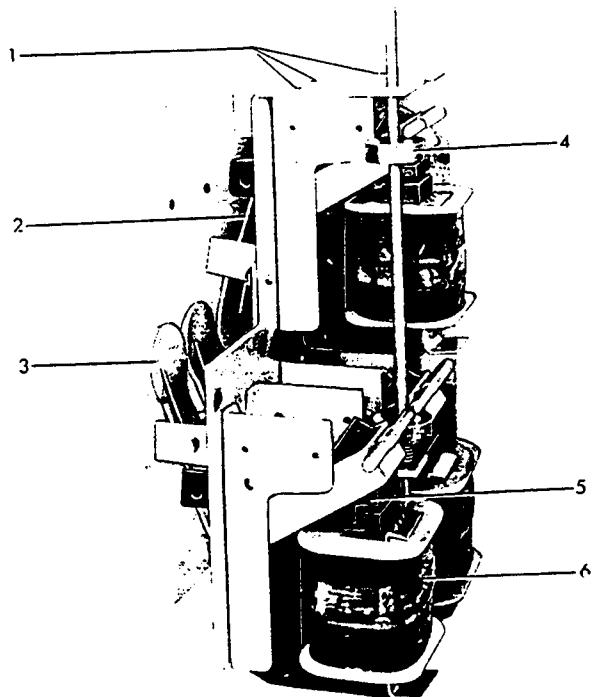


Figure 31. (8041865) Open Fuse Lockout Device

1. Mounting Holes
2. Lever
3. Reset Button
4. Collar
5. Armature
6. Coil

2. Check that each armature holds the breaker trip free when the armature position is limited in reset by the lower latch surface on the indicator.

3. With the breaker in the closed position, the top collar must clear the trip shaft paddle by more than 1/32 inch.

#### REPLACEMENT

1. Remove three mounting screws at top of device.
2. Remove coil leads from fuses and work wire harness back to the device. Remove device from breaker.
3. Replace new unit in reverse order and check procedure under ADJUSTMENTS.

### AKD-5 INTERLOCK

(Figure 32)

The rackout mechanism is interlocked so that the circuit breaker must be open before the operating handle can be inserted. When the breaker is closed, the interlock link (1) operated by the breaker cross bar blocks the interlock linkage on the rackout mechanism.

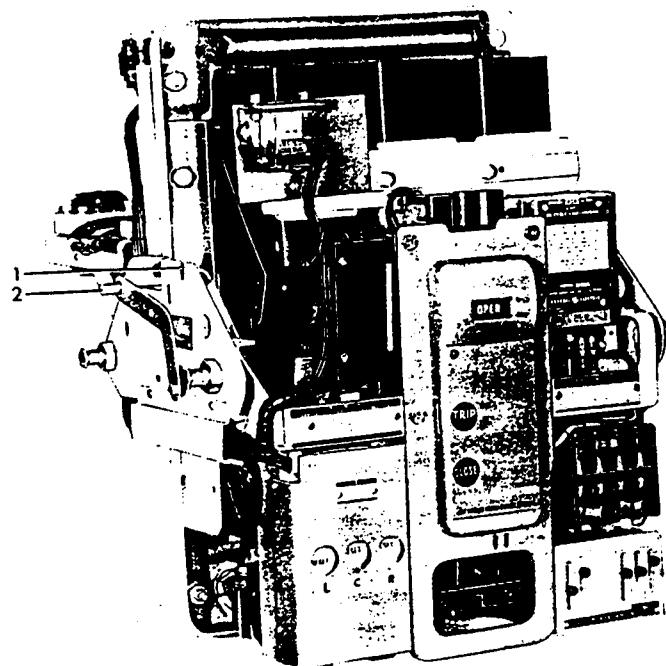


Figure 32. (8039852) AKD-5 Interlock

1. Rackout Mechanism Interlock
2. Trip Interlock

## MISCELLANEOUS

Changes in breaker requirements may occasionally bring about the necessity of adding or changing breaker components or accessories in the field. The AK-2 breaker has been designed so that such additions or conversions are simple and easy to make, requiring only a minimum of time or skill on the part of the operator.

Special instructional drawings are available which will further simplify the addition of such accessories to breakers which were originally shipped without them.

These drawings will accompany the necessary material when it is shipped from the factory. They will also be available upon request. The drawings and the accessory additions which they cover are listed below.

When an accessory is added to a breaker, it is recommended that the section of instructions contained herein covering that particular accessory be reviewed, in addition to referring to the following instructional drawing. Any adjustments described in these instructions should be carefully made after the device has been assembled on the breaker.

Conversion of breakers from manual to electrical operation is also covered on an instructional drawing. This operation consists simply of separation of the front and back frames of the breaker as described under "Maintenance" in these instructions and the reassembly of the existing back frame with the new front frame.

<u>Addition of</u>	<u>Covered By</u>
Shunt Trip Device	698C900
Auxiliary Switch	698C901
Undervoltage Device	698C902
Bell Alarm & Lockout Device	698C904
Drawout Mechanism	698C922
Conversion to Elec. Oper.	698C904

### MAINTENANCE TOOLS

The following tools are recommended for proper maintenance of AK-2-15 and AK-2/3-25 breakers. (NOTE: Obtain from local hardware firm; do not order on General Electric Company.)

#### Screw Drivers

Long thin, slotted screw  
Standard, slotted screw  
Phillips, No. 2, (8" shaft)

#### Pliers

Waldes Truarc, No. 2 straight  
Long Nose, side cutting, 6"

#### End Wrenches

Adjustable, 8"  
1/4" open end

#### Allen Head Wrenches

5/16" for 3/8" screw  
1/8" for 1/4" screw

#### Socket Wrenches (3/8" drive)

Ratchet Handle  
12" extension bar  
3/8" socket  
9/16" socket  
7/16" socket (long)

#### Miscellaneous Tools

1/4" Spintite (long shank)  
7/16" Spintite  
8/32 screw (at least 2" long)

## RENEWAL PARTS

When ordering renewal parts, address the nearest Sales Office of the General Electric Company, specifying the quantity required. Complete nameplate data of the breaker involved should be given as well as an accurate description of the parts required. If the parts needed are illustrated in this book, refer to the figure number and part number involved.

Renewal Parts which are furnished may not

be identical to the original parts since from time to time design changes may be made. The parts supplied, however, will be interchangeable with the original parts.

#### Renewal Parts Bulletin

Bulletin  
GEF-4149F

Breaker Type  
AK-2-15/25  
AK-3-25

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For further information  
call or write your local  
General Electric  
Sales Office or...

Distribution Equipment  
Division  
41 Woodford Avenue  
Plainville, CT 06062, USA

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GENERAL  ELECTRIC





# RENEWAL PARTS

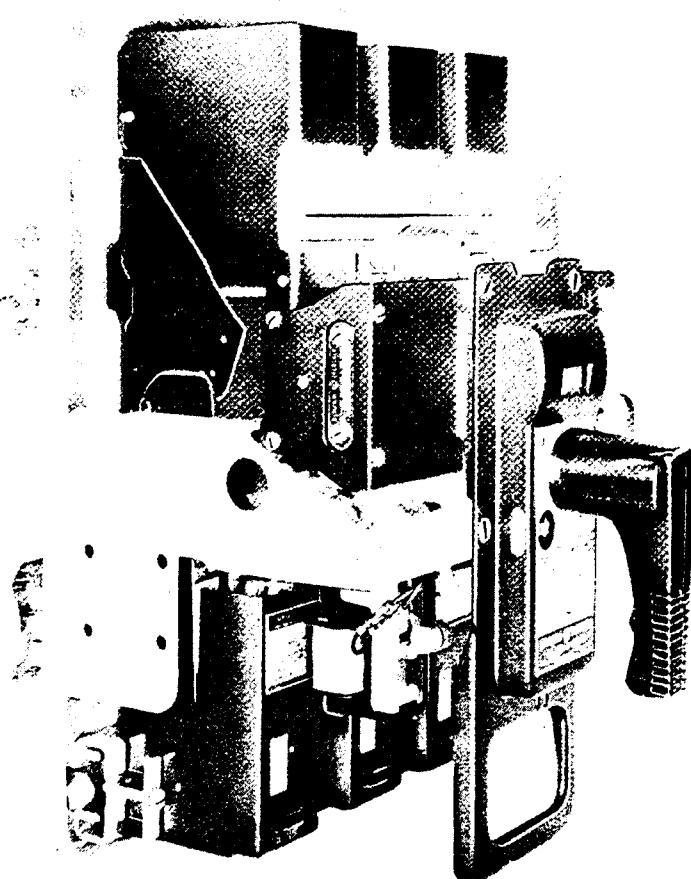
GEF-4149G  
Supersedes GEF-4149F



## POWER CIRCUIT BREAKERS

### TYPES

225 AMP FRAME SIZE	600 AMP FRAME SIZE		
AK-2-15	AK-2-25	AK-3-25	AKF-2-25
AK-2A-15	AK-2A-25	AK-3A-25	AKF-2A-25
	AKU-2-25	AKU-3-25	
	AKU-2A-25	AKU-3A-25	



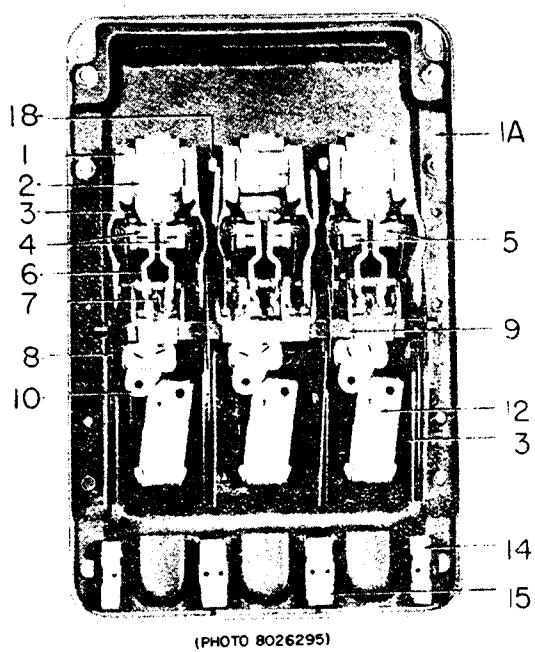
(PHOTO 8024021)

**Fig. 1. Type AK-2-25 manually operated power circuit breaker**  
**ORDERING INSTRUCTIONS**

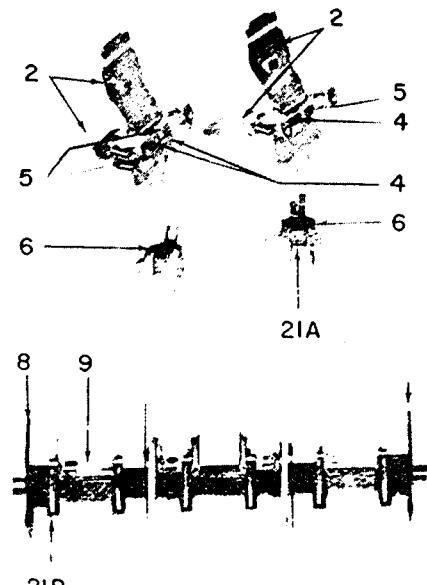
1. Always specify the complete nameplate data of the breaker.
2. Specify the quantity, catalog number (if listed), reference number (if listed), description, and this bulletin number.
3. CAUTION: When local facilities for breaker recalibration are not available, the breaker should be forwarded to the nearest G-E Service Shop, or to the General Electric Company, 6901 Elmwood Avenue, Philadelphia 42, Pa.
4. Standard hardware, such as screws, bolts, nuts, washers, etc., is not listed in this bulletin. Such items should be purchased locally.
5. For prices, refer to the nearest office of the General Electric Company.

GENERAL ELECTRIC

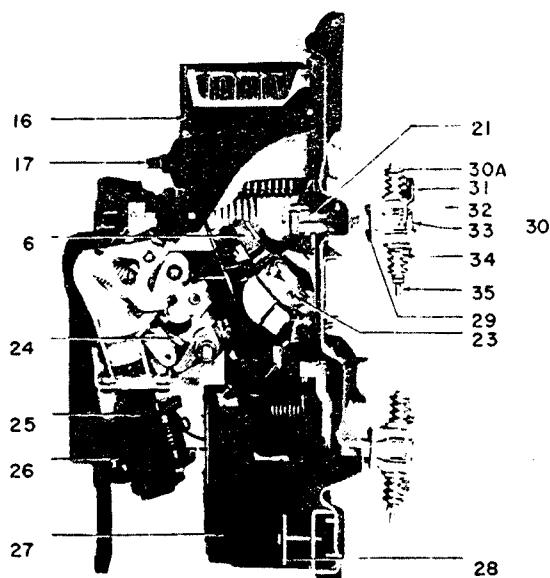
## TYPE AK POWER CIRCUIT BREAKERS



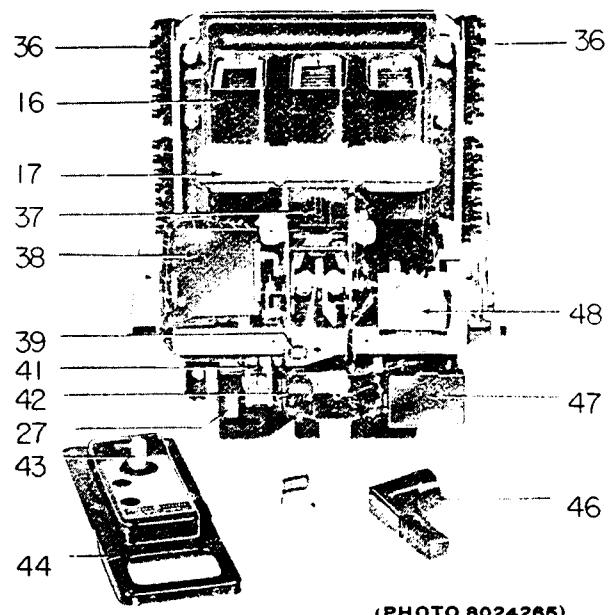
**Fig. 2. Type AK-2-25 power circuit breaker back frame (operating mechanism removed)**



**Fig. 2A. Spring (back of pivot)**



**Fig. 4. Cutaway view of type AK-2-25 electrically operated power circuit breaker**



**Fig. 5. Type AK-2-25 electrically operated power circuit breaker (escutcheon removed and dismantled)**

## TYPE AK POWER CIRCUIT BREAKERS

GEF-4149G

Ref. No.	Quantity Required for 3-pole Breaker Frame 225 Amp**	Size 600 Amp**	Catalog Number	Description
1A	1	1	227D190P1	Back plate
1	3	3	269C260G1	Insulation for upper stud, rear
†1B	3	3	269C260G2	Insulation for upper stud, front
2	3	-	269C283G1	Upper stud assembly
2	-	3	269C283G2	Upper stud assembly
3	3	3	295B460P1	Barrier
*4	3	6	269C257G1	Stationary contact assembly
*5	3	6	269C257G2	Stationary contact assembly
*6	3	-	269C257G14	Moving contact
*6	-	3	269C257G15	Moving contact
*7	2	2	412A250	Spring (outside poles)
*7A	1	1	269C280P5	Spring clip (center pole)
8	2	2	269C277P9	Barrier
8A	1	1	269C277P10	Barrier, complete (includes Ref. Nos. 8 and 8A)
9	1	1	269C277G1	Cross bar assembly
10	3	3	269C258G3	Pivot
*11	3	3	269C280P8	Spring (back of pivot)
12	-	3	269C258G1	Lower stud assembly (not used on AK-3 or AK-3A)
12	3	-	269C258G2	Lower stud assembly
13	2	2	263C526P1	Insulation (under lower stud)
14	2	2	269C280P7	Support (outside)
15	2	2	269C280P6	Support (intermediate)
16	3	3	269B288G1	Arc quencher
17	-	1	121C7514G2	Arc quencher clamp AK-3 or 3A only
17	1	1	269C273G2	Arc quencher clamp (sand gray) AK-2 or 2A
18	2	2	269C280P4	Stud, arc quencher clamp
†19	2	2	177L215P219	Insulation for Ref. No. 18
†20	2	2	393A993P9	Stop nut for Ref. No. 18
*21	6	12	412A286	Stationary contact spring
21A	3	3	412A208	Movable contact spring
21B	6	6	269C277P11	Spring clip
†22	1	1	269C280P1	Moving contact pivot pin (center pole)
23	2	2	269C280P2	Moving contact pivot pin (outside poles)
*24	1	1	0412A0290	Spring
25	1	1	622C521G1	δMagnet and armature assembly
26	1	1	See table B	δClosing coil
27	3	3	See note below	Overcurrent trip device
28	6	6	386A163P1	Clamp for EC-2 trip device
28	3	3	6555445P1	Clamp for EC-1 trip device
29	-	6	269C281P5	Retaining ring
29	6	-	269C281P6	Retaining ring
30	3	-	845C276G2	Primary disconnect assembly
30	-	3	845C276G4	Primary disconnect assembly
30A	6	6	412A222	Spring
31	12	12	269C281P3	Retainer
*32	24	24	453A100P2	Contact finger
33	6	-	453A129P1	Retainer
33	-	6	453A129P2	Retainer
34	6	6	457A681P4	Spacer
35	6	6	-----	Screw, hex. hd. 1/4 in. -20 by 3 1/2 in.

\* Recommended for stock for normal maintenance.

† Not shown.

\*\* See breaker nameplate for frame size.

## δ Electrically operated breakers

## Note for overcurrent trip devices:

- (1) No parts furnished for field installation on EC-1 trip devices.
- (2) Only part furnished for field installation on EC-2 or EC-2A trip devices is plastic cover, Cat. No. 242C645P1.
- (3) When replacement trip devices are ordered, it is imperative that order includes complete nameplate reading of the breaker or breakers involved and, if a contemplated ampere rating change is involved, the order should also include information as to ampere rating, time-current characteristic, and instantaneous trip setting desired.

## Note for operating mechanisms:

- (1) Individual parts cannot be furnished for operating mechanisms.
- (2) When replacement is necessary give complete nameplate reading when ordering.

## TYPE AK POWER CIRCUIT BREAKERS

Ref. No.	Quantity Required for 3-pole Breaker Frame 225 Amp**	Size 600 Amp**	Catalog Number	Description
36	4 maximum	4 maximum	386A110G2	Movable secondary disconnects (drawout breaker)
37	1	1	622C505G1	Cutoff switch (electrically operated breaker)
38	1	1	432A671G2	Auxiliary switch, 2 stages
38	1	1	432A671G5	Auxiliary switch, 5 stages
39	1	1	269C268P1	Manual trip button
†39A	1	1	269C268P12	Trip label
†40	1	1	412A133	Spring for manual trip button
41	1	1	622C502G1	Shunt trip device with coil
42	1	1	622C529G1	Closing switch
43	1	1	101C7891G1	Shaft assembly (Manual Breaker only) order Ref. 43 and 43A together
†43A	1	1	101C7891G2	Link assembly
44	1	1	259C607G1	Escutcheon, manual breaker (black)
44	1	1	259C607P10	Escutcheon, electrically operated breaker (black)
44	1	1	259C607G2	Escutcheon, electrically operated breaker (with handle) (black)
†44	1	1	259C607G3	Escutcheon, manual breaker (blue)
†44	1	1	259C607P11	Escutcheon, electrically operated breaker (blue)
†44	1	1	259C607G4	Escutcheon, electrically operated breaker (blue) with pistol grip handle
45	1	1	259C608G1	Indicator
46	1	1	276B191P1	Handle (black)
46	1	1	669D807P1	Handle (gray)
47	1	1	-----	"X" relay (see Table A, page 6)
*48	1	1	-----	"Y" relay (see Table A, page 6)
†49	1	1	148A2238	Return spring, rear of escutcheon
Δ*50	1	1	295B445P221	Stationary contacts, "X" relay
Δ*51	1	1	295B445P222	Moving contacts, "X" relay
†Δ52	1	1	295B445P223	Springs, moving contacts, "X" relay
†Δ*52A	1	1	116B7197P221	Stationary contacts, "X" relay
†Δ*52B	1	1	116B7197P223	Molded moving arm, "X" relay (with moving contacts)
†Δ52C	1	1	116B7197P222	Armature return spring, "X" relay
Δ*53	1	1	-----	Operating coil, "X" relay (see Table A, page 6)
Δ54	1	1	622C501P1	Cover, "X" relay
Δ55	1	1	622C501P2	Jumper, "X" relay
*56	1	1	-----	Coil for shunt trip device (see Table B, page 7)
	1	1	269C282G2	†Instantaneous undervoltage device, a-c (with coil)
	1	1	269C282G5	†Instantaneous undervoltage device, d-c (with coil)
57	1	1	†	Time-delay undervoltage device, a-c
57	1	1	†	Time-delay undervoltage device, d-c
*58	1	1	-----	Coil for undervoltage device (see Table B, page 7)
59	1	1	Δ	Static time delay, a-c or d-c (replaces complete time delay and volt device coil only)
*†60	1	1	6172594	Spring, for undervoltage device
61	1	1	269C299G2	†Bell alarm device
62	1	1	6293908G275	Terminal board, 6 terminals
62	1	1	6293908G274	Terminal board, 10 terminals
63	1	1	846C865G1	Link and bushing for auxiliary switch
64	1	1	6314936P1	Cover for auxiliary switch, 1 stage
64	1	1	6314936P2	Cover for auxiliary switch, 2 stages
64	1	1	6314936P3	Cover for auxiliary switch, 5 stages
65	3	3	295B475P2	Base for wall mounted, general purpose breaker
66	3	-	394A144P1	Angle for wall mounted, general purpose breaker
67	6	-	275B995P1	Terminal for wall mounted, general purpose breaker
67	-	6	695C131P1	Terminal for wall mounted, general purpose breaker
68	6	-	394A106P1	Cable clamp for wall mounted, general purpose breaker
68	-	6	457A673G1	Cable clamp for wall mounted, general purpose breaker
69	1	1	269C276G2	Maintenance handle

\* Recommended for stock for normal maintenance.

\*\* See breaker nameplate for frame size.

† Not shown.

‡ If at any time a breaker is to have added to it either shunt trip, undervoltage device, or bell alarm device, the order for the device must include the following information:

- (1) Complete nameplate reading of breaker involved.
- (2) Desired voltage rating of device, whether a-c or d-c, and if a-c, the frequency.
- (3) In the case of undervoltage devices, specify whether instantaneous or time delay.

Δ On -1, specify Cat. No. of "X" relay when ordering these parts.

Δ Order by circuit breaker Serial No.

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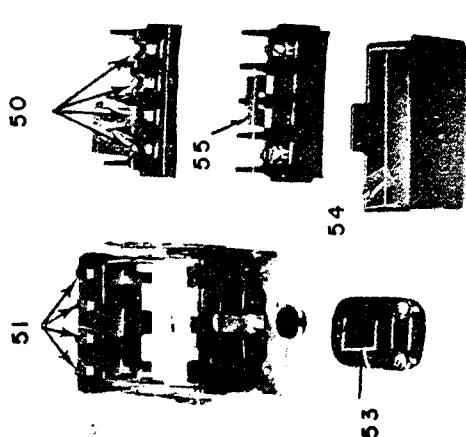


Fig. 6. "X" contactor  
(ref. 47)

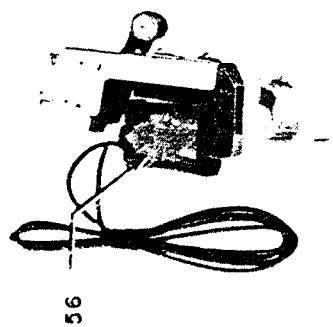


Fig. 7. "Y" relay  
(ref. 48)

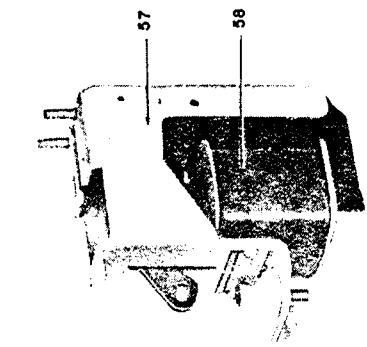


Fig. 8. Shunt trip  
device (ref. 41)

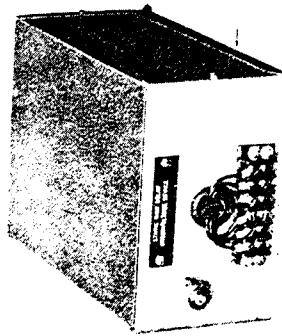


Fig. 9. Time delay undervoltage  
device (ref. 57)

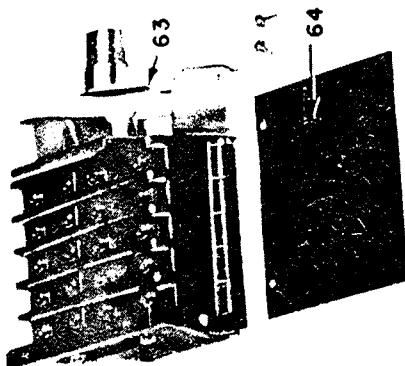


Fig. 10. Cutoff switch  
(ref. 37)

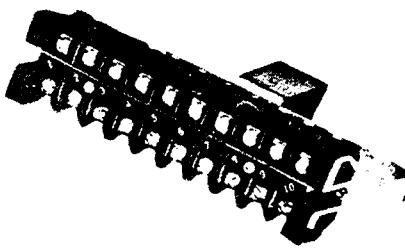


Fig. 11. Bell alarm  
device (ref. 61)

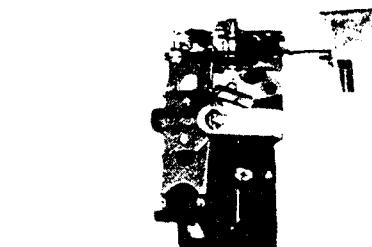


Fig. 12. Terminal  
board (ref. 62)

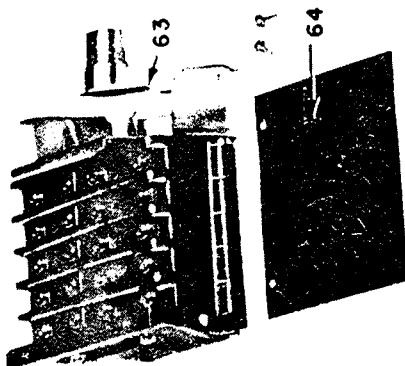


Fig. 13. Auxiliary  
switch (ref. 38)

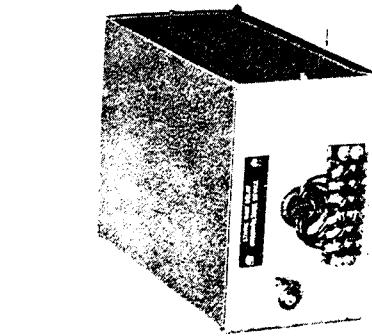
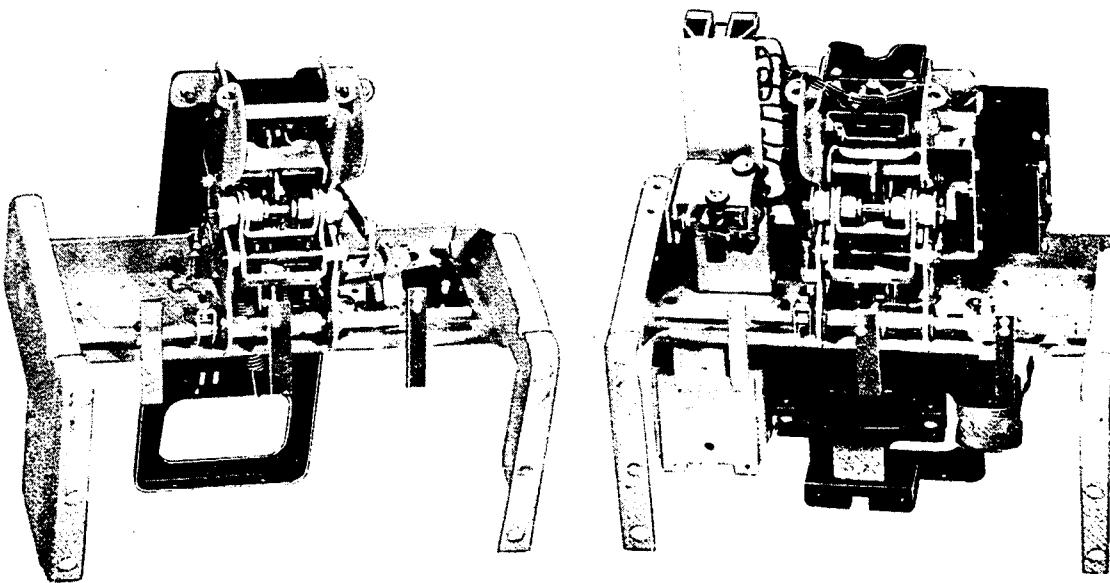


Fig. 13A. Static time delay  
device (ref. 57)

## TYPE AK POWER CIRCUIT BREAKERS



(PHOTO 8026400)

**Fig. 14. Manual (left) and electrical (right)  
front frame assemblies for  
Type AK-2-15 and -25  
power circuit breakers**

## NOTES FOR FIG. 14:

- (1) Should it become necessary to replace the complete front frame of the breaker, it is necessary that the order include complete nameplate reading of existing breaker.
- (2) If an existing manual breaker is to be converted to electrical operation, the order must include, in addition to complete nameplate reading, a description of desired change and complete voltage and frequency rating of both closing and tripping circuits.

TABLE A

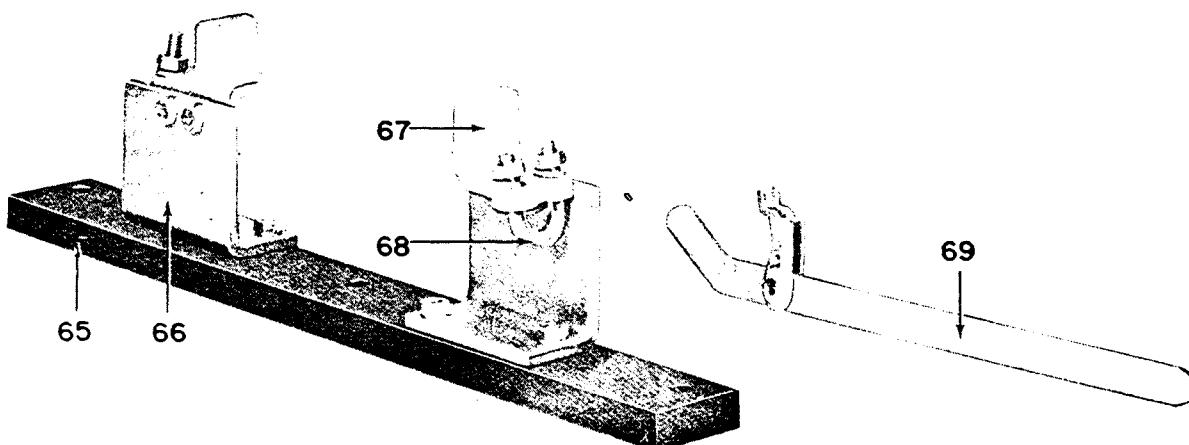
Rating		Catalog Number				"Y" Relay Complete (Ref. 48) §
		"X" Relay				
Volts	Cycles	Relay Complete, Ref. 47	Coil, only (Ref. 53)	Relay Complete, Ref. 47	Coil, only (Ref. 53)	
		for Δ and Early -1 Breakers		for Late -1, and all -2 Breakers		
24 48 125 250	D-C	295B445P1	295B445P201	116B7197P1	116B7197P201	295B444P1
		295B445P2	295B445P202	116B7197P2	116B7197P202	295B444P2
		295B445P3	295B445P203	116B7197P3	116B7197P203	295B444P3
		295B445P4	295B445P204	116B7197P4	116B7197P204	295B444P4
115 208 230 460	25	295B445P7	295B445P207	116B7197P7	116B7197P207	295B444P7
		295B445P10	295B445P210	116B7197P10	116B7197P210	295B444P10
		295B445P13	295B445P213	116B7197P13	116B7197P213	295B444P13
		-----	-----	116B7197P16	116B7197P216	-----
230	40	295B445P12	295B445P212	-----	-----	295B444P11
115 208 230 380 460	50	295B445P6	295B445P206	116B7197P6	116B7197P206	295B444P5
		295B445P9	295B445P209	116B7197P9	116B7197P209	295B444P8
		295B445P12	295B445P212	116B7197P12	116B7197P212	295B444P11
		295B445P17	295B445P214	116B7197P17	116B7197P217	295B444P17
295B445P15	295B445P216	116B7197P15	116B7197P215	116B7197P215	295B444P14	
115 208 230 460	60	295B445P5	295B445P205	116B7197P5	116B7197P205	295B444P5
		295B445P8	295B445P208	116B7197P8	116B7197P208	295B444P8
		295B445P11	295B445P211	116B7197P11	116B7197P211	295B444P11
		295B445P14	295B445P214	116B7197P14	116B7197P214	295B444P14

Δ Original breaker had no suffix numeral or letter.

§ Only complete relay furnished.

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(PHOTO 8026586)

**Fig 15. Accessories for wall mounting (ref. 65, 66, 67, 68)**

**Fig. 16. Maintenance handle for electrically operated breakers not equipped with manual handles (ref. 69)**

TABLE B

Rating		Catalog Number		
		Closing Solenoid Coil (Ref. 26)	Shunt Trip Device Coil (Ref. 56)	Undervoltage Device Coil (Ref. 58)
Volts	Cycles		Instantaneous or Old Design Oil Dashpot Type Time Delay	Static Time Delay Type
24 48 125 250	D-C	---	6275081G55	6275081G15
		366A773G17	6275081G28	6275081G9
		366A773G13	6275081G29	6275081G18
		366A773G15	6275081G30	6275081G19
115 208 230 460 575	25	366A773G3	6275081G26	6275081G12
		366A773G6	6275081G29	6275081G10
		366A773G14	6275081G29	6275081G10
		366A773G11	6275081G7	6275081G17
		366A773G12	6275081G5	6275081G21
115 208 230 380 460 575	50	366A773G2	6275081G56	6275081G4
		366A773G3	6275081G26	6275081G12
		366A773G5	6275081G26	6275081G12
		366A773G6	6275081G27	6275081G31
		366A773G8	6275081G4	6275081G3
		366A773G10	6275081G29	6275081G28
115 208 230 460 575	60	366A773G1	6275081G25	6275081G26
		366A773G3	6275081G26	6275081G27
		366A773G4	6275081G26	6275081G7
		366A773G7	6275081G27	6275081G31
		366A773G9	6275081G7	6275081G20

πInput voltage to static timing unit (Fig. 13A) indicated.

## TYPE AK POWER CIRCUIT BREAKERS

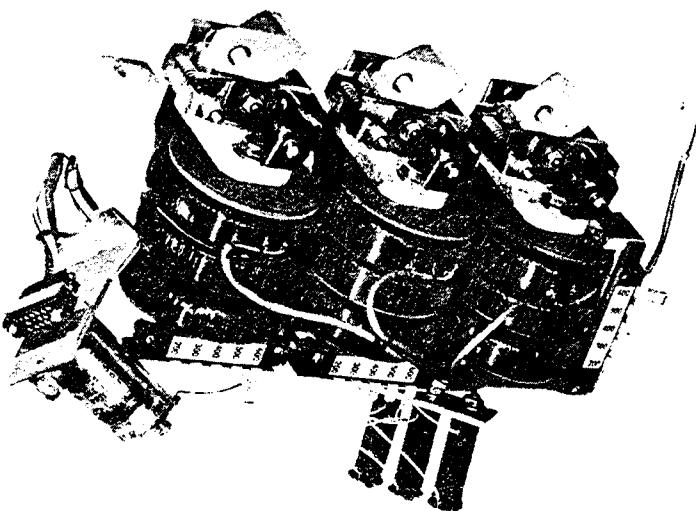


Fig. 17. Magnetic coil assembly

Magnetic Sensor Coils - Assembly (Fig. 17)

Without ground trip			With ground trip			
Poles	Rating	Cat. No.	Poles	Rating	Grd. Trip Range	Cat. No.
2	45/225	107D7554G2	2	45/225	100/400	107D7554G6
3	45/225	107D7554G3	3	45/225	100/400	107D7554G7
2	200/600	107D7554G4	2	200/600	100/400	107D7554G8
3	200/600	107D7554G5	3	200/600	100/400	107D7554G9
			2	200/600	300/1200	107D7554G10
			3	200/600	300/1200	107D7554G11



Fig. 18. Power supply unit

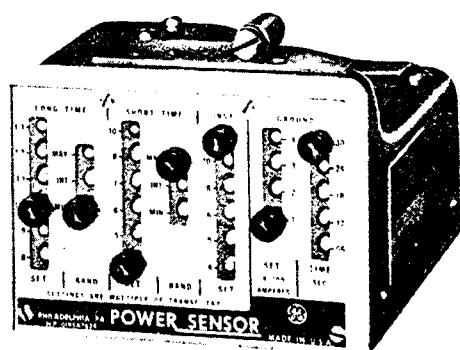
Power Supply Units - Cat. No. 156C4508G10

Fig. 19. Power sensor unit

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Power Sensor Unit AK-25 (Fig. 19)

	With Long Time Delay 80 to 130% Range  With Instantaneous Trip 4 to 12X Range	Without Long Time Delay  With Instantaneous Trip 4 to 12X Range	With Long Time Delay 80 to 130% Range  Without Instantaneous Trip	Without Long Time Delay  Without Instantaneous Trip
With Ground Fault Protection 100 to 400 Amp Range				
Without Short Time Delay	184L373G57	184L373G78	----	----
With Short Time Delay 2 to 5X Range 4 to 10X Range	184L373G51 184L373G54	184L373G66 184L373G69	184L373G60 184L373G63	184L373G72 184L373G75
Without Ground Fault Protection				
Without Short Time Delay	184L373G43	184L373G50	----	----
With Short Time Delay 2 to 5X Range 4 to 10X Range	184L373G41 184L373G42	184L373G46 184L373G47	184L373G44 184L373G45	184L373G48 184L373G49

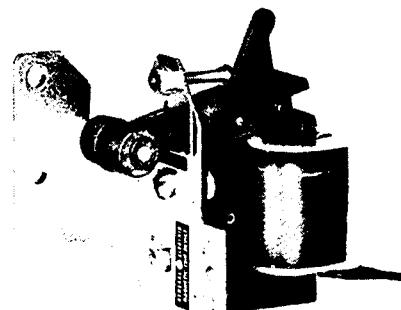


Fig. 20. Magnet trip device with mounting bracket

Magnet Trip Device with Mounting Bracket - Cat. No. 0846C0882 G4

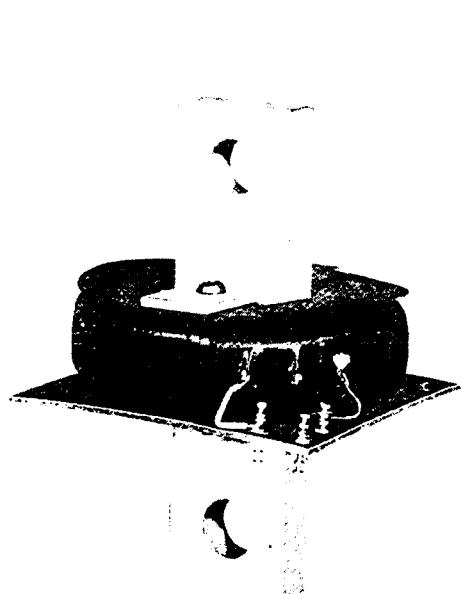


Fig. 21. Ground sensor coil with neutral mounting

Fourth Wire Grid Sensor Coils

100/400 Cat. No. 152C9218G1

300/1200 Cat. No. 152C9218G2



Fig. 22. Power sensor kit

Power Sensor Test Kit - Cat. No. 0102D2526 G10

## TYPE AK POWER CIRCUIT BREAKERS

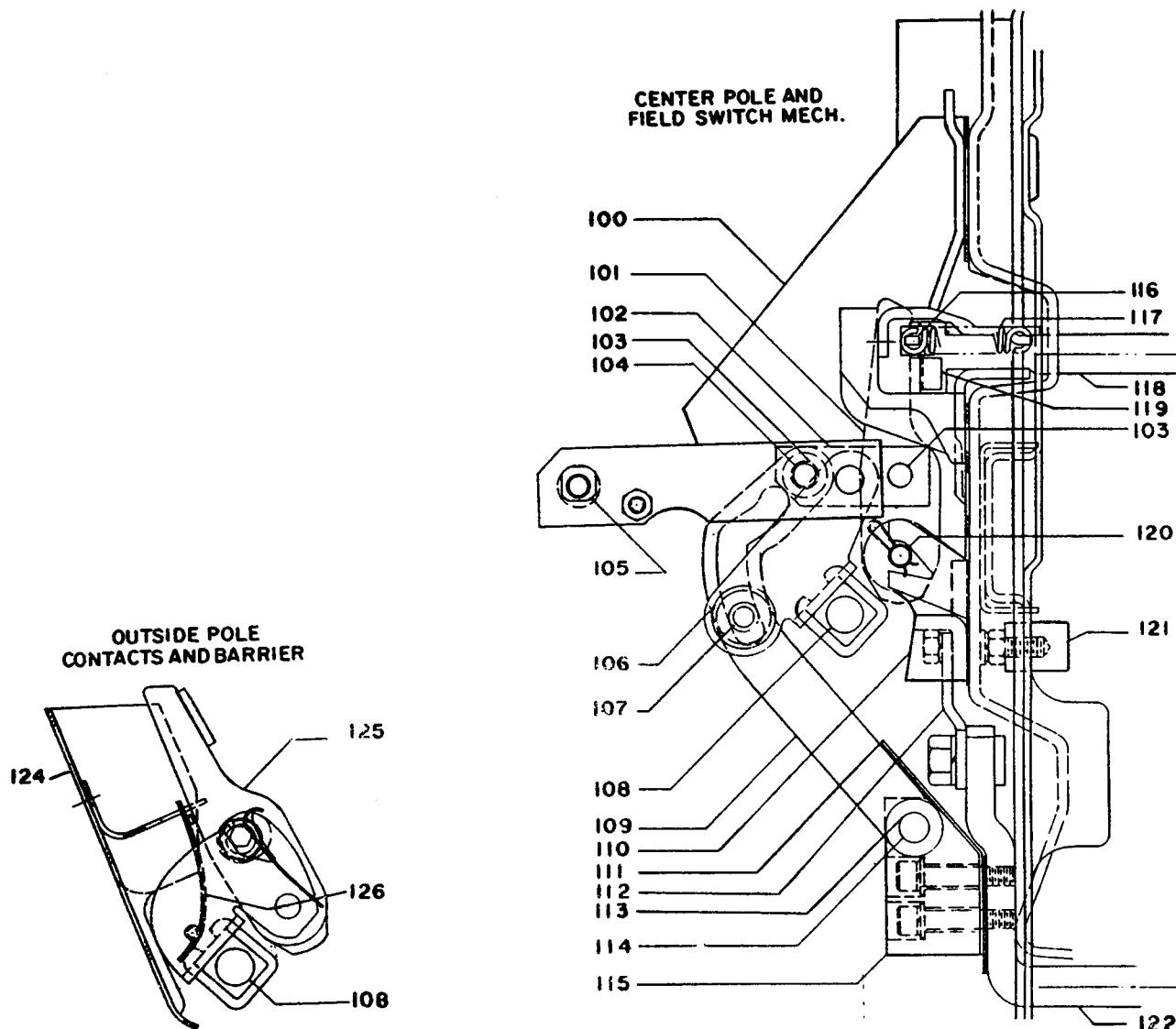


Fig. 23. Field switch mechanism and contact assemblies

NOTE: Parts listed below apply only to Types AKF-2-25 and AKF-2A-25. All other parts are identical to those used on Type AK-2-25.

Ref. No.	Qty. Per Center Pole	Catalog No.	Description	Ref. No.	Qty. Per Center Pole	Catalog No.	Description
100	1	073-108C9697P9	Insulation	114	1	073-412A404P136	Pin
*101	1	108C9698G1	Moving contact	115	1	108C9694P7	Lower pivot
102	2	108C9695P2	Link	*116	1	269C257G1	Stationary contact
103	4	394A133P8	Retaining ring	*116	1	269C257G2	Stationary contact
104	1	108C9695P9	Pin	117	2	412A286	Stationary contact spring
105	2	148A2279P1	Adjustable bushing	118	1	269C283G4	Upper stud
106	2	377A871P12	Bearing	119	1	108C9697P11	Contact spacer right side
107	1	108C9695P10	Cam follower	119	1	108C9697P12	Contact spacer left side
108	1	108C9696G1	Crossbar	120	1	269C280P1	Moving contact pivot pin
109	1	108C9695G3	Cam assembly, left	121	1	108C9698P14	Spacer
109	1	108C9695G4	Cam assembly, right	122	1	269C258G13	Lower stud
110	1	108C9695P6	Pivot	*123	1	293B288G1	Arc quencher
111	1	108C9694P8	Lower stud insulation	124	1	108C9697G3	Insulation
112	1	108C9695P3	Connector	*125	1	108C9698G2	Moving contact
113	2	394A133P9	Retaining ring	126	2	108C9694P5	Spring

\* Recommended for stock for normal maintenance.

10 † Not shown.

**GENERAL ELECTRIC CO.  
DISTRIBUTION EQUIPMENT DIVISION  
PLAINVILLE, CONN. 06062**

**GENERAL  ELECTRIC**

## **MEMORANDUM**

# POWER CIRCUIT BREAKERS

## Types AK-2-15 and AK-2/3-25

### INTRODUCTION

The instructions contained herein provide information for performing maintenance procedures and for replacing AK-2/3-15/25 breaker components and accessories. For information regarding

the receiving, handling, storage and installation of these breakers, refer to GEK-7302 furnished with all AK breakers.

### OPERATION

#### ELECTRICAL OPERATION Figure 1

The electrically operated breaker closes whenever the closing solenoid coil is energized. This causes an upward movement of the solenoid armature, which initiates the mechanical closing action. The closing signal may be given either by a remote switch or relay, or by a closing button in the front escutcheon if the breaker is so equipped. Either action (refer to the elementary of the wiring diagram) energizes the coil of the X relay through the bb contacts of cutoff switch G and the normally closed contacts of the Y relay. When the X relay or contactor is energized, it closes its contacts. One of these (X1-2) seals in the X coil. The other three sets of contacts, which are arranged in series, activate the closing solenoid.

The breaker control scheme has an anti-pump feature which allows only one closure of the breaker for a single operation of the closing switch no matter how long the switch may be held closed. This prevents the repeated operations that would ensue if one of the automatic trip devices was activated at the time of closing. The Y relay, together with the cut-off switch, provides the anti-pump feature. The mechanical action of closing operates the cut-off switch, reversing the position of the contacts from that shown on the diagram. This energizes the Y relay, if contact is still maintained at the closing switch, with the result that the X relay circuit is opened by Y contacts 5-6. This prevents the X relay from again becoming energized. Y contact 1-2 seals in the Y coil as long as contact is maintained at the closing switch.

Electrically operated breakers may also be closed by means of the maintenance handle which is furnished with the breaker. This is a separate tool and is simply a lever which permits an operator to push upwards on the closing solenoid armature. Two small hooks on one end of maintenance handle are engaged in slots (8A) Figure 5, located in the lower portion of the front escutcheon (8A) Figure 5. Rotation of the long end of the handle downwards forces the shorter end of the handle upwards against the bottom of the solenoid armature, and closes the breaker.

The breaker may be tripped open by any one of a number of electrical tripping devices which will be described in detail later in these instructions. An individual breaker may have none or any combination of these devices. They are the overcurrent tripping device, shunt tripping device, undervoltage tripping device, reverse current tripping device, and open fuse lockout device. All of them effect tripping by displacing the trip latch of the mechanism. The trip latch is rigidly attached to a trip shaft which runs through the breaker from left to right. Whenever the trip shaft is rotated in a counterclockwise direction looking from the right, the latch is displaced. The tripping devices are all equipped with strikers or trip arms which act against trip paddles rigidly fastened to the trip shaft, causing it to rotate on its bearings in a direction to trip the breaker.

The reverse current device and the shunt tripping device each have a set of auxiliary switch "a" contacts in their circuits. (An "a" contact is open when the breaker contacts are open.) This prevents their operation unless the breaker is closed.

The undervoltage device coil is normally continually energized. When the control voltage is low or non-existent, as when the breaker has been pulled out for inspection or maintenance, the breaker is rendered trip-free by the undervoltage device. If it is desired to close the breaker, the device armature must be tied down or blocked closed against the magnet. The open fuse lockout device is used on all AKU breakers and breaker fuse combinations. The purpose of this device is to trip the breaker upon the blowing of any one of the breaker fuses.

#### MANUAL OPERATION

The manually operated breaker is closed by first rotating the handle in a counterclockwise direction through 90 degrees, then rotating it clockwise back to its normal vertical position. The counterclockwise stroke resets the mechanism, readying it for the clockwise closing stroke.

The breaker may be tripped manually by pushing the manual trip button. This action pushes

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 rod against a trip paddle of the trip shaft, rotating it, and causing the mechanism trip latch to be displaced. This allows the mechanism linkage to collapse through the action of the mechanism operating springs.

**CAUTION:** If the breaker is tripped manually while the operating handle is in the reset position, the handle should be lowered by the right hand while operating the trip button with the left hand.

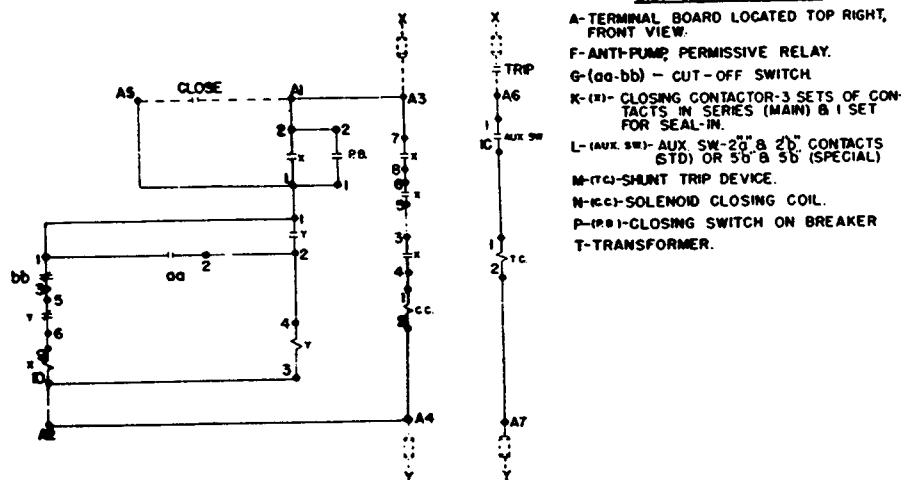
### ELECTRICAL WITH MANUAL OPERATION

This operating mechanism provides both manual and electrical closing. The operating mechanism is similar to the mechanism of the standard electrical breaker with the addition of the manual handle, cam and mechanism connecting link. The

solenoid connecting link and manual cam connecting link are both connected to the closing spring pin at the top of the mechanism, thus compressing the springs when force is provided by either means of breaker closing.

The breaker is manually closed by rotating the closing handle 90 degrees counterclockwise. No reset stroke is necessary as is the case with the standard manual breaker. Electrical closing may be performed either locally or remotely in the same manner as the standard electrical breaker.

Tripping is accomplished by the manual trip button on the escutcheon or by any of the electrical tripping devices available for use on the standard breakers.



ELEMENTARY DIAGRAM

FIG.

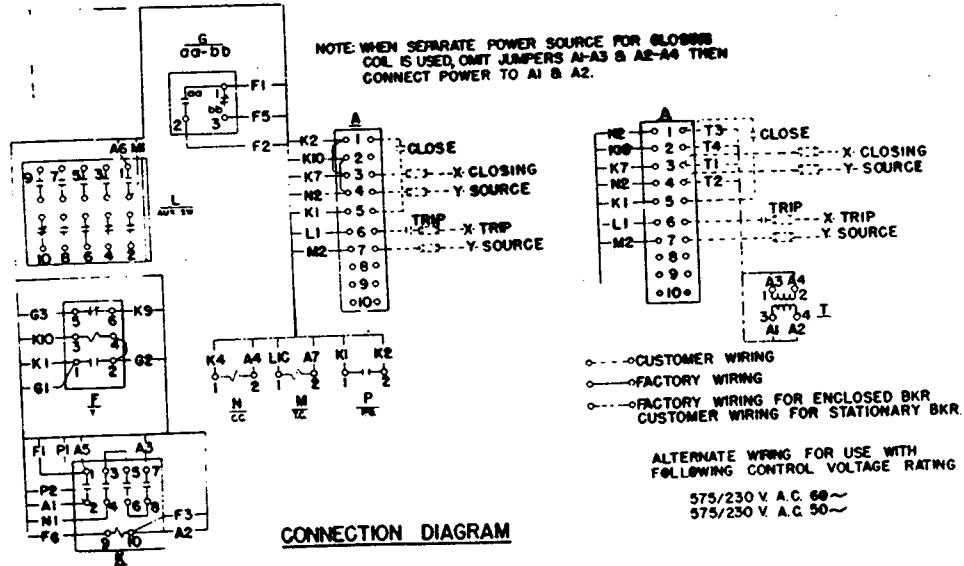


Figure 1. (695C160-1) &amp; (695C159-1) Typical Wiring Diagram

## MAINTENANCE

### INSPECTION

BEFORE INSPECTION OR ANY MAINTENANCE WORK IS DONE, BE SURE THAT THE BREAKER IS IN THE OPEN POSITION. ALL ELECTRICAL POWER, BOTH PRIMARY AND CONTROL SOURCES, SHOULD ALSO BE DISCONNECTED.

Periodic inspection of the circuit breaker is recommended at least once a year. More frequent inspections are recommended, if severe load conditions, dust, moisture, or other unfavorable conditions exist.

If the breaker remains open or closed for a long period of time, it is recommended that arrangements be made to open and close it several times in succession, preferably under load.

At all times it is important not to permit pencil lines, paint, oil or other foreign materials to remain on the insulating surfaces of the breaker as they may cause low resistance between points of different potential and result in eventual electrical breakdown.

Always inspect the breaker after a short circuit current has been interrupted.

At the time of periodic inspection, the following checks should be made after the breaker has been de-energized.

1. Manually operate the breaker several times checking for obstructions or excessive friction.
2. Electrically operate the breaker several times (if breaker has electrical control) to ascertain whether the electrical attachments are functioning properly.
3. Remove and inspect the arc quencher. Breakage of parts or extensive burning will indicate need for replacement.
4. Check contact condition and wipe
5. Check latch engagement.
6. Check operation of tripping devices, including overcurrent trip devices, making sure all have positive tripping action. (Discernible movement in tripping direction beyond point of tripping.)

(For detailed information on breaker features listed, refer to appropriate sections of these instructions.)

### SEPARATION OF FRONT AND BACK FRAMES

Figure 3

Many maintenance operations will either require or be greatly facilitated by separating the

front frame and mechanism of the breaker from the back frame or base, which consists of the current carrying parts of the breaker and their supporting structure. The procedure for this operation is as follows:

1. Remove the arc quenchers (see section on "Arc Quenchers").
2. Disconnect the two insulated connecting links (6), between the mechanism and the crossbar (10), by removing the tie bolt (7), and slipping the ends of the links off the ends of the shoulder pin, (5) Figure 5 in the mechanism.
3. If the breaker is a drawout type, with secondary disconnects, Figure 2, remove the secondary disconnect supporting bracket from the breaker back frame. Also remove any wiring bundle retainers that may be attached to the back frame.
4. Remove one elastic stop nut from each of two studs (3), which tie the upper ends of the mechanism frame to the back frame of the breaker.
5. Remove the two elastic stop nuts (9/16" Hex.) which fasten the wrap around portion of the front frame to the back frame. One of these is located on each side of the breaker, about 2/3 of the distance down from the top edge of the back frame.

On drawout breakers for AKD Equipment, the bottom plate must be removed by first removing two #8-36 screws located at the front of the bottom plate and then freeing the plate from the slots located in the bottom of the back frame.

6. The two frames are now disconnected. However, care should be exercised in separating them to avoid damage to the trip shaft arms and paddles. While the back frame is held steady, lift the front frame and mechanism up and out so that the trip paddles on the trip shaft clear the trip arms of the overload trip devices.

Reassembly of the two breaker halves is accomplished by following the procedure outlined in reverse order.

### LUBRICATION

In general, the circuit breaker requires very little lubrication. Bearing points and sliding surfaces should be lubricated very lightly at the regular inspection periods with a thin film of extreme temperature, high pressure, light grease, similar to G.E. Spect. No. D50H15 or RPM No. 5. Hardened grease and dirt should be removed from latch and bearing surfaces by the use of a safe cleaning solvent such as kerosene. Latch surfaces should be left clean and dry and not be lubricated.

ALL EXCESS LUBRICANT SHOULD BE REMOVED WITH A CLEAN CLOTH IN ORDER TO AVOID ANY ACCUMULATION OF DIRT OR DUST.

At each maintenance period, all silver to silver friction points, such as primary disconnects, should be cleaned and given a fresh coat of G.E. Spec. No. D50H47 lubricant.

### TROUBLESHOOTING

The following table lists several typical symptoms of breaker malfunction, together with their causes and remedies. If, at any time, these symptoms are observed, their cause should be determined and the necessary corrective action should be taken.

TROUBLE	CAUSE	REMEDY
Overheating AK-2/3 Breakers	Contacts not aligned Contacts dirty, greasy or coated with dark film Contacts badly burned or pitted Current carrying surfaces dirty Corrosive atmosphere Insufficient bus or cable capacity Bolts and nuts at terminal connections not tight Current in excess of bus rating Excessive ambient temperature	Adjust contacts. Clean contacts Replace contacts Clean surfaces of current carrying parts Relocate or provide adequate enclosure Increase capacity of bus or cable Tighten, but do not exceed elastic limit of bolts or fittings. Check breaker application or modify circuit by decreasing load Provide adequate ventilation
Failure to trip AK-2 Breakers	Travel of tripping device does not provide positive release of tripping latch Worn or damaged trip unit parts Bind in overcurrent trip device	Re-adjust or replace tripping device and check mechanism latch adjustment Replace trip unit Replace overcurrent trip device
False Tripping AK-2 Breakers	Overcurrent trip device pick up too low Overcurrent trip device time setting too short Bind in overcurrent trip device	Check application of overcurrent trip device Check application of overcurrent trip device Replace overcurrent trip device
Failure to Close and Latch AK-2/3 Breakers	Binding in attachments preventing resetting of latch Latch out of adjustment Latch return spring too weak or broken Hardened or gummy lubricant Closing solenoid burned out Solenoid control device not functioning properly	Re-align and adjust attachments Adjust latch Replace spring Clean bearing and latch surfaces Replace solenoid coil Re-adjust or replace device
False Tripping AK-3 Breakers	Captive Thump screw on Power Sensor loose fail-safe circuitry reverts characteristic to minimum setting and maximum time delay Tap setting dial on Power Supply incorrectly set External Ground Sensor Coil improperly connected	Tighten thumb screw on desired setting  Set dial to correspond with Power Sensor coil tap Refer to Figure 22, page 29 for polarity and connections. Check continuity of shield and conductors connecting the external Ground Sensor coil.
Failure to Trip AK-3 Breakers	Loose or disconnected power sensor disconnect plugs Loose or broken power sensor coil tap connections	Tighten or reconnect disconnect plugs Tighten or reconnect tap connections

## BASIC BREAKER COMPONENTS

### DISCONNECTS

#### PRIMARY DISCONNECTS

The primary disconnects are attached to the ends of the breaker studs on the rear side of the breaker base. Each disconnect assembly consists of two pair of opposed contact fingers. These are secured to the breaker stud by a bolt which passes through the assembly and the stud. When engaged with the stationary stud of the enclosure, the disconnect fingers exert a set amount of force against the stationary stud through the action of the compression springs. Retainers and spacers hold the contact fingers in correct alignment for engagement with the stud. The amount of force which the fingers exert against the stud is determined by degree to which the springs are compressed by the bolt and nut which hold the assembly together. This pressure is factory set between 60 and 70 pounds. If, for any reason, the disconnects must be taken apart, the position of the nut on the bolt should be carefully noted, so that in reassembling, the original amount of compression can be restored by replacing the nut at its former position on the bolt.

#### SECONDARY DISCONNECT, FIGURE 2.

The secondary disconnects serve as connections between breaker control circuit elements and external control circuits. They are used only on drawout type breakers. A terminal board serves the same purpose on stationary mounted and general purpose enclosure mounted breakers. The secondary disconnects allow removal of the breaker without the necessity of having to detach external connections.

The movable part of the secondary disconnect consists of an insulating body which holds a conducting spring loaded plunger to which a flexible lead is attached. As the breaker moves into its enclosure, the plunger is depressed by sliding onto the stationary disconnects of the enclosure.

#### REPLACEMENT OF MOVABLE SECONDARY DISCONNECTS

1. Unfasten disconnect body from breaker back frame.
2. Open tabs which hold wires on inner side.
3. Pull contact tip loose from hollow tube.
4. Remove contact tip by cutting wire at its base.
5. Push wire through hollow tube on new disconnect assembly.
6. Strip insulation off end of wire to about 1/4 of an inch from end.
7. Place new contact tip on end of wire and crimp.
8. Pull wire through hollow tube until contact tip fits snugly against end of hollow tube.
9. Crimp tab on other side of assembly to hold wire in place.
10. Any hollow tubes which are not used should be pushed into the disconnect body and held in that position by placing fibre spacers over inner ends of tubes and spreading tabs.

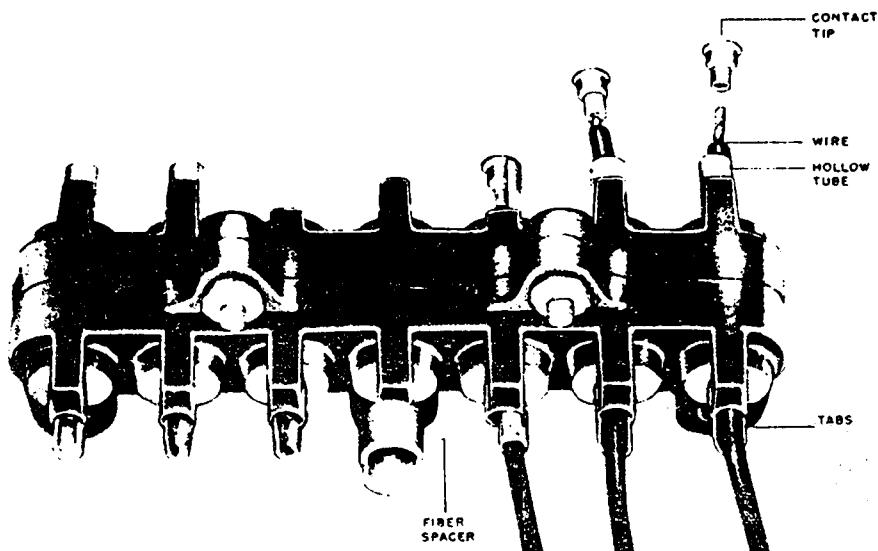


Figure 2. (8017973) Movable Secondary Disconnects

- When all wires have been connected, refasten the body of the assembly to the breaker back frame.

### ARC QUENCHER

The arc quencher is an integral riveted assembly composed of two ceramic side plates, a series of steel plates, and a muffler. The assembly is covered by a wrap around of insulating material which inhibits any sidewise emission of gases. The steel plates are held in position and supported by the ceramic sides which are grooved vertically to provide recesses for the vertical edges of the steel plates. The bottom edges of the latter form an inverted "V" along the path of the arc that may be drawn between the breaker contacts during interruption. The steel plates have the effect of breaking up the arc, and cooling it and the gases that result from interruption. The entire assembly provides a "chimney" effect which directs the hot, ionized gases upwards through the steel plates and mufflers and allows their safe and controlled escape at a cooler temperature.

The muffler at the top of the assembly is a serpentine shaped strip of perforated, copper plated steel. It is important that the perforations of the muffler be kept open, since their closure could tend to prevent the escape of the gases along the desired path. At the regular maintenance inspection, it would be well to check their condition and open any of the perforations that appear to be clogged.

If any very extensive burning or corrosion is noted in the arc quencher, it should be replaced. Replacement is also indicated if any breaks or cracks are noted in the ceramic material.

### REPLACEMENT

Removal of the arc quencher is simply a matter of lifting the assembly up and out, after the steel retainer across the front of the arc quenchers has been removed. The upper edge of the steel arc runner, fastened to the back plate of the breaker, fits into a recess in the back portion of the arc quencher which locates it in its proper position upon replacement. Make sure the steel retainer is replaced and fastened firmly to its mounting studs after the arc quenchers have been replaced.

### BREAKER CONTACT STRUCTURE

The copper current carrying parts of the breaker are all mounted on a common base of insulating material made of polyester glass mat. The copper of each pole consist of an upper stud and pivot, stationary contacts, two movable contact arms, a movable contact pivot, and the lower stud.

The upper stud branches into two pivot surfaces on its inner end on the forward or front side of the breaker base. Each of these convex pivot

surfaces mates with the concave pivot surface on the rear side of the stationary contacts. Each of the stationary contacts pivot in a horizontal plane approximately at their mid-points. The end of the contact opposite to the contact tip end is formed into the shape of a small hook. A tension spring engages this hook and provides the necessary contact pressure at the pivot and also at the point of contact with the movable contact arm. When the breaker contacts open, a projection on the contact tip end of the stationary contact bears against a stop pin restricting the movement of the stationary contact. This arrangement results in a continual high force existing between the mating pivot surfaces.

The movable contact arms pivot in a vertical plane, each making contact with a pair of stationary contacts, and thus providing four low resistant parallel paths of current for each breaker pole. The movable contacts rotate about a burnished, silver plated, copper pin which, in turn, is held by a pivot support. Each side of the pivot support bears against the lower, outer surface of the contact arm and supplies a second low resistance path through the pivot. A "U" shaped spring clip made of silver plated conducting material provides an additional current path and protects the other contact surfaces of the pivot against pitting when in motion. It also contributes to the force tending to increase the contact pressure between the lower ends of the movable contacts and the pivot support.

The movable contact pivot support is mounted securely to the breaker base. If, as is normally the case, the pole is equipped with an overcurrent trip device, one of the terminals of the series coil of the trip unit is fastened to the lower end of the pivot support. The other terminal of the coil fastens to the lower stud.

### CONTACT ADJUSTMENTS

The only adjustment to be made on the breaker contacts is that of contact wipe. This may be described as the distance the movable and stationary move while they are touching one another in the process of breaker closing. The amount of contact wipe can be measured by comparing the position of the front surface of the stationary contact when the breaker is open to its position when the breaker is closed, in reference to some absolutely stationary part of the breaker. The most convenient stationary part of the breaker to use as a reference point is the steel arc runner above and behind the stationary contacts.

The amount of wipe the contacts should have is nominally  $1/8$  of an inch. A plus or minus tolerance of  $1/32$  of an inch is allowed.

The means of adjusting contact wipe is provided by an eccentric pin which passes through the center of the movable contact assembly. Each end of this pin has a free, projecting, hexagon

stationary contacts and be sure to locate them in the breaker with the upper and lower contacts having their stop projecting surfaces as shown in the section AA, Figure 3. The upper left and lower right contacts are identical as are the lower left and upper right contacts.

3. By placing the hook on the end of the contact through the loop of the contact spring, the contact can be pushed toward the pivot surface and slipped behind the stop pin. Install all stationary contacts in all poles.

#### REPLACEMENT OF MOVABLE CONTACTS (18) Figure 3.

1. Coat the pivot area only of the new movable contacts with a thin coat of D50H47 grease.
2. Assemble the center pole movable contacts, align the pivot pin holes with the bullet nosed rod, and install the pivot pin and split pin.
3. Move the cross bar assembly into position and insert the eccentric contact wipe adjust-

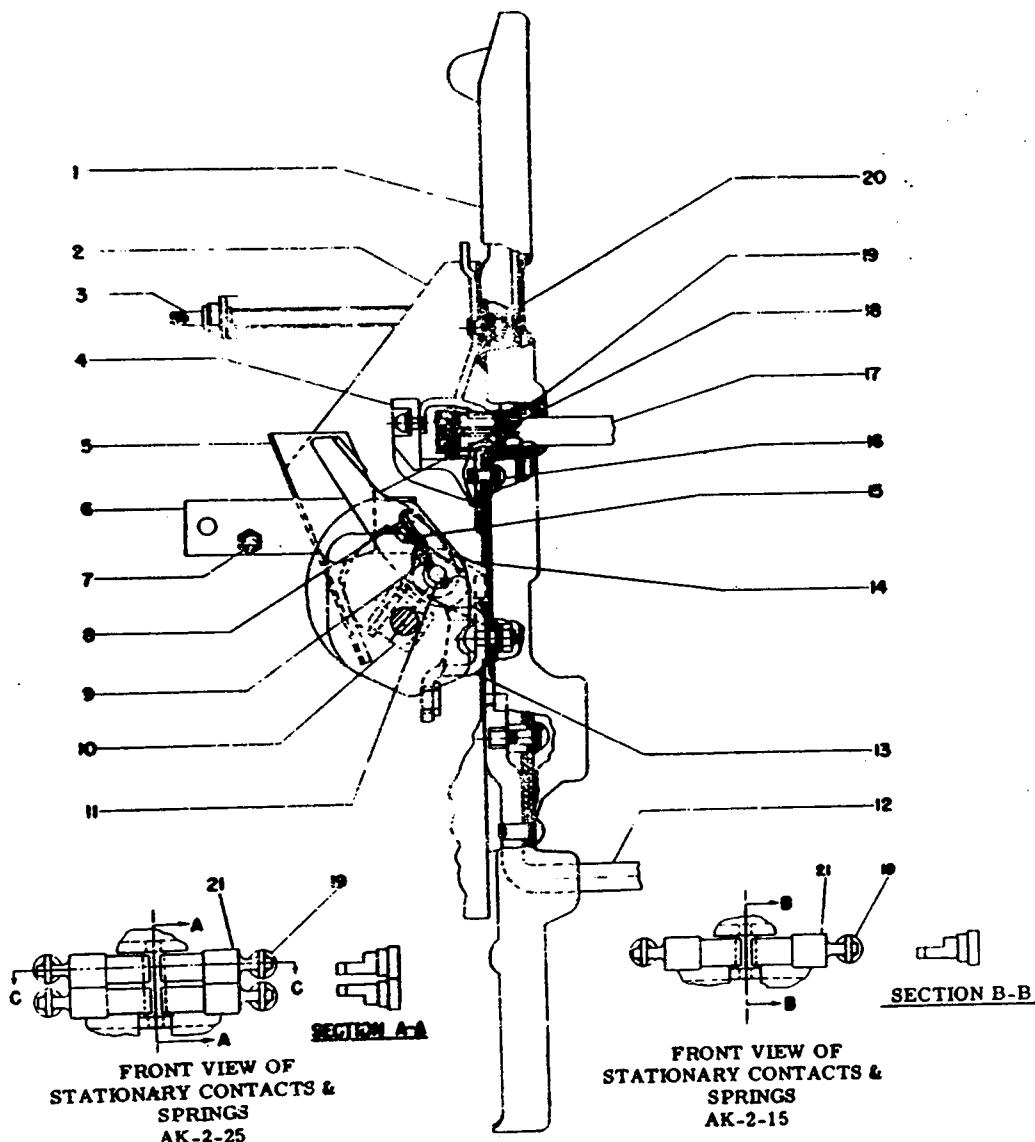


Figure 3. (549D409-2) Contact Assembly

1. Breaker Base	8. Spring	15. Contact Wipe Adjustment Pin
2. Insulation	9. Spring Clip (Retainer)	16. Screw
3. Insulated Stud	10. Cross Bar	17. Upper Stud & Arc Runner
4. Upper Stud Barrier	11. Pivot Pin	18. Movable Contact
5. Insulation	12. Lower Stud	19. Spring
6. Links (Insulated)	13. Contact Pivot Support	20. Nut
7. Tie Bolt	14. Spring	21. Stationary Contacts

shaped section which is easily accessible to a small, open end, 1/4 inch wrench. Two cantilever springs, which bear on each end against a portion of the hexagon section of the pin, lock the adjusting pin in place and provide index stops for the process of adjustment. The right hand hexagon shaped end of the pin is numbered from 1 to 6, which provides a reference for making wipe adjustments.

When contacts are to be adjusted, the recommended procedure is as follows:

1. With the breaker in the open position and using the numbers on the right end of each adjusting pin as a reference, set each pin in the same position. In many cases, the number 3 is a good beginning point. The proper view of the number on the adjusting pin is obtained by viewing the breaker from the front and the adjusting pin from approximately a 15 degree angle with respect to the movable contacts. Note that the numbers on the pin are not in numerical sequence as the pin is rotated.
2. By measurement, establish the position of the front surfaces of the stationary contacts with reference to the steel arc runners above and behind the contacts.
3. Close the breaker, and establish the amount of wipe by again measuring as in step two, and comparing the measurements with those taken with the breaker open.
4. If any set of contacts lead or lag the others, open the breaker and advance or retard the adjusting pin to the next higher or lower number. Moving the adjusting pin to a higher number will increase the contact wipe and moving to a lower number will decrease the contact wipe.

NOTE: No attempt should be made to move the adjusting pin when the breaker is closed. Besides being more difficult, the additional force required to move the pin will tend to round off the flats of the hex section of the pin.
5. When all the contacts have the recommended wipe of 3/32 to 5/32 of an inch, the contact adjustments are complete.

#### CONTACT REPLACEMENT

##### Figure 3

The normal situation that will exist in the matter of contact replacement will call for replacement of all the movable and stationary contacts at the same time. This will be the case

where long use of the breaker in service has resulted in extensive wear or erosion of the silver alloy contact tips. A commonly used "rule of thumb" is that contact replacement is indicated if less than one-half of the original thickness (1/8 of an inch) of the contact tip material remains.

#### GENERAL PREPARATION

1. Remove arc quencher retainer (1), Figure 5 by loosening the two captured nuts with a 7/16" wrench.
2. Lift off the three arc quenchers.
3. Remove the U shaped insulation (5) Figure 3 from each pole by lifting it and disengaging the rivet heads thru the keyholed slots in the insulation.
4. As an aid to future reassembly of the movable contacts, note the position of all stationary insulation barriers with respect to barriers mounted on the cross bar.

#### REMOVAL OF MOVABLE CONTACTS

##### (18) Figure 3.

1. Screw the threaded end of the steel rod lightly into pivot pin (11) on the right pole.
2. With a pair of long nosed pliers, unhook safety pin type spring clip (9) and extract pin (11) and remove spring clip (9).
3. Grasp movable contact assembly and remove it from its seat on the cross bar.
4. Repeat procedure 1, 2, and 3 above on the left pole.
5. Move the cross bar downward to disengage it from the contact wipe adjusting pin (15) on the center pole, then move the cross bar toward the front of the breaker.
6. Remove the split pin retaining the center pole pivot pin.
7. Remove the pivot pin and movable contact assembly.

#### REMOVAL OF STATIONARY CONTACTS

##### (21) Figure 3.

1. Slip the blade of a heavy screw driver between the two upper contacts and force the contacts toward their pivot point sufficiently far to disengage the contact stop surface from the pin.
2. The contact can then be removed by disengaging the end of the contact from its spring.
3. The two lower contacts can be similarly removed.

#### REPLACEMENT OF STATIONARY CONTACTS

##### (21) Figure 3.

1. Coat the contact pivot area only of each of the four contacts with a thin coat of D50H47 grease. Use only D50H47 grease.
2. Note the difference between the two types of

ment pin (15) on the center pole into position. Be sure the stationary insulation barriers are correctly located.

4. Align the cross bar with the left and right pole pivot supports and install the left and right pole movable contacts. Use the bullet nosed steel pin to aid in aligning the holes in the cross bar, the contacts and the pivot supports.
5. Install the left and right pole pivot pins while threading them through the spring clips and lock the spring clips (9). Be sure the pivot pins are fully inserted.
6. Adjust the contact wipe to  $1/8" \pm 1/32"$  by adjusting the eccentric contact wipe adjusting pin (15). The breaker must be open to adjust the wipe. In the event acceptable wipe cannot be obtained by moving the contact wipe adjusting pin (15), from the movable contact forward or backward as necessary to bring the wipe within the range of the contact wipe adjusting pin (15). Do not exceed the recommended settings for wipe; otherwise the breaker may not close completely. When viewed from the top with the breaker closed, the movable contact should be centrally located with respect to the stationary contacts. If the movable contacts are not centrally located as shown in section CC, form the movable contacts until they are nominally centered.

If the moving contacts are not centered with  $1/8"$  separation when closed against the fixed contacts, they should be bent laterally (after opening the breaker contacts). To do this without squeezing the two movable contact arms together, a  $1/8"$  spacer plate should be inserted between them; then the pair can be grasped with pliers and bent in the desired direction for centering.

New contacts should be adjustable using eccentric numbers 1, 2, or 3. These numbers are the ones visible when viewing the breaker from the front, not from above. (The higher numbers should be reserved for tightening at future maintenance readjustments after wear.) Also, if higher numbers are used, where adequate wipe is obtainable at settings 1, 2, or 3, it is possible that the stationary contacts will bottom, producing excessive back force on the breaker closing mechanism so that the toggle link will not pass center. As a result, the breaker will not complete its stroke, and inadequate pressure and wipe will result; burn-up of contacts from just load current will follow.

If the required wipe of new contacts cannot be obtained with eccentric number of 3 or lower, bending of the contact arms toward the closed position is required. This should be done individually, using an 8" Crescent or 1/2 - 5/8" tapered open end wrench to grasp the contact and a 10" Crescent or the 1" - 1-1/8" tapered

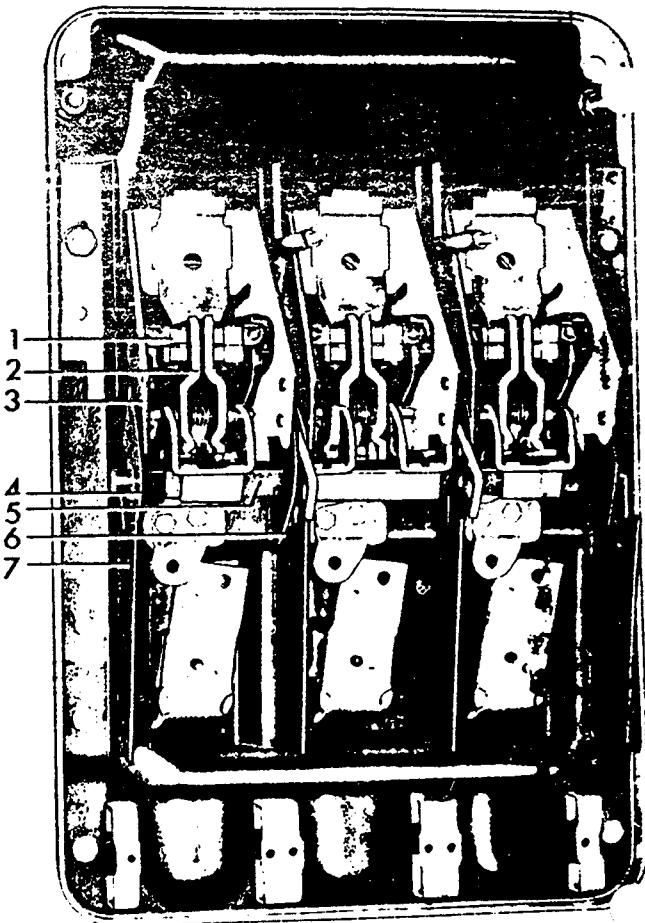


Figure 4. (8039851) AK-2-25 Back Frame - Location of Crossbar and Pole Shields

1. Stationary Contacts
2. Movable Contacts
3. Upper Stud Asbestos Shield
4. Crossbar Plastic End Shield
5. Crossbar Assembly
6. Crossbar Asbestos Inner Shield
7. Lower Stud Asbestos Shield

open-end wrench to grasp the pivot portion of the arm. The soft copper arm will bend with little difficulty. Both arms should be bent identically.

Operate breaker several times, and recheck wipe to make sure bending of movable arms did not occur in these operations.

7. Operate the breaker manually several times to assure proper functioning occurs, then replace the U shaped insulation (5) Figure 3 and arc quenchers. When replacing the arc quenchers be sure the quencher is seated downward completely and that the quencher clamp covers the knobs protruding through the arc quencher insulation.

## CONTACT SPRINGS (19) Figure 3

A minimum force of 5 lbs and a maximum force of 9 lbs. should be required to begin movement of a single stationary contact from the open position towards the closed position. This may be checked by using a push scale applied at the point at which the movable contact touches the stationary contact. If these pressures are not obtained or if the spring is damaged, replacement is required.

In order to replace the contact spring the upper stud (17) must be removed. The hardware which fastens the stud to the breaker base consists of two screws (16), and nut (20). When these are removed, the stud may be withdrawn from the base in a forward direction. After the stud has been removed, it is a simple matter to disconnect the two ends of the spring (19) and replace it with a new one.

## MECHANISM

The breaker mechanism is a spring actuated, over-center toggle type of mechanism. As the closing force is applied, either by movement of the operating handle or the closing solenoid armature, energy is stored in the operating springs. After the springs have gone over center, movement of the output crank of the mechanism is still blocked for a time by a cam arrangement. As the springs are further extended, the blocking cam moves away from the output crank, and the springs are allowed to discharge part of their stored energy, closing the breaker contacts.

This assures a fast-snapping closing action regardless of the speed at which the closing handle is operated.

The breaker mechanism is tripped by the displacement of the trip latch (7), Figure 6. Looking at the breaker from the right hand side as in Figure 5, the tripping movement of the latch is counter-clockwise. Operation of any of the automatic trip devices or the trip push button causes the latch to move in the tripping direction. When the latch moves off the trip latch roller (7), the remaining force in the operating spring causes the mechanism toggle to collapse, resulting in the opening of the breaker contacts.

## ADJUSTMENT

Since all the mechanism adjustments are carefully set by experienced factory personnel after assembly at the factory, it should normally not be necessary to make any adjustments in the field. At the time of installation, and also in the course of a maintenance inspection, if the breaker functions properly through several repeated operations, it is best to assume that adjustments are satisfactory.

If the breaker mechanism does not function properly, it is best to first perform the available remedial measures listed in the "Trouble Shooting" chart of these instructions. One of the remedies

listed is that of proper mechanism latch engagement, the amount of engagement between the latch (7) and latch roller (5), Figure 6. This is the only adjustment that is required on the breaker mechanism, and proper latch engagement is obtained in the following manner:

(NOTE - Before making latch adjustments, check to make sure that the buffer paddle which stops against the end of the latch adjustment screw is rigidly fastened to the trip shaft. Hold the trip shaft (8), Figure 5, steady and attempt to move the buffer paddle. If any relative movement between the two is noted, tighten the fasteners holding the buffer paddle to the trip shaft.)

### Latch Adjustment - Manual Breaker

1. Locate the latch adjustment screw on the lower, outer side of the right-hand mechanism side frame. This screw is threaded through a nylon insert locknut which, in turn, is welded to a projecting bracket on the side frame.
2. Rotate the closing handle 90 degrees counter-clockwise, setting the closing mechanism in the reset position. Turn the adjusting screw into the locknut until the closing mechanism trips open, the closing handle returning to its normal vertical position. NOTE: KEEP HANDS CLEAR OF THE CLOSING HANDLE WHEN MAKING THIS ADJUSTMENT.
3. Withdraw the adjusting screw from the locknut 1/4 turn at a time, attempting to close the breaker after each 1/4 turn, and observe whether the contacts move toward closing before tripping occurs. If the contacts move before tripping occurs, you have established the position of the adjusting screw where the latch and latch roller begin to engage. In some cases, it may be necessary to turn the adjusting screw less than 1/4 turn in order to establish the position where the contacts begin to move before tripping occurs. When this position is established, note the position of the slot in the head of the adjusting screw.
4. Withdraw the adjusting screw three and one-half turns from the position noted in step 3. This sets the proper amount of latch engagement.

### Latch Adjustment - Electrical Breaker

1. Locate the latch adjustment screw on the lower, outer side of the right mechanism side frame. This screw is threaded through a nylon insert locknut which, in turn, is welded to a projecting bracket on the side frame.
2. With the breaker in the open position turn the adjusting screw into the locknut one complete turn at a time, closing the breaker after each complete turn of the adjusting screw, un-