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GENERAL ELECTRIC

1. GEH-5019 INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR TYPES AKR-30S AND AKRU-30S
2. GEI-86150-A INSTALLATION MANUAL FOR TYPES AKR-30/50 AND AKRT-50
3. GEK-64459B MAINTENANCE MANUAL FOR TYPES AKR-30/50 AND AKRT-50
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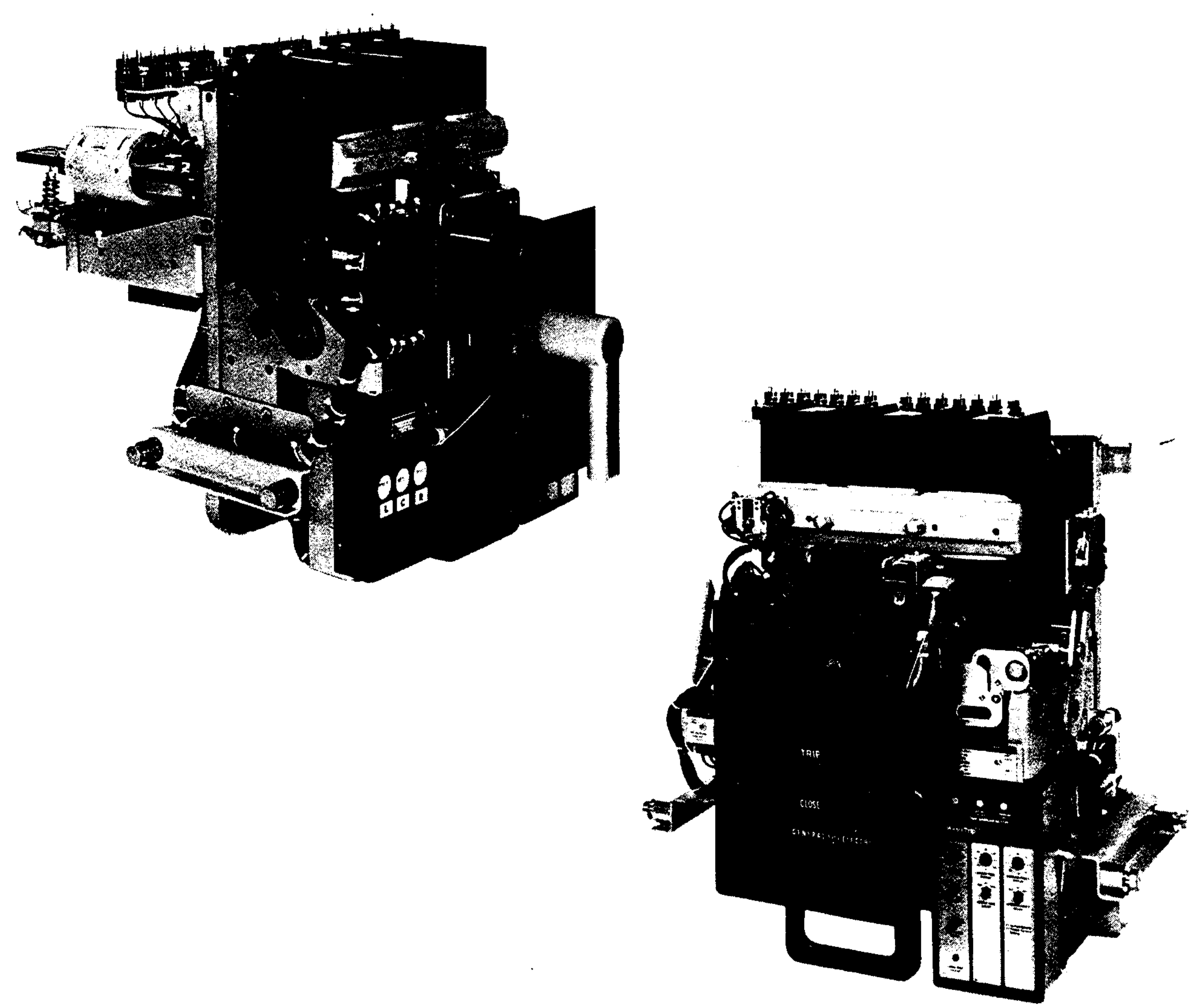
8. GEK-64461 AKR 30 CLOSING SPRING ASSEMBLY REPLACEMENT INSTRUCTIONS

GEH-5019

Installation and
Maintenance
Instructions

Power Circuit Breakers

Types AKR-30S and AKRU-30S



GENERAL ELECTRIC

Power Circuit Breakers
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DISCONNECTED — Both primary and secondary contacts are disengaged.

WITHDRAWN — With the compartment door open, the breaker can be manually pulled out to the WITHDRAWN position. At this point the tracks are fully extended and the breaker is completely out of its compartment, ready for removal. Note that the racking mechanism is not employed for movement of the breaker between the DISCONNECTED and WITHDRAWN positions.

Breaker Insertion

1. Prior to lifting a breaker to its intended compartment location, observe the following precautions:

> **PRECAUTIONS**
>
> a. *Check the compartment to ensure that it is free of foreign objects.*
>
> b. *Verify that the breaker is the correct type for that compartment.*
>
> c. *Ensure that the breaker is OPEN.*
>
> d. *Apply a thin, fresh coat of D50HD38 lubricant to the breaker's primary disconnects.*
>
> e. *Ensure that the racking cams on the breaker are correctly positioned for initial engagement with the pins in the compartment. To do this, insert the racking handle and rotate it fully counter-clockwise.*

2. Using the lifting wire provided, raise the breaker above the elevation of the tracks.

3. Slowly lower and guide the breaker so that the breaker mounting pins drop into the slots in the tracks. Remove the lifting wire.

4. Push the breaker into the compartment until it reaches the stops. This is the DISCONNECT position. At this point the racking arms are positioned to engage the fixed racking pins in the compartment, ready to begin the racking motion.

5. Push in the inner rails and close the compartment door. Insert the racking handle into the racking screw opening in the compartment door. By clockwise rotation of the handle, move the breaker through the TEST position into the CONNECTED position; the latter is indicated when the jackscrew comes to a solid stop.

Breaker Removal

1. With the door closed and latched, trip the breaker.

2. Insert the racking handle and rotate it counterclockwise until the breaker travels from CONNECTED through TEST to the DISCONNECTED position, as indicated by the jackscrew coming to a solid stop. This operation should be performed with the door closed.

3. Open the compartment door and pull inner rails to the extended position. Pull the breaker out to the travel limit—this is the WITHDRAWN position.

4. Attach the lifting wire and hoist the breaker until its mounting pins clear the track slots.

5. Swing the breaker forward until the primary disconnects clear the compartment and lower the breaker onto a flat surface free of protrusions that could damage the breaker's internal parts.

> **NOTE:** *Before installing or operating these circuit breakers, carefully read Sections 1, 2, and 3.*

SECTION 1 — Receiving, Handling, and Storage

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

SECTION 2 — Installation

Location

In choosing a location for the installation of these breakers there are two factors to be considered. The first is the location's environmental impact on the breaker. Better performance and longer life can be expected if the area is clean, dry, dust-free, and well ventilated. The second is convenience for operation and maintenance. The breaker should be easily accessible to the operator and there should be sufficient space available for maintenance work.

Stationary Breakers (Code S)

These breakers are designed for mounting in a switchboard or enclosure designed and constructed by others. Mounting 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, including a cutout opening through which the front escutcheon of the breaker can protrude.

The surface on which the breaker is mounted must be flat to avoid internal distortion of the breaker. 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. Connecting bus and cables must be rigidly supported to prevent undue stress on the breaker terminals.

The outline drawings in Table 1 provide basic dimensional information for designing the panel or enclosure mounting.

Table 1 — Outline Drawings

Breaker Type	Outline Dwg No.
AKR-30S Draw Out	139C5317
AKRU-30S Draw Out	139C5318
AKR-30S Stationary	139C5319

Draw Out Breakers — Code D AKD-8 Switchgear and Substructure

The draw out breaker is supported by two protruding pins on each side of its frame; these pins engage slots in telescoping slide rails (tracks) mounted to each sidewall of the switchgear.

All draw out breakers are equipped with a deep escutcheon with side labels showing these discrete positions:

CONNECTED — This is the breaker's "in-service" position. It is fully inserted in its compartment; the primary and secondary disconnect contacts are fully engaged. The breaker must be tripped before it can be racked into or out of this position.

TEST — In this position the primary contacts are disconnected but secondary contacts remain engaged. This allows complete breaker operation without energizing the primary circuit.

SECTION 3 — Operation

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, and open fuse lockout device. All of them affect 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 shunt trip device has a set of of auxiliary switch "a" contacts in its curcuit. (An "a" contact is open when the breaker contacts are open.) This prevents its 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 drawn 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 AKRU (fused) breakers. 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 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.*

Connections

In all electrical connections, good joint conductivity is a must. When making power connections to stationary breakers, the mating joint surfaces must be clean and have a smooth finish. They should be parallel and firmly bolted or clamped together. In addition, the bus or cable conductors must have ample ampacity to prevent overheating.

Control Connections

The equipment connections to a breaker's accessories and control devices must be in accordance with the specific wiring diagram applicable to that breaker.

Control connections to stationary breakers are made to a terminal board mounted on the breaker. Figure 2 shows typical closing and tripping connections. If equipped with an overcurrent trip device which includes a ground fault element for use on 4-wire circuits, an additional terminal board is provided on the breaker for connecting to the equipment-mounted neutral sensor (physically located in the neutral conductor).

On draw out breakers the control circuits terminate in the breaker compartment on the stationary portion of separable secondary disconnects. See Fig. 3.

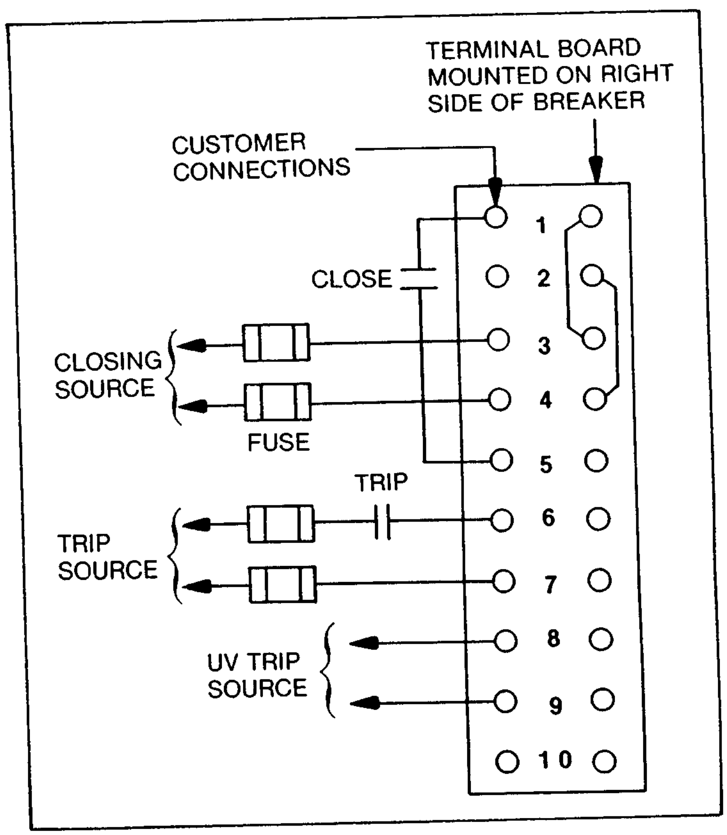


Fig. 2. Control connections to stationary breakers — front view

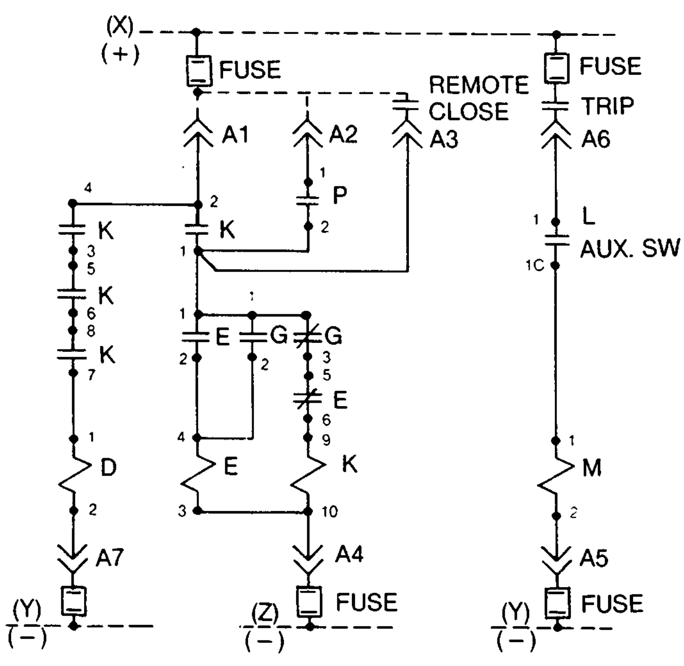
SECTION 3 — Operation

Electrical Operation (See Fig. 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 "K" relay through the normally closed contacts of cutoff switch G and the normally closed contacts of the "E" relay. When the "K" relay or contactor is energized, it closes its contacts. One of these ("K"1-2) seals in the "K" 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 were activated at the time of closing. The "E" relay, together with the cutoff switch, provides the anti-pump feature. The mechanical action of closing operates the cutoff switch, reversing the position of the contacts from that shown on the diagram. This energizes the "E" relay, if contact is still maintained at the closing switch, with the result that the "K" relay circuit is opened by "E" contacts 5-6. This prevents the "K" relay from again becoming energized. "E" contact 1-2 seals in the "E" 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 (12), Fig. 7, located in the lower portion of the front escutcheon (10). 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.



STANDARD LIST OF ABBREVIATIONS
(SOME DEVICES MAY NOT BE INCLUDED IN DIAGRAMS)

A —SECONDARY DISCONNECT LOCATED TOP LEFT, FRONT VIEW
B —SECONDARY DISCONNECT LOCATED TOP CENTER, FRONT VIEW
C —SECONDARY DISCONNECT LOCATED TOP RIGHT, FRONT VIEW
D —CLOSING SOLENOID
E —ANTI-PUMP RELAY
G —CUT-OFF SWITCH
K —CLOSING RELAY
L —(AUXILIARY SWITCH) "A" CONTACTS TAKE POSITION OF BREAKER CONTACTS, "B" CONTACTS OPPOSITE TO BREAKER CONTACTS
M —SHUNT TRIP DEVICE
P —PUSH BUTTON CLOSING SWITCH ON BREAKER

Fig. 1. Typical wiring diagram — electric operation

Power Circuit Breakers

SECTION 4 — Maintenance

Inspection

> **CAUTION:** *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 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 depression.
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 (See Fig. 5)

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 and their supporting structure. The procedure for this operation is as follows:

1. Remove the arc quenchers (see "Arc Quenchers," Section 5).
2. Disconnect the two insulated connecting links (7), Fig. 5, between the mechanism and the crossbar (11), by removing the tie bolt (8), and slipping the ends of the links off the ends of the shouldered pin in the mechanism. Removal of the two top flux shifter support screws will permit disengagement of the reset activator.
3. If the breaker is a draw out type, with secondary disconnects, 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 the rear 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. Remove two side support standoff bolts attached to back frame.
5. Remove two bolts (7/16" Hex) supporting the programmer mounting bracket. Disconnect programmer harness at current sensor terminal boards. Note polarity and tap setting (where applicable).
6. Remove the two elastic stop nuts (9/16" Hex) which fasten the wraparound 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.
7. The two frames are now disconnected.

> **CAUTION:** *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.

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 GE lubricant D50HD38 (Mobil 28). 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.

> **NOTE:** *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 GE lubricant D50HD38.

SECTION 3 — Operation

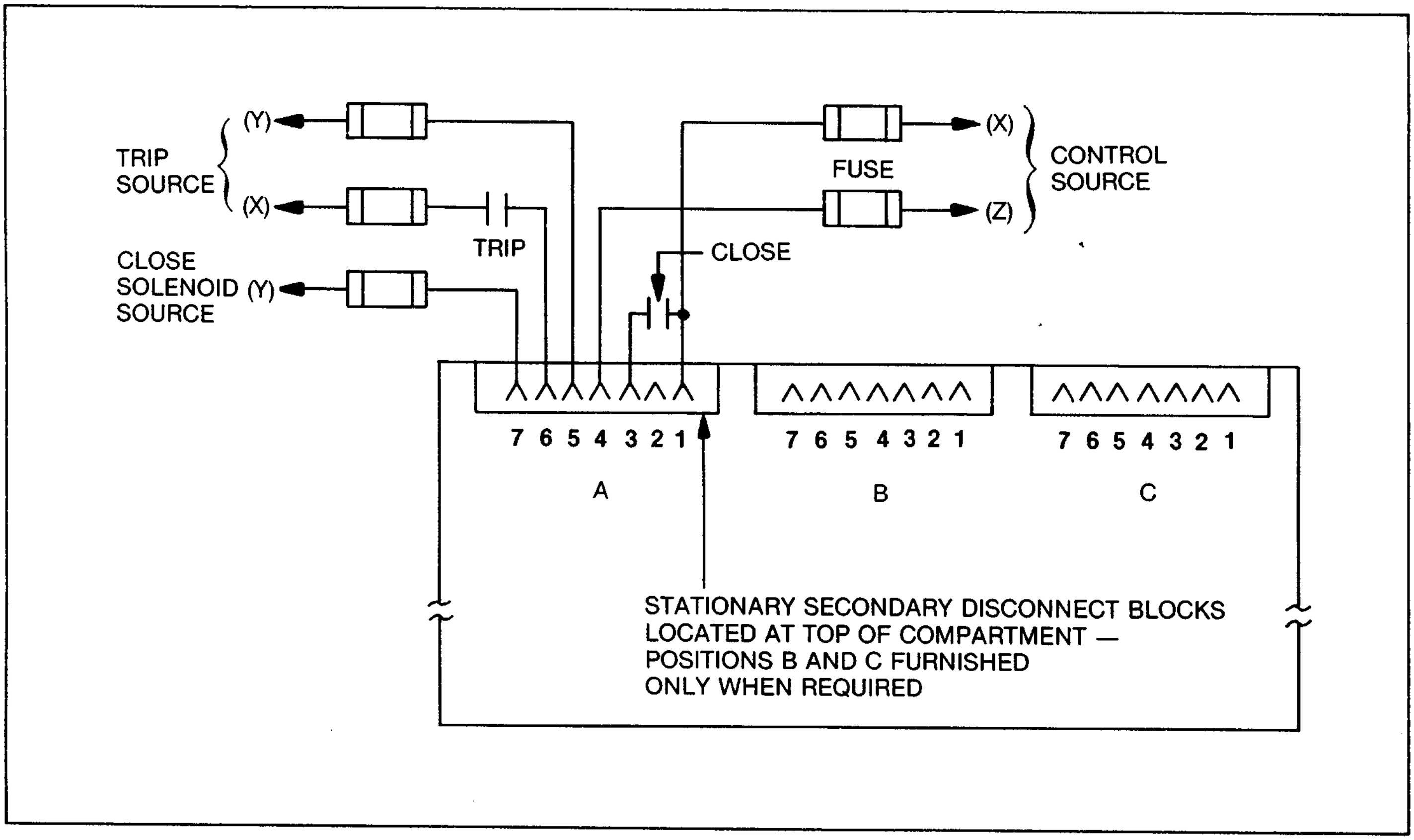


Fig. 3. Control connections to draw out breakers — front view of breaker compartment

Power Circuit Breakers

SECTION 5 — 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 pairs 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 the degree to which the springs are compressed by the bolt and nut which hold the assembly together. 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 reassemblying, the original amount of compression will be restored by replacing the nut at its former position on the bolt. The nominal compressed spring height is 25/32 inch.

Secondary Disconnect (See Fig. 4)

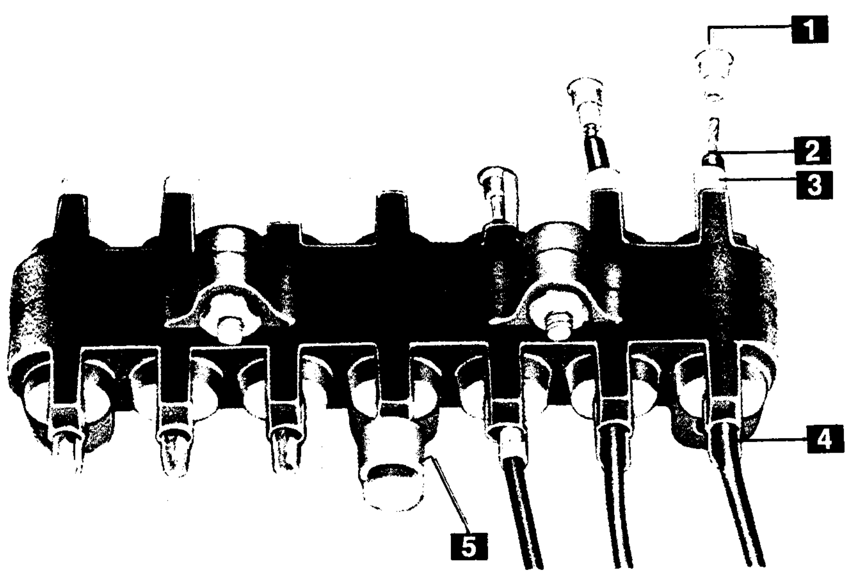
The secondary disconnects serve as connections between breaker control circuit elements and external control circuits. They are used only on draw out type breakers. A terminal board serves the same purpose on stationary mounted and general purpose enclosure mounted breakers. The secondary disconnects 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

To replace movable secondary disconnects, proceed as follows:

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 of new disconnect assembly.
6. Strip insulation off end of wire to about 1/4 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.



1. Contact tip
2. Wire
3. Hollow tube
4. Tabs
5. Fiber spacer

Fig. 4. Movable secondary disconnects

SECTION 4 — Maintenance

Troubleshooting

The following table lists several possible 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	Contacts not aligned.	Adjust contacts.
	Contacts dirty, greasy or coated with dark film.	Clean contacts.
	Contacts badly burned or pitted.	Replace contacts.
	Current carrying surfaces dirty.	Clean surfaces of current carrying parts.
	Corrosive atmosphere.	Relocate or provide adequate enclosure. Replace corroded parts.
	Insufficient bus or cable capacity.	Increase capacity of bus or cable.
	Bolts and nuts at terminal connections not tight.	Tighten, but do not exceed elastic limit of bolts or fittings.
	Current in excess of breaker rating.	Check breaker application or modify circuit by decreasing load.
	Excessive ambient temperature.	Provide adequate ventilation.
Failure to Trip	Travel of tripping device does not provide positive release of tripping latch.	Re-adjust or replace tripping device and check mechanism latch adjustment.
	Worn or damaged trip unit parts.	Replace trip unit.
	Loose or disconnected programmer plug.	Check disconnect plug fit and terminals.
	Loose or broken current sensor harness connections.	Tighten or replace harness.
False Tripping	Overcurrent trip device pick-up too low.	Check application of overcurrent trip device.
	Overcurrent trip device time setting too short.	Check application of overcurrent trip device.
	Insufficient clearance to trip paddles.	Re-adjust clearances and check latch adjustment.
	Tap setting on current sensors incorrectly set.	Check application.
	External ground sensor coil improperly connected.	Check polarity and connections. Check continuity of conductors connecting the neutral sensor.
Failure to Close and Latch	Binding in attachments preventing resetting of latch.	Re-align and adjust attachments.
	Latch out of adjustment.	Adjust latch.
	Latch return spring too weak or broken.	Replace spring.
	Hardened or gummy lubricant.	Clean bearing and latch surfaces.
	Closing solenoid burned out.	Replace solenoid coil.
	Solenoid control device not functioning properly.	Re-adjust or replace device; verify minimum closed circuit voltage (see Table 5).

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 depression adjustments.

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

1. When the breaker is in the open position and using the numbers on the right end of each adjusting pin as reference, set each pin in the same position. In many cases, the number 2 is a good beginning point. The corresponding pin number is the one clearly viewed from the front (not the top) of the breaker. 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 depression by again measuring as in Step 2 and comparing the measurements with those taken with the breaker open.

4. If any set of contacts leads or lags 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 depression; moving to a lower number will decrease the contact depression.

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

5. Be sure not to exceed the maximum depression recommended. If higher adjustment numbers are used, it is possible that the stationary contacts will bottom, producing excessive back force on the breaker closing mechanism so that the toggle link (4), Fig. 7, will not pass center. As a result, the breaker will not complete its stroke and inadequate pressure and depression will result, followed by burn-up of contacts from load current.

Contact Replacement

Under normal situations, the replacement of all the movable and stationary contacts should be performed 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.

General Preparation

1. Remove arc quencher retainer (1), Fig. 7, by loosening the two captured nuts with a 7/16-inch wrench.

2. Lift off the three arc quenchers.

3. 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 (2), Fig. 6 or (21), Fig. 5

1. Separate the front and back frames as previously outlined in Section 4.

2. Remove two hole plugs (3), Fig. 6, from barrier (2), Fig. 5. Remove the U-shaped insulation barrier (6) from each pole by lifting it and disengaging the rivet heads through the keyholed slots in the insulation.

3. Thread a #8-32 screw lightly into pivot pin (12) on the right pole.

4. With a pair of long-nosed pliers, unhook safety-pin-type spring clip (10) and extract pin (12) and remove spring clip (10).

5. Grasp movable contact assembly and remove it from its seat on the cross bar.

6. Repeat procedures 1, 2, and 3 on the left pole.

7. Move the cross bar downward to disengage it from the contact wipe adjusting pin (18) on the center pole; then, move the cross bar toward the front of the breaker.

8. Remove the split pin retaining the center pole pivot pin.

9. Remove the pivot pin and movable contact assembly.

Removal of Stationary Contacts (1), Fig. 6 or (24), Fig. 5

1. Slip the blade of a heavy screw driver between the two upper contacts (1), Fig.6, 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 (22), Fig. 5.

3. The lower contacts can be similarly removed.

Replacement of Stationary Contacts (1), Fig. 6 or (24), Fig. 5

1. Coat the contact pivot area only of each of the six contacts (1), Fig. 6, with a thin coat of D50HD38 grease.

2. Note the difference between the three 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, Fig. 5. The upper left and lower right contacts are identical as are the lower left and upper right contacts.

SECTION 5 — Basic Breaker Components

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.

11. 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 side barriers on the arc quencher contain flares which must overlap the contact barriers. 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 its closure could tend to prevent the escape of the gases along the desired path.

> **CAUTION:** *AT THE REGULAR MAINTENANCE INSPECTION, CHECK THE CONDITION OF THE MUFFLER 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

To remove the arc quencher, lift 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. Ensure the arc quencher is fully seated on the arc runner prior to fastening retainer clamp.

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. The copper of each pole consists 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. 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 three stationary contacts, and thus providing six low-resistance parallel paths of current for each breaker pole. The movable contacts rotate about a silver-plated copper pin which 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. U-shaped spring clips made of silver-plated conducting material provide an additional current path and protect the other contact surfaces of the pivot against pitting when in motion. These clips also contribute to the force tending to increase the contact pressure between the lower ends of the movable contacts and the pivot support.

Contact Adjustments

The only adjustment to be made on the breaker contacts is that of contact depression. This is the distance the movable and stationary contacts move while they are touching one another in the process of breaker closing. The amount of contact depression 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. 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 proper contact depression is $1/8 \pm 1/32$ inch measured at the end of the contact tip.

The means of adjusting contact depression 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-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,

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.

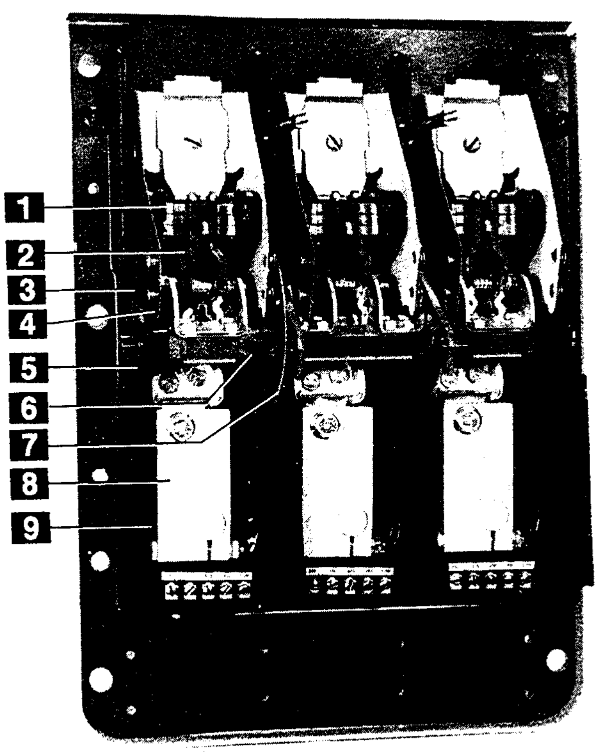
Replacement of Movable Contacts (2), Fig. 6 or (21), Fig. 5

1. Coat the pivot area only of the new movable contacts with a thin coat of D50HD38 grease.

2. Assemble the center pole movable contacts, align the pivot pin holes, and install the pivot pin and split pin.

3. Move the cross bar assembly (6), Fig. 6, into position and insert the eccentric contact wipe adjustment pin (18), Fig. 5, 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 (16) and install the left and right pole movable contacts.



1. Stationary contacts
2. Movable contacts
3. Hole plug
4. Upper stud phase barrier
5. Crossbar plastic end shield
6. Crossbar assembly
7. Crossbar inner shield
8. Lower stud
9. Phase sensors

Fig. 6. Back frame — location of crossbar and pole shields

Use a bullet-nosed 5/16-inch diameter 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 (12), Fig. 5, while threading them through the spring clips and lock the spring clips (10). Be sure the pivot pins are fully inserted. Press both hole plugs (3), Fig. 6, back into barriers (4). Install the U-shaped insulators (6), Fig. 5. See "Contact Adjustments," at the beginning of this section.

6. Reassemble front and back frames in reverse order of disassembly.

7. Adjust the contact depression. If the moving contacts are not centered when closed against the fixed contacts, they should be bent laterally.

8. Operate the breaker manually several times to assure proper functioning occurs, then replace the 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 (22), Fig. 5

A minimum force of 7 lbs and a maximum force of 8 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 center of the contact's curved surface. If these pressures are not obtained, the spring anchor tabs may require bending for adjustment. If the spring is damaged, replacement is required.

To replace or adjust the contact springs, the upper stud (20), Fig. 5, must be removed. The hardware which fastens the stud to the breaker base consists of two screws (19) and nut (23). When these are removed, the stud (13) and barrier (2) may be withdrawn from the base in a forward direction.

Contact force may also be adjusted without removal of the upper stud by slightly bending the stationary hook ends (Up to increase force; Down to decrease force).

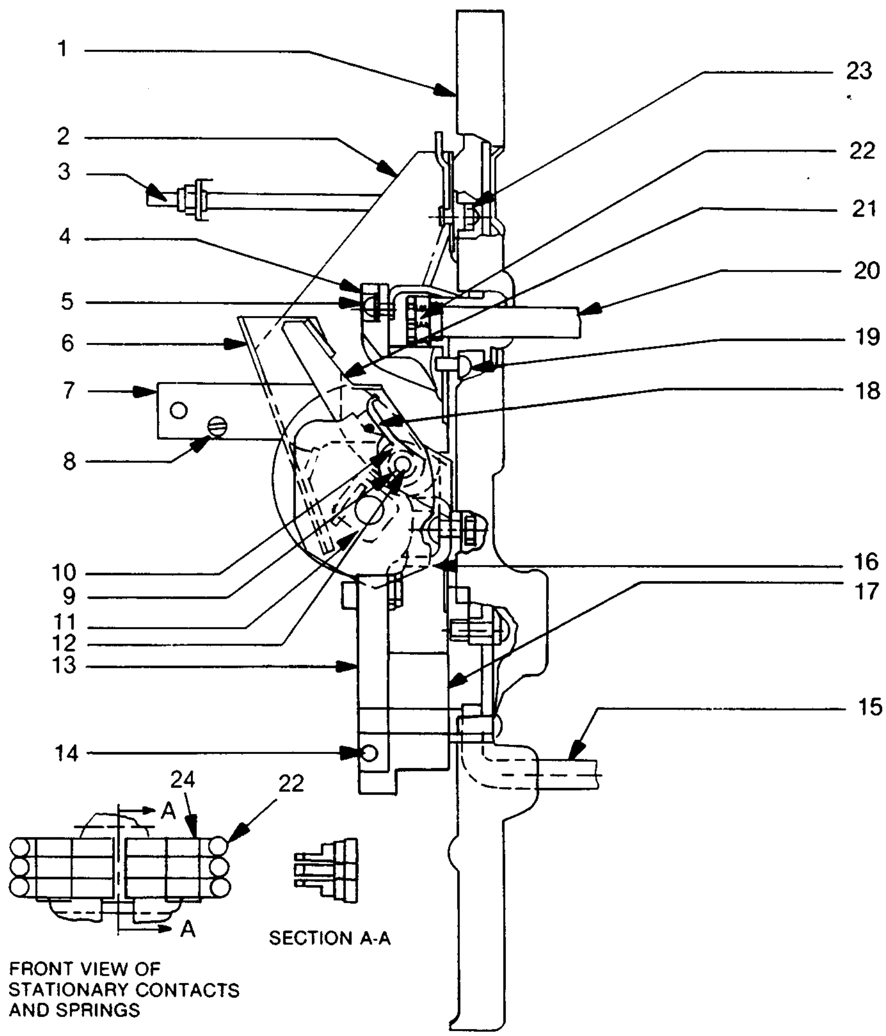
Mechanism

The breaker mechanism is a spring actuated, over-center toggle-type 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 or solenoid is operated.

The breaker mechanism is tripped by the displacement of the trip latch (7), Fig. 8. Looking at the breaker from the right-

SECTION 5 — Basic Breaker Components



1. Breaker base
2. Barrier
3. Insulated stud
4. Upper stud barrier
5. Insulated screws
6. Barrier
7. Links (insulated)
8. Tie bolt
9. Hole plug
10. Spring clip retainer
11. Cross bar
12. Pivot pin
13. Connector
14. Bolt
15. Lower stud
16. Contact pivot support
17. Phase sensor
18. Contact wipe adjustment pin
19. Screw
20. Upper stud & arc runner
21. Movable contact
22. Stationary contact springs
23. Nut
24. Stationary contacts

Fig. 5. Back frame/contact assembly

roller (5). 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 (9), Fig. 7, 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. Verify that no trip paddles are restricting the buffer leaf spring's shock absorption in the reset position.*

Latch Adjustment

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 mechanism side frame.

2. Close breaker. Turn in (tighten) adjusting screw slowly until breaker just trips.

> **NOTE:** *If mechanism will not close breaker, withdraw the screw approximately two turns to permit closure.*

3. Withdraw the adjusting screw three and one-half turns from the position noted in Step 2. This sets the proper amount of latch engagement. Re-check all trip paddle clearances.

4. Should the mechanism continue to function improperly after the proper latch engagement has been set and the corrective measures listed in the Troubleshooting Chart, Section 4, carried out, it is recommended that no attempt be made to repair the mechanism interior but that a replacement mechanism assembly be obtained from the factory.

Mechanism Replacement

1. If the breaker is electrically operated, remove the front escutcheon held by four screws. If the breaker is a draw out type, remove the deep escutcheon held by three hex screws. (For removal of front escutcheon from manually operated breakers, see the following procedure.)

2. Remove arc quenchers (see "Arc Quencher" in this section).

3. 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" in Section 4.

4. Remove the two elastic stop nuts which fasten the upper extensions of mechanism frame to studs connecting with rear frame.

5. Remove four screws which fasten the bottom of the mechanism frame to the horizontal cross member of the front frame.

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" in this section.

7. If the breaker is electrically operated, it will be necessary to disconnect the mechanism from the solenoid armature. To do this, displace the trip latch and raise the mechanism as far as the travel of the armature will permit. Remove the screw which holds 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 disassembly procedures. After reassembly, check the operation of the breaker and, if necessary, adjust the latch engagement.

Removal of Front Escutcheon of Manual Breakers

1. Loosen the set screw fastening the handle to the operating shaft and remove.

2. Remove the retainer and two flat washers from the shaft.

3. Remove four screws from the flange of the escutcheon. If the breaker is a draw out type, first remove the deep escutcheon held by three hex screws.

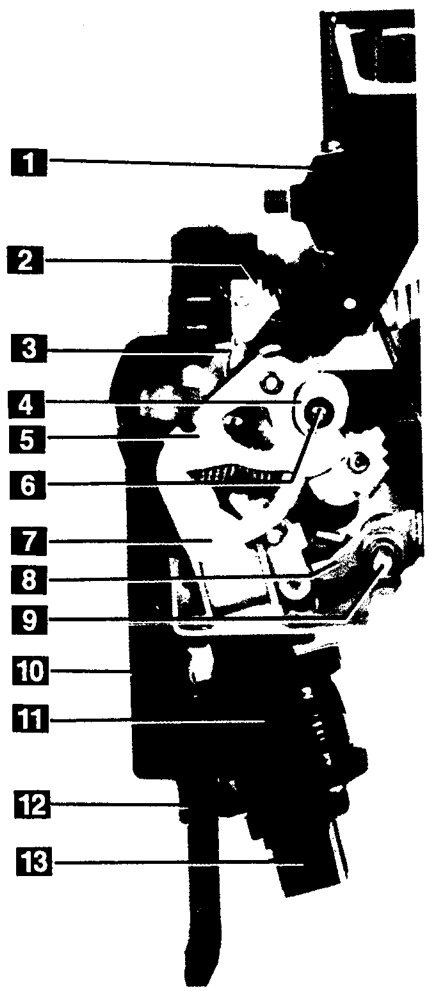
4. Push steel operating shaft through escutcheon bushing.

5. Remove handle reset spring (8), Fig. 8., and the escutcheon is free of the breaker.

Auxiliary Switch

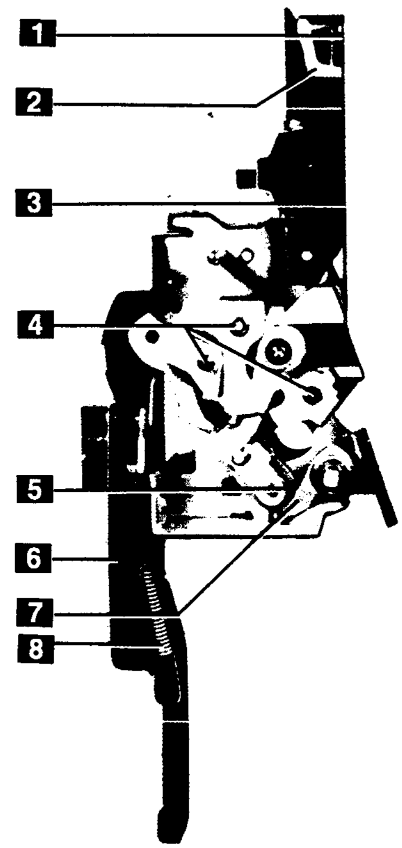
The auxiliary switch is mounted on the left side of the operating mechanism frame. Its operating shaft is linked to the output crank of the breaker mechanism. Through a cam arrangement, the operating shaft of the switch controls the open and closed positions of the individual contact pairs. Each stage 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. 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.

SECTION 5 — Basic Breaker Components



1. Arc quencher retainer
2. Cut-Off switch
3. Cut-Off switch actuator
4. Toggle link stop
5. Spring carrier
6. Shoulder pin
7. Connecting link
8. Trip latch
9. Trip shaft
10. Front escutcheon (Deep escutcheon removed)
11. Closing solenoid
12. Location of slots for maintenance handle
13. Closing solenoid armature

Fig. 7. Electric mechanism



1. Arc quencher muffler
2. Ceramic side plates
3. Arc chute barrier
4. Fixed centers in mechanism
5. Latch roller
6. Escutcheon (Deep escutcheon removed)
7. Trip latch
8. Handle return spring

Fig. 8. Manual mechanism

hand side as in Fig. 7, the tripping movement of the latch is counterclockwise. 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, the remaining force in the operating spring causes the mechanism toggle to collapse, resulting in the opening of the breaker contacts.

Adjustment

If the breaker mechanism does not function properly, it is best to first perform the available remedial measures listed in the Troubleshooting Chart in Section 4. One of the remedies listed is that of proper mechanism latch engagement, i.e., the amount of engagement between the latch (7), Fig. 8, and latch actuator and movable contact assembly (4) to rotate counter-clockwise about pin (7), opening the "N.C." contacts (8) and closing the "N.O." contacts (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 "K" and "E" relays are de-energized and energized, respectively, at the proper time and the circuit's anti-pump feature is maintained.

Replacement

The cutoff 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.The top two flux shifter mounting screws may require removal to gain access to the right side screw.

4. Remove the front escutcheon from the breaker.

5. Slide the cutoff switch out from between the steel side plates by pulling straight forward.

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

Closing Switch (Fig. 10)

The closing switch is mounted on the upper flange of the closing solenoid coil. A hole in the escutcheon (3), Fig. 10, 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 "K" relay coil which seals itself in, and, in turn, energizes the closing solenoid.

Replacement

1. Remove escutcheon (3), Fig. 10.

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.

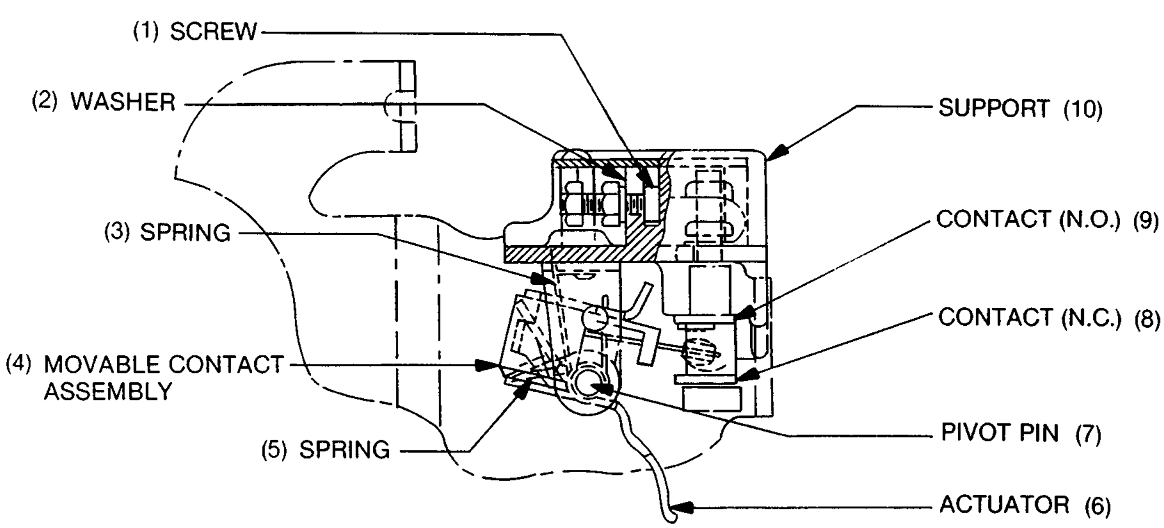


Fig. 9. Cut-off switch

SECTION 5 — Basic Breaker Components

Replacement

1. Remove auxiliary switch cover.

2. Disconnect leads to switch terminals.

3. Remove the top screw which fastens switch to side of mechanism frame.

4. Remove switch by lifting lower bracket slot out of mechanism frame tab.

> **NOTE:** *With mechanism in the CLOSED position, slot access is improved.*

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.

6. Complete mounting by following disassembly steps in reverse order.

SECTION 6 — Electrical Replacement Control Components

Closing Solenoid

The closing solenoid (11), Fig. 7, 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.

Coil Replacement

1. Remove escutcheon by unfastening four flat head screws in flange.

2. Remove closing switch (see "Closing Switch" in this section).

3. Cut off or disconnect the coil leads.

4. Remove four screws which fasten lower section of magnet to upper section.

5. Disconnect armature from mechanism (see "Mechanism Replacement," Section 5) and slide assembly down.

6. Reassemble with new coil by reversing order of disassembly.

"K" Relay

The "K" relay 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 contacts of the device are arranged in series to minimize the duty required of any one contact. As explained under "Operation," Section 3, the fourth contact is used to "seal-in" the "K" coil.

The "K" relay is located on the lower right behind the programmer. To replace the relay, remove the programmer mounting bracket first. Disconnect wires (noting location) and three mounting screws.

"E" Relay

As described under "Operation," Section 3, the "E" relay is a permissive relay which provides anti-pump protection. It is shock-mounted to the arc chute retainer clamp.

Replacement

If replacement of the "E" 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.

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

1. Apply closing voltage to terminal board or secondary disconnnects.

2. Push the button of closing switch and hold closed.

3. Continue to hold the push button in the "closed" position and manually trip the breaker open.

4. If the breaker stays open and makes no attempts to close, the "E" relay is functioning properly.

5. While releasing the close button, observe the "E" relay. It should open as the closing switch is released.

Cutoff Switch (Fig. 9)

As explained under "Operation," Section 3, the function of the cutoff switch is to de-energize the "K" contactor coil and energize the "E" 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), Fig. 9. This causes the

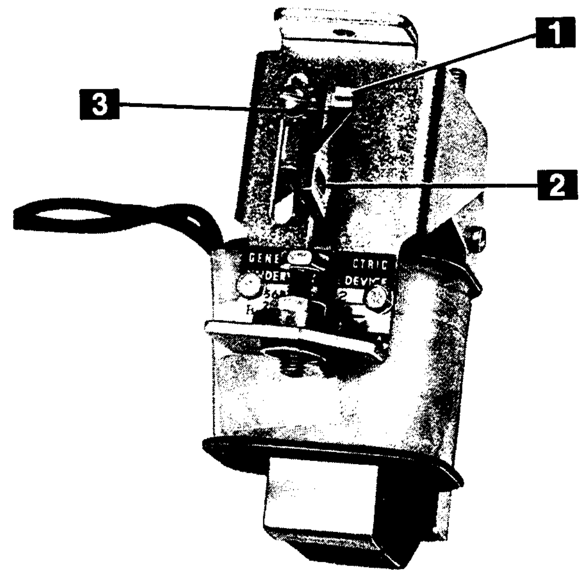
SECTION 6 — Electrical Replacement Control Components

Replacement

The entire shunt trip device may be dismounted by disconnecting the coil leads and removing nuts (1), Fig. 11.

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. To be sure of this, armature arm (11), Fig. 11, must travel from 1/32 to 1/16 inch beyond the point at which the breaker trips. A good method of checking this is to insert a 1/32-inch shim between the magnet (7) and armature (10) and with the breaker closed, push down on the arm (11), closing the armature against the magnet. If the breaker trips, there is sufficient over-travel. If adjustment is necessary, trip paddle (12), Fig. 11, may be formed towards or away from the armature arm (11). Assure a minimum clearance of 1/16 inch between the trip paddle and breaker frame with the mechanism in the RESET position.



1. Stop
2. Armature
3. Insert wire gage

Fig. 12. Undervoltage device positive trip check

SECTION 6 — Electrical Replacement Control Components

Shunt Trip Device (Fig. 11)

The shunt trip device typically is mounted underneath the horizontal cross frame member, just to the left of the front escutcheon. It is composed of a magnet (7), Fig. 11, coil (8) and armature (10). 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.

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.

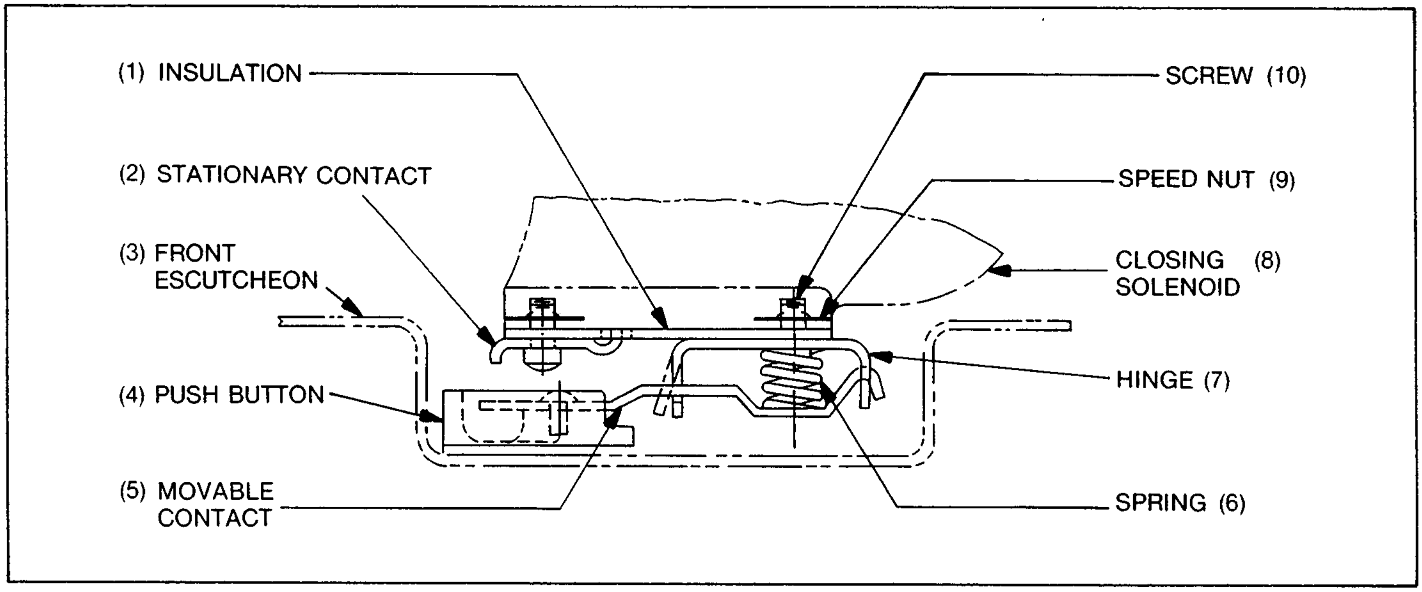


Fig. 10. Closing switch (top view)

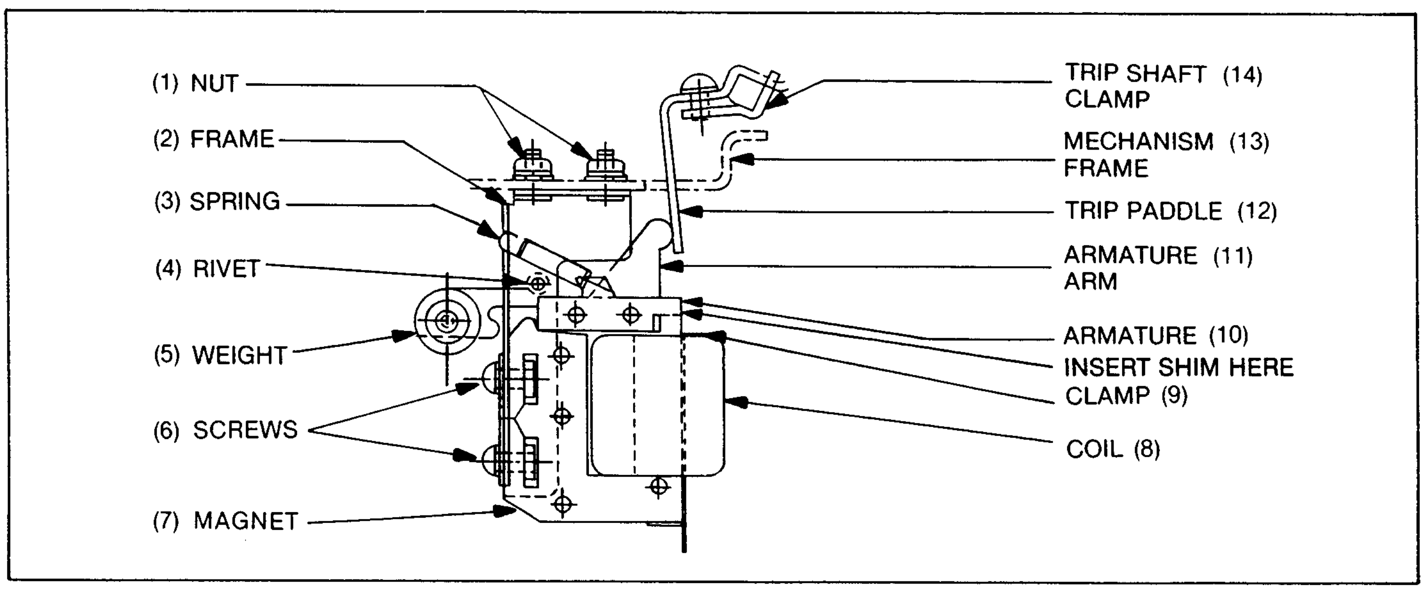


Fig. 11. Shunt trip device

paddle on the trip shaft. An extension of the other end of the armature (towards the front of the breaker) extends through the device frame and limits the movement of the armature. When the armature is released, this extension stops against a stop which is factory set. To check positive trip, the armature should be held down, the end of a 1/32-inch diameter wire should be inserted against the stop, and the armature released. If this trips the breaker, the setting is correct. The place to insert the wire is shown in Fig. 12. Note that only the tip of the wire is to be against the stop.

If the undervoltage device does not have positive tripping ability, the adjustment screw of the trip paddle assembly on the trip shaft may be turned in increments of half turns until the check is successful.

When the undervoltage device is closed and the breaker mechanism is reset, there must be clearance (1/32-inch minimum) between the trip paddle and the device armature.

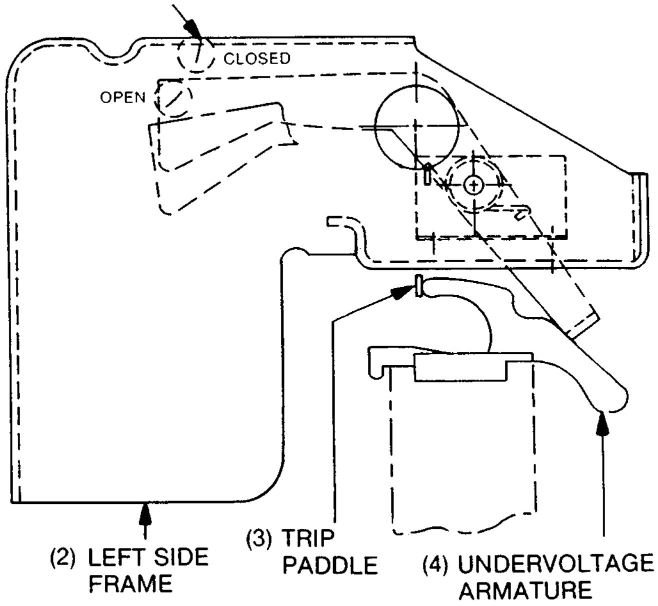


Fig. 14. Electric lockout device

Static Time-Delay Undervoltage

In addition to the undervoltage tripping device mounted on the breaker, the static time-delay undervoltage includes a separately mounted time-delay unit. Table 2 lists the catalog numbers of the available units.

If the ac control voltage is any voltage other than 208/240 Vac, a control power transformer (also remotely mounted with respect to the breaker) must be used. This must have a minimum rating of 100 volt-amperes.

When installed, the voltage to be monitored is connected across terminals No. 1 and No. 2 of the static delay box. The coil of the tripping unit is connected across terminals No. 4 and No. 5 of the static box through the secondary disconnects of the breaker. The secondary disconnects to be used will be shown on the breaker wiring diagram.

No more than one undervoltage tripping device should be used in conjunction with one static time-delay unit.

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:

1. Check input voltages across terminals 1 and 2 on the static box. See Table 2 for these values.

2. Check output voltages on terminals 4 and 5 with the undervoltage device connected. See Table 2 for values.

3. Check resistance of the disconnected undervoltage device. See Table 2 for values.

See Instruction Sheet GEH-4545 for more detailed information, including schematic diagrams and circuit description.

Electric Lockout Device (Fig. 14)

The electric lockout device holds an open breaker trip-free when the coil of the undervoltage device is de-energized. When the breaker is in the closed position, linkage operated by the

Table 2 — Time-delay Units

Cat. No.	Control Voltage Terminals 1 & 2	Approximate Steady State DC Operating Voltage Terminals 4 & 5	Nominal DC Coil Resistance (Ohms) @ 25°C
TAKYUVT-1	125 Vdc	50	440
TAKYUVT-2	250 Vdc	100	1600
TAKYUVT-3	208/240 Vac	110/125	1600

SECTION 7 — Protective Devices

Undervoltage Device (Fig. 13)

The undervoltage device trips the breaker when its coil is de-energized. The leads of the coil are connected directly to secondary disconnects or to a terminal board. Under normal conditions, the coil remains energized and the breaker may be closed.

"Drop out" of the armature, with resultant breaker tripping, occurs when the voltage is reduced to less than 60 percent of the rated voltage. An open armature will render the breaker incapable of closing. The armature "picks up" and allows closing, if the voltage is 85 percent or more of its nominal value.

If the breaker is disconnected and for some reason the breaker is to be operated manually, the undervoltage device may be tied or wired down so that it will not cause tripping.

The undervoltage device is mounted to the left underside of the breaker front frame.

Adjustment

When this device is installed or replaced, its positive ability to trip the breaker must be demonstrated.

Undervoltage devices trip the breaker when the armature opens. This causes an extension on the armature to strike the

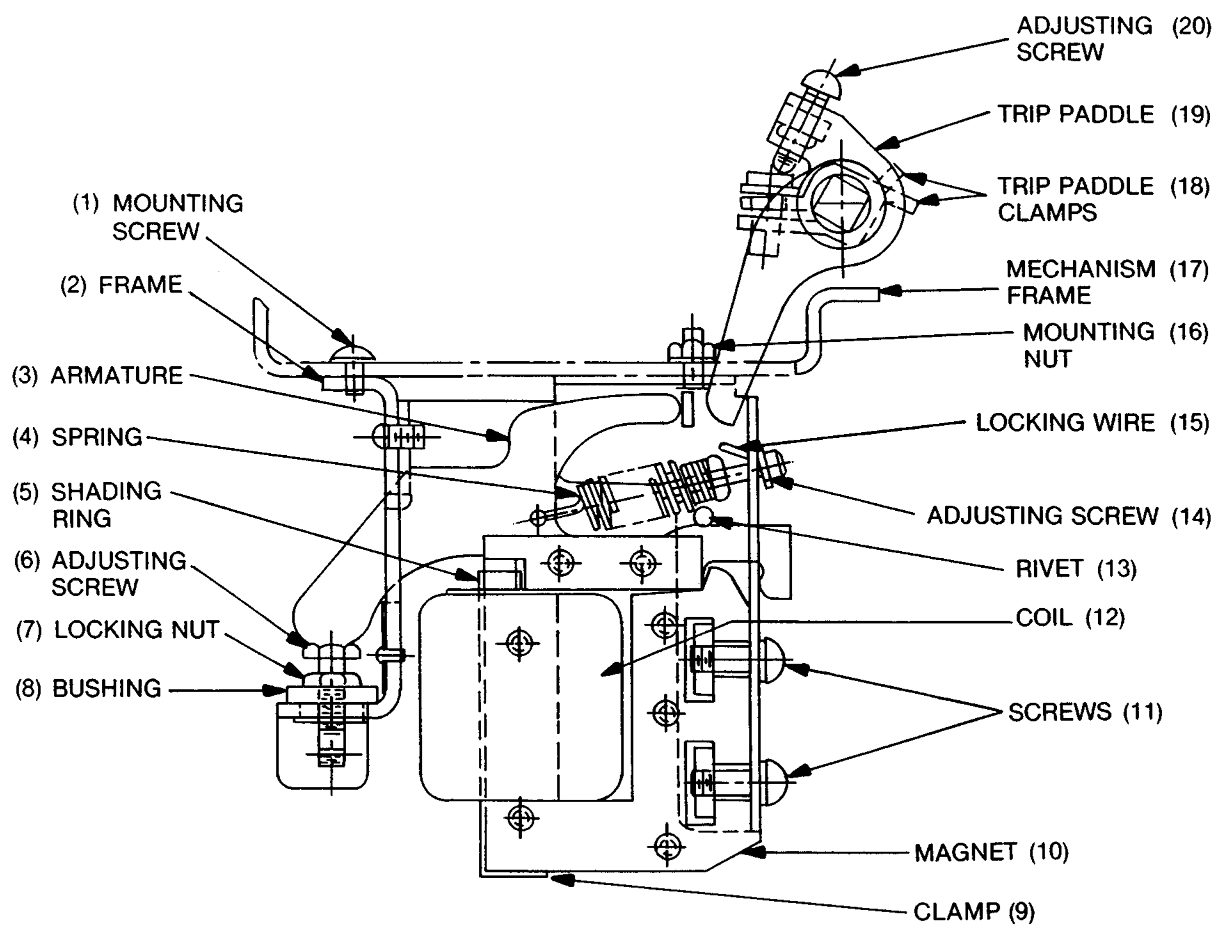


Fig. 13. Undervoltage tripping device

trip device will displace latch (link) (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.

Open Fuse Lockout Device (OFLO) (Fig. 16)

The open fuse lockout device (OFLO) consists of three separately operated coils (one per phase). Each coil is wired in parallel to the corresponding breaker fuses. This device is furnished on all AKRU 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

When any one of the breaker fuses blow, the coil (6), Fig. 16, 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 (3). The coil is de-energized as soon as the breaker opens.

Adjustments

1. With the breaker in the closed position and OFLO reset, the top collar must clear the trip shaft paddle by a minimum of 1/32 inch.

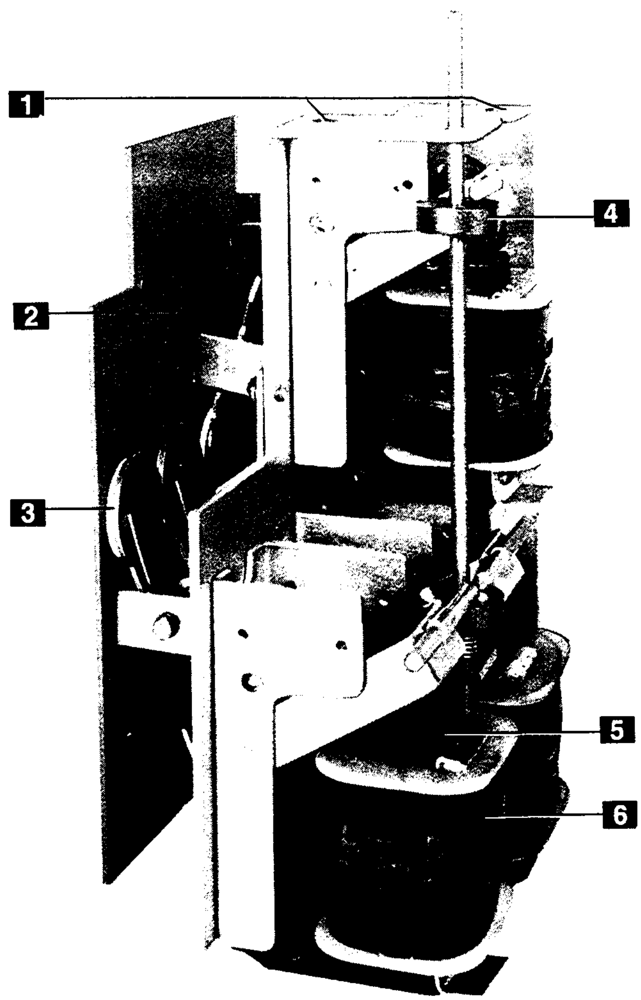
2. Check that each armature holds the breaker trip free when the armature position is limited in reset by the lower latch surface on the indicator (blown fuse condition).

Replacement

1. Remove the mounting screws on top of the 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."



1. Mounting holes
2. Lever
3. Reset button
4. Collar
5. Armature
6. Coil

Fig. 16. Open fuse lockout device

SECTION 7 — Protective Devices

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 de-energized. 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 (Fig. 15)

The bell alarm device is mounted on top of the front frame just to the left of the mechanism frame. 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. Without the lockout option, the bell alarm mechanism is also reset simply by closing the breaker.

Operation

The lever (2), Fig. 15, 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

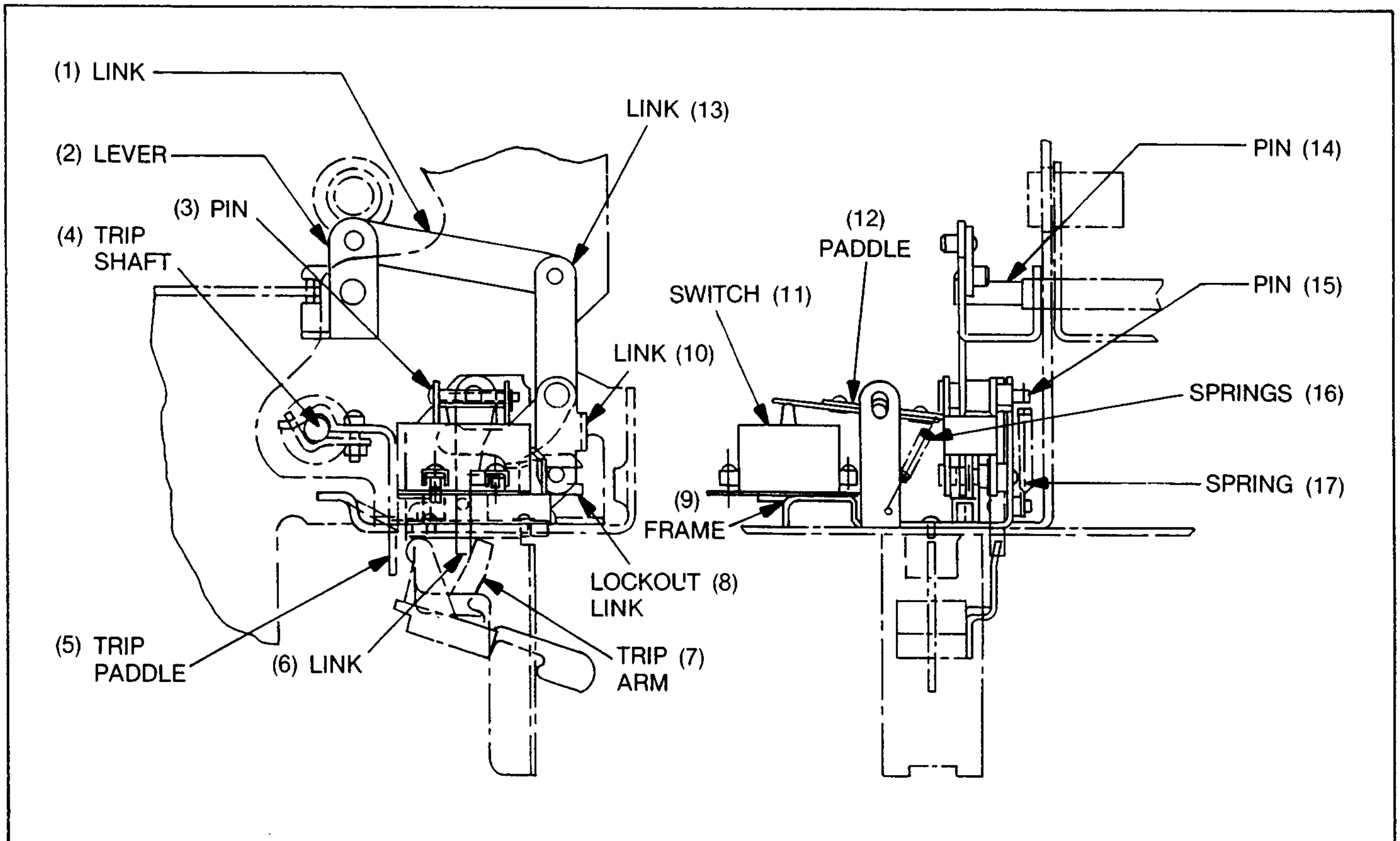


Fig. 15. Bell alarm and lockout device

Power Circuit Breakers

SECTION 8 — MicroVersaTrip® Trip Device

The MicroVersaTrip is a solid-state, direct-acting, self-powered trip device system. The MicroVersaTrip system consists of the MicroVersaTrip programmer, current sensors, and a flux shifter trip device. Figure 18 shows a block diagram of the system.

Programmer Unit

Figure 19 shows a typical MicroVersaTrip programmer unit. The MicroVersaTrip provides the comparison basis for over-current detection and delivers the energy necessary to trip the

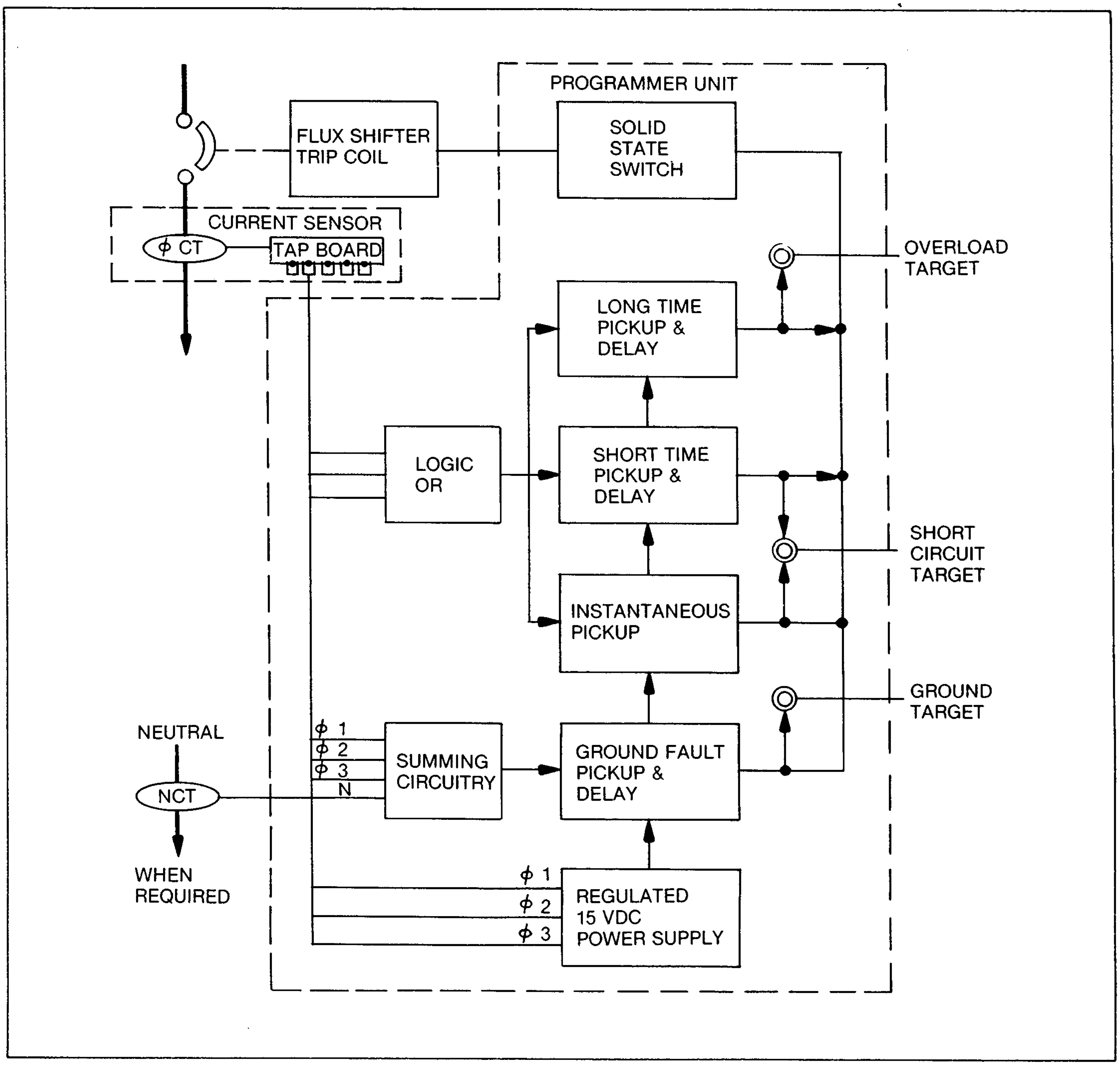


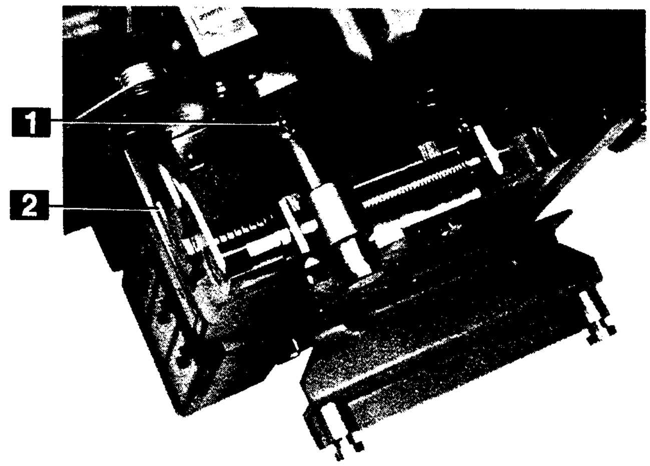
Fig. 18. MicroVersaTrip® block diagram

SECTION 7 — Protective Devices

Draw Out Interlocks (Fig. 17)

The rackout mechanism is interlocked so that the circuit breaker must be open before the operating wrench can be inserted. When the breaker is closed, the interlock shaft (2), Fig. 17, is blocked by the breaker cross bar. The trip interlock linkage (1) on the rackout mechanism shaft holds the breaker trip free when racking between the "Connect" and "Test" positions.

To adjust trip interlock screw (1), Fig. 17, rotate racking screw CCW to full "disconnect" position. Rotate this screw CW 23 full turns. Back out screw (1) to close breaker. Run in screw until breaker just trips. Run in screw one additional turn and tighten jam nut. Continue to rotate racking screw CW to full "connect" position stop. Check that screw (1) has approximately 1/32-inch clearance with trip paddle. To adjust, rotate trip paddle about its mounting screw and re-tighten.



1. Trip interlock
2. Rackout mechanism interlock

Fig. 17. Draw out interlocks

Power Circuit Breakers

SECTION 8 — MicroVersaTrip® Trip Device

MicroVersaTrip Installation

The programmer mounts to the lower right of the breaker as shown in Fig. 20. It mounts to the bracket assembly with guide pins which mate with the holes on either side of the programmer connector. They provide the necessary alignment for the connector engagement. The locking lever engages with the pin which is assembled to the programmer frame and secures the programmer to the mounting bracket. To remove programmer, disconnect remote fault indication harness (if equipped), pull locking lever out, and remove programmer by pulling forward. To install programmer, align guide pins and push on until locking lever snaps back in. Reconnect remote harness (if equipped). Verify that programmer is fully seated and secure.

Current Sensors

The current sensors supply the power and signal input necessary to operate the trip system. The MicroVersaTrip uses three phase and one neutral sensor.

Figure 6 shows the phase sensors assembled to the back frame. Tapped and fixed phase sensors are available. The tapped sensors provide field adjustment of the trip device's continuous ampere rating. See Fig. 23 for cable diagram.

The tapped and fixed phase sensors have a polarity associated with their windings. Their COMMON terminal is the right-hand terminal as shown in Fig. 6. A white wire with a ring terminal will be connected to this COMMON terminal. All phase sensors must be correctly wired for the programmer summing circuit to function properly.

Special phase sensors are used when the short time ("M"-option) or the hi-level instantaneous MicroVersaTrip option ("H"-option) is required. These sensors have four leads, two flag terminal connections (air core winding), and two screw terminal connections (ampere rating). There is no polarity associated with the flag terminals. Figure 27 shows the connections for the additional air core windings.

A neutral sensor is required when integral ground fault protection is used on single-phase three-wire or three-phase four-wire systems. It is inserted into the neutral conductor and therefore is separately mounted in the cable or bus compartment.

The outputs of the phase sensors and neutral sensor are connected to a programmer circuit which sums these values. The total value will remain zero as long as there is no ground current flowing. See cable diagram, Fig. 24.

The neutral sensor is an electrical duplicate of the phase sensor, including taps. Therefore, when taps are charged on the phase sensors, those on the neutral sensor must be correspondingly positioned.

Since the neutral sensor is mounted separately from the breaker, a disconnect means is required to connect its output to the breaker. Figure 20 shows the breaker mounted 4th wire secondary disconnect used with the MicroVersaTrip system.

Replacement of Current Sensors

Referring to Fig 5, replacement of MicroVersaTrip current sensors (17) is accomplished as follows:

1. Disconnect the programmer harness from the terminal board, removing cable ties as necessary.
2. Remove pivot block bolt (13).
3. Loosen the clamping bolt (14) and remove the stud connector. Lift out the sensor with its tap terminal board.
4. When replacing the stud connector, make sure the screws and clamping bolts are sufficiently tightened.
5. When replacing the programmer harness to the phase sensors verify that the winding polarity is maintained, white wire with ring terminal to COMMON terminal (right-hand terminal).

Flux Shift Trip Device

The flux shift trip device is a low-energy, electromagnetic device which, upon receipt of a trip signal from the programmer unit, trips the breaker by actuating the trip shaft.

The mounting arrangement of this component is illustrated in Fig. 21. An electromagnetic actuator located on the right side

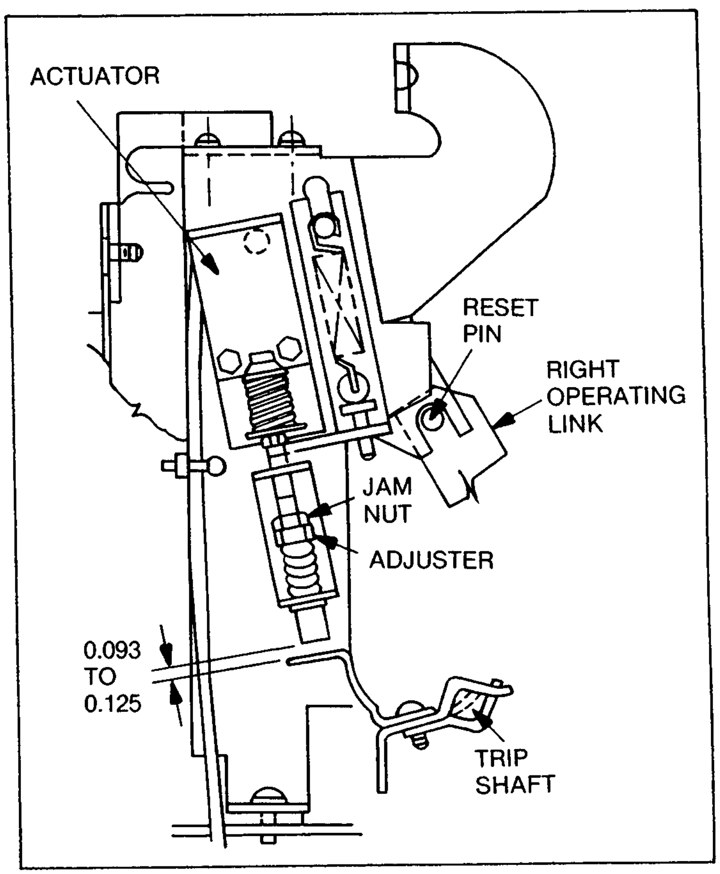


Fig. 21. Flux shifter trip device

SECTION 8 — MicroVersaTrip® Trip Device

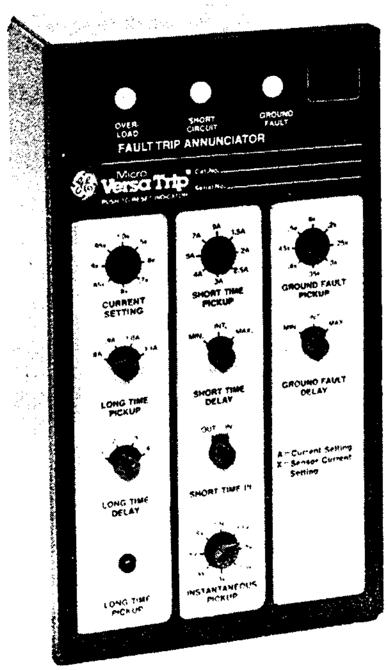


Fig. 19. MicroVersaTrip® Programmer

breaker. It contains a programmable microelectronic processor which incorporates nine adjustable time-current functions, three mechanical fault indicators (local and remote), a long-time pickup (local LED indicator, remote 1/2 A, 120 Vac switch) and a zone selective interlocking function. All adjustable programmer functions are automatic and self-contained requiring no external relaying, power supply or accessories. A detailed description of each trip function is given in publications GEA-10265 and GEH-4657.

Fault Trip Indicators

The optional fault trip indicators are mechanical pop-out type for identifying overload or short circuit over-currents faults when breakers are ordered without integral ground fault protection. They are also available to identify overload, short circuit and ground fault trips for breakers supplied with integral ground fault protection.

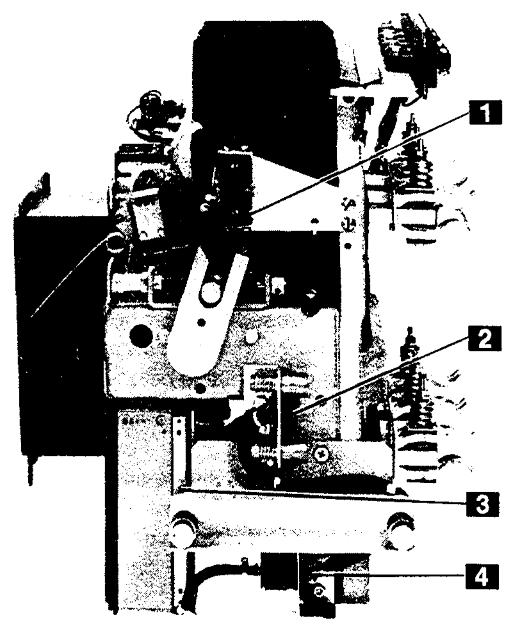
Each target pops out when its associated trip element operates to trip the breaker. After a trip, the popped target must be reset by hand. However, neglecting to reset does not affect normal operation of any trip element or prevent the breaker from being closed.

Remote Fault Indication

Remote fault indication is available in the form of a mechanical contact which may be incorporated directly into the customer's control circuitry. This is a normally open contact which is activated when its associated target pops out. When the target is reset, the contact is returned to its open position. Each contact is rated 0.25 amp at 125 Vdc and 1.0 amp (10 amp inrush) at 120 Vac.

The remote fault indication switch leads are brought out the bottom of the MicroVersaTrip programmer as shown in Fig. 20. This switch lead harness is plugged into the mating connector on the breaker.

The switch leads are brought out from the breaker through the programmer secondary disconnect shown in Fig. 20. The zone selective interlocking function wiring is also brought out through this disconnect. See Figs. 28 and 29 for the remote fault indication and zone selective interlocking cable diagrams.



1. 4th wire disconnect (neutral sensor)
2. Programming secondary disconnects
3. Programmer mount locking lever
4. Remote target harness disconnect

Fig. 20. Programmer installation and secondary disconnects

False Tripping — Breakers Equipped with Ground Fault

When nuisance tripping occurs on breakers equipped with the ground fault trip element, a probable cause is the existence of a false "ground" signal. As indicated by the cabling diagram of Fig. 23, each phase sensor is connected to a summing circuitry in the programmer. Under no-fault conditions on 3-wire load circuits, the currents in this circuitry add to zero and no ground signal is developed. This current sum will be zero only if all three sensors have the same electrical characteristics. If one sensor differs from the others (i.e., different rating or wrong tap setting), the circuitry can produce output sufficient to trip the breaker. Similarly, discontinuity between any sensor and the programmer unit can cause a false trip signal.

If nuisance tripping is encountered on any breaker whose MicroVersaTrip components have previously demonstrated satisfactory performance via the TVTS1 Test Set, the sensors and their connections should be closely scrutinized. After disconnecting the breaker from all power sources, proceed as follows:

1. Check that all phase sensors are the same type (ampere range).

2. Ensure that the tap settings on all 3-phase sensors are identical.

3. Verify that the harness connections to the sensors meet the polarity constraints indicated by the cabling diagram.

4. On Ground Fault breakers serving 4-wire loads, check that the neutral sensor is properly connected (see cabling diagram, Fig. 24). In particular,

   a. Verify that the neutral sensor has the same rating and tap setting as the phase sensors.

   b. Check continuity between the neutral sensor and its equipment-mounted secondary disconnect block. Also check for continuity from the breaker-mounted neutral secondary disconnect block through to the female harness connector.

   c. If the breaker's lower studs connect to the supply source, then the neutral sensor must have its LOAD end connected to the source. See Fig. 25.

   d. Ensure that the neutral conductor is carrying only that neutral current associated with the breaker's load current (neutral not shared with other loads).

   e. If the preceding steps fail to identify the problem, then the sensor resistances should be measured. Since the phase and neutral sensors are electrically identical, their tap-to-tap resistances should closely agree. See Tables 3 and 4.

Fig. 22. MicroVersaTrip® test set, Cat. No. TVTS1

SECTION 8 — MicroVersaTrip® Trip Device

of the mechanism frame is coupled to the breaker's trip shaft via a trip rod. The actuator is a solenoid whose armature is spring-loaded and held in its normal (RESET) position by a permanent magnet. In this state, the spring is compressed.

As long as the actuator remains in the RESET position, the breaker can be closed and opened normally at will. However, when a closed breaker receives a trip signal from the programmer unit, the actuator is energized and its solenoid flux opposes the magnet, allowing the spring to release the armature; this drives the trip rod against the trip shaft paddle, tripping the breaker.

As the breaker opens, the actuator arm is returned to its normal (RESET) position via a pin driven by the right-side crossbar operating link. The permanent magnet again holds the armature captive in readiness for the next trip signal.

The trip device requires only one adjustment — the trip rod length. As shown in Fig. 21, the clearance between the trip rod end and the trip shaft paddle is 0.093 to 0.125 inch. To adjust, open the breaker and restore the breaker mechanism to its RESET position. Loosen the jam nut, rotate the adjuster end until the proper gap is attained, then retighten the jam nut.

The actuator is a sealed, factory-set device and requires no maintenance or field adjustment. In case of malfunction, the complete actuator unit should be replaced. When making the electrical connection to the replacement unit, untie the breaker harness and remove the old actuator leads directly from the female AMP connector on the end of the breaker harness.

When replacing a MicroVersaTrip flux shifter, AMP extraction tool Cat. No. 455822-2 is required to remove the socket leads from the AMP connector. See cable diagram, Fig. 23, for correct pin locations.

Troubleshooting

When malfunctioning is suspected, the first step in troubleshooting is to examine the circuit breaker and its power system for abnormal conditions such as:

1. Breaker tripping in proper response to overcurrents or incipient ground faults.

2. Breaker remaining in a trip-free state due to mechanical interference along its trip shaft.

3. Inadvertent shunt trip activations.

> **WARNING:** *DO NOT CHANGE TAPS ON THE CURRENT SENSORS OR ADJUST THE PROGRAMMER UNIT SET KNOBS WHILE THE BREAKER IS CARRYING CURRENT.*

Once it has been established that the circuit breaker can be opened and closed normally from the test position, attention can be directed to the trip device proper. Testing is performed by either of two methods:

1. Conduct high-current, single-phase tests on the breaker using a high-current low-voltage test set.

> **NOTE:** *For these single-phase tests, special connections must be employed for MicroVersaTrip breakers equipped with ground fault. Any single-phase input to the programmer circuit will generate an unwanted "ground fault" output signal which will trip the breaker. This can be nullified either by:*
>
> - *Testing two poles of the breaker in series, or*
> - *Using the Ground Fault Defeat Cable as shown in Fig. 26. This special test cable energizes the programmer circuit in a self-cancelling, series-parallel connection so that its output is always zero.*

2. Test the components of the MicroVersaTrip system using portable Test Set Type TVTS1 (Fig. 22). The applicable test procedures are detailed in instruction book GEK-64464.

Resistance Values

For use in troubleshooting the MicroVersaTrip current sensors, the resistance of the tapped and fixed windings is given in Tables 3 and 4 respectively.

Table 3 — Tapped Sensor Resistance Values

Ampere Tap	Resistance in Ohms Between Common and Tap Terminals
100	5-6
150	7-9
225	11-19
300	16-19
300	19-22
400	25-30
600	40-47
800	56-66

Table 4 — Fixed Sensor Resistance Values

Ampere Rating	Resistance in Ohms Between Terminals
100	2-4
150	5-7
225	12-14
300	16-19
400	21-25
600	35-41
800	59-70

The coil resistance of the MicroVersaTrip flux shifter device is approximately seven ohms.

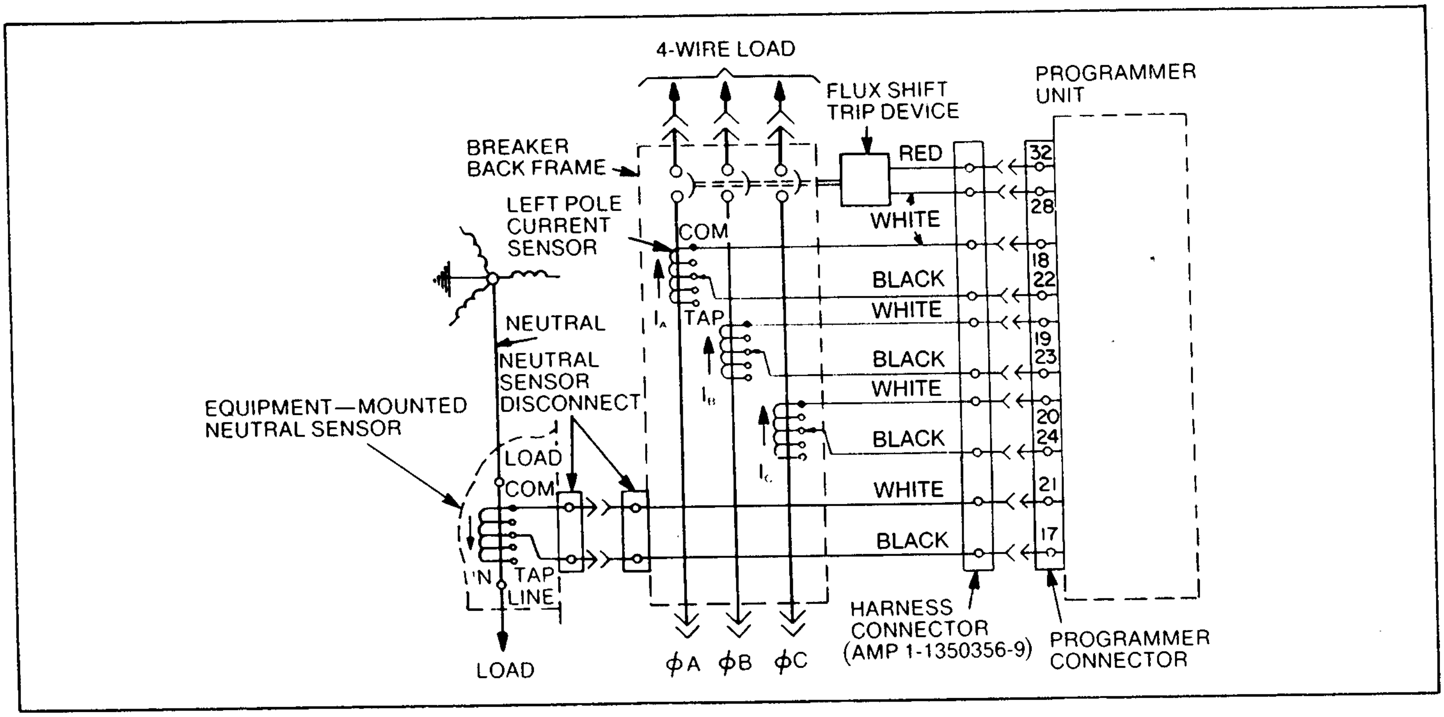


Fig. 25. Cabling diagram — MicroVersaTrip® with ground fault on 4-wire load-breaker reverse feed

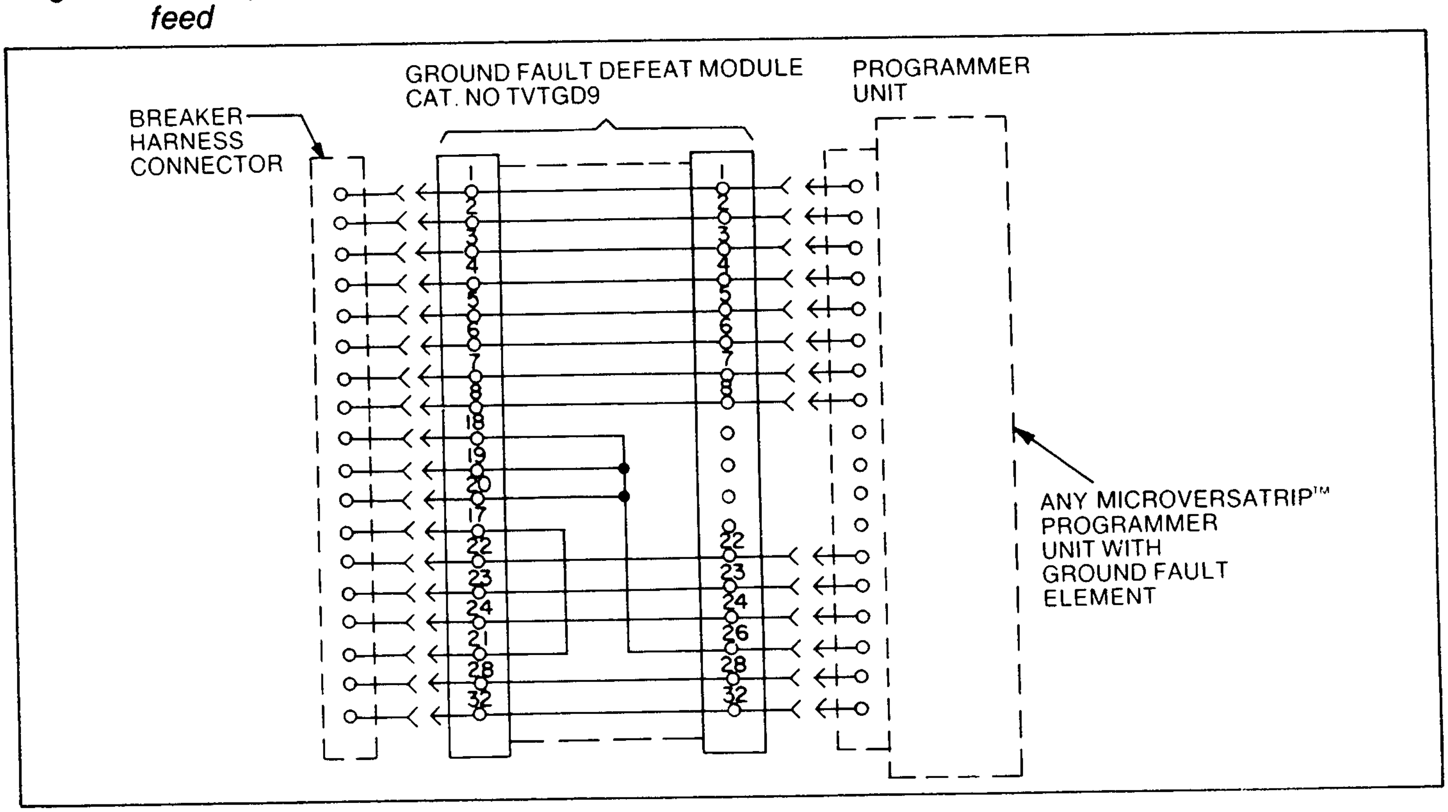


Fig. 26. Cabling diagram with ground fault defeat module inserted between breaker harness and MicroVersaTrip® programmer unit — for use during single-phase high-current low-voltage testing

SECTION 8 — MicroVersaTrip® Trip Device

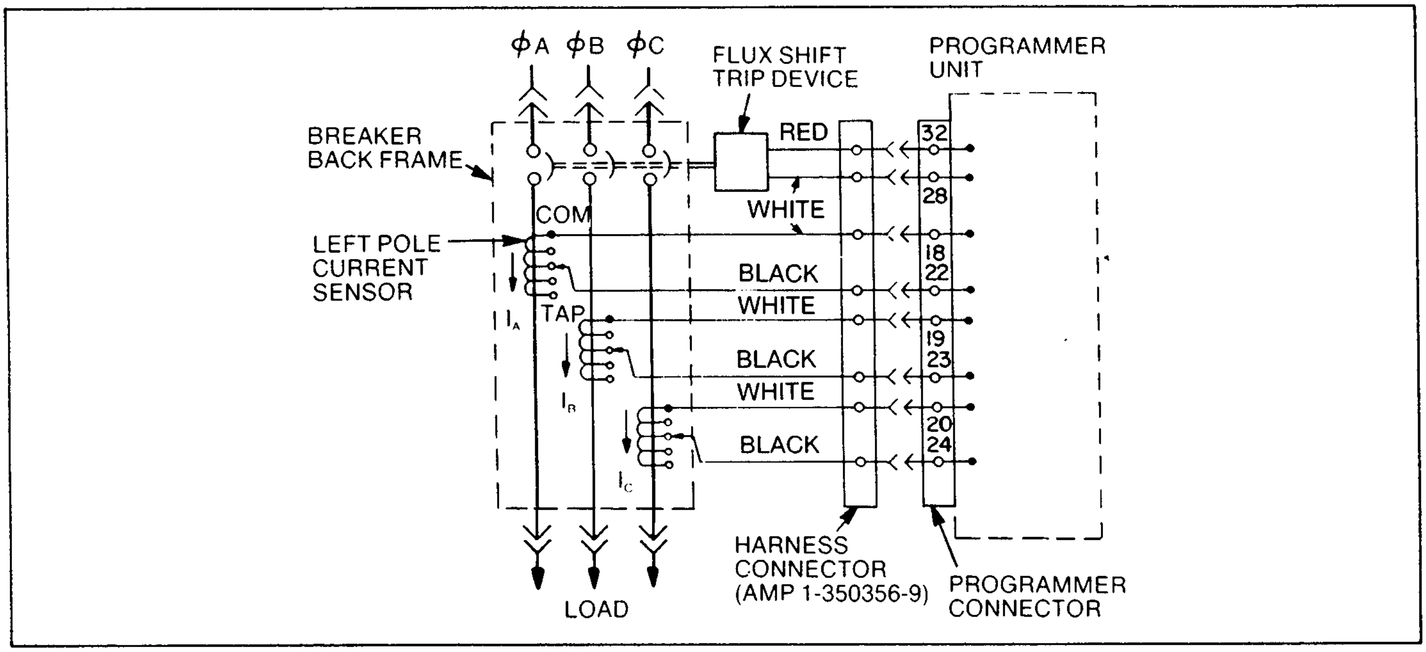


Fig. 23. Cabling diagram — MicroVersaTrip® without ground fault and MicroVersaTrip with ground fault on 3-wire load

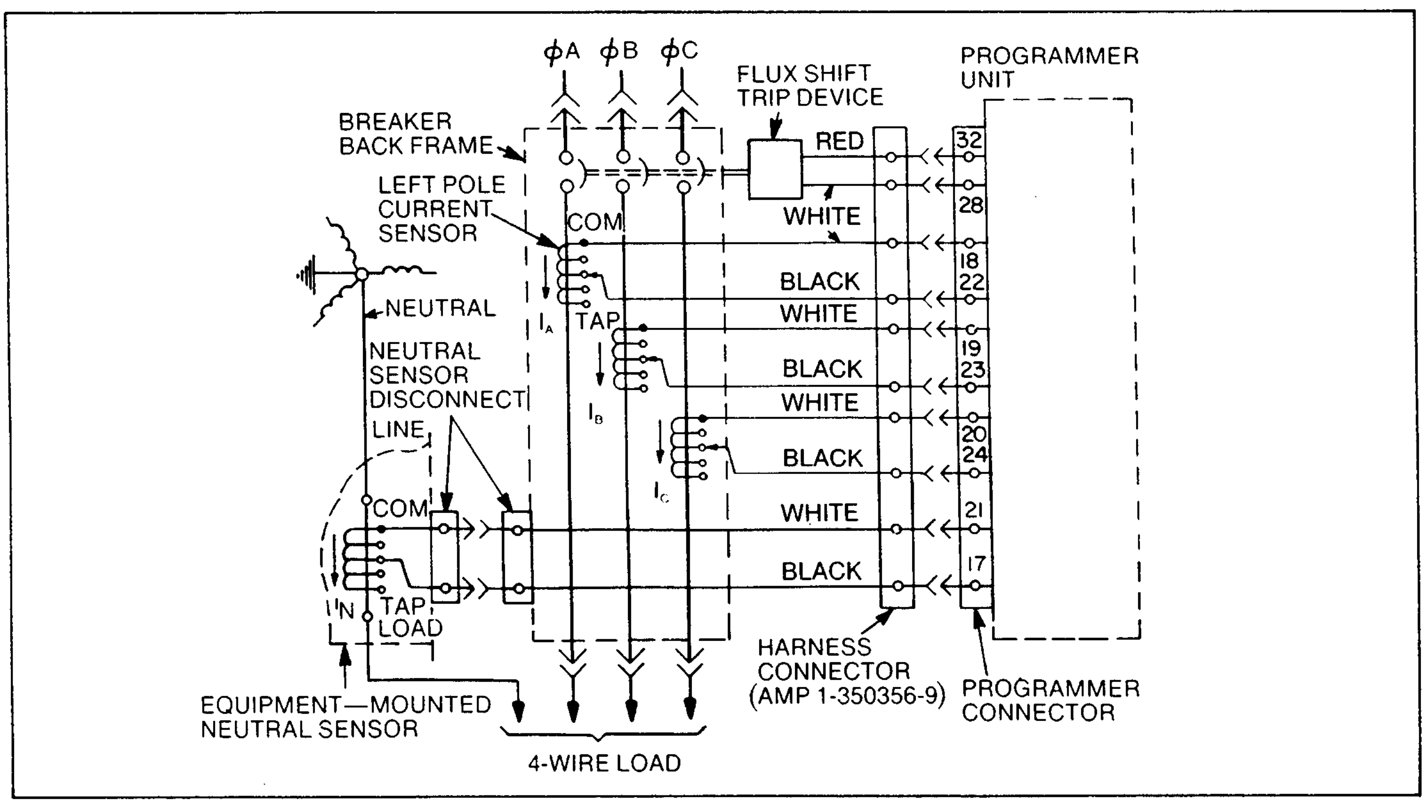


Fig. 24. Cabling diagram — MicroVersaTrip® with ground fault on 4-wire load

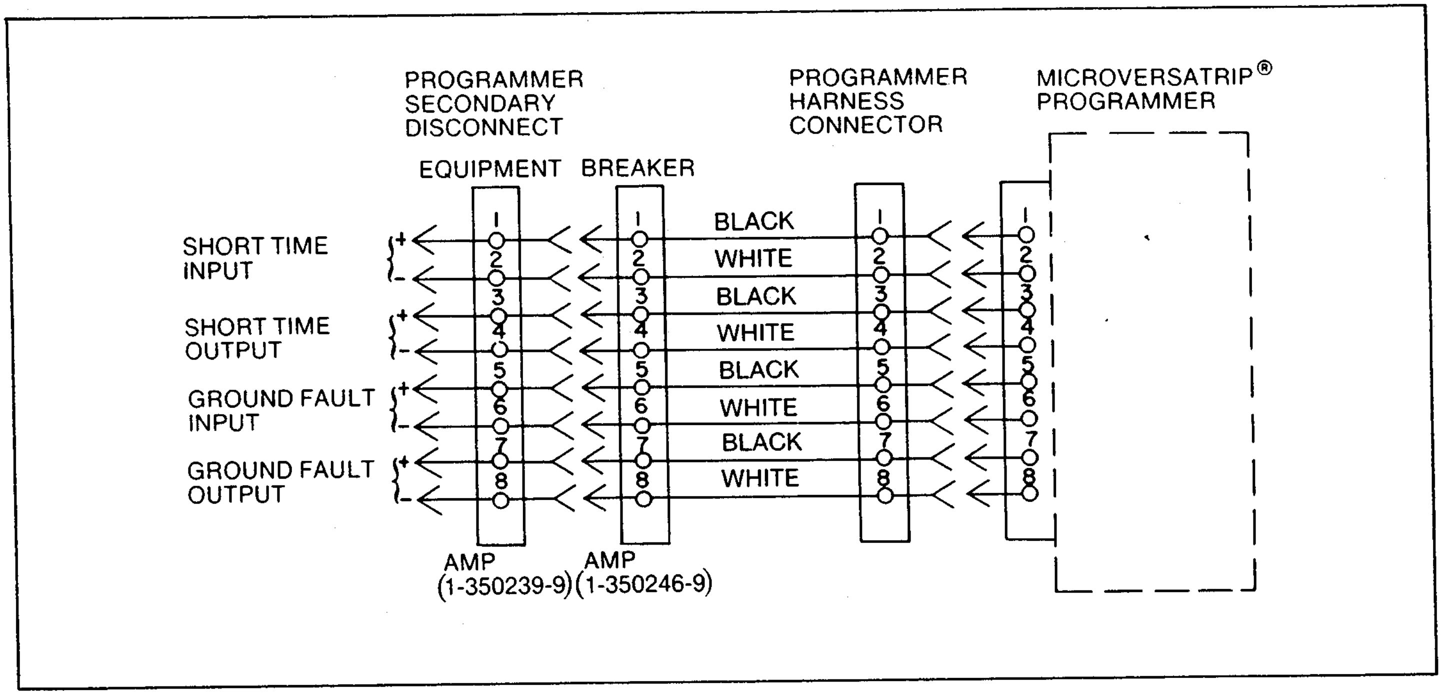


Fig. 29. Cabling diagram — zone selective interlock

SECTION 8 — MicroVersaTrip® Trip Device

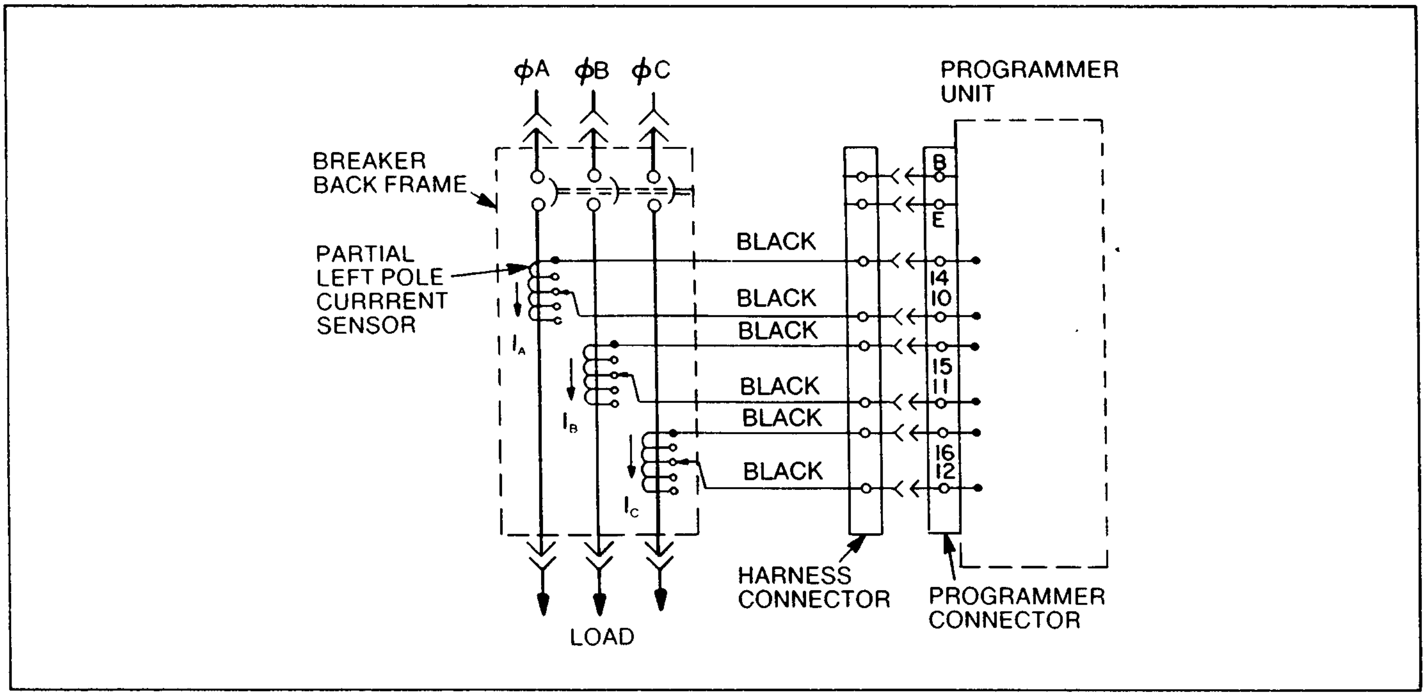


Fig. 27. Partial cabling digram: Air core phase sequence winding connections

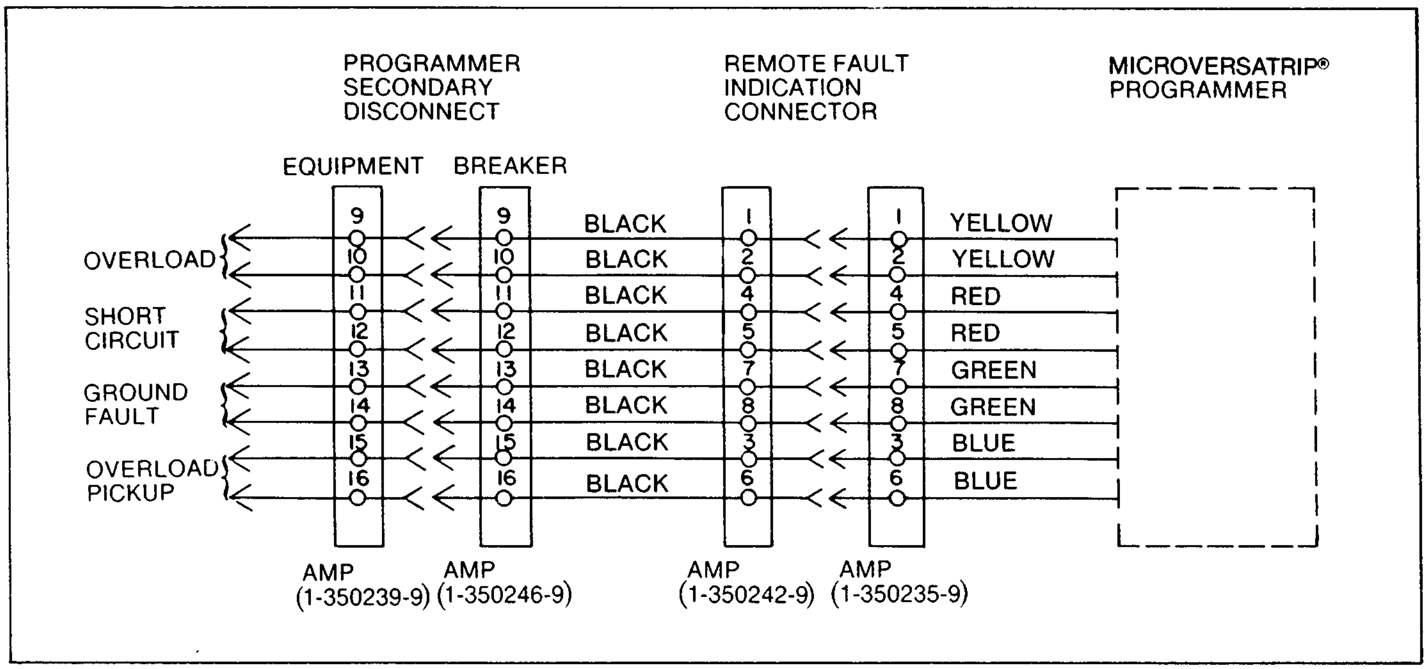


Fig. 28. Cabling diagram — remote fault indication

Power Circuit Breakers

SECTION 9 — Electrical Characteristics

Table 8 — Shunt Trip and Undervoltage Device Operating Currents

Nominal Control Voltage	Frequency Hz	Shunt Trip Operating Voltage Range		Shunt Trip Current (Amps) Inrush Open	Shunt Trip Current (Amps) Sealed Closed	Undervoltage Operating Voltage Range	Undervoltage Current (Amps) Inrush Open	Undervoltage Current (Amps) Sealed Closed
24	DC	14	30	8.3	8.3	Pickup at 85% of Nominal Control Voltage, Dropout at 30%-60% of Nominal Control Voltage	.38	.38
48	DC	28	60	4.5	4.5		.19	.19
125	DC	70	140	2.0	2.0		.08	.08
250	DC	140	280	1.0	1.0		.04	.04
70	60	59	132	—	—		N/A	N/A
120	60	95	127	12.3	10.8		.66	.24
120	50	95	127	7.6	6.7		.75	.25
208	60	175	220	3.2	2.6		.51	.17
208	50	175	220	3.8	3.1		.30	.10
240	60	190	254	3.9	3.4		.37	.12
240	50	190	254	4.7	4.1		.34	.11
240	40	190	254	5.8	5.1		N/A	N/A
380	50	315	410	2.9	2.6		.22	.08
480	60	380	508	3.4	3.1		.23	.08
480	50	380	508	7.5	7.3		.17	.06
575	60	475	625	2.8	2.5		.16	.06
575	50	475	625	5.1	4.7		.14	.06

SECTION 9 — Electrical Characteristics

Table 5 — Charging and Closing Operating Currents

Nominal Control Voltage	Frequency Hz	Voltage Range	Min (volts) Pick-up	Anti-pump Relay "E" Rated-Amps		Min (volts) Pick-up	Control Relay "K" Rated Amps		Min (volts) Pick-up	Closing Solenoid Rated Amps		Fuse Selection
				Inrush Open	Sealed Closed		Inrush Open	Sealed Closed		Inrush Open	Sealed Closed	
48V	DC	38-56	38	.063	.063	30	4.1	4.1	38	95	95	20A
125V	DC	100-140	85	.024	.024	90	1.05	1.05	100	43.6	43.6	10A
250V	DC	200-280	170	.015	.015	180	.53	.53	200	23.9	23.9	6A
120V	60			.090	.052		1.0	.14		153	78.4	30A
120V	50	104-127	95	.090	.052	95	1.0	.15	98	142	63.4	30A
120V	25			.047	.032		6.85	1.27		70.6	45.5	15A
208V	60			.050	029		.45	.063		90.8	37.4	15A
208V	50	180-220	175	.050	.029	175	.55	.083	177	103	46.9	15A
208V	25			.032	.018		3.86	.76		45.3	27.3	10A
240V	60			.064	.036		.50	.07		67.5	27.6	15A
240V	50	208-254	190	.064	.036	190	.50	.08	196	74.8	30.3	15A
240V	25			.035	.023		3.42	.64		43.1	23.5	6A

Table 6 — Bell Alarm Contact Rating

Control Voltage		Bell Alarm Contact Rating (amperes) Inrush	Continuous
DC	125	2.5	2.5
	250	0.9	0.9
60 Hz. AC	120	30	10
	240	15	5
	480	7	3

Table 7 — Auxiliary Switch Contact Ratings

Control Voltage		Auxiliary Switch Interrupting Ratings (Amperes) ▲ Non-Inductive	Inductive
DC	48	25	—
	125	11	6.3
	250	2	1.8
AC	115	75	50
	240	50	25
	480	25	12

▲ Limited to 20A continuous rating of switch on all breakers and to 15A continuous rating of #16 wire on draw out breakers.

Power Circuit Breakers

SECTION 10 — 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.

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.

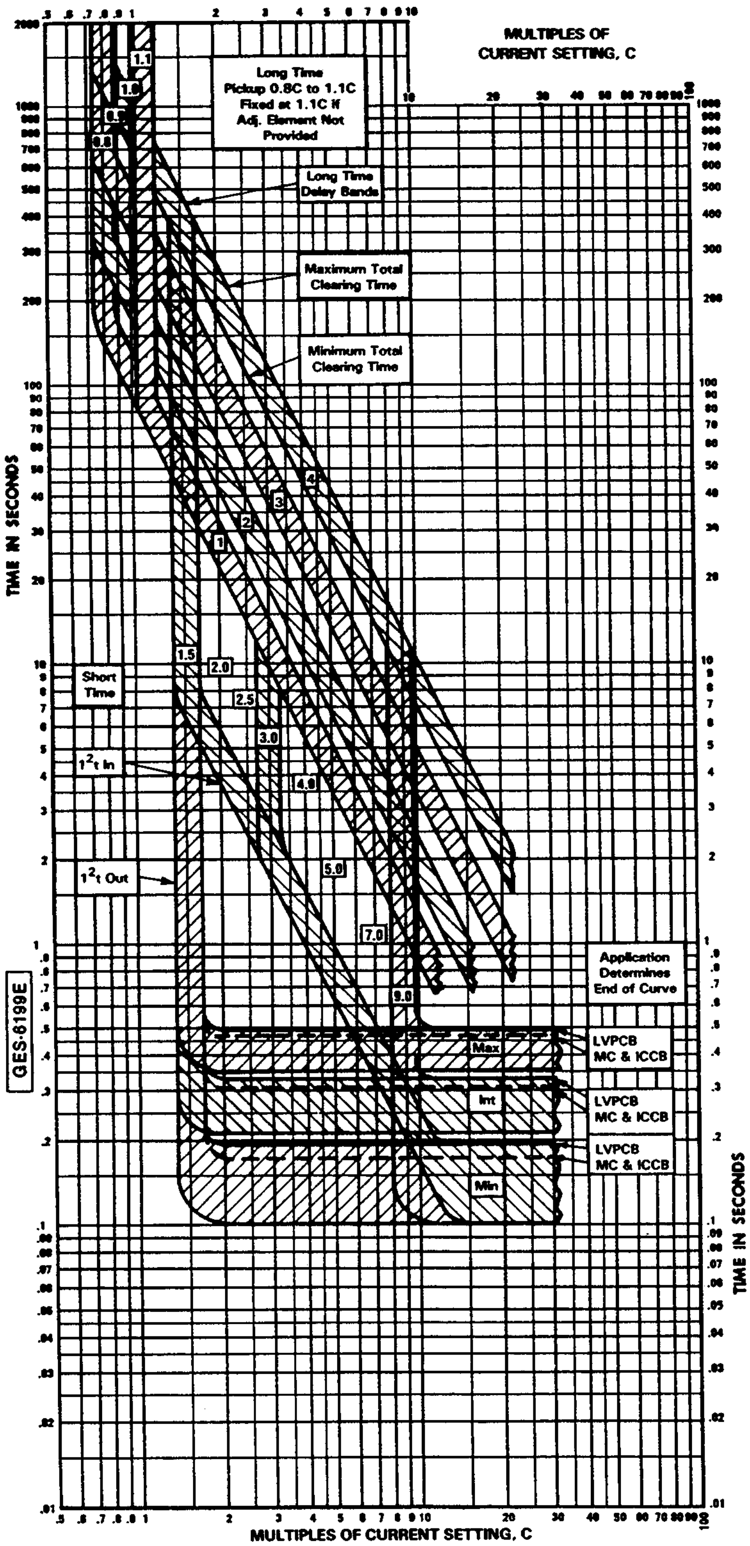
Renewal Parts Bulletin

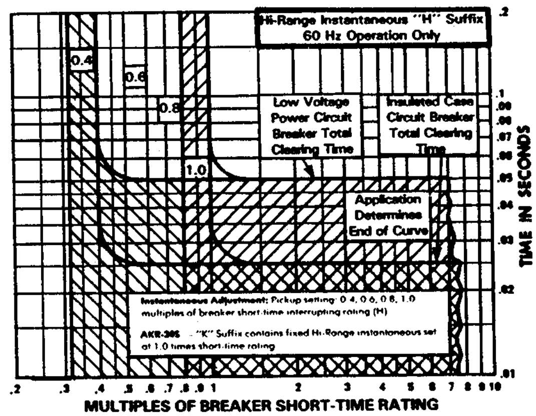
The applicable Renewal Parts Bulletin for this equipment is GEF-6005.

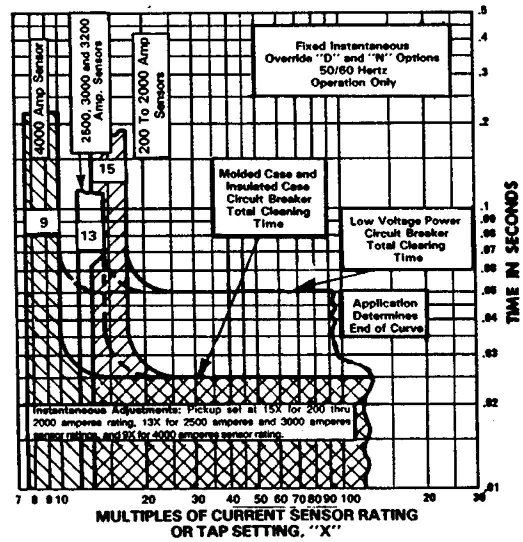
SECTION 9 — Electrical Characteristics

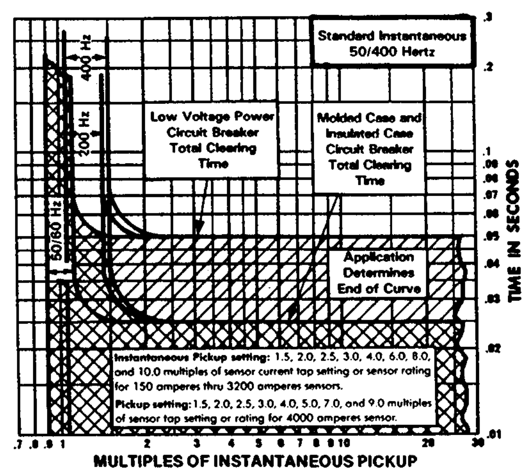
Table 9 — Coil Resistance — DC Ohms @ 25°C

Nominal Control Voltage	Frequency Hz	Anti-Pump Relay "E"	Control Relay "K"	Shunt Trip	Undervoltage	Closing Solenoid
24V	DC	N/A	N/A	3	64	N/A
48V	DC	802	12	11	240	.49
125V	DC	5000	119	64	1600	2.76
250V	DC	16400	476	260	6700	10.50
120V	60	450	54	3.9	25.4	.248
120V	50	450	75	7.15	33	.316
208V	60	1450	216	25.4	64	.825
208V	50	1450	300	25.4	146	.825
240V	60	1450	300	25.4	100	.930
240V	50	1450	300	25.4	146	1.27
380V	50	N/A	N/A	64	370	3.17
480V	60	N/A	N/A	64	370	4.10
480V	50	N/A	N/A	32	580	5.10
575V	60	N/A	N/A	100	580	5.85
575V	50	N/A	N/A	64	918	8.00









GENERAL ELECTRIC

LOW-VOLTAGE POWER CIRCUIT BREAKERS TYPE AKR
INSULATED-CASE CIRCUIT BREAKERS TYPE TPV, THV, TCV, THCV, TDV, THDV
MOLDED-CASE CIRCUIT BREAKERS TYPES TJ9V, THJ9V, TK9V, THK9V, TLC9V
All with MicroVersaTrip®

Long-time-delay, Short-time delay, and Instantaneous Time-current Curves

(Curves apply at 50/400 Hertz and from −20C to +55C breaker ambient or −20C to +70C programmer ambient)

X=Current Sensor Tap Setting or Rating

Current Sensor Taps (Amperes) LVPCB

AK-25	70/100/150/225 or 200/300/400/600
AKR-30S	100/150/225/300 or 300/400/600/800
AKR-50	300/400/600/800 or 600/800/1200/1600
AKRT-50	800/1200/1600/2000
AKR-75	1200/1600/2000/3200
AKR-100	1600/2000/3000/4000

Fixed Current Sensor Ratings (Amperes) LVPCB

AKR-30S	100, 150, 225, 300, 400, 600, 800
AKR-50	300, 400, 600, 800, 1200, 1600
AKRT-50	800, 1200, 1600, 2000
AKR-75	1200, 1600, 2000, 3200
AKR-100	1600, 2000, 3000, 4000

Current Sensor Taps (Amperes) ICCB

800 Envelope	400/200,600/300,800/400
1600 Envelope	800/400,1000/500, 1200/600,1600/1000
2000 Envelope	2000/1200
2500 Envelope	600/300,800/400,1000/500, 1200/600,1600/1000 2000/1200, 2500/1800
3000 Envelope	3000/2400
4000 Envelope	4000/3000

Fixed Current Sensor Ratings (Amperes) ICCB and MCCB
150,200,300,400,500,600,800,1000
1200,1600,2000,2500,3000,4000

Voltage Rating: 600 Volts, ac, 50 through 400 Hertz (see caution at right)

GES-6199E

Programmer Adjustments

Long Time Delay Unit Current Settings (C): 0.50, 0.60, 0.70, 0.80, 0.85, 0.90, 0.95 and 1.00 multiples of current sensor tap setting or rating (X). Pickup: 0.8, 0.9, 1.0, 1.1 multiples of the current setting (C). Long time pickup fixed at 1.1 C when the adjustable unit is omitted. Delay Bands: 1, 2, 3 and 4.

Short Time Delay Unit Pickup Settings: 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.0, and 9.0 multiples of current setting (C).

Delay Bands: MIN, INT, MAX; I^2t = Constant.

Instantaneous Adjustments: See Curves above.

NOTE: Operation above 60 Hertz required continuous current derating of the circuit breaker for thermal reasons.

CAUTION: 60-Hertz short-circuit ratings do not apply at frequencies over 65 Hertz.

9-84 (5M)
GENERAL ELECTRIC CO., CONSTRUCTION EQUIPMENT BUSINESS OPERATIONS, PLAINVILLE, CONN. 06062

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. These instructions are intended for use by qualified personnel only.

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

General Electric Company
41 Woodford Avenue
Plainville, CT 06062, USA

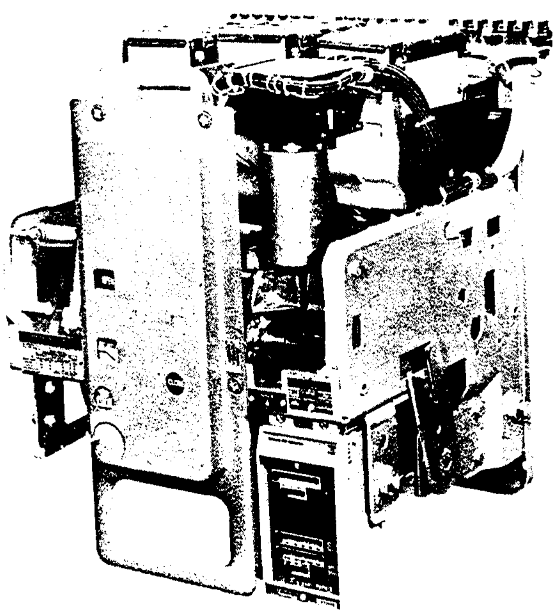
GEH-5019 1184 CMB

GENERAL ELECTRIC

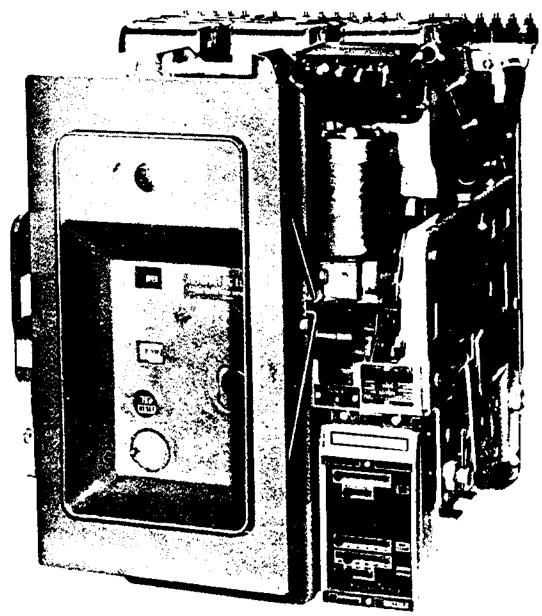
Installation Manual

Low Voltage Power Circuit Breakers

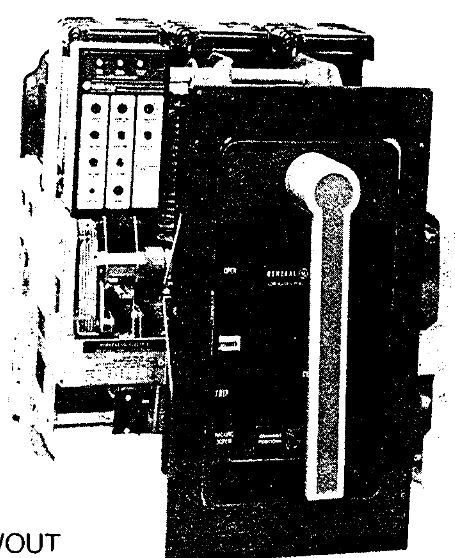
Types AKR-30/50 and AKRT-50



A-TYPE DRAWOUT
Electrically Operated



B-TYPE DRAWOUT
Electrically Operated



D-TYPE DRAWOUT
Manually Operated

GENERAL ELECTRIC

INSTALLATION AND OPERATION AKR/AKRU-30, 50 & AKRT-50 FRAME SIZE LOW-VOLTAGE POWER CIRCUIT BREAKERS

CONTENTS

OTHER PUBLICATIONS

The instructions in this publication are general in nature. For more detailed information on troubleshooting, overhauling or replacing parts, refer to the following:

Maintenance Manual	GEK-64459
Renewal Parts	GEF-4527
EC Trip Devices	GEI-86157
ECS/SST Test Set:	
Cat. TAK-TS2	GEK-73300-1
MicroVersa Trip Test Set:	
Cat. TVTS1	GEK-64464
Time Current Curves	GEZ-4431
Obsolete Test Set for ECS/SST	
Cat. TAK-TS1	GEK-64454

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.

INTRODUCTION

These instructions describe the installation and operation of the Low Voltage Power Circuit Breakers tabulated below. They cover a variety of models which may differ in rating, trip device and/or mounting type. Each model has a distinctive designation.

MOUNTING TYPES

As listed in Tale 1, the 800 thru 2000A frame AKR breakers are furnished in four different mounting types—drawout A, drawout B, drawout D, and stationary (S). Each of these is described in the text. A breaker's type is indicated on its nameplate; the designation system is explained in Fig. 1.

TABLE 1—BREAKER DESIGNATIONS

FRAME SIZE (Amperes)		DRAWOUT MOUNTING				
250V.Dc	**600V.Ac 50/60 Hz.**	**AKD-6 Switchgear (CODE A)**	**Substructure (1) (CODE B)**	**Substructure AKD-8 Switchgear (CODE D)**	**STATIONARY MOUNTING (CODE S)**	**NOTES**
800	800	AKR-(*)A-30 AKR-(*)A-30H	AKR-(*)B-30 AKR-(*)B-30H	AKR-(*)D-30 AKR-(*)D-30H	AKR-(*)S-30 AKR-(*)S-30H	(2)
2000	1600	AKR-(*)A-50 AKR-(*)A-50H	AKR-(*)B-50 AKR-(*)B-50H	AKR-(*)D-50 AKR-(*)D-50H	AKR-(*)S-50 AKR-(*)S-50H	(2)
—	2000	AKRT-(*)A-50 AKRT-(*)A-50H	AKRT-(*)B-50 AKRT-(*)B-50H	AKRT-(*)D-50 AKRT-(*)D-50H	AKRT-(*)S-50 AKRT-(*)S-50H	(2)
— —	800 1600	AKRU-(*)A-30 AKRU-(*)A-50	AKRU-(*)B-30 AKRU-(*)B-50	AKRU-(*)D-30 AKRU-(*)D-50	— —	(3) (3)
Special Dc Breakers For Field Switching						
800 2000	— —	— —	AKR-NB-30F AKR-NB-50F	AKR-ND-30F AKR-ND-50F	AKR-NS-30F AKR-NS-50F	

(1) All substructures and AKD-8 breakers employ a deep escutcheon.
(2) The "H" suffix denotes extended short circuit ratings.
(3) Integrally fused models.
(*) This digit identifies the trip device:
- 2 = EC-1 or EC-2A. Dc only.
- 4 = ECS 50/60 Hertz only
- 5 = SST 50/60 Hertz only
- 6 = Micro Versa Trip 50/60 Hertz Only
- N = Non-automatic. In addition, all non-automatic 250V.Dc breaker types carry the suffix letter D after the frame number, e.g., AKR-NB-50D.

Example: AKR-5B-50 identifies a drawout, substructure-mounted breaker equipped with the SST trip device.

The EC trip devices are electro-mechanical. ECS, SST and Micro-Versa Trip units are Solid State.

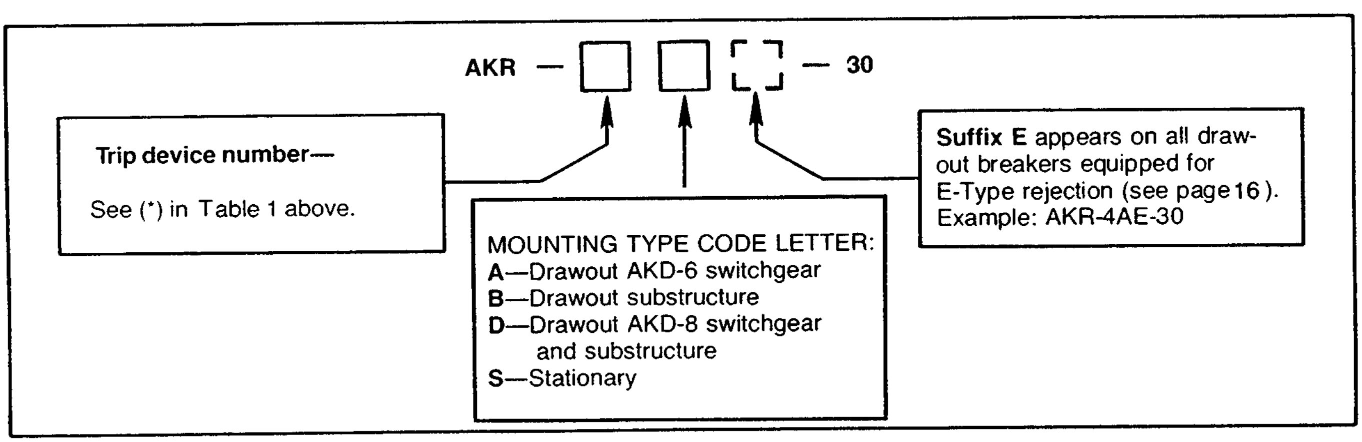


Fig. 1. AKR breaker type designation

RECEIVING, HANDLING AND STORAGE

Before installing or operating these circuit breakers, carefully read these instructions.

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

NOTE: *Before installing in a Nuclear Class 1E application, determine that this product is intended for such use by checking the procurement records.*

LOCATION

In choosing a location for the installation of these breakers there are two factors to be considered. The first is the location's environmental impact on the breaker. Much better performance and longer life can be expected if the area is clean, dry, dust-free and well ventilated. The second is convenience for operation and maintenance. The breaker should be easily accessible to the operator and there should be sufficient space available for maintenance work.

STATIONARY BREAKERS

These breakers are designed for mounting in a switchboard or enclosure designed and constructed by others. Mounting 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, including a cut-out opening through which the front escutcheon of the breaker can protrude.

The surface on which the breaker is mounted must be flat to avoid internal distortion of the breaker. 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. Connecting bus and cables must be rigidly supported to prevent undue stress on the breaker terminals.

The outline drawings in Table 2 provide basic dimensional information for designing the panel or enclosure mounting.

TABLE 2

Stationary Breaker Type	Outline	
	Manually Operated	Electrically Operated
AKR-( )S-30/30H	139C4300	139C4301
AKR-( )S-50/50H AKRT-( )S-50/50H	139C4761	139C4762

DRAWOUT BREAKERS

GENERAL

Drawout breakers are manufactured in three different styles identified by mounting code letters A, B and D. Code A breakers are employed in AKD-6 switchgear and feature closed-door drawout operation. Code B breakers provide an alternate closed-door drawout arrangement with the stationary element furnished as a preassembled "substructure". Code D breakers are employed in AKD-8 or substructure type gear and feature closed door drawout. The construction and operation of each of these drawout styles is covered under respective headings in the following text.

As a general rule, breakers of the same drawout type, voltage rating and ampere frame size are physically interchangeable. However, to be electrically interchangeable with respect to secondary and control circuits, they must have duplicate wiring. The degree of interchangeability and the mechanisms for controlling it are discussed separately on page (14).

Note: *The three drawout types are mutually noninterchangeable; before insertion is attempted, verify that the breaker model matches its intended compartment.*

CODE A (AKD-6 SWITCHGEAR) (Fig. 2)

This type drawout breaker is supported by two protruding pins on each side of its frame; these engage slots in telescoping slide rails (tracks) mounted to each sidewall of the breaker compartment. The door of the compartment is hung on a telescoping inner housing also attached to the movable tracks. These elements are arranged so that the door moves in unison with the breaker between the CONNECTED and DISCONNECTED positions, allowing the breaker to be racked without opening the door. This feature is referred to as "closed-door drawout".

The in and out movement of the breaker between the CONNECTED-TEST-DISCONNECTED positions is performed by a breaker-mounted apparatus called the drawout or "racking" mechanism. It comprises a transversely-mounted, jackscrew-driven crankshaft with a slotted crank arm at each end. As the crankshaft is rotated, each crank arm fulcrums about a fixed pin in the compartment to move the breaker in or out.

The jackscrew drives the crankshaft via an internally threaded trunnion supported in a crank centrally located on the crankshaft. The jackscrew is rotated by a removable, externally-operated crank handle (Part No. 193A1990P1) inserted thru an opening in the breaker's escutcheon. Access to this opening is via a sliding cover marked RACKING SCREW.

The drawout operation features four discrete positions:

CONNECTED—This is the breaker's "In-Service" position. It is fully inserted in its compartment; the primary and secondary disconnect contacts are fully engaged. The breaker must be tripped before it can be racked into or out of this position.

TEST—In this position the primary contacts are disconnected but secondary contacts remain engaged. This allows complete breaker operation without energizing the primary circuit.

DISCONNECTED—Both primary and secondary contacts are disengaged.

Breakers can be racked between the above positions with the compartment door closed. Each of the three positions is clearly shown by a rotatry indicator visible through an opening in the door.

WITHDRAWN—With the compartment door open, the breaker can be manually pulled out to the WITHDRAWN position. At this point the tracks are fully extended and the breaker is completely out of its compartment, ready for removal. Note that the racking mechanism is not employed for movement of the breaker between the DISCONNECTED and WITHDRAWN positions.

Breaker Insertion

1. Prior to lifting a breaker to its intended compartment location, observe the following precautions:

   a. *Check the compartment to insure that it is free of foreign objects.*

   b. *Verify that the breaker is the correct type for that compartment.*

   c. *Insure that the breaker is OPEN.*

   d. *Apply a thin, fresh coat of D50HD38 lubricant to the breaker's primary disconnects.*

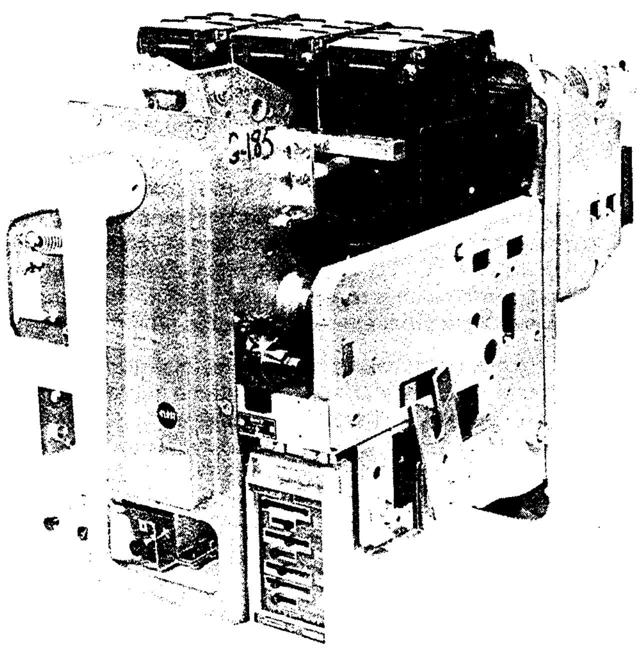


Fig. 2

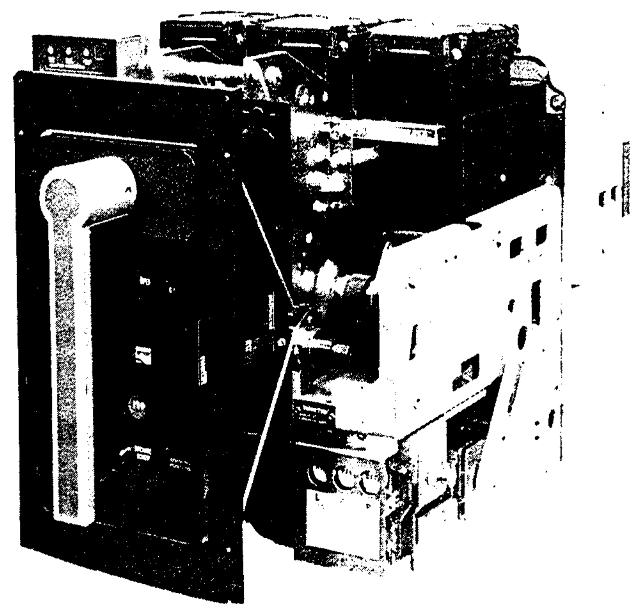


Fig. 3

2. AKD-6 switchgear breaker compartments are factory shipped less breakers and with the inner housing stowed in the CONNECTED position by a shipping bolt painted yellow. As the first step in preparing for breaker insertion, remove and discard this bolt and its shipping tag.

3. Pull the inner housing out until it stops. It will then be in the DISCONNECTED position.

4. Rotate the two track lock links and pull the right track all the way out.

5. Using a suitable lifting device, hoist the breaker until its mounting pins are approximately one inch above the tracks.

> **NOTE:** *To avoid damaging the arc quenchers, a spreader bar must be used for hoisting these breakers. Two hoisting slots are provided in each side frame—see Fig. 2. The spreader bar's hooks should be placed in the forward slots for non-fused breakers and in the rear slots for fused breakers.*

6. Pull the left track out to the limit of its travel; lower the breaker onto the track so that its mounting pins drop into the track slots.

> **CAUTION:** *Breakers and tracks are equipped with rejection hardware which acts to prevent the tracks from accepting a breaker whose rating does not match that of the compartment. This rejection system is separately described under the heading INTERCHANGEABILITY starting on Page 14.*

7. Attach the racking handle to the racking screw thru the opening at the lower left corner of the breaker escutcheon. Access to the racking screw is obtained by depressing the TRIP button and sliding the racking screw cover to the right; releasing the TRIP button locks the cover open.

8. Rotate the racking handle counterclockwise (if possible) until it stops, then remove it. The purpose of this step is to position the slotted crank arms at the proper angle necessary to engage the fixed racking pins in the compartment.

9. Push the breaker in against the track stops. Rotate the two track lock links to lock the breaker in place. Close the door.

10. Again insert the racking handle (as in Step 7) and rotate it clockwise until it stops. A few turns before the stop is reached, turning torque will noticeably increase as the breaker's disconnect fingers engage the stationary studs. The breaker is now in the CONNECTED position and the position indicator will show CONN.

The complete racking cycle requires approximately 24 turns of the racking handle.

11. Remove the racking handle and depress the TRIP button to close the racking screw cover.

Breaker Removal (Code A)

1. Trip the breaker.

2. Insert the racking handle and rotate it counterclockwise until it stops. The indicator should read DISC.
Toward the end of the above racking movement, the breaker's "closing spring interlock" is activated; this automatically discharges the closing spring (if in a charged state) but does not close the breaker.

3. Remove the racking handle, open the compartment door.

4. Rotate the two track lock links and pull the breaker all the way out.

5. Attach the lifting device and raise the breaker until its mounting pins clear the track.

6. Push the tracks into the compartment, then lower the breaker to a flat surface; avoid protrusions that could damage the internal parts of the breaker.

> **NOTE:** *After a breaker is removed from its compartment, the inner house cannot be manually pushed all the way back into the compartment. The latches that rest on the drawout mechanism pins prevent this.*

CODE B (AKR SUBSTRUCTURE) (Fig. 4)

The AKR substructure is a self-contained, open-type framework serving as the stationary receptacle for a drawout breaker. Featuring closed-door type drawout operation, it is designed for convenient mounting in individual breaker compartments of drawout switchgear equipments. It provides means for making the primary and secondary connections to the removable breaker element and is factory aligned.

All AKR B-type breakers for use in substructures are equipped with a "deep" escutcheon instead of the standard escutcheon employed on the A-type models. This configuration allows the breaker to be racked between the CONNECTED and DISCONNECTED positions with the door closed. The door is hung on the compartment (not on the slide rails) and does not move with the breaker as it does in the A-type AKD-6 models.

The racking mechanism is breaker-mounted and is identical to that of the Code A breaker; the same support method (pins engaging slots in slide rails) is also used. In operation, the substructure traverses the same four drawout positions as the A-types: CONNECTED—TEST—DISCONNECTED—WITHDRAWN. Breaker position is registered directly by markings on the left side of the escutcheon, these becoming visible as it emerges throught the door cutout.

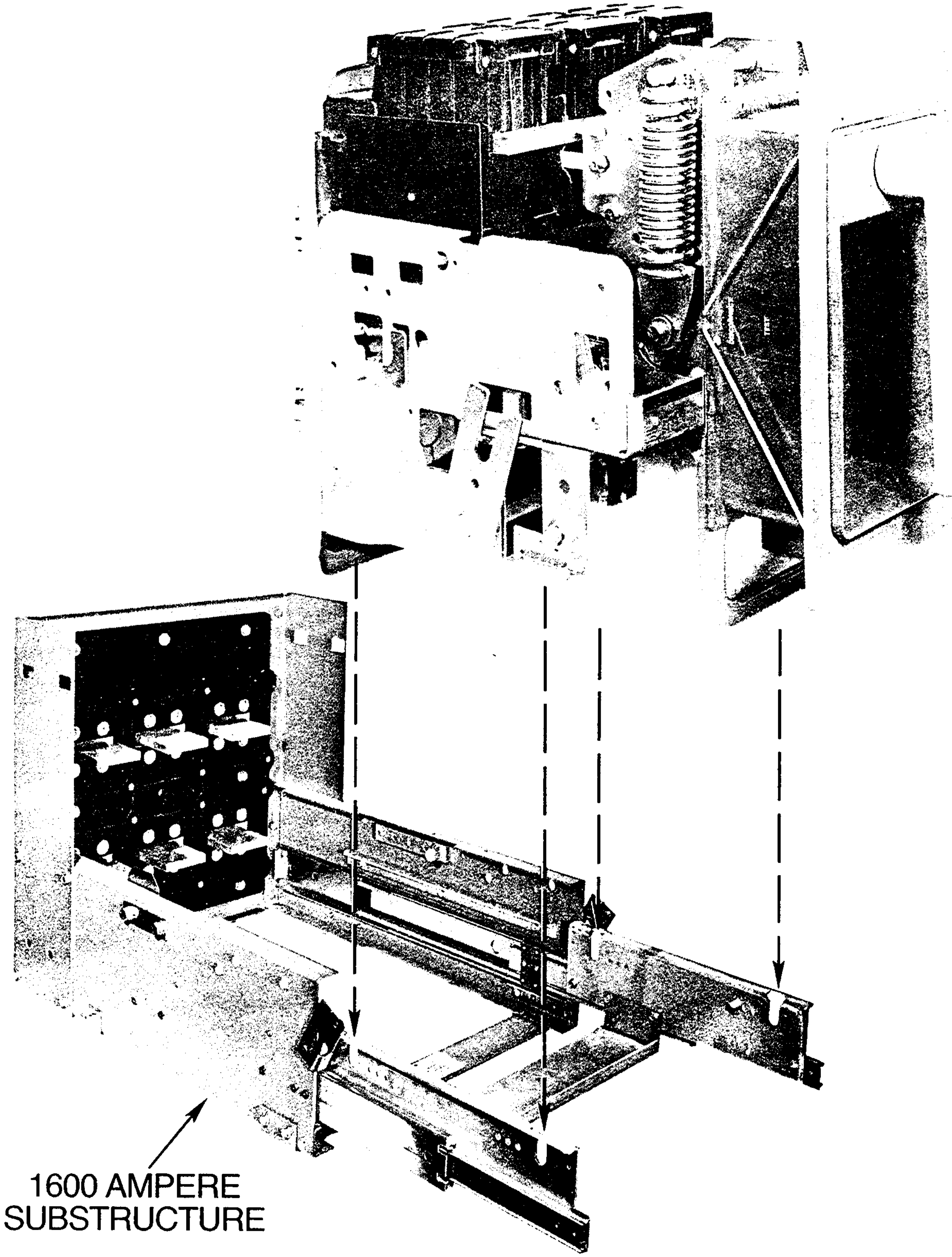


Figure 4. AKR-50 breaker, B-type drawout substructure mounting, manually operated

Breaker Insertion (Code B)

1. Prior to lifting a breaker to its intended compartment location, observe the following precautions:

   a. *Check the compartment to insure that it is free of foreign objects.*

   b. *Verify that the breaker is the correct type for that compartment.*

   c. *Insure that the breaker is OPEN.*

   d. *Apply a thin, fresh coat of D50HD38 lubricant to the breaker's primary disconnects.*

   e. *Insure that the racking cams on the breaker are correctly positioned for initial engagement with the pins in the compartment. To do this, insert the racking handle and rotate it fully counterclockwise.*

2. Using a suitable lifting mechanism and spreader rig, raise the breaker above the elevation of the tracks. (Use the forward slots for non-fused breakers, the rear slots for fused models.)

3. Rotate the two track lock links and pull the tracks out to the limit of their travel.

4. Slowly lower and guide the breaker so that the breaker mounting pins drop into the slots in the tracks. Remove the lifting device.

5. Push the breaker into the compartment until it reaches the track stops. This is the DISCONNECT position. At this point the racking arms are positioned to engage the fixed racking pins in the compartment, ready to begin the racking motion.

6. Close the compartment door. Insert the racking handle into the racking screw opening in the breaker escutcheon. By clockwise rotation of the handle, move the breaker through the TEST position into the CONNECTED position; the latter is indicated when the jackscrew comes to a solid stop.

Breaker Removal (Code B)

1. With the door closed and latch, trip the breaker.

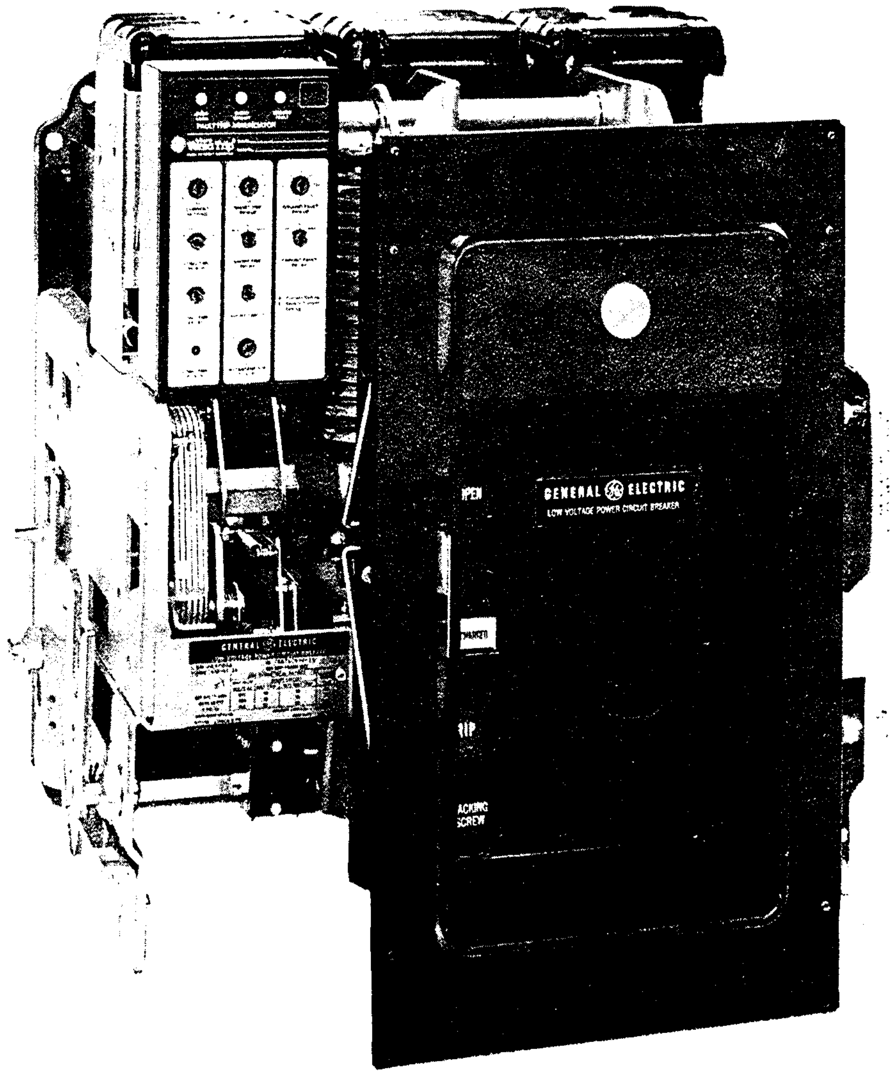
2. Insert the racking handle and rotate it counterclockwise until the breaker travels from CONNECTED through TEST to the DISCONNECTED position, as indicated by the jackscrew coming to a solid stop. This operation should be performed with the door closed. If the breaker closing spring is fully charged, it will be automatically discharged a few turns before the end of the racking action.

3. Open the compartment door. Rotate the two track lock links and pull the breaker out to the track travel limit—this is the WITHDRAWN position.

4. Before proceeding with subsequent operations to remove the breaker from the compartment, visually check the breaker's spring charge and close indicators to verify that breaker is open and the springs are discharged.

5. Attach the lifting device and hoist the breaker until its mounting pins clear the track slots.

6. Swing the breaker forward until the primary disconnects clear the compartment; lower the breaker onto a flat surface free of protrusions that could damage the breaker's internal parts.



AKR-6D-50

Fig. 5

CODE D (AKD-8 SWITCHGEAR) (Fig. 5)

This type drawout breaker is supported by two protruding pins on each side of its frame; these engage slots in telescoping slide rails (tracks) mounted to each sidewall of the switchgear. Unlike AKD-6 Switchgear the door on AKD-8 switchgear remains stationary and closed while the breaker is racked out from the connected, thru test to disconnected position.

All AKR D-type breakers for use in AKD-8 are equipped with a deep escutcheon instead of the standard escutcheon employed on the A-type models.

The in and out movement of the breaker between CONNECTED-TEST-DISCONNECTED positions is identical to "A" type AKD-6 models with the exception of breaker positioning indication. AKR-"D" type breaker position is registered directly by markings on the left and right side of the escutcheon, these becoming visible as it emerges through the door cutout.

The drawout operation features four discrete positions:

CONNECTED—This is the breaker's "In-Service" position. It is fully inserted in its compartment; the primary and secondary disconnect contacts are fully engaged. The breaker must be tripped before it can be racked into or out of this position.

TEST—In this position the primary contacts are disconnected but secondary contacts remain engaged. This allows complete breaker operation without energizing the primary circuit.

DISCONNECTED—Both primary and secondary contacts are disengaged.

WITHDRAWN—With the compartment door open, the breaker can be manually pulled out to the WITHDRAWN position. At this point the tracks are fully extended and the breaker is completely out of its compartment, ready for removal. Note that the racking mechanism is not employed for movement of the breaker between the DISCONNECTED and WITHDRAWN positions.

Breaker Insertion (Code D)

1. Prior to lifting a breaker to its intended compartment location, observe the following precautions:
   - a. *Check the compartment to insure that it is free of foreign objects.*
   - b. *Verify that the breaker is the correct type for that compartment.*
   - c. *Insure that the breaker is OPEN.*
   - d. *Apply a thin, fresh coat of D50HD38 lubricant to the breaker's primary disconnects.*
   - e. *Insure that the racking cams on the breaker are correctly positioned for initial engagement with the pins in the compartment. To do this, insert the racking handle and rotate it fully counterclockwise.*
2. Using a suitable lifting mechanism and spreader rig, raise the breaker above the elevation of the tracks. (Use the forward slots for non-fused breakers, the rear slots for fused models.)
3. Slowly lower and guide the breaker so that the breaker mounting pins drop into the slots in the tracks. Remove the lifting device.
4. Push the breaker into the compartment until it reaches the track stops. This is the DISCONNECT position. At this point the racking arms are positioned to engage the fixed racking pins in the compartment, ready to begin the racking motion.
5. Close the compartment door. Insert the racking handle into the racking screw opening in the breaker escutcheon. By clockwise rotation of the handle, move the breaker through the TEST position into the CONNECTED position; the latter is indicated when the jackscrew comes to a solid stop.

Breaker Removal (Code D)

1. With the door closed and latch, trip the breaker.
2. Insert the racking handle and rotate it counterclockwise until the breaker travels from CONNECTED through TEST to the DISCONNECTED position, as indicated by the jackscrew coming to a solid stop. This operation should be performed with the door closed. If the breaker closing spring is fully charged, it will be automatically discharged a few turns before the end of the racking action.
3. Open the compartment door. Pull the breaker out to the track travel limit—this is the WITHDRAWN position.
4. Before proceeding with subsequent operations to remove the breaker from the compartment, visually check the breaker's spring charge and close indicators to verify that breaker is open and the springs are discharged.
5. Attach the lifting device and hoist the breaker until its mounting pins clear the track slots.
6. Swing the breaker forward until the primary disconnects clear the compartment; lower the breaker onto a flat surface free of protrusions that could damage the breaker's internal parts.

CONNECTIONS

In all electrical connections good joint conductivity is a must. When making power connections to stationary breakers, the mating joint surfaces must be clean and have a smooth finish. They should be parallel and firmly bolted or clamped together. In addition, the bus or cable conductors must have ample ampacity to prevent overheating.

Control Connections

The outgoing connections to a breaker's accessories and control devices must be in accordance with the specific wiring diagram applicable to that breaker.

Control connections to stationary breakers are made to a terminal board mounted on the breaker. Figure 6 shows typical closing and tripping connections. If equipped with an overcurrent trip device which includes a ground fault element for use on 4-wire circuits, an additional terminal board is provided on the breaker for connecting to the equipment-mounted neutral sensor (physically located in the neutral conductor).

On drawout breakers the control circuits terminate in the breaker compartment on the stationary portion of separable secondary disconnects — see fig. 7.

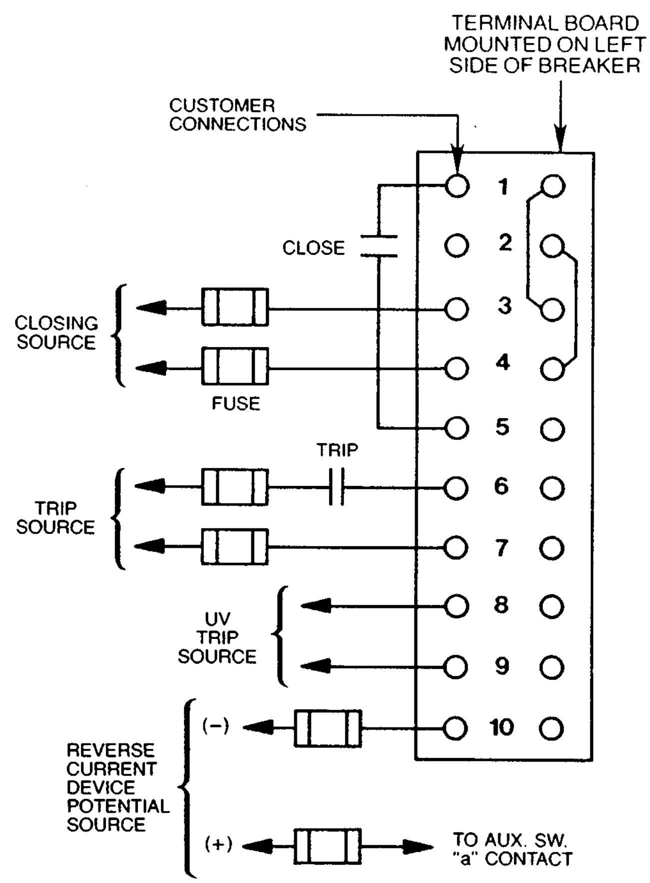


Fig. 6 Control connections to stationary breakers—front view.

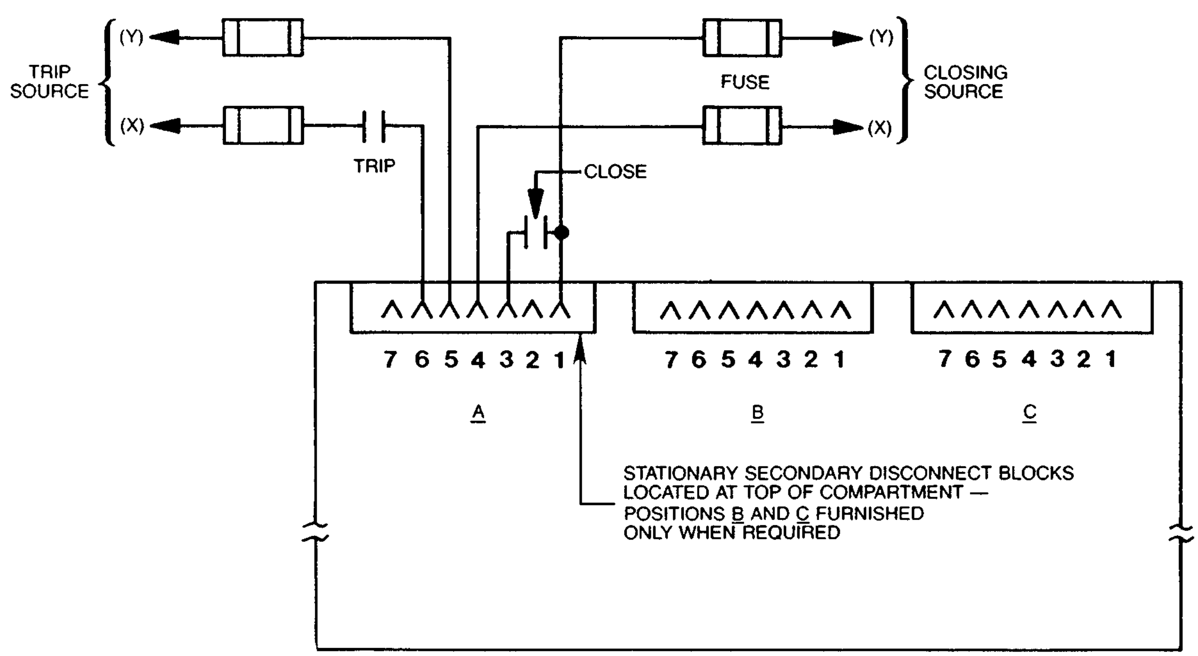


Fig. 7 Control connections to drawout breakers—front view of breaker compartment.

OPERATION

GENERAL

A breaker may be equipped to operate either manually or electrically. Both types of operation result in the same fast-closing movement as far as the contact action is concerned. The variation is in the way energy is stored in the closing spring, and how it is released.

MANUAL CLOSING

Manually operated AKR breakers are constructed with front-mounted handles. Handle operation resets the mechanism and fully charges the closing spring. A complete charge is accomplished in either cranking the handle through one cycle (135-degree swing) or three cycles (50-degree swing). The CLOSE button, mounted on the escutcheon, is used to close the breaker contacts and the TRIP button to open them.

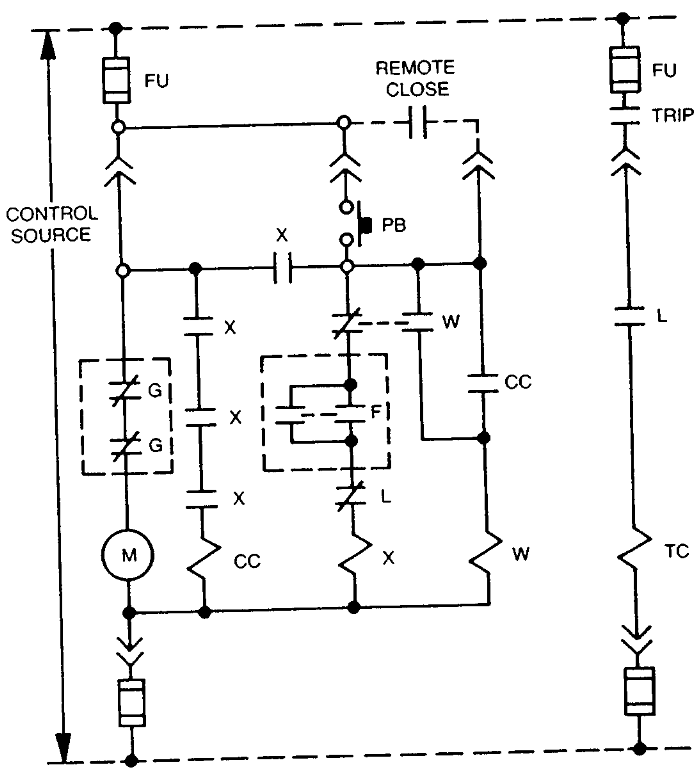
If equipped with a closing solenoid, a manual breaker may be closed remotely by a control switch or relay. Before this can be done, however, the closing spring has to be charged by hand. The closing solenoid is an optional accessory and is not supplied unless specified in the breaker order.

ELECTRICAL CLOSING

On electrically operated breakers the closing springs are charged by a gear motor. With the springs discharged, voltage applied to the control circuit will energize the motor through the "G" switch contacts — see fig. 8. The motor, through the gear reduction output crank, compresses the closing springs until they are fully charged. As this fully charged position is reached, mechanically operated switches "F" and "G" reverse their shown position, the "G" switch deenergizing the motor and the "F" switch establishing a circuit to the "X" relay. At the same time, a mechanical prop is positioned to prevent the discharge of the fully charged closing spring.

With the closing spring propped fully-charged, the breaker is ready for closing. This may be accomplished electrically by depressing the closing switch on the breaker (if so equipped) or by a remote closing switch. Operation of the closing switch energizes the "X" relay, which in turn energizes the closing solenoid. This removes the prop, releasing the closing springs to close the breaker.

As the closing relay is energized, it energizes anti-pump relay "W". If the closing switch is maintained closed, the anti-pump relay will remain picked-up to prevent a second closing operation on the breaker in the event it is tripped open automatically. The closing impulse must be released and reapplied before a second closing operation can occur.



LEGEND

- CC — CLOSING SOLENOID
- F — CUTOFF SWITCH, CLOSED WHEN CLOSING SPRING IS FULLY CHARGED.
- G — CUTOFF SWITCH. OPEN WHEN CLOSING SPRING IS FULLY CHARGED
- L — AUXILIARY SWITCH
- M — CHARGING MOTOR
- PB — CLOSE PUSHBUTTON ON BREAKER ESCUTHEON, OPTIONAL.
- TC — SHUNT TRIP DEVICE
- W — ANTI-PUMP RELAY
- X — CONTROL RELAY

Fig. 8 Elementary diagram for electrically operated drawout breaker. Contact positions are shown with breaker open and closing springs discharged.

TRIPPING

In the closed position, the breaker's movable contacts are held in by a toggle linkage. The breaker is tripped open by displacing a mechanism latch which allows this toggle linkage to collapse. The trip latch is rigidly fastened to a horizontal trip shaft running from left to right through the breaker. In turn, the trip shaft carries paddles actuated by the manual trip button and the various other trip devices — overcurrent, reverse current, shunt trip, undervoltage, open fuse lockout. Viewing the breaker from the right, rotating the trip shaft counterclockwise trips the breaker; clockwise movement resets the mechanism latch.

In addition to tripping the breaker, some devices hold the breaker trip free, i.e., prevent the contacts from closing even though a closing impulse is applied to the mechanism. Such devices are the undervoltage, bell alarm and lockout, electric lockout, open fuse lockout, and the key operated locks. These devices and the drawout mechanism interlocks must be in the reset position before the breaker can be closed.

FUSED BREAKERS

The AKRU-30/50 type breakers employ current limiting fused mounted integrally with the breaker (see Fig. 9). Included is an open fuse lockout device (OFLO) to prevent single-phasing in the event only one fuse blows.

The OFLO is a special trip device having three (3) shunt trip elements (one per phase), the coil of each being connected across its corresponding fuse. The arc voltage generated by a blown fuse activates its OFLO shunt trip coil, thereby tripping the breaker and preventing single phase power from being supplied to the load. An indicator on the OFLO device signals which fuse is blown. The breaker cannot be closed until the blown fuse is acknowledged by resetting the OFLO. The fuse, of course, must be replaced.

MAINTENANCE

INSPECTION

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

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 deenergized:

1. Manually operate the breaker several times, checking for obstructions or excessive friction. Manual closing of an electrically operated breaker may be performed by the following two steps:

(1) Install maintenance crank (568B386G1) to the motor gear reducer shaft on the front right side of the breaker. Ratchet the maintenance crank up and down until the springs are fully charged as indicated by the distinct click as the prop is set and prevents any further charging of the closing springs. After the prop is set do not apply undue force to the maintenance handle.

(2) Manually pull the armature of the closing solenoid (located behind the lower right-hand corner of the escutcheon) toward the front of the breaker. This dislodges the prop and allows the closing springs to discharge, closing the breaker.

2. Electrically operate the breaker several times to check performance of the electrical accessories.

3. Visually check the breaker for loose hardware on the breaker and the bottom of the compartment for any hardware that has fallen from the breaker.

4. Remove the arc quenchers and inspect the arc quenchers and contacts for breakage or excessive burning.

5. The performance of the solid-state current trip devices may be checked with a suitable test set. Check electromechanical devices for positive trip in accordance with the instructions in their Maintenance Manual. (GEK-64459)

6. Check insulating parts for evidence of overheating and for cracks that indicate excessive thermal aging.

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 D50HD38 (Mobil 28). 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 ACCUMULATION OF DIRT OR DUST.

On drawout breakers the contact surface of the disconnect studs should be cleaned and greased with GE Lubricant D50HD38. (Order part number 193A1751P1)

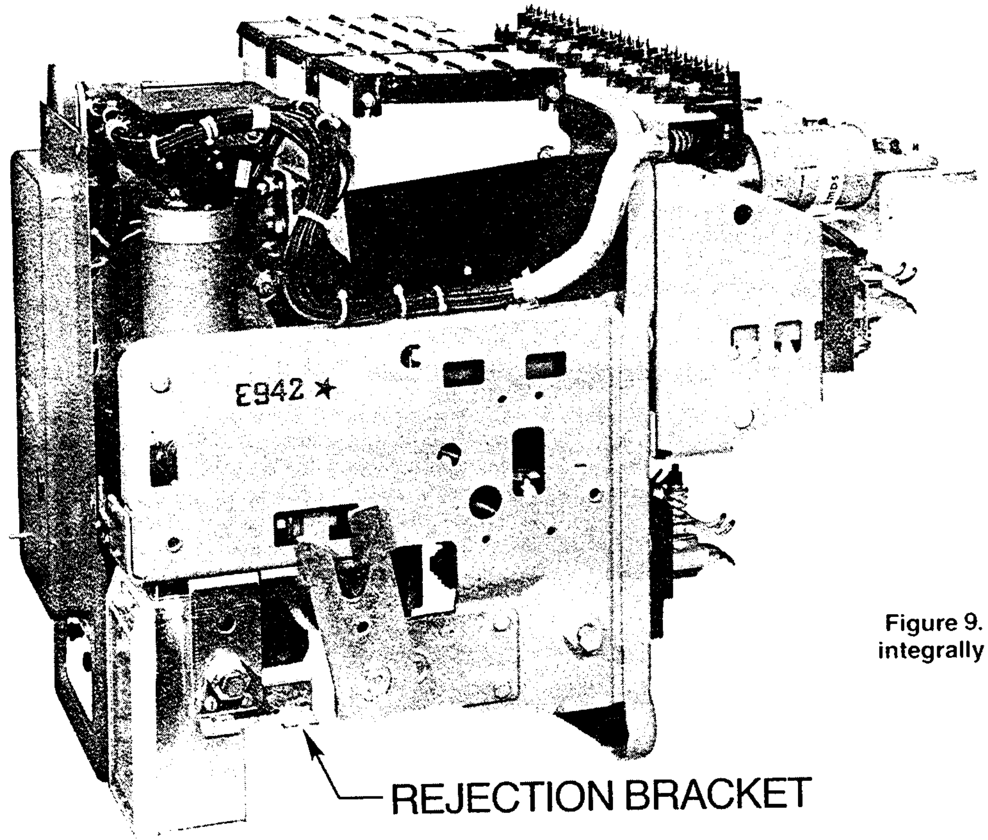


Figure 9. AKRU-5A-30 integrally fused breaker

INTERCHANGEABILITY OF DRAWOUT BREAKERS

In general, drawout breakers of the same type and rating are interchangeable in their equipment compartments: drawout breakers of different frame sizes or short circuit ratings are intentionally made non-interchangeable. To prevent inserting the wrong type breaker into a drawout compartment, unique "rejection hardware" is affixed to each breaker and its compartment. Figure 9 shows a typical breaker-mounted rejection bracket which aligns with a rejection pin in the drawout rail (Fig. 10). When the wrong type breaker is inserted into a compartment, the bracket and pin do not mate, preventing the breaker from seating itself into the rail slots.

There is one exception to the above. Breakers of the same frame size having different short circuit ratings may be interchanged in one direction only. Specifically,

a. *An AKR-30H can be inserted into an AKR-30 compartment.*

b. *An AKR-50H can be inserted into an AKR-50 compartment.*

The rejection hardware prevents the converse of a. and b.

Figures 15, 16 and 17 display the rejection pin/bracket combinations employed for the various breaker models and frame sizes. As dictated by its intended breaker type, each drawout compartment has its rejection pin(s) installed in positions A, B or C (Fig. 10 and 14) along the drawout rails. The AKRU-30 and -50 fused breakers employ a single bracket, while all non-fused breakers carry two brackets.

Note that the rejection hardware is identical for both A and B-type breakers: however, because their escutcheons are different, the breakers are not interchangeable. D type breaker rejection hardware is different than A or B type (Fig. 12 and 13)

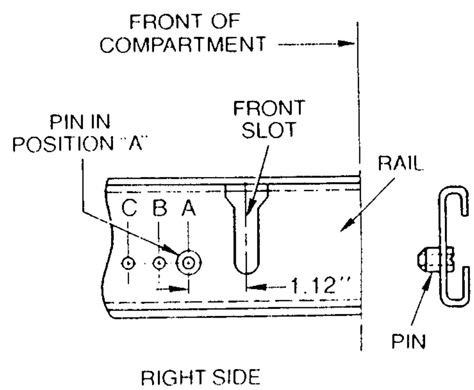


Fig. 10 Slide rail rejection pin locations (A-type rail shown)

Drawout breakers of the D type are interchangeable within AKD-8 switchgear only. Drawout breakers of different frame size, short circuit ratings, horizontal or vertical lower studs are intentionally made non-interchangeable. To prevent inserting the wrong type breaker into a drawout compartment, unique "rejection hardware" is affixed to each breaker and its compartment Fig 11 shows a typical breaker-mounted rejection bracket which aligns with a rejection pin in the drawout rail. When the wrong type breaker is inserted into compartment, the bracket and pin do not mate, prevented the breaker from seating itself into the rail slot.

Breakers of the same frame size having different short circuit rating may be interchanged in one direction only. Fig 17 will show the interchangeable.

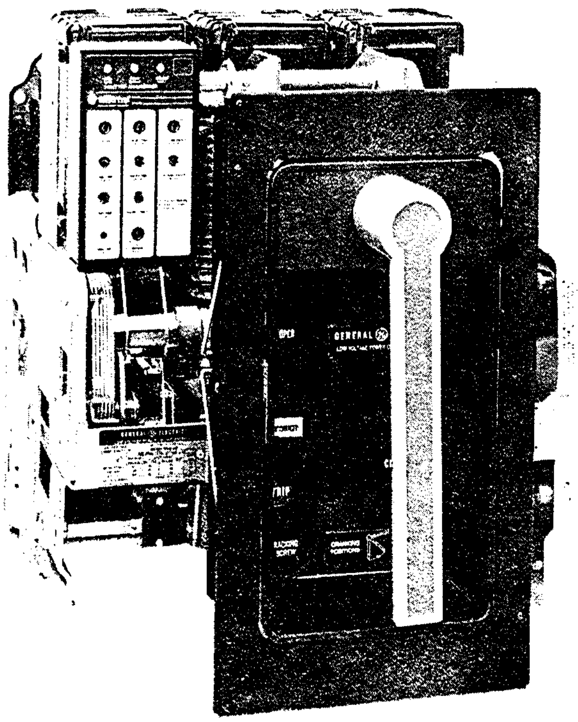


Fig. 11 AKR-6D-30

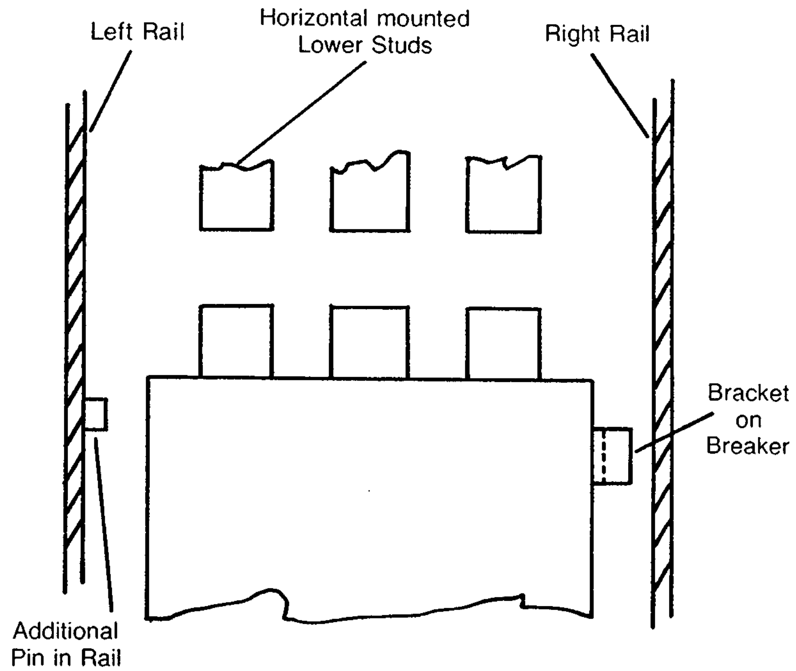


Fig. 12

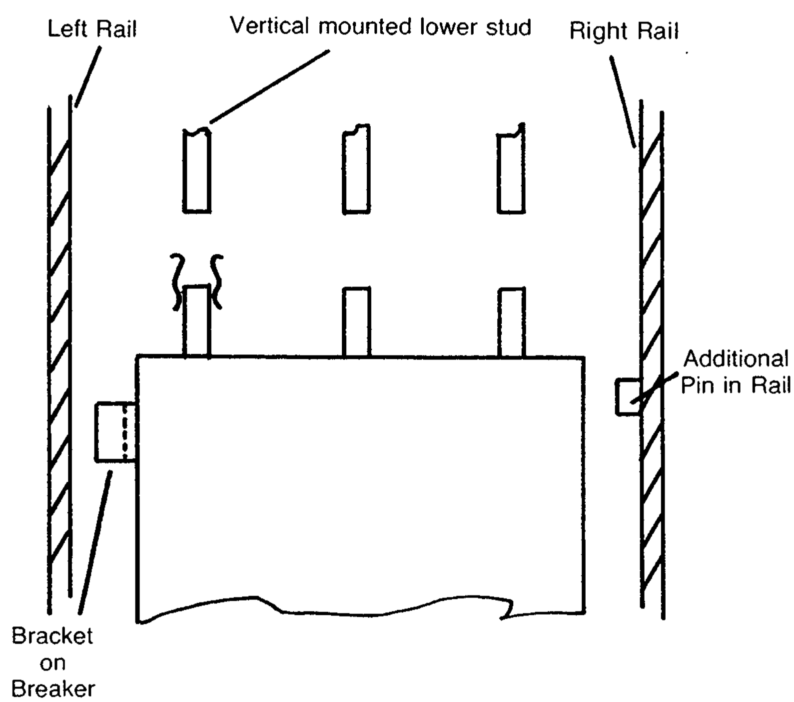


Fig. 13

"E-TYPE" REJECTION

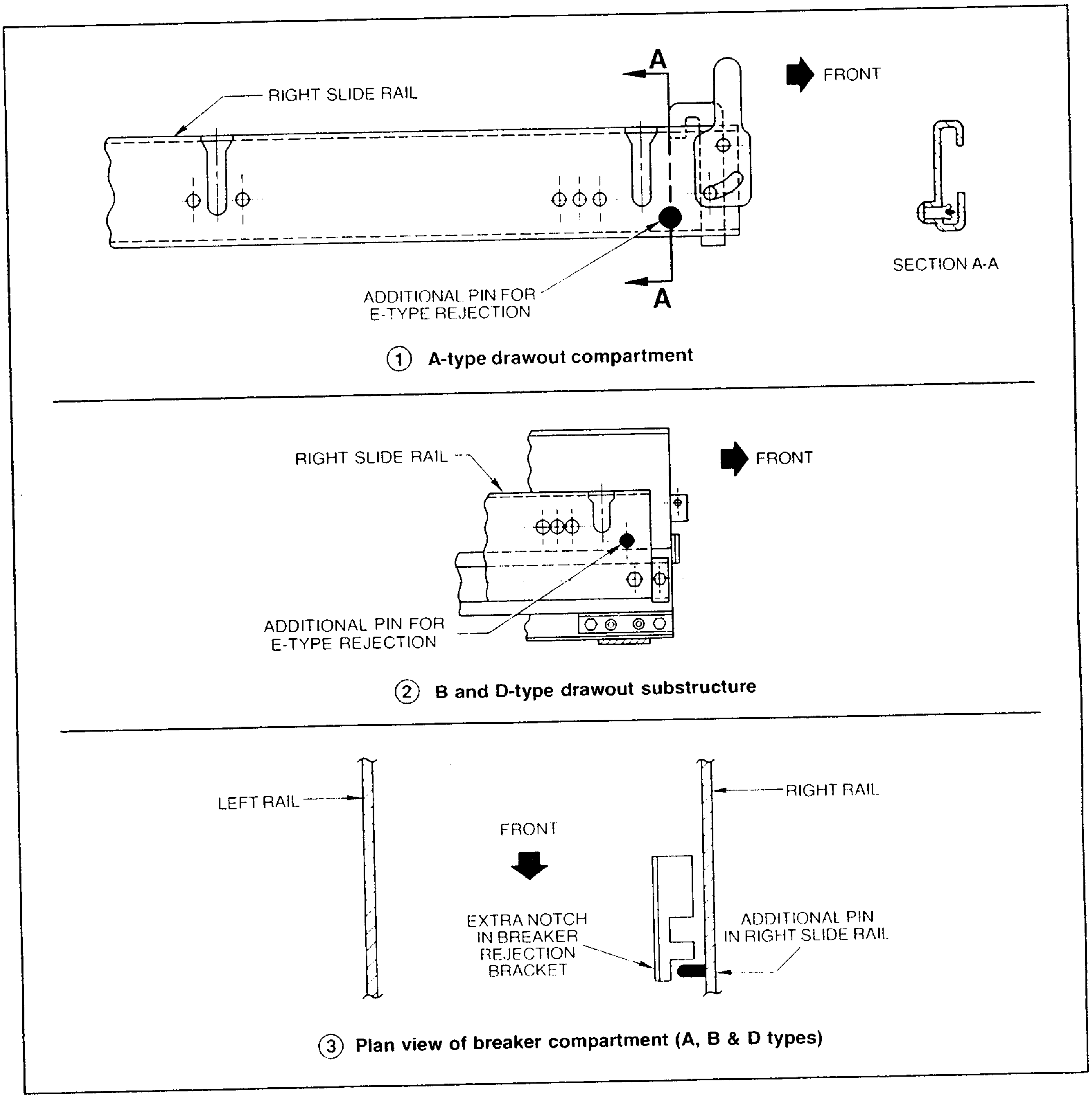
Some installations require that breakers serving essential circuits be segregated from identical models deployed elsewhere in the power system. The segregation is physical and is accomplished by supplemental rejection hardware added to the breaker and its drawout compartment.

In this publication these special category breakers are designed as "E-type". They are interchangeable as follows:

- E-type compartments reject standard breakers.
- Standard compartments accept E-type breakers.

E-type rejection is an optional feature available on both A and B-type breakers. It is achieved by installing an extra pin in the right-hand slide rail which engages an additional notch in the breaker's rejection bracket—see Fig. 14.

All E-type breakers have the suffix letter E added to the middle digits of their designation as in the following example: AKR-4BE-30.

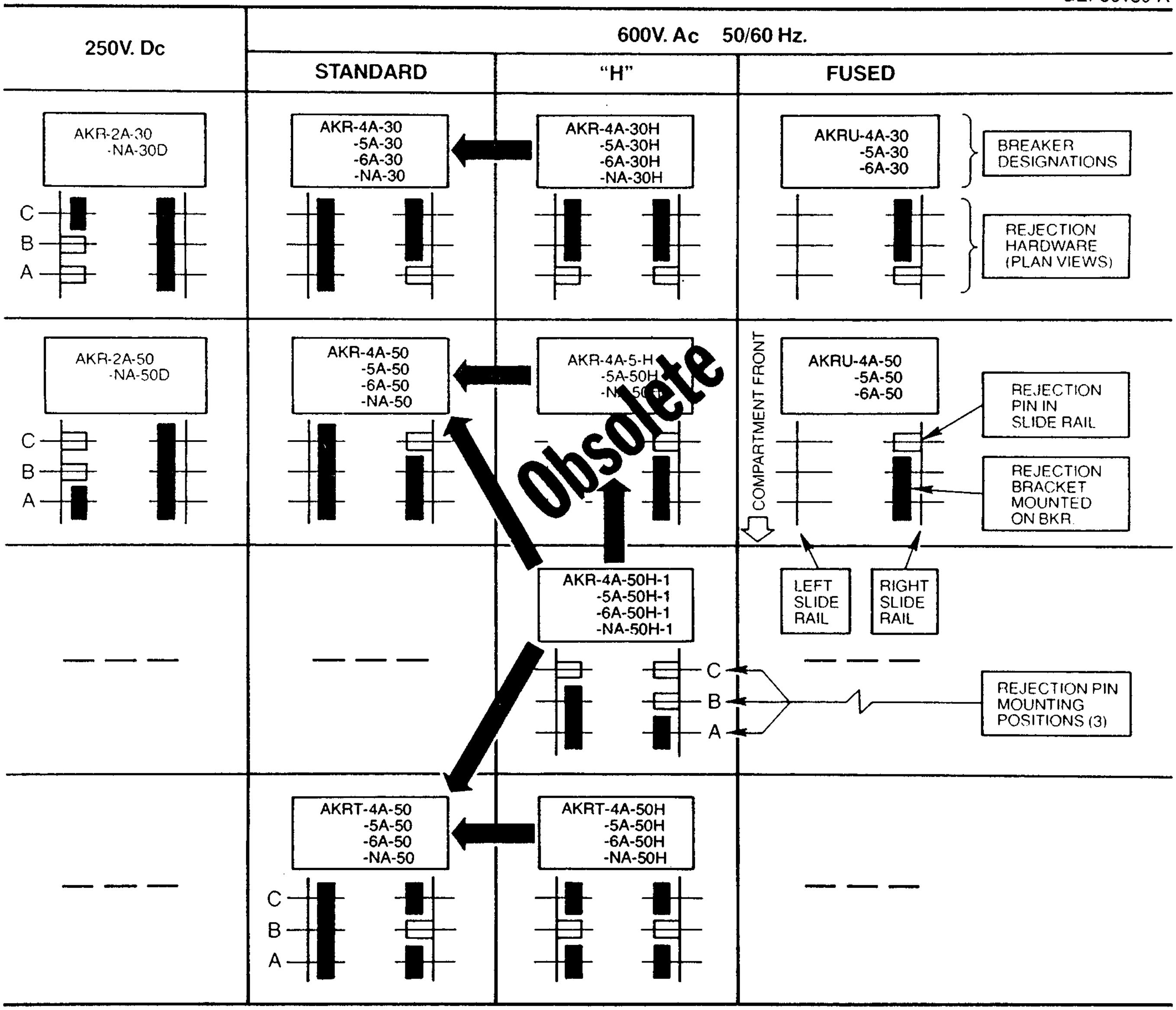


(1) **A-type drawout compartment**

(2) **B and D-type drawout substructure**

(3) **Plan view of breaker compartment (A, B & D types)**

Figure 14. "E-type" rejection feature for drawout breakers (optional)

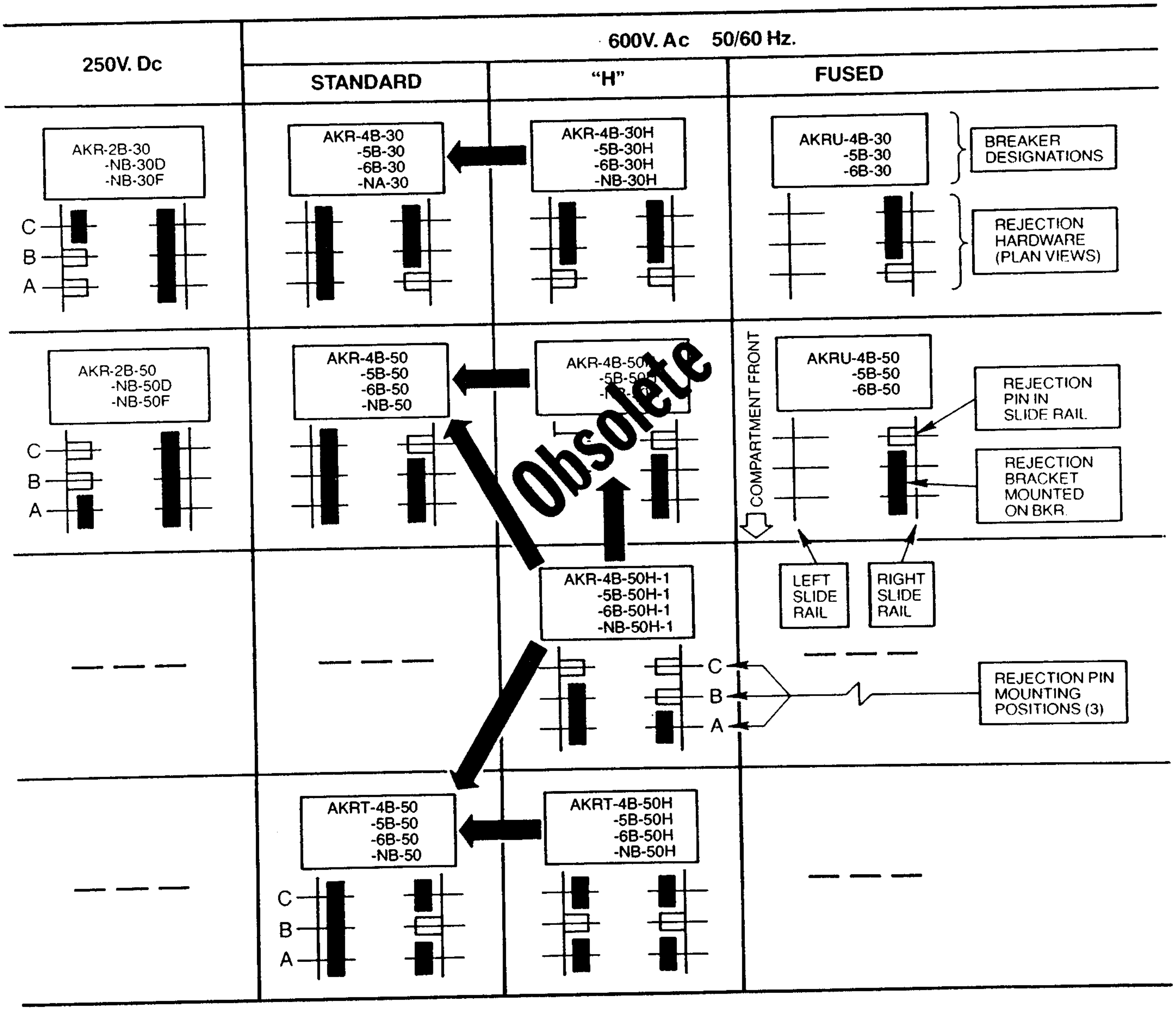


NOTES: (1) All breaker models listed within a given block are interchangeable.

(2) Except where joined by arrows, units in one block are not interchangeable with units in any other block.

(3) ⬅ Denotes one-way interchangeability in direction indicated.

FIG. 15 –Interchangeability and rejection hardware chart for A-type drawout breakers used in AKD-6 switchgear.



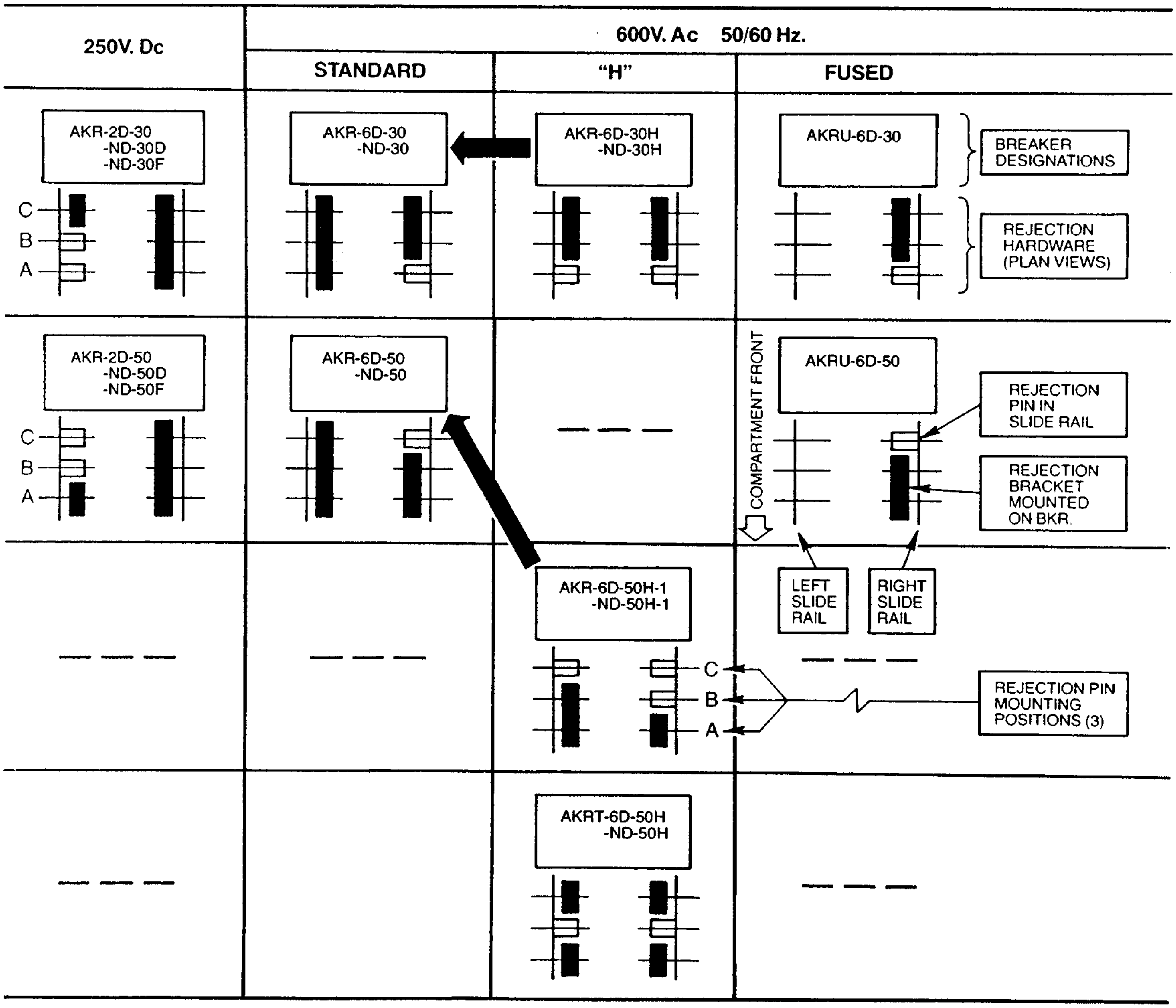
NOTES: (1) All breaker models listed within a given block are interchangeable.

(2) Except where joined by arrows, units in one block are not interchangeable with units in any other block.

(3) ⬅ Denotes one-way interchangeability in direction indicated.

(4) These pin and bracket combinations are identical to those employed on the A-type breakers of fig. 15.

FIG. 16—Interchangeability and rejection hardware chart for B-type drawout breakers used in substructures.



NOTES: (1) All breaker models listed within a given block are interchangeable.

(2) Except where joined by arrows, units in one block are not interchangeable with units in any other block.

(3) ⬅ Denotes one-way interchangeability in direction indicated, providing lower studs are the same.

(4) These pin and bracket combinations are identical to those employed on the A-type breakers of fig. 15.

FIG. 17—Interchangeability and rejection hardware chart for D-type drawout breakers used in AKD-8 switchgear.

TABLE 3. CURRENT RATINGS FOR AUXILIARY DEVICES

Voltage		Interrupting Rating (Amperes)			
		Auxiliary Switch		Bell Alarm Switch	EC-1 Switchette
Nominal	Range	Resistance Load	Electro-Magnet Load	Resistance or Electro-Magnet Load	
48 dc	38-56	25	15	—	—
125 dc	100-140	11	6.25	2.5	0.3
250 dc	200-280	2	1.75	0.9	0.15
600 dc	508-672	0.45	0.35	0.3	—
		75-85% Lagging PF	30-35% Lagging PF	75-85% or 30-35% Lagging PF	
120 ac	104-127	75	50	30	—
240 ac	208-254	50	25	15	10
480 ac	416-508	25	12	7	10
600 ac	520-635	12	8	5	—

Current Ratings	Amperes		
	Auxiliary Switch	Bell Alarm Switch	EC-1 Switchette
Continuous	20*	10*	10*
Closing (30-35% PF or Resistive)	50	30	**

*On drawout breakers, limited to 5 amperes continuous, based on rating of #16 control wire.

**Adequate for breaker shunt trip coils with voltage ratings same as tabulated above (12.3A max. for the 120V. ac coil).

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

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Plainville, CT 06062

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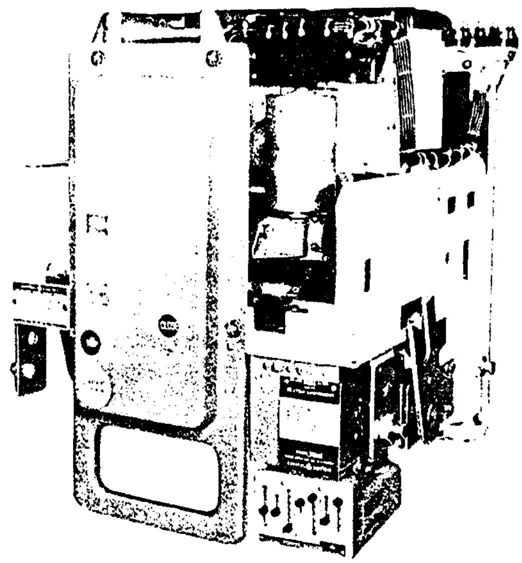
GENERAL ELECTRIC

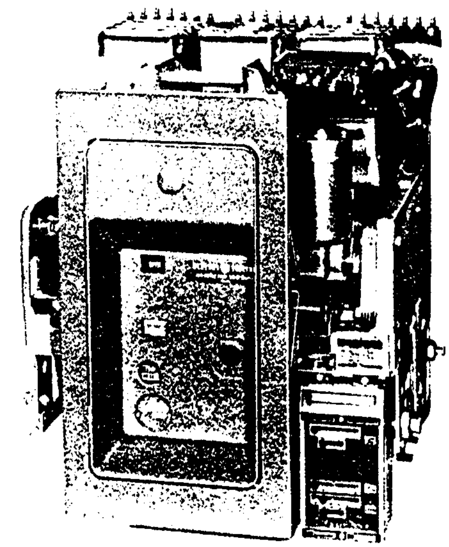
GEK-64459B

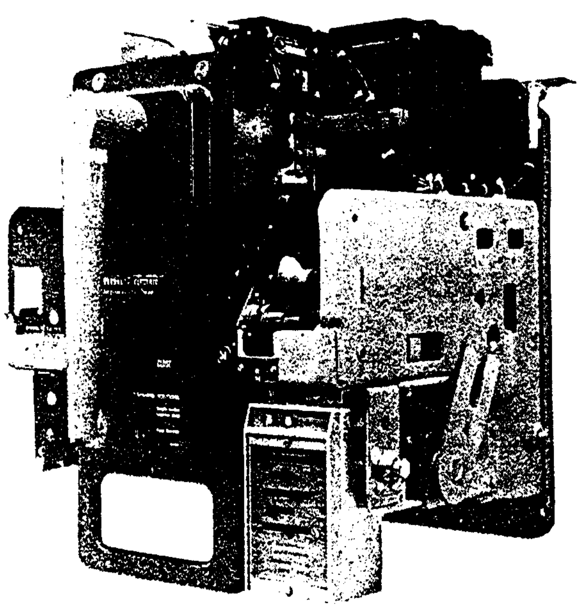
Maintenance Manual

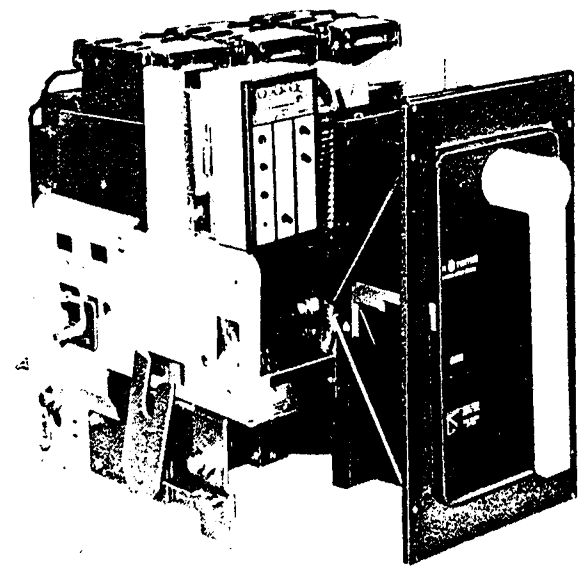
Low-Voltage Power Circuit Breakers

Types AKR-30/50 and AKRT-50









GENERAL ELECTRIC

Table of Contents

SECTION 1—Introduction

These instructions provide the maintenance procedures and describe the operation of the 800 thru 2000 amp frame size type AKR low voltage power circuit breakers listed in Table 1.

The proper use, care, and maintenance of these breakers is a prime safety consideration for the protection of personnel, as well as a means of minimizing equipment damage when faults occur. Persons who apply, use, and service these breakers will acquire the knowledge they need by gaining the information contained in these instructions.

1.1 INSPECTION AND MAINTENANCE

Breakers should be cared for under a systematic maintenance program. Taking each breaker out of service periodically for inspection and maintenance is an excellent means of establishing high service reliability. It is good policy to have one or more spare breakers to install in place of breakers requiring maintenance. Keeping a stock of recommended renewal parts will insure that maintenance work can be done quickly.

How frequently an individual breaker should be inspected will depend on the circumstances of its use. It would be well to inspect any breaker at least once a year. If it is frequently operated, operated under severe load conditions, or installed in an area of high humidity or a dusty, dirty atmosphere, inspections should be more often. Inspections might be monthly under adverse conditions.

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

SAFETY PRECAUTION

BEFORE INSPECTING OR BEGINNING ANY MAINTENANCE WORK ON THE BREAKER, IT MUST BE DISCONNECTED FROM ALL VOLTAGE SOURCES, BOTH POWER AND CONTROL, AND BE IN THE "OPEN" POSITION.

A basic inspection should consist of the following:

a. Visual Check — Look for dirt, grease or other foreign material on any breaker parts. Check insulating surfaces for conditions that could degrade insulating properties (cracks, overheating, etc.). Also check for loose hardware and components on the breaker and the compartment's bottom, loose or damaged control wiring and similar problem areas.

b. Operation — Observe a few close-open operations using the operating or maintenance handle. If a breaker is seldom operated such that it remains open or closed for a period of six months or more, it is recommended that arrangements be made to open and close it several times in succession.

c. Interlocks — During the Operational check verify the safety interlocks are properly working.

d. Arc Chutes and Contacts — Inspect the condition of the arc chutes and contacts. Look for excessive burning or breakage. Check the amount of contact depression or wipe.

e. Accessories — Verify that the various accessories are working properly.

f. The performance of the solid-state current trip devices may be checked with a suitable test set. Check electromechanical devices for positive trip in accordance with the instructions in their Maintenance Manual, GEI 86157.

1.2 RENEWAL PARTS

The AKR breakers contain a variety of parts and assemblies. Many of these are available as replacement parts when the need arises. See publication GEF 4527, Renewal Parts, for a complete listing of these parts.

TABLE 1 BREAKER MODELS

FRAME SIZE (AMPERES)	BREAKER DESIGNATION	MOUNTING TYPE: DRAWOUT: AKD-5	MOUNTING TYPE: DRAWOUT: AKD-8	MOUNTING TYPE: DRAWOUT: SUB-STRUCTURE	MOUNTING TYPE: STATIONARY	DEEP ESCUTCHEON	FUSED BREAKER
800 AC	AKR-(*)A 30, 30H	X					
	AKR-(*)B 30, 30H			X		X	
	AKR-(*)D 30, 30H		X	X		X	
	AKR-(*)S 30, 30H				X		
1600 AC	AKR-(*)A 50, 50H	X					
	AKR-(*)B 50, 50H			X		X	
	AKR-(*)D 50, 50H		X	X		X	
	AKR-(*)S 50, 50H				X		
2000 AC	AKRT-(*)A 50, 50H	X					
	AKRT-(*)B 50, 50H			X		X	
	AKRT-(*)D 50, 50H		X	X		X	
	AKRT-(*)S 50, 50H				X		
800 DC	AKR-2A 30	X					
	AKR-2B 30			X		X	
	AKR-2D 30		X	X		X	
	AKR-2S 30				X		
2000 DC	AKR-2A-50	X					
	AKR-2B-50			X		X	
	AKR-2D-50		X	X		X	
	AKR-2S-50				X		
800	AKRU-(*)A 30	X					X
	AKRU-(*)B 30			X		X	X
	AKRU-(*)D 30		X	X		X	X
1600	AKRU-(*)A 50	X					X
	AKRU-(*)B 50			X		X	X
	AKRU-(*)D 50		X			X	X

(*) - This digit identifies the trip device type as follows:

2 - EC (DC only)
4 - ECS } 50/60 Hertz Only
5 - SST } 50/60 Hertz Only
6 - MicroVersa Trip } 50/60 Hertz Only
N - Non-automatic. In addition, all non-automatic 250VDC breaker types carry the suffix letter D after the frame number, e.g. AKR-NB-50D

SECTION 2—General Description

Type AKR low-voltage power circuit breakers are used for controlling and protecting power circuits in the low-voltage range (usually up to 600 volts). In serving this function, they are a means of safely switching loads and automatically clearing circuits when abnormal conditions occur. Among these conditions, the more common are short circuits and sustained overloads and under voltages.

The type AKR breakers are of the "quick-make, quick-break description, having the feature of storing energy in a closing spring for quick release in closing. In closing, some energy is transferred to an opening spring to be used subsequently for fast tripping.

Knowledge of how the breaker is designed and how it operates will enable the owner to make proper use of the breaker and to avoid mistakes in its operation. Specific directions on adjustments and maintenance procedures will be treated later.

The three main functional components of a breaker are its mechanism, an assembly comprising the conductive members, and the interrupter.

The mechanism unit is designed to receive energy, store it, and later (when called upon to do so) deliver it to close the breaker's contacts. It must be able to reverse its commitment to close the breaker at any point upon the activation of an automatic trip device (i.e., be "Trip-Free"). Finally, it also must be able to trip open a closed breaker quickly enough to minimize arc erosion and in such a manner as to effect proper arc transfer to the arc runner.

The current-carrying members of the breaker are assembled on the back frame, which provides the mechanical support required and also the insulating structure needed. The conductive members are the studs for external connections, movable and stationary contact sets, pivots for the movable contacts, and provision for mounting the current transformers.

The interrupter components are, in addition to the arcing contacts, the arc runners mounted on the back base and the removable arc quencher assemblies.

In addition to these basic components, a breaker may be equipped with any combination of many accessories and interlocking devices. Breakers may also differ in a variety of areas as shown in Table 1. A brief description of these areas is given below.

2.1 FRAME SIZE

The breakers are available in 5 frame sizes — 800 amperes A.C. (AKR 30/30H, AKRU 30), 1600 amperes A.C. (AKR 50/50H, AKRU 50), 2000 amperes AC (AKRT 50/50H), 800 amperes D.C. (AKR 30) and 2000 amperes D.C. (AKR 50).

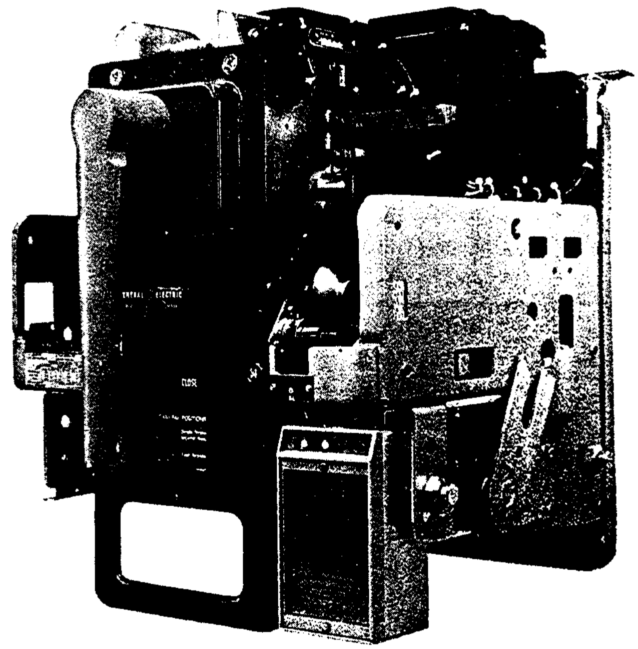


FIG. 1 — Manually Operated AKR-4A-50-1

These values represent the maximum continuous current capability of the respective frames. However, each breaker carries a specific rating which is determined by the current sensor ampere rating or top setting of the trip device with which it is equipped.

2.2 OPERATION

There are Manual and Electrical breaker models. The Manual breaker, shown in Fig. 1, has an operating handle which is used to manually charge the mechanism closing spring.

The Electric breaker, shown in Fig. 2, contains an electric motor which charges the mechanism closing spring. External control power is required to energize this motor and its control circuit. A nameplate indicates what voltage is required by the motor circuit.

2.3 FUSED/NON FUSED

Fused breakers are identified as either AKRU 30 (800 ampere frame size) or AKRU 50 (1600 ampere frame size). A fused breaker is shown in Fig. 3. They are not interchangeable with Non-Fused breakers, since they require deeper compartments for their fuses.

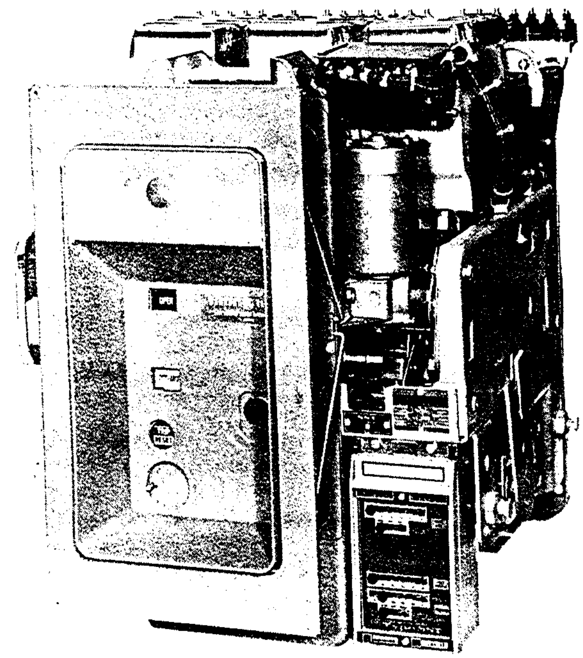


FIG. 2 — Electrically Operated AKR-5B-30

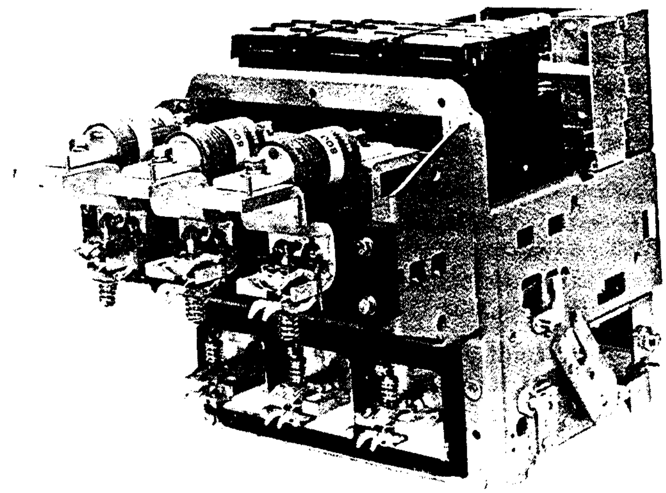


FIG. 3 — Fused Breaker AKRU-6D-30

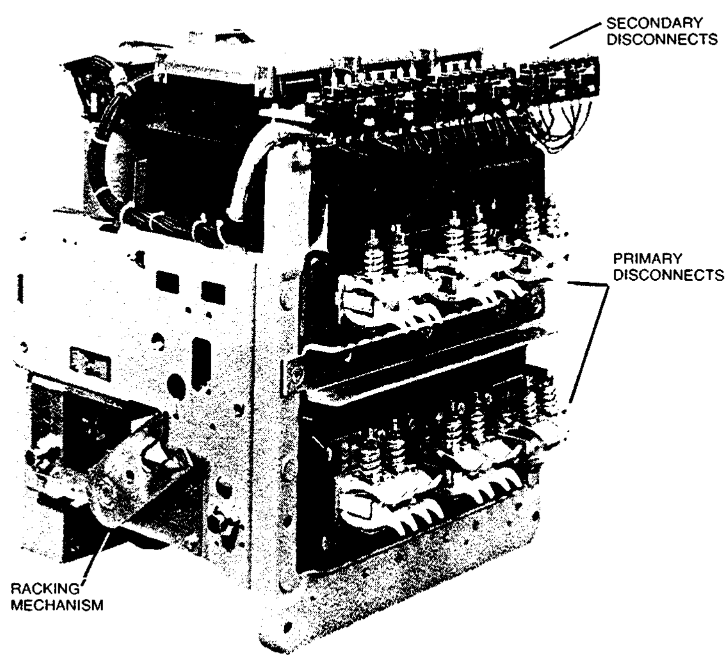


FIG. 4 — Drawout Breaker

2.4 MOUNTING

Type AKR breakers are designed for either drawout or stationary mounting. Drawout breakers (See Fig. 4) are equipped with features which make them easy to install in or withdraw from their associated switchgear equipment. These features are a racking mechanism (which facilitates inserting and withdrawing the breaker unit) and primary and control power disconnects which connect and part automatically. Interlocking devices are included.

Stationary breakers are designed to be mounted on a framework or panel, with mechanical fasteners being used to secure the breaker frame and make power connections. If control power connections are needed, a suitable terminal board is supplied.

The mounting type is identified by the second middle digit in the breaker's nameplate designation as follows:

AKR-5 (▲)-30
└── Mounting type code letter per Table 2

TABLE 2 MOUNTING TYPE CODES

Code Letter	Breaker Type: Drawout	Breaker Type: Stationary
A	AKD-5 AKD-6	—
B	Substructure	—
D	AKD-8 Substructure	— —
S	——	X

2.5 TRIP DEVICE

There are 4 types of solid-state, direct-acting, self-powered trip device systems associated with AKR breakers. These systems are for AC applications only. For DC applications an electro-mechanical system is available.

The trip device system is identified by the first middle digit in the breaker's nameplate designation as follows:

AKR-(▲)B-30
└──Trip device code number per Table 3

TABLE 3 TRIP DEVICE CODES

CODE NUMBER	TRIP DEVICE	APPLICATION
2	EC	DC
3	Power Sensor[1]	AC
4	ECS	AC
5	SST	AC
6	MicroVersa Trip	AC

[1]Power Sensor devices are discontinued. See publications GEK-7309 and GEK-7301 for detailed servicing procedures

2.6 MODEL NUMBER

Type AKR breakers (see Table 2) exist as either no model number of "-1" versions. For example AKR-5A-30H or AKR-5A-30H-1.

The difference between these models is their arc chute construction. The arc chutes in the no model number breakers have a two piece porcelain frame and use 2 arc chute retainers, see Fig. 5. The "-1" breaker arc chutes have a one piece molded polyester glass frame and 1 arc chute retainer, see Fig. 6.

All AKRT50H breakers use only molded arc chutes.

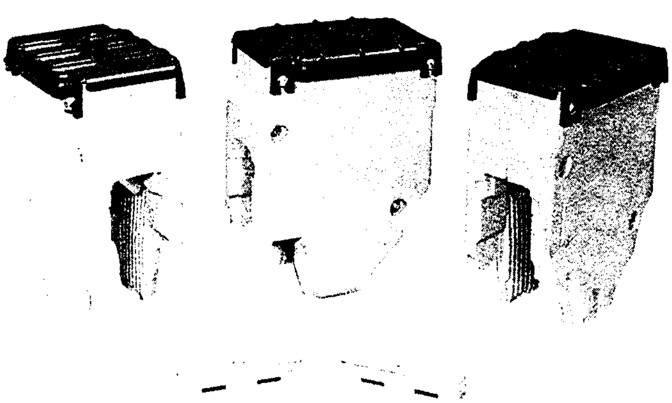


FIG. 5 — CERAMIC ARC CHUTES

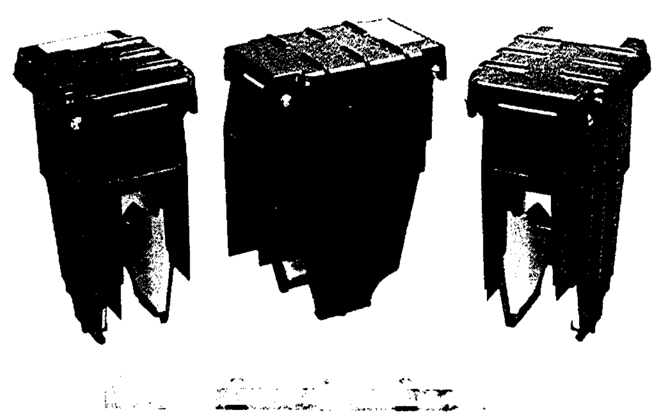


FIG. 6 — MOLDED ARC CHUTES

2.7 SHORT CIRCUIT RATINGS

Short circuit ratings vary with the applied system voltage. On 240 VAC systems they are also dependent upon whether the overcurrent trip device contains an instantaneous trip element. See Table 4.

TABLE 4 — BREAKER INTERRUPTION RATINGS

FRAME SIZE (AMPERES)	BREAKER TYPE	RATED MAXIMUM VOLTAGE (60 HZ AC)	3ϕ INTERRUPTION RATING KA RMS SYMMETRICAL		SHORT TIME
			WITH INSTANTANEOUS TRIP	WITHOUT INSTANTANEOUS TRIP	
800 AC	AKR 30	635			
		508	30	30	30
		254	42		
	AKR 30H	635			
		508	42	42	42
		254			
1600 AC	AKR 50	635	42	42	
		508	50	50	50
		254	65		
	AKR 50H	635	50	50	50
		508	65	65	65
		254			
	AKR 50H-1	635			
		508	65	65	65
		254			
2000 AC	AKRT 50	635	50	50	50
		508	65	65	65
		254			
	AKRT 50H	635			
		508	65	65	65
		254			
800	AKRU 30	600	200	200	—
1600	AKRU 50	600			
800 DC	AKR 30	300VDC	25[1]	[3]	25
2000 DC	AKR 50	300 VDC	50[2]		50

[1]With 40-800 Amp Trip Coils
[2]With 200-2000 Amp Trip Coils
[3]Consult Factory For Application Data

SECTION 3—Storage

It is recommended that the breaker be put into service immediately in its permanent location. If this is not possible, the following precautions must be taken to insure the proper storage of the breaker:

1. The breaker should be carefully protected against condensation, preferably by storing it in a warm dry room, since water absorption has an adverse effect on the insulation parts. Circuit breakers for outdoor switchgear should be stored in the equipment only when power is available and the heaters are in operation to prevent condensation.

2. The breaker should be stored in a clean location free from corrosive gases or fumes. Particular care should be taken to protect the equipment from moisture and cement dust, as this combination has a very corrosive effect on many parts.

CAUTION: *IF THE BREAKER IS STORED FOR ANY LENGTH OF TIME, IT SHOULD BE INSPECTED PERIODICALLY TO SEE THAT RUSTING HAS NOT STARTED AND TO ASSURE GOOD MECHANICAL CONDITION. SHOULD THE BREAKER BE STORED UNDER UNFAVORABLE ATMOSPHERIC CONDITIONS, IT SHOULD BE CLEANED AND DRIED OUT BEFORE BEING PLACED IN SERVICE.*

SECTION 4— Drawout Breaker Interchangeability

In general, drawout breakers of the same type and rating are interchangeable in their equipment compartments; drawout breakers of different frame sizes are not interchangeable. To prevent inserting the wrong type breaker into a drawout compartment, suitable "rejection hardware" is affixed to each breaker and its compartment. Figure 7 shows a typical rejection bracket which aligns with a rejection pin in the drawout rail (Fig. 8). When the wrong type breaker is inserted into a compartment the bracket and pin do not mate, preventing the breaker from seating itself into the drawout rails.

There is one exception to the above. Breakers of the same frame size having different short circuit ratings may be interchanged in one direction only:

a. An AKR-30H can be inserted into an AKR-30 compartment.
b. An AKR-50H can be inserted into an AKR-50 compartment.
c. An AKR-50H-1 can be inserted into an AKR-50 and AKR-50H compartment.
d. An AKRT-50H can be inserted into an AKRT-50 compartment.

The rejection hardware prevents the converse of a. thru d. above.

A detailed description of the rejection pin and bracket combinations used is given in Installation manual, GEI 86150.

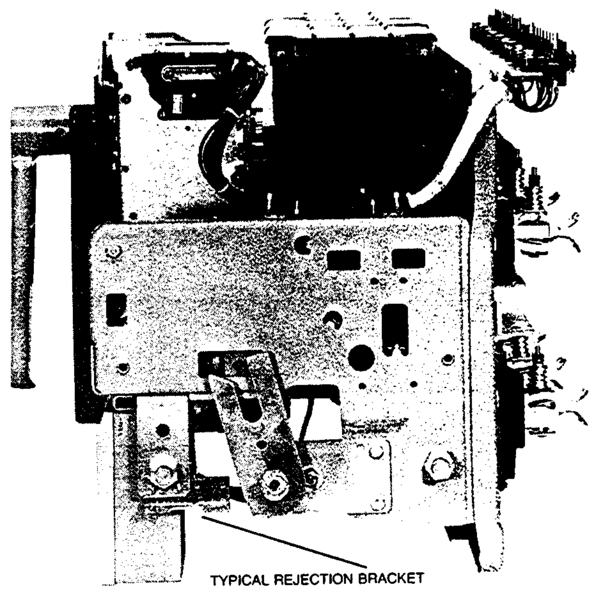


FIG. 7 — DRAWOUT BREAKER REJECTION SYSTEM

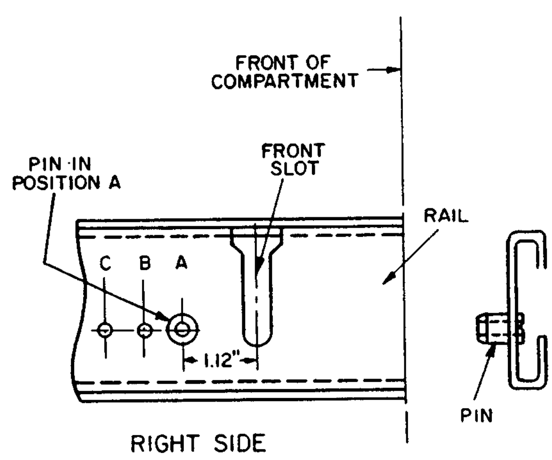


FIG. 8 INSERTING THE BREAKER

SECTION 5—Breaker Operation

A breaker may be equipped to operate either manually or electrically. Both types of operation result in the same fast-closing movement as far as the contact action is concerned. The variation is in the way energy is stored in the closing spring, and how it is released.

5.1 MANUAL CLOSING

Manually operated AKR breakers are constructed with front-mounted handles. Handle operation resets the mechanism and fully charges the closing spring. A complete charge is accomplished in either cranking the handle through one cycle (135-degree swing) or three cycles (50-degree swing). Manually operated breakers manufactured after July, 1984 can only be charged by cranking the handle through one cycle. The CLOSE button mounted on the escutcheon, is used to manually close the breaker contacts and the TRIP button is used to open them.

If equipped with a closing solenoid, a manual breaker may be closed remotely by a control switch or relay. Before this can be done, however, the closing spring has to be charged by hand. The closing solenoid is an optional accessory and is not supplied unless specified in the breaker order.

5.2 ELECTRICAL CLOSING

On electrically operated breakers the closing springs are charged by a gear motor. With the springs discharged, voltage applied to the control circuit will energize the motor through the "G" switch contacts — see Fig. 9. The motor, through the gear reduction output crank, compresses the closing springs until they are fully charged. As this fully charged position is reached, mechanically operated switches "F" and "G" reverse their shown position, the "G" switch deenergizing the motor and the "F" switch establishing a circuit to the "X" relay. At the same time, a mechanical prop is positioned to prevent the discharge of the fully charged closing spring.

With the closing spring propped fully-charged, the breaker is ready for closing. This may be accomplished electrically by depressing the closing switch on the breaker (if so equipped) or by a remote closing switch. Operation of the closing switch energizes the "X" relay, which in turn energizes the closing solenoid. This removes the prop, releasing the closing springs to close the breaker.

As the closing relay is energized, it energizes anti-pump relay "W". If the closing switch is maintained closed, the anti-pump relay will remain picked-up to prevent a second closing operation on the breaker in the event it is tripped open automatically. The closing impulse must be released and reapplied before a second closing operation can occur.

The closing springs on electrically operated breakers can be manually charged. The breakers can also be manually closed. Refer to Section 5.4 for this procedure.

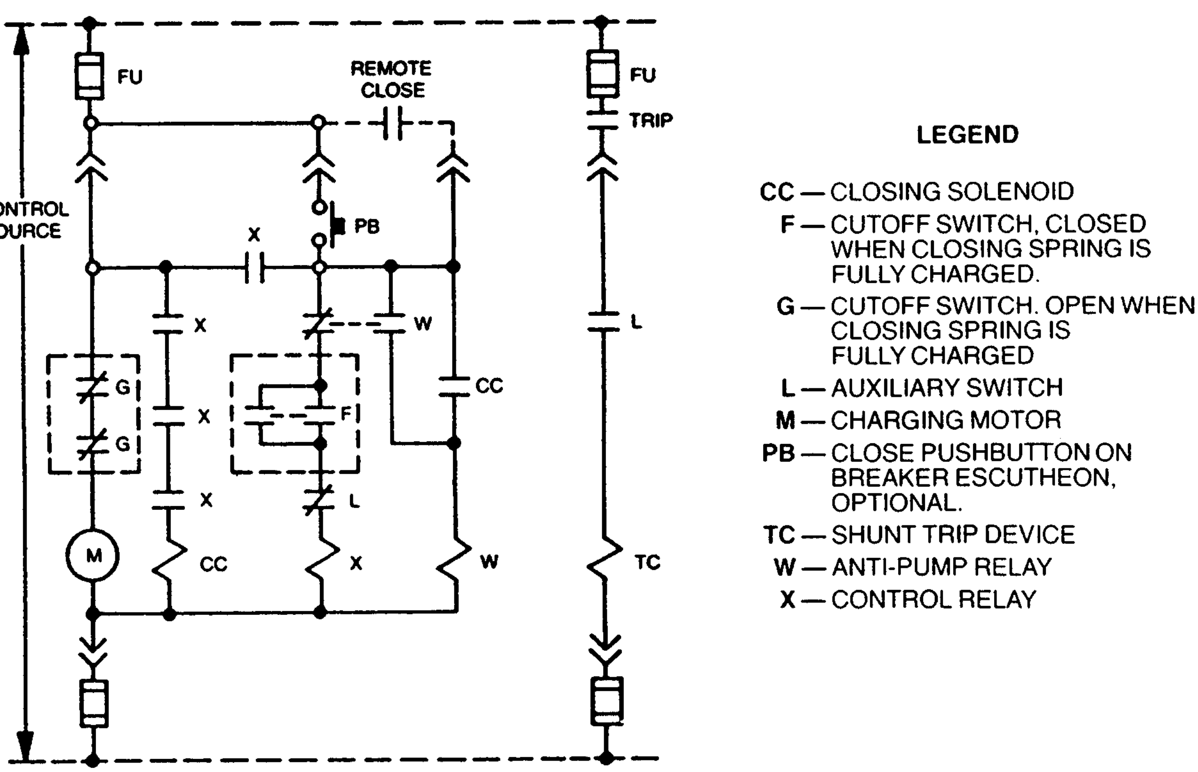


FIG. 9 — ELEMENTARY DIAGRAM FOR ELECTRICALLY OPERATED DRAWOUT BREAKER. CONTACT POSITIONS ARE SHOWN WITH BREAKER OPEN AND CLOSING SPRINGS DISCHARGED.

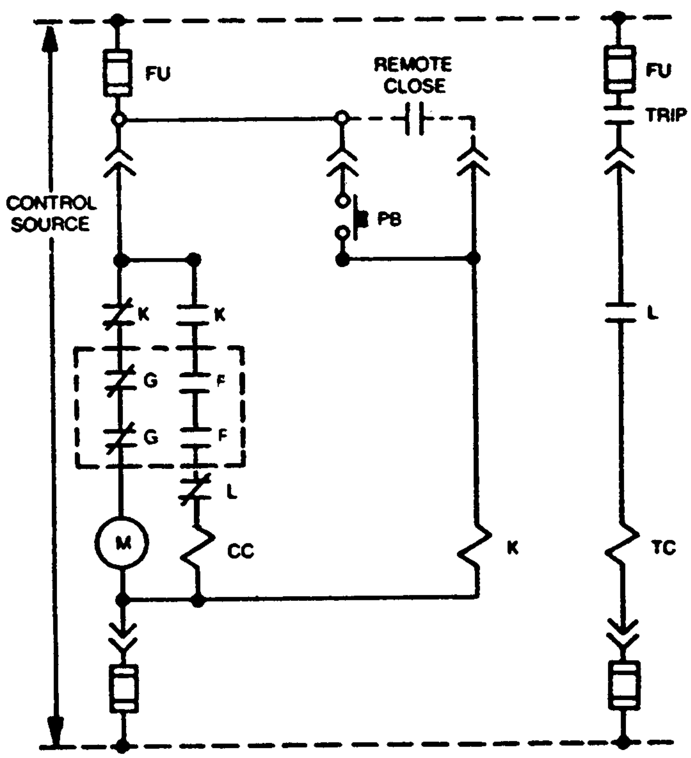
5.2.1 ALTERNATE CONTROL CIRCUIT

Later production breakers use the electrical control circuit shown in Fig. 9A for all control voltages except 250 volts D.C. which uses the circuit shown in Fig. 9. This alternate control circuit eliminates the X-relay and CC switch shown in Fig. 9.

The motor is energized through the 'G' cutoff switch and the K-relay contact. The motor is deenergized when the 'G' cutoff switch changes state which occurs when the closing spring is fully charged.

With the closing spring propped fully-charged, the breaker is ready for closing. This may be accomplished electrically by depressing the closing switch on the breaker (if so equipped) or by a remote closing switch. Operation of the closing switch energizes the K-relay, which in turn energizes the closing solenoid. This removes the prop, releasing the closing springs to close the breaker. The 'F' cutoff switch is only installed on breakers using D.C. control voltage.

The anti-pump function is obtained through the normally closed K-relay contact in the motor circuit. If a close signal is maintained after the breaker has tripped open automatically, the K-relay is energized preventing the motor from charging the closing spring. The closing signal must be removed for approximately 1.3 to 2.0 seconds to allow the closing spring to charge.



LEGEND

CC — CLOSING SOLENOID
F — CUTOFF SWITCH, CLOSED WHEN CLOSING SPRING IS FULLY CHARGED (D.C. ONLY)
G — CUTOFF SWITCH, OPEN WHEN CLOSING SPRING IS FULLY CHARGED.
L — AUXILIARY SWITCH
M — CHARGING MOTOR
PB — CLOSE PUSHBUTTON ON BREAKER ESCUTCHEON. OPTIONAL
TC — SHUNT TRIP DEVICE
K — ANTI-PUMP RELAY

FIG. 9A. ALTERNATE ELEMENTARY DIAGRAM. CONTACT POSITIONS ARE SHOWN BREAKER OPEN AND CLOSING SPRINGS DISCHARGED.

5.3 MECAHNISM OPERATION

Figure 10 shows the mechanism components in the Closed, Tripped and Reset positions. The closing spring is shown in the charged position in all of these details.

Closed Position — As shown in Fig. 10A, the movable contacts are held against the stationary contacts by the toggle linkage. The toggle linkage is held in position through the engagement of its cam rollers, item no. 5, with the prop, item no. 2 and the secondary latch/trip latch, item nos. 14 & 11.

Tripped Position — The mechanism goes from the Closed position to the Tripped position, shown in Fig. 10B, when the trip shaft, item no. 10, is rotated by either the manual trip button or one of the other trip devices. The trip latch, item no. 11 is assembled to the trip shaft. When the trip shaft rotates, the trip latch disengages from the secondary latch roller. The secondary latch pivots, resulting in the collapse of the toggle linkage. This collapse along with the opening spring, item no. 15, causes the breaker contacts to open.

Reset Position — The mechanism is shown in Fig. 10C. The cam, item no. 3, which is assembled to the cam shaft, item no. 4, is rotated by the charging motor, manual operating handle, or maintenance handle. The cam engages the cam roller and partially extends the toggle linkage. This allows the secondary latch to pivot against the front frame as shown leaving a gap between the trip latch and secondary latch roller. The secondary latch is now in a position to engage with both the top latch and cam roller.

The breaker closes when the closing spring discharges and rotates the cam against the cam roller. The toggle linkage is fully extended, pivoting the secondary latch from the front frame and engaging it with the trip latch and cam roller as shown in Fig. 10A.

When the breaker is closed and the closing spring discharged, the upper cam roller is supported by the cam rather than the prop. This is the position the mechanism must be in to check contact adjustment refer to Sectior 8.

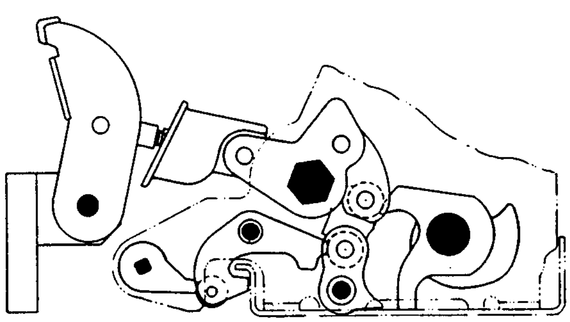


FIG. 10A CLOSED

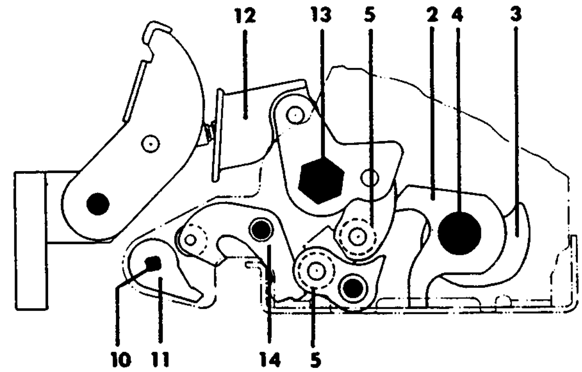


FIG. 10B TRIPPED

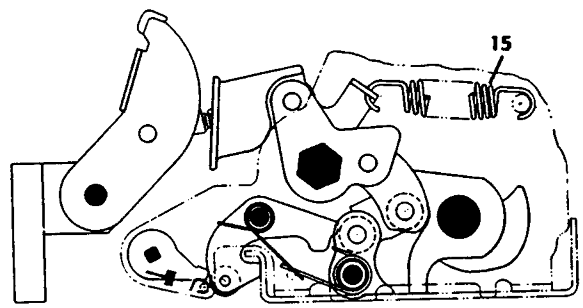


FIG. 10C RESET

2. Prop	11. Trip Latch
3. Cam	12. Insulated Coupling
4. Camshaft	13. Main Shaft
5. Cam Roller	14. Secondary Latch
10. Trip Shaft	15. Opening Spring

5.4 CHARGING USING THE MAINTENANCE HANDLE

The closing spring on electrically operated breakers can be manually charged by using the maintenance handle (568B386G1) as shown in Fig. 11. The triangular socket in the maintenance handle mates with the mechanism's camshaft extension on the front right side of the breaker. Using the knob on the handle, it will probably be necessary to align this socket to fit on the end of the shaft.

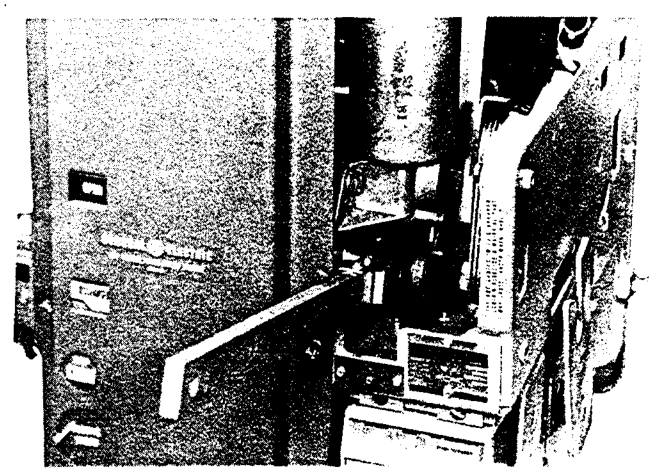


FIG. 11 — MAINTENANCE HANDLE INSTALLED ON CAMSHAFT EXTENSION

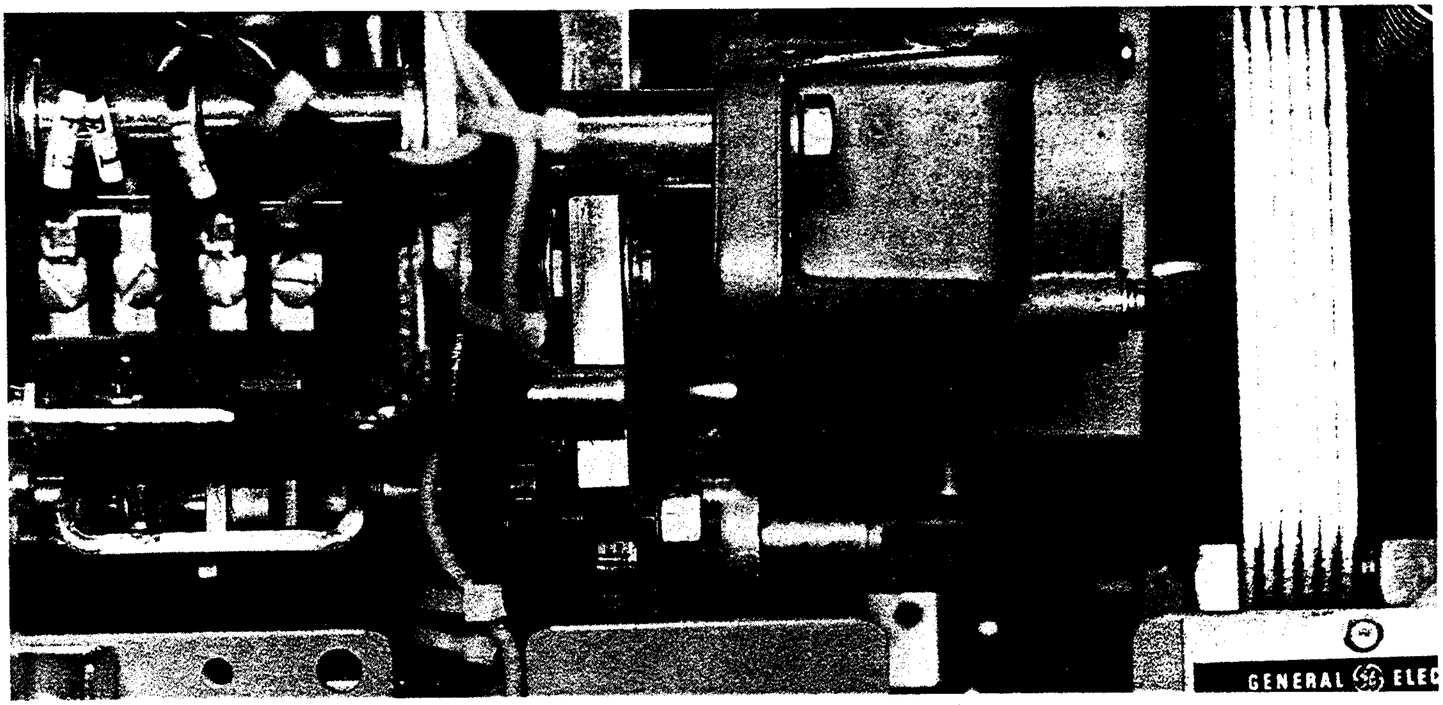


FIG. 12 — ROLLER ENGAGED WITH CLOSING PROP

There is a ratchet assembly attached to the camshaft extension. This ratchet is normally driven by the breaker's gear motor. A roller on this ratchet engages with a prop when the closing spring is fully charged and driven over center, see Fig. 12. This holds the closing spring in a charged condition.

Rotate the camshaft using the maintenance handle until the ratchet assembly's roller engages with the prop. Do not drive the roller against the prop with undo force. The breaker can now be closed by removing the prop from the roller. This is done by manually activating the closing solenoid's armature. Push the solenoid's armature into its windings. See Fig. 13.

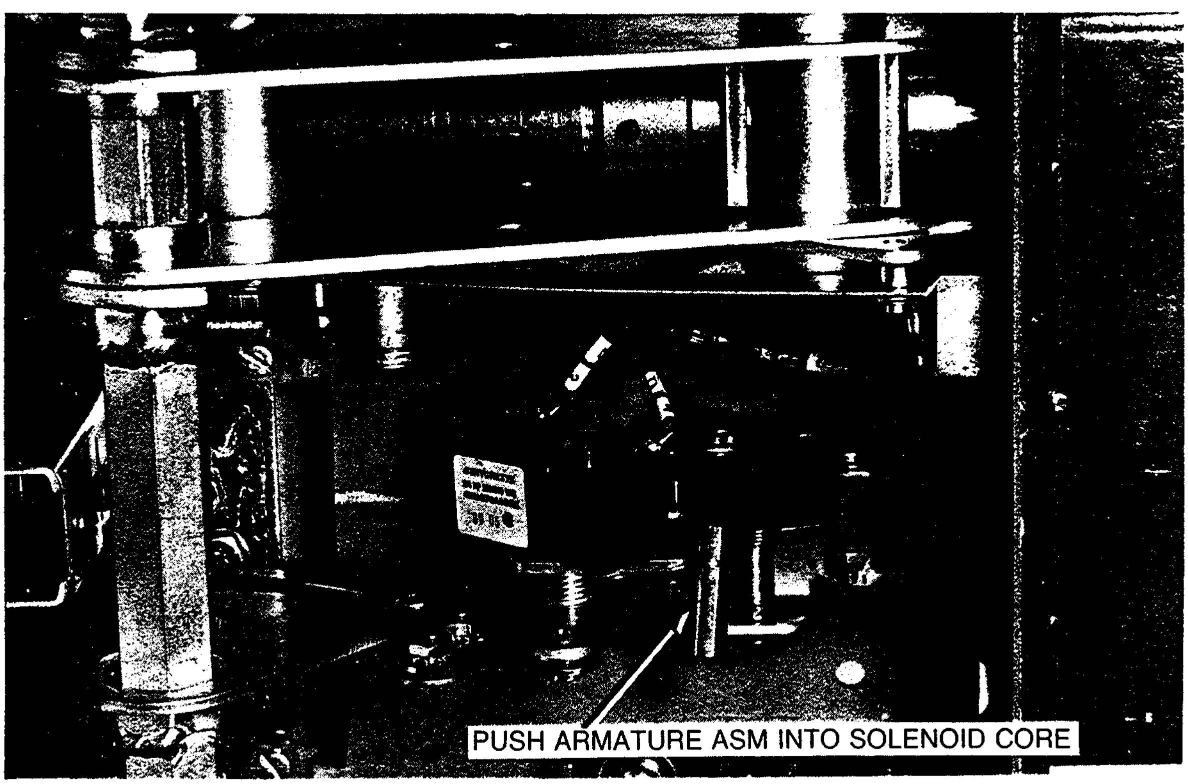


FIG. 13 — MANUAL OPERATION OF CLOSING SOLENOID

SECTION 6—Interlocks

AKR breakers are equipped with safety interlock devices that are required by Industry Standards and Certifying Authorities. Interlock devices for special applications are also available as options. The standard interlock devices described below are used only on drawout breakers. Stationary breakers have no required interlocks.

6.1 RACKING MECHANISM INTERLOCK

The function of the racking mechanism interlock is to prevent the breaker from moving from its CONNECTED position before it is in the OPEN position.

The racking mechanism drive shaft is located behind the RACKING SCREW cover shown in Fig. 14. This cover must be slid to the right to gain access to the drive shaft. When the breaker is in the CLOSED position, a link engages the RACKING SCREW cover preventing it from being opened. This link is driven by the motion of the OPEN/CLOSED indicator as shown in Fig. 15.

The TRIP button also engages with the RACKING SCREW cover in both the OPEN and CLOSED positions. Therefore, the TRIP button must be pushed in before the cover can be opened. This will open the breaker if it was closed and also remove the OPEN/CLOSED linkage discussed above.

When the RACKING SCREW cover is open it holds the TRIP button in. This keeps the breaker trip-free so a mechanism closing cycle will not cause contact movement especially when the breaker is being racked in or out.

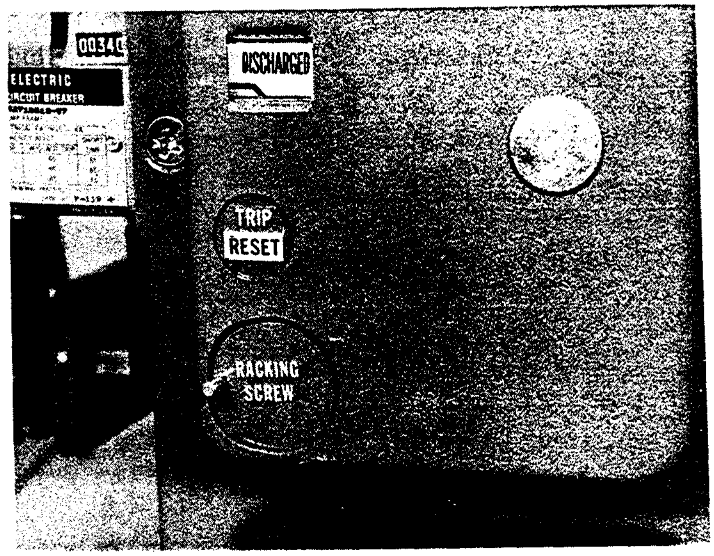


FIG. 14-A — RACKING SCREW

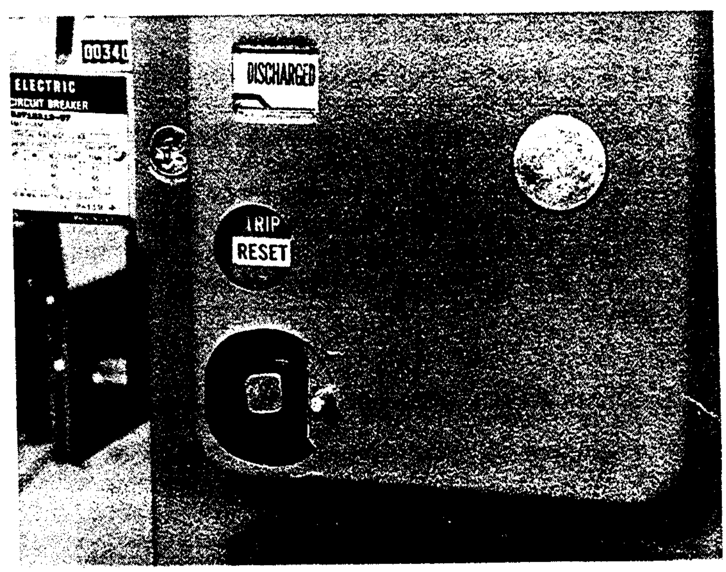


FIG. 14-B

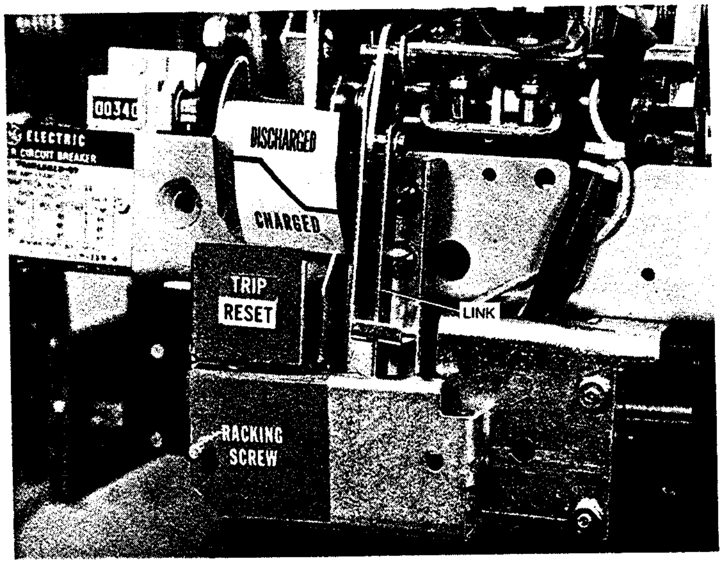


FIG. 15
RACKING SCREW COVER INTERLOCK
CLOSED POSITION

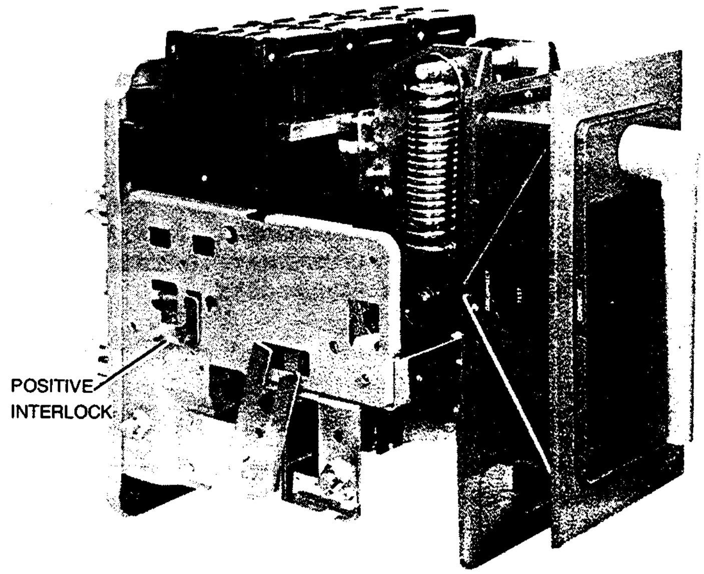


FIG. 16 — POSITIVE INTERLOCK

6.2 POSITIVE INTERLOCK

The function of the positive interlock is to keep the breaker trip-free while it is being racked in or out between the CONNECTED and TEST positions.

The positive interlock is located on the breaker's left side as shown in Fig. 16. As the breaker moves between the CONNECTED and TEST positions, the positive interlock engages with a ramp cam located in the breaker compartment. This cam raises the interlock's lever assembly causing the trip shaft to move and preventing the trip latch from engaging with the secondary latch assembly roller. The breaker is held trip-free and cannot be closed during this interval.

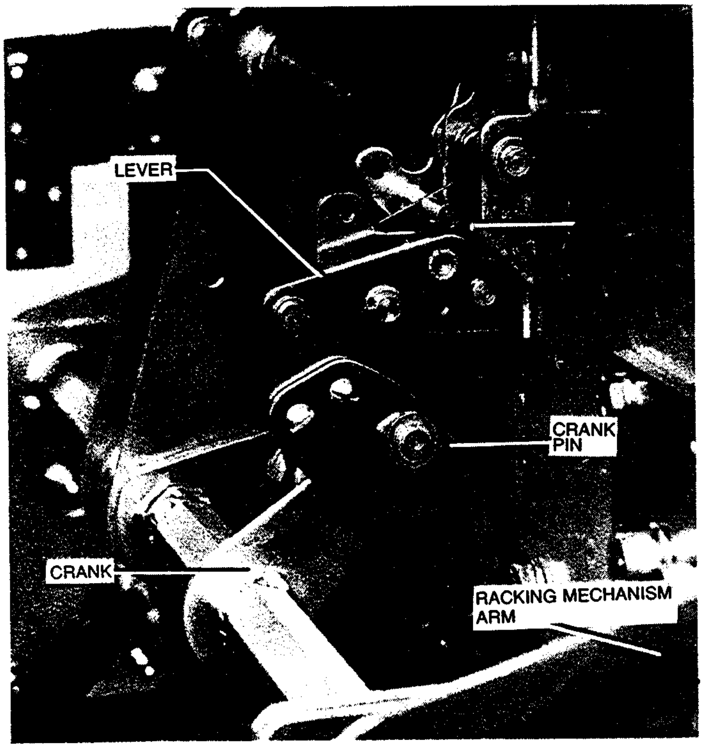
6.3 CLOSING SPRING INTERLOCK

The function of the closing spring interlock is to discharge the closing spring as the breaker is being racked out of its housing. This eliminates the hazard of a completely charged breaker being discharged after the breaker is removed from its compartment.

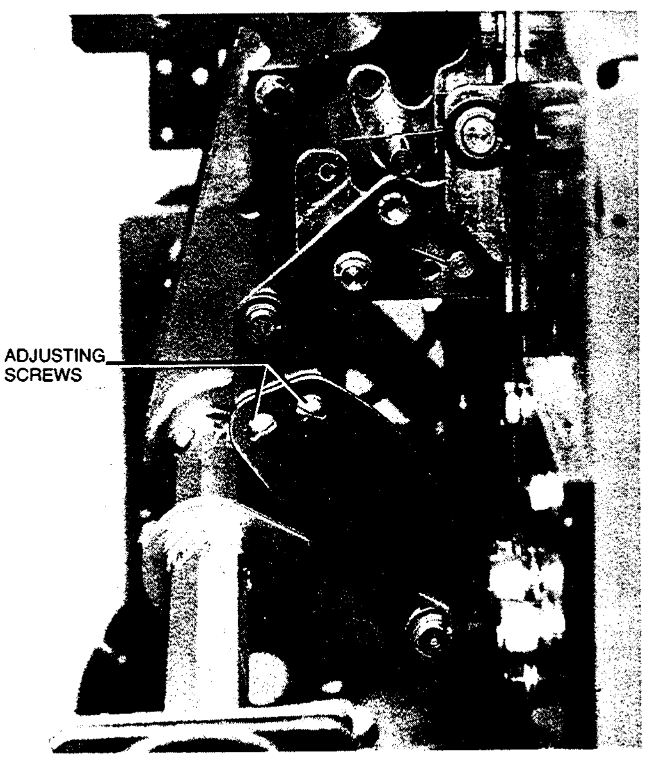
The operation of the closing spring interlock is shown in Fig. 17. The racking mechanism arms and the crank are connected to a common shaft. As the breaker is racked out a pin attached to the crank moves through the slot in the linkage. The linkage is connected to a lever which engages with a pin on the closing solenoid armature linkage. When the racking mechanism approaches the DISCONNECT position, the crank's pin reaches the end of the slot in the linkage. Continued motion of the racking mechanism causes the linkage to rotate the lever which moves the closing solenoid armature forward. The armature linkage then releases the prop, discharging the closing spring.

The Closing Spring interlock should be adjusted to cause the closing spring to discharge when the racking mechanism is a minimum of 1 and a maximum of 2½ turns short of the fully racked out position. In this position the racking handle can no longer be turned. If adjustment is required, use the linkage adjusting screws shown in Fig. 17.

Note — undue force on the racking handle at the fully racked out position will cause the lever to move past the pin on the armature linkage. This will bind up the overall interlock. Under these conditions, continued application of this force will deform the linkage assembly. A later lever design (shown in Fig. 17) includes a stop which prevents the lever from moving past the pin. When the pin is against this stop, undue force may still deform the linkage assembly.



Breaker Racked In — Lever And Armature Linkage Pin Not Engaged



Breaker Being Racked Out — Lever Activates Armature Linkage

FIG. 17 — CLOSING SPRING INTERLOCK

6.4 DISCONNECT POSITION INTERLOCK

The function of the Disconnect Position Interlock is to block the RACKING SCREW cover open when the racking mechanism is in the DISCONNECTED position. When the cover is held open, the TRIP button is depressed. The mechanism is held trip-free and there is no contact arm movement when the closing spring is discharged by the Closing Spring interlock.

The operation of this interlock is shown in Fig. 18. A crank, which is attached to the racking mechanism shaft, is connected to the blocking plate through a link. As the shaft turns, the blocking plate rotates; holding the cover open in the DISCONNECTED position, but allowing it to close in the TEST and CONNECTED positions.

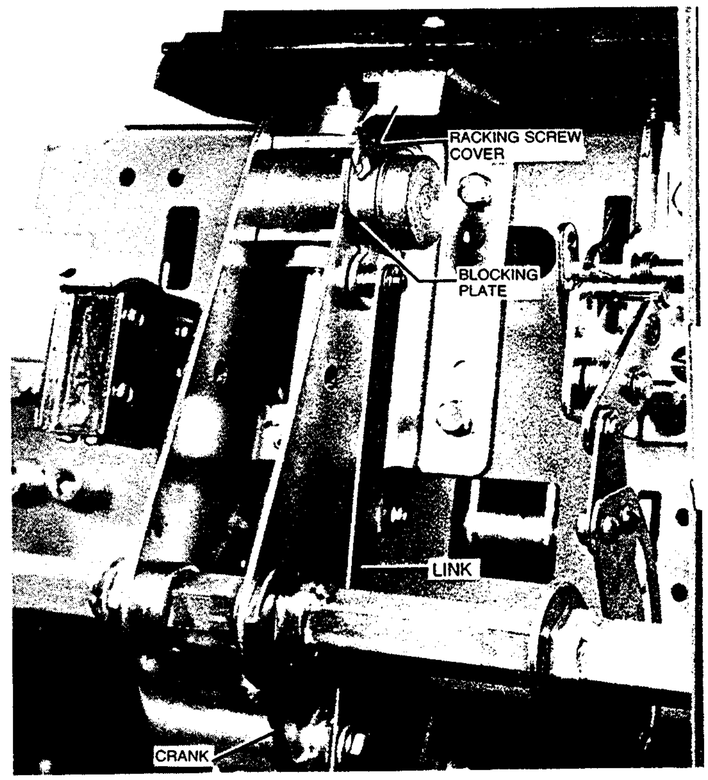


FIG. 18 - DISCONNECT POSITION INTERLOCK

6.5 PADLOCKS

Provisions are made in all breakers to use padlocks to prevent the breaker from being closed. For non Type B or D breakers the padlock shackle goes through the TRIP button hole and out the slot in the side of the escutcheon. For Type B or D breakers the padlock shackle goes through the TRIP button hole and out the RACKING SCREW cover hole in the deep escutcheon. In either case, the shackle holds the TRIP button in keeping the mechanism trip-free.

SECTION 6—Interlocks (Cont.)

6.6 KEY INTERLOCK-STATIONARY BREAKER

The function of the Key Interlock is to prevent an open breaker from being closed when the lock bolt is extended and its key is removed.

The operation of this interlock is shown in Fig. 19. When the breaker is in the OPEN position, the end plate assembly on the main shaft pivots the lever counter-clockwise. This removes the pin on the lever from blocking the lock bolt. Extending the lock bolt rotates the linkage which moves the trip shaft, preventing the mechanism from closing the breaker.

6.7 OPTIONAL INTERLOCKS

The optional interlocks are key interlocks and door interlocks. On drawout breakers, these devices are mounted in the equipment and are part of the breaker enclosure. Padlocks may be used to lock the "inner" house in the "disconnected" position.

When the breaker is in the CLOSED position, the flywheel assembly is away from the lever. The lever is spring loaded and rotates clockwise causing its pin to block the lock bolt extension.

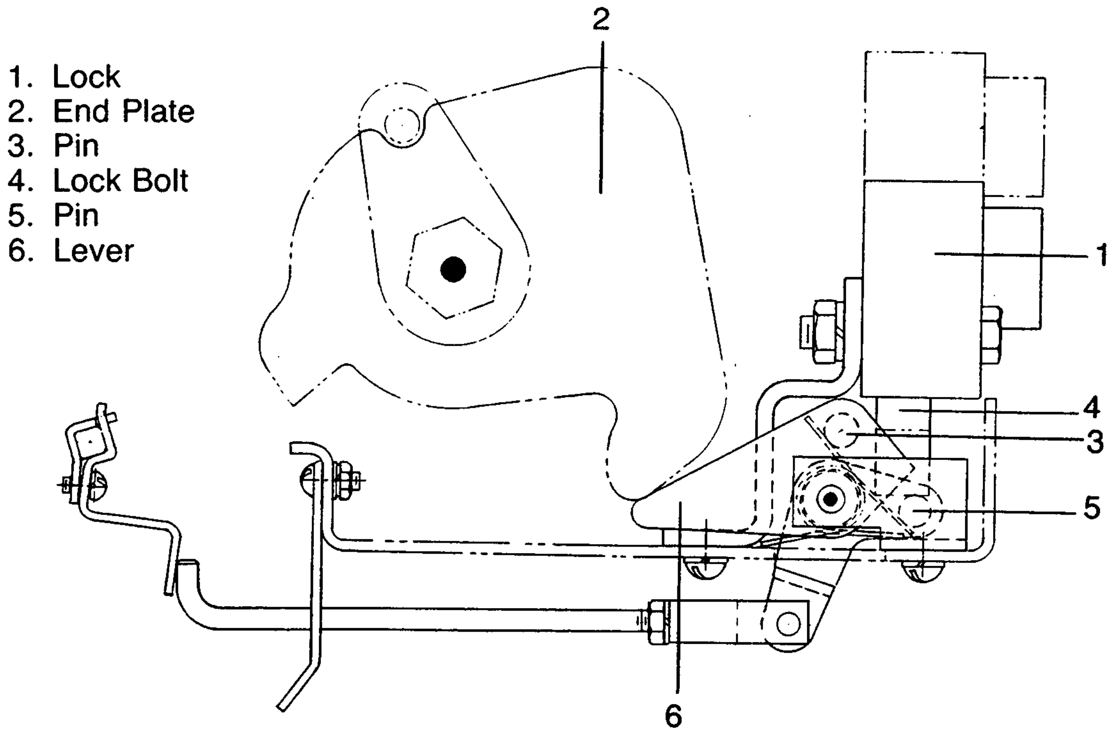


FIG. 19 — KEY INTERLOCK—STATIONARY BREAKERS

SECTION 7—Breaker Maintenance

SAFETY PRECAUTION

WARNING: *BEFORE INSPECTING OR BEGINNING ANY MAINTENANCE WORK ON THE BREAKER, IT MUST BE DISCONNECTED FROM ALL VOLTAGE SOURCES, BOTH POWER AND CONTROL, AND THE BREAKER MUST BE IN THE "OPEN" POSITION.*

7.1 LUBRICATION

In general, the circuit breaker requires moderate lubrication. The majority of the factory lubricated bearing points and sliding surfaces are accessible for inspection and if necessary, cleaning and relubricating. The only lubricant used on the breaker for both electrical and mechanical areas is General Electric specification D50HD38 (Mobilgrease 28).

The areas requiring lubrication are:

1. Contacts — A thin film on the stationary and movable contact assembly pivot surfaces. Refer to Section 8.
2. Racking Mechanism — The drive threads, jamb nut/trunnion interface, thrust washer/collar interface, and the shaft support bearings. Refer to Section 7.13.
3. Manual Operating Handle — Lubricate the two pivot areas associated with the adjustment linkage. Also, the handle, mounting shaft/support bushing interface. Refer to Section 7.2.
4. Flux Shifter — Lubricate pivoting and sliding surfaces of the reset linkage. Refer to Section 10.3.
5. Switchette — Lubricate the activator lever surface that contacts the switchette button.
6. Mechanism — All accessible bearing and sliding surfaces that have been factory lubricated.
7. Primary Disconnects — Lubricate the finger contact surface just prior to installing in switchgear or lubricate and then cover the disconnect assembly to protect from dust, dirt, etc. Refer to Section 7.5

Before lubricating, remove any hardened grease or dirt from the latch and bearing surfaces. After lubricating, remove all excess lubricant of dirt or dust. The use of cotton waste to wipe bearing surfaces should be avoided. The cotton ravelings may become entangled under the bearing surfaces and destroy the surface of the bearing.

7.2 MANUAL HANDLE ADJUSTMENT

On manually-operated AKR breakers, the closing springs may be charged either by a single 135 degree clockwise handle stroke or up to four multiple strokes of lesser swing. The following adjustment procedures should be performed using the single-stroke method. By so doing, proper multi-stroke operation is assured.

There are two handle adjustment linkage designs in use. The adjustment linkage connects the handle assembly to the chain drive mechanism which turns the cam shaft. The length of this linkage provides the handle adjustment.

If the link is too long, the handle stroke cannot extend the closing spring enough for it to go over center. In this event, use the maintenance handle to complete the spring charging. The breaker can then be closed and opened preparatory to further shortening of the link.

If the link is too short, one-stroke charging is not possible. However, more than one stroke will charge the springs.

The original linkage design used a double-ended stud in the linkage center. A hex section in this stud allowed adjusting with an open-end wrench. When looking down on the breaker, turning the wrench clockwise lengthens the link. The opposite motion shortens it. The range of adjustment is 300 degrees. In the confined space available, each wrench stroke imparts 15 degrees movement. The best setting is approximately mid-range.

The present design is shown in Fig. 20. This linkage is assembled together on a threaded stud. Adjustment is accomplished by removing the upper linkage assembly from the handle assembly and changing the linkage length by turning the upper linkage up or down the threaded stud.

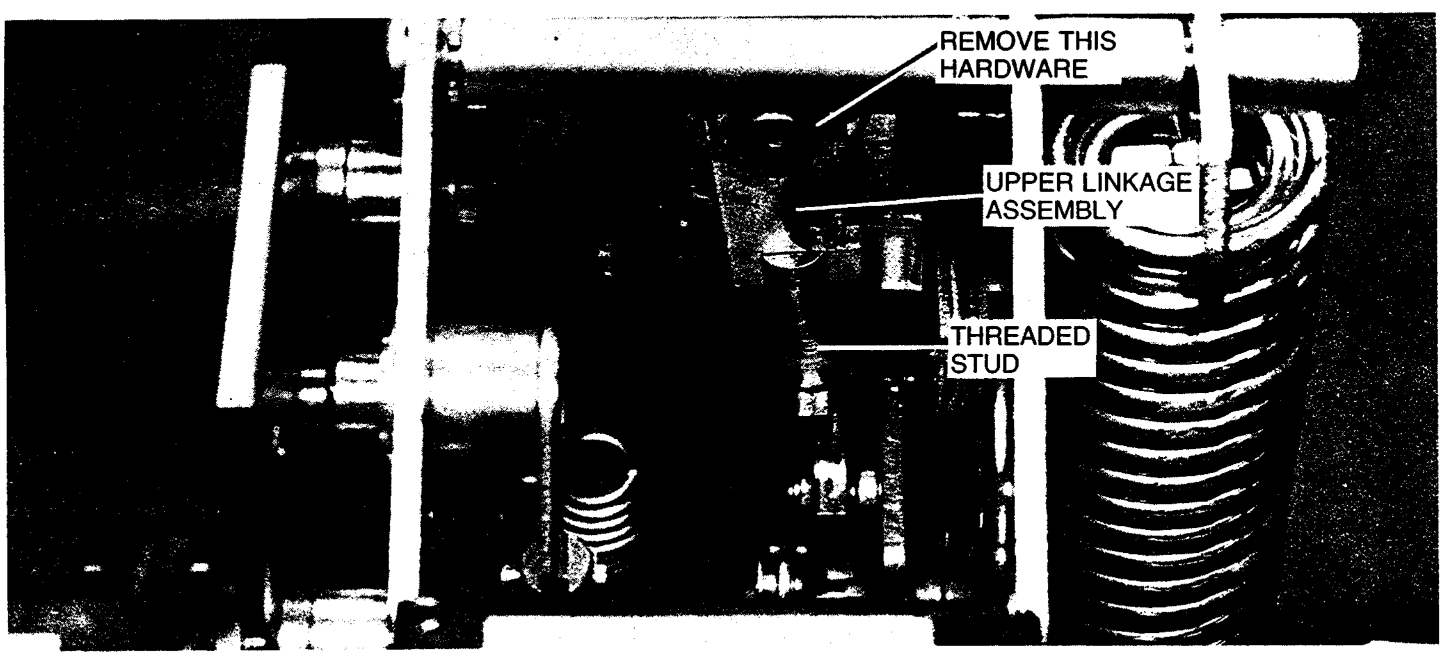


FIG. 20 — MANUAL HANDLE ADJUSTMENT

7.3 DRAWOUT MECHANISM POSITION

Maintenance or inspection should be conducted with the breaker on a workbench. The drawout mechanism must be placed in the CONNECT position. This will deactivate the various interlocks which would otherwise prevent the mechanism or contacts from closing. Engage the racking handle with the racking shaft and turn clockwise until it stops.

Remember, before installing the breaker back into its compartment, the drawout mechanism must be returned to the DISCONNECT position.

7.4 SLOW CLOSING THE BREAKER

Closing the breaker slowly, while observing the action of the mechanism and contacts, is a good way of judging the correctness of mechanical and contact relationships. Some of the maintenance procedures described later will involve operating the breaker in this manner. The procedure for slow closing is given below.

The closing spring must be isolated from the mechanism's camshaft. This is done by disconnecting the lower spring assembly from the mating camshaft linkage. Remove the hex-head bolt as shown in Fig. 21. Remove this bolt only with the mechanism in the DISCHARGED position and the spring at its minimum extension.

Remove the hex-head bolt only, do not remove or loosen the slotted head screw shown in Fig. 21. Removal of the slotted head will cause the closing spring to become disengaged from the camshaft with considerable force. Verify that this screw remains tightened during the slow close operation.

After the bolt is removed, use the maintenance handle to rotate the ratchet assembly's roller onto the closing prop (see Charging Using The Maintenance Handle, section 5.4). At this point, the closing prop must be removed by either pushing the CLOSE button on Manual breakers, or pushing the closing solenoid armature on electric breakers (see Fig. 13). When the closing prop is removed, continue turning the camshaft. The contacts and mechanism is in its fully closed position, the cam will support the cam roller (refer to Fig. 10 & section 5.3) and the contacts will develop maximum depression.

Push the TRIP button to release the mechanism and open the contacts.

CAUTION — The mechanism and contacts will open with normal speed and force.

When replacing the hex-head bolt, turn the camshaft with the maintenance handle to align the mating holes in the lower spring assembly and camshaft linkage.

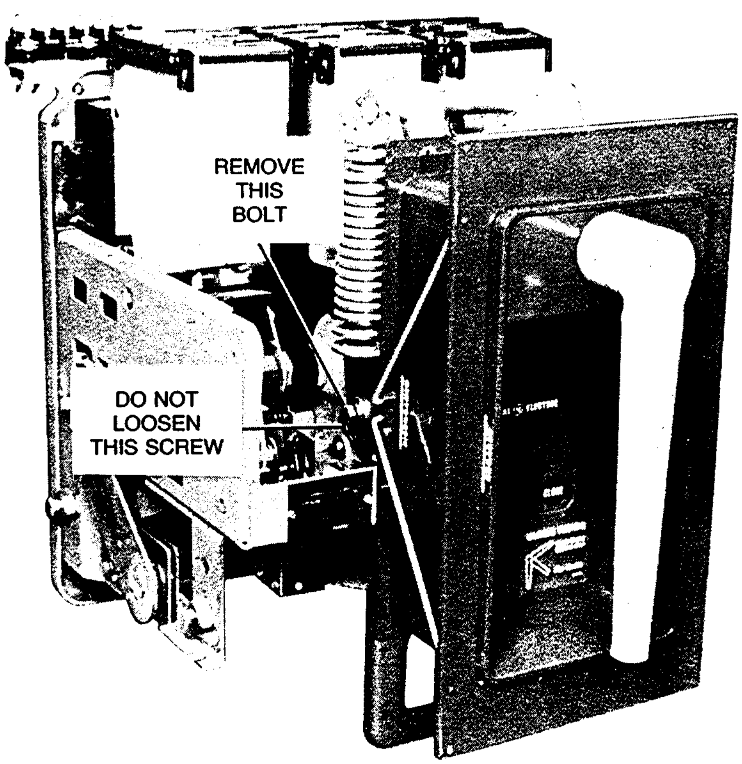


FIG. 21 — SLOW CLOSING—LOWER SPRING ASM HARDWARE

SECTION 7—Breaker Maintenance (Cont.)

7.5 PRIMARY DISCONNECTS

Primary disconnects are found only on drawout breakers. They provide the flexible connection between the breaker's line and load terminals and the equipment's line and load terminals.

The 800 ampere breakers use four primary disconnect fingers per phase. The 1600 and 2000 ampere breakers use eight fingers per phase. Fig. 22 shows a line and load end disconnect assembly. The line end disconnects on fusible breakers have the spring pointing downwards, otherwise they are identical.

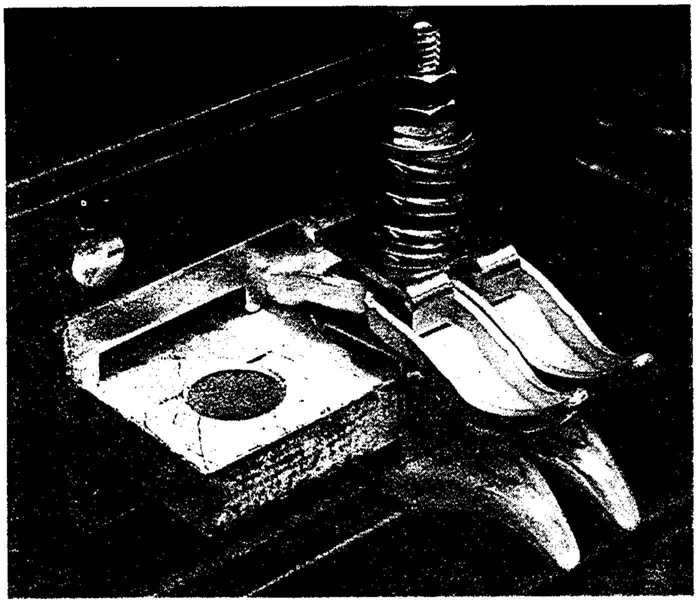


FIG. 22 — PRIMARY DISCONNECT ASSEMBLY

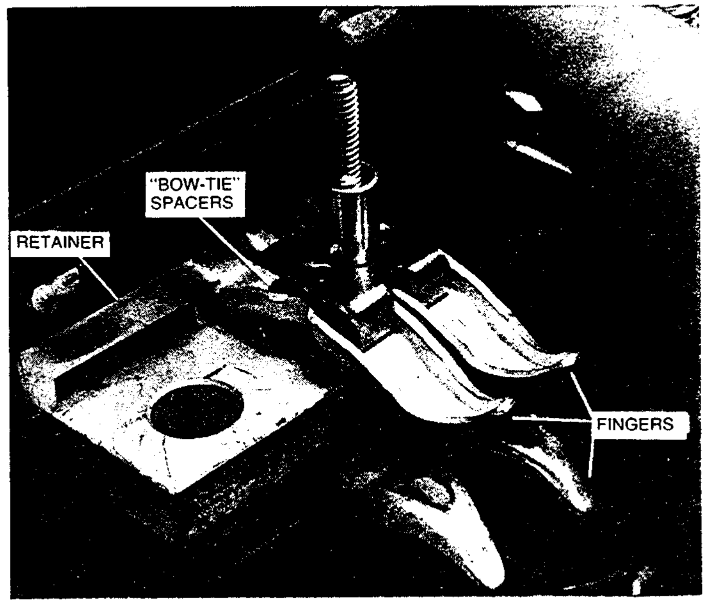


FIG. 23 — PARTIAL PRIMARY DISCONNECT ASM

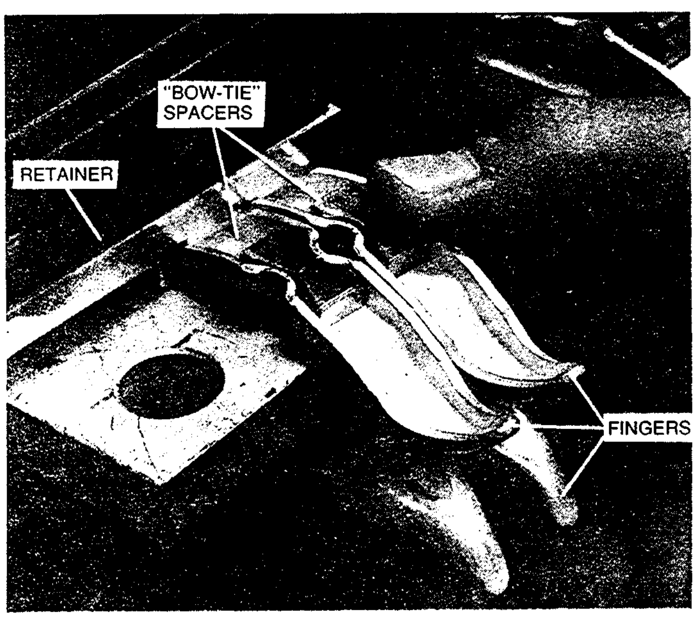


FIG. 24 — PARTIAL PRIMARY DISCONNECT ASM

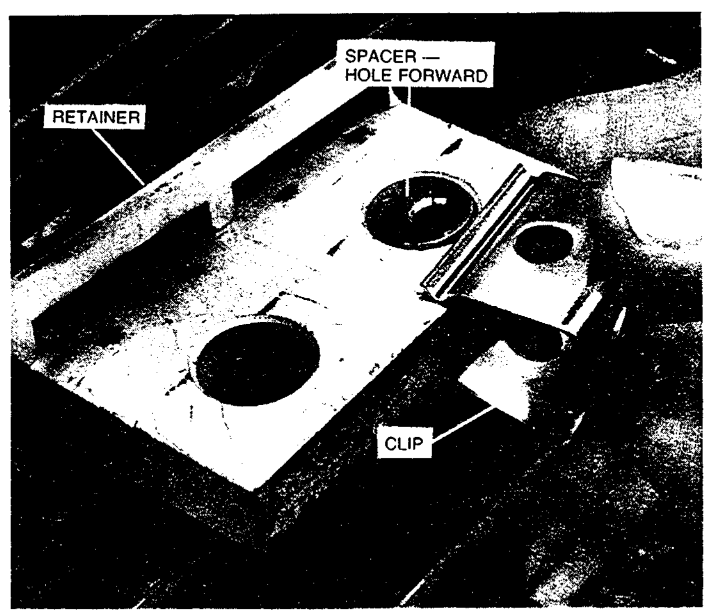


FIG. 25 — PARTIAL PRIMARY DISCONNECT ASM

SECTION 7—Breaker Maintenance (Cont.)

7.5.1 REPLACEMENT

Figs. 22, 23, 24, and 25 show the primary disconnect assembly breakdown. Refer to these illustrations when replacing the disconnects. Note the following details:

Fig. 25 — The position of the spacer in the breaker stud. The hole in the spacer must be positioned as shown so it will align with the holes in the clip.

Fig. 24 — The engagement of the fingers with the retainer. Also the location of the 'bowtie' spacers in the fingers, both upper and lower.

Fig. 22 & 23 — The position of the upper and lower retainers and, again, the 'bowtie' spacers.

7.5.2 ADJUSTMENT

The primary disconnect assembly is factory adjusted to apply a force of 85-105 pounds on a 1/2 thick copper bar inserted between the upper and lower fingers. After installation of the disconnect assembly this force range is obtained by tightening the locknuts to set the dimension shown in Fig. 26. Note that this dimension is measured between the top of the retainer and the underside of the washer. Also note that no bar is inserted between the fingers when setting this dimension.

7.6 AUXILIARY SWITCH

All electrically operated breakers and manual breakers having shunt trips are supplied with auxiliary switches. Depending upon the requirements of the breaker's application, the switch may contain from two to six stages. Usually, each stage has one "A" contact and one "B" contact. "A" contacts are opened or closed as the breaker is opened or closed. "B" contacts are the reverse of this.

The auxiliary switch is mounted on the upper side of the mechanism frame as shown in Fig. 27. A crank on the main shaft operates the switch through an adjustable link which connects it to the switch crank.

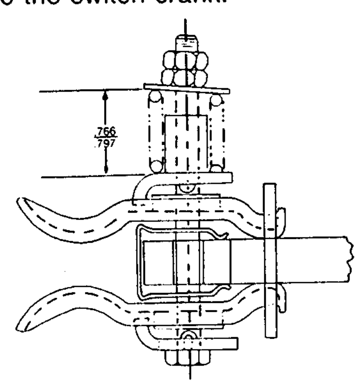


FIG. 26 — PRIMARY FINGER ADJUSTMENT

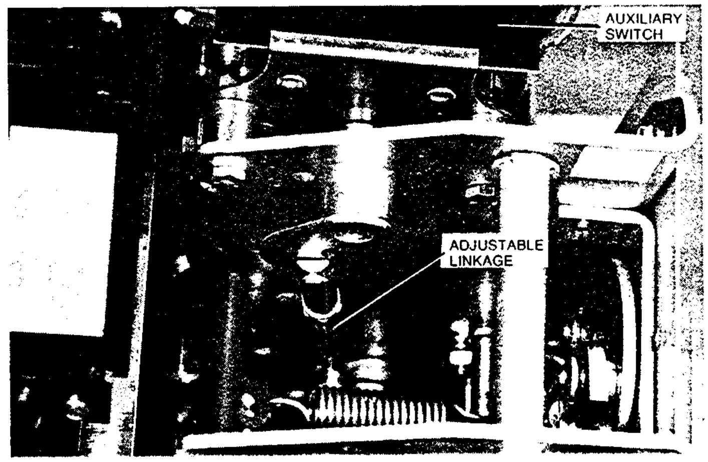


FIG. 27 — AUXILIARY SWITCH LINKAGE

7.6.1 REPLACEMENT

The switch may be dismounted by removing the two bolts which fasten it to the mechanism frame.

The replacement switch should have its crank shaft set so that the arrow head on the end of the shaft points as shown in Fig. 28 when the breaker is open.

If a switch is added to a breaker having none, the adjusting link will also have to be installed. This is connected to the pin on the crank which is attached to the main shaft. It is secured by means of a cotter pin.

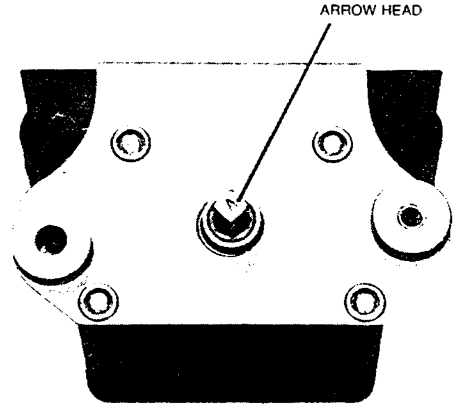


FIG. 28 — AUXILIARY SWITCH—CRANK SHAFT POSITION

7.6.2 ADJUSTMENT

If the adjustable link is installed, its length should be set, before installing, at 6 3/8 inches, between pin centers.

After installing a new switch, its operation should be checked. Viewing the switch from above, the contacts toward the front of the breaker are normally the "B" contacts. Even if a special switch is used, it is always the case that the first two stages nearest the crank have the "B" contacts to the front, and the "A" contacts towards the back. "A" contacts are closed when the breaker is closed. "B" contacts are closed when the breaker is open.

To check the setting, arrange the breaker for "slow-close" as described in Section 7.4. Through the use of a continuity tester, observe the position of the breaker contacts when the switch's LI-LIC "A" contacts touch. At this point the breaker's arcing contacts must be within .250" to .500" of closing.

Adjustment is made by disconnecting the upper end of the adjustable link and varying its length as required.

7.7 SHUNT TRIP

The shunt trip device opens the breaker when its coil is energized. An "A" auxiliary switch, which is closed only when the breaker is closed, is in series with the device coil. Connections are made to the external tripping source through secondary disconnects on drawout breakers, or to the auxiliary switch and terminal board on stationary breakers.

The shunt trip is mounted to the underside of the breaker front frame as shown in Fig. 29. A second shunt trip may also be mounted to the frame (see Fig. 30) if a second undervoltage device isn't already installed, see Section 7.8.

7.7.1 REPLACEMENT

If it is necessary to replace or add one of these devices, the easiest procedure is to remove the mounting bracket, shown in Fig. 29, from the breaker frame and remove the device from the bracket. If a replacement or new device is ordered, a mounting bracket will be supplied with the device.

If a second shunt trip is added, this is mounted by means of an additional bracket as shown in Fig. 30. This additional bracket is fastened by two of the hex head bolts used to fasten the buffer assembly to the breaker frame.

7.7.2 ADJUSTMENT

When these devices are installed or replaced, their positive ability to trip the breaker must be demonstrated. This is done by placing a 1/32-inch shim between the armature and magnet of the device and manually operating the armature to trip the breaker.

If the shunt trip is not successful in this test, check the mounting fasteners to make sure they are reasonably tight. If they are, then bend the trip paddle on the trip shaft to slightly reduce the distance between the trip arm of the device and the trip paddle, and recheck for positive trip. If this bending is necessary, be careful that it is not overdone. Verify that there is a .030"-.050" gap between the trip arm and the trip paddle with the breaker closed. This gap is necessary to prevent nuisance tripping.

7.8 UNDERVOLTAGE DEVICE

The undervoltage deivce trips the breaker when its coil is de-energized. The leads of the coil are connected directly to secondary disconnects or to a terminal board. Under normal conditions, the coil remains energized and the breaker may be closed.

"Drop-out" of the armature, with resultant breaker tripping, occurs when the voltage is reduced to less than 60 percent of the rated voltage. An open armature will render the breaker incapable of closing. The armature "picks up" and allows closing, if the voltage is 85 percent or more of its nominal value. Refer to Table 23, Section 14 for the actual drop out and pick up voltage ranges.

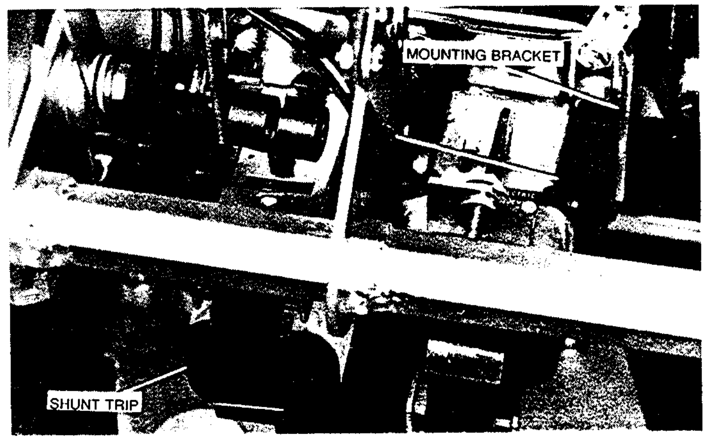


FIG. 29 — SHUNT TRIP AND UNDERVOLTAGE MOUNTING

If the breaker is disconnected, and for some reason the breaker is to be operated manually, the undervoltage device may be tied or wired down so that it will not cause tripping.

The undervoltage device is mounted to the underside of the breaker front frame as shown in Fig. 29. A second undervoltage may also be mounted to the frame (see Fig. 31) if a second shunt trip isn't already installed, see Section 7.7.

If a second undervoltage device is added, a new buffer assembly block will be supplied. This is required for clearance, in this case, the buffer assembly must be taken off, disassembled, and remounted together with the number two undervoltage device. Before disassembling the original buffer, carefully measure the distance between the faces of the threaded members as shown in Fig. 31, and set this dimension carefully on the new assembly. Refer to the breaker wiring diagram for the coil lead connections.

7.8.1 REPLACEMENT

If it is necessary to replace or add one of these devices, the easiest procedure is to remove the mounting bracket shown in Fig. 29, from the breaker frame and remove the device from the bracket. If a replacement or new device is ordered, a mounting bracket will be supplied with the device.

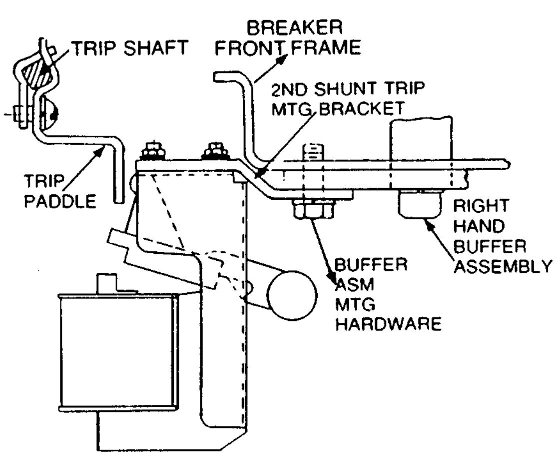


FIG. 30 — 2ND SHUNT TRIP INSTALLATION

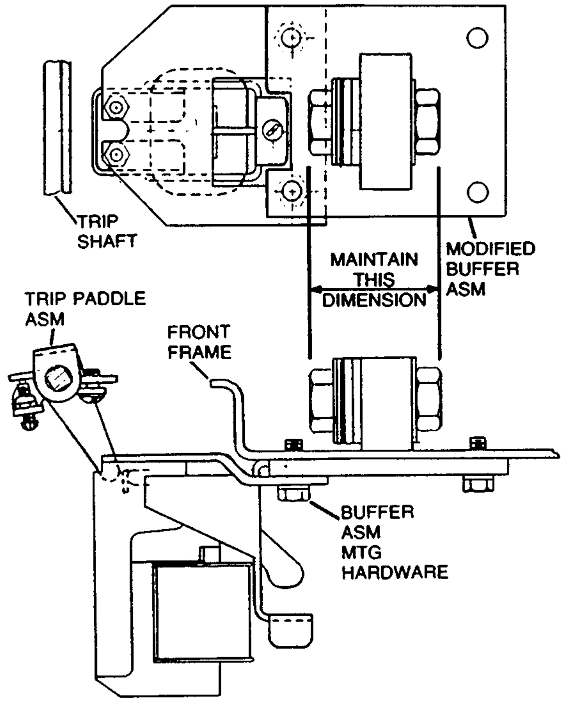


FIG. 31 — 2ND UNDERVOLTAGE DEVICE

7.8.2 OPERATIONAL CHECK

When the undervoltage device is used as part of a shut down circuit which opens the breaker by deenergizing the coil, the following operational check should be made. It is recommended that this check be performed every 12 months or every 1750 operations for AKR 30 breakers and 500 operations for AKR 50 / AKRT 50 breakers.

1. Check the trip latch engagement as described in Section 7.15. Trip Latch Adjustment.

2. Check the torque required on the trip shaft to trip the closed breaker. The value must be 24 inch-ounces maximum.

3. Check the response time required to go from **zero volts across the undervoltage coil** to the breaker contacts opening. This time should be 20 to 50 milliseconds.

If steps 1 and 2 above are acceptable, but the response time is too high, refer to Section 7.8.3.

7.8.3 ADJUSTMENTS

It is recommended that the following checks be made at the intervals given in Section 7.8.2.

1. Hold the armature against the magnet as shown in Fig. 32A and check the following:
   a. The rivet can turn freely.
   b. There is no binding between the armature pivot and the shading ring.
   c. There is a .001 to .010 inch clearance between the rivet and armature as shown in Fig. 32A. This measurement should be made at the outer edge of the armature where its constant radius is closest to the rivet.

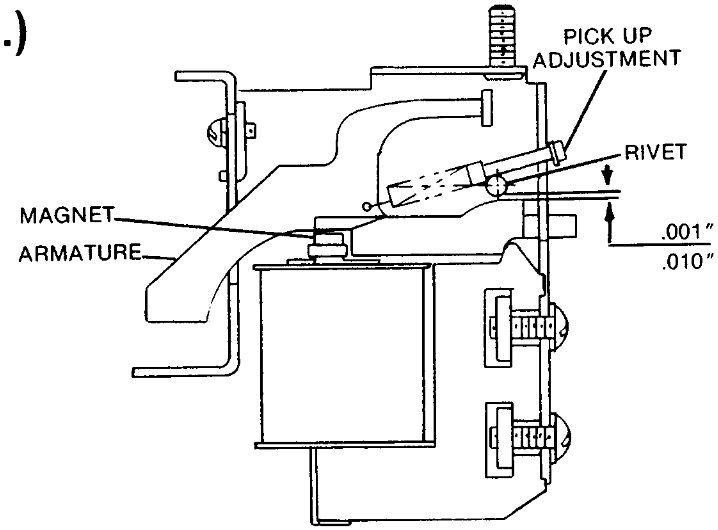


FIG. 32A — UNDERVOLTAGE DEVICE

If excessive clearance or binding exists, loosen the screws holding the magnet assembly to the frame and move the magnet up or down as necessary. Tighten the screws to 27 to 32 in-lbs.

2. The air gap between the armature and magnet with the undervoltage device de-energized should be .25 inches. Check the gap by inserting a .201 ± .005 diameter gage between the armature and magnet as shown in Fig. 32B. If necessary reset the air gap adjusting plate so that the gage pin fits. Tighten the adjusting plate screw to 9 to 11 inches and cover it with RTV.

3. Check the pick up voltage level with the undervoltage device mounted on the breaker. Refer to Table 23 for the allowable voltage ranges. The voltage measurements should be made at the breaker's secondary disconnects and with the undervoltage coil energized. The coil should also be close to room temperature (approx. 20-24°C) when taking voltage measurements. The coil resistance will increase as its temperature increases and will change the actual pick up level.

If necessary, the pick up level is changed by using the adjustment screw shown in Fig. 32A. Remove the locking wire, turn the screw clockwise to raise the pick up level and counterclockwise to lower. Once the pick up level is set, install the locking wire. Allow the coil to cool and then recheck the pick up level with 3 quick measurements.

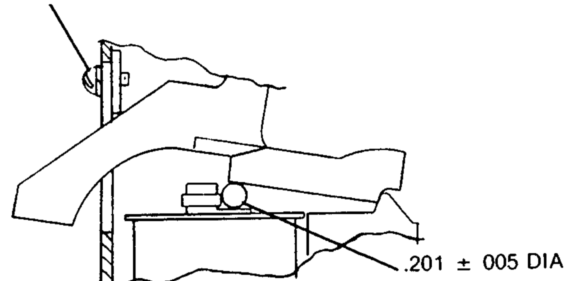


FIG. 32B — OPEN GAP CHECK

When adjusting the pick up level on instantaneous dc undervoltage devices, set the gap between the armature and magnet to .030 inches using the adjustment screw as shown in Fig. 32C. After setting the pick up level, use this same adjustment screw to obtain the drop out setting. Cover the adjustment screw locknut with RTV.

4. When this device is installed or replaced, its positive ability to trip the breaker must be demonstrated.

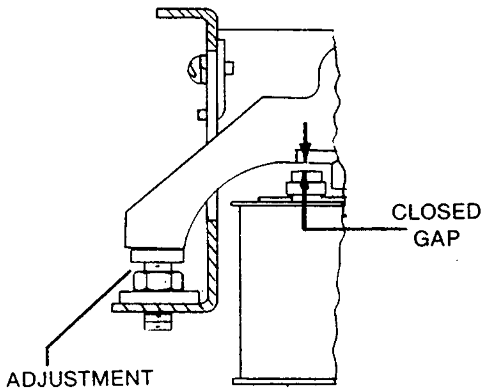


FIG. 32C — CLOSED GAP CHECK

Undervoltage devices trip the breaker when the armature opens. This causes an extension on the armature to strike the paddle on the trip shaft. An extension of the other end of the armature. When the armature is released, this extension stops against a stop which is factory set. To check positive trip, the armature should be held down, the end of a 1/32-inch diameter wire should be inserted against the stop, and the armature released. If this trips the breaker, the setting is correct. The place to insert the wire is shown in Fig. 32D. Note that only the tip of the wire is to be against the stop.

If the undervoltage device does not have positive tripping ability, the adjustment screw of the trip paddle assembly on the trip shaft may be turned in increments of half turns until the check is successful.

When the undervoltage device is closed and the breaker mechanism is reset, there must be clearance between the trip paddle and the device armature.

7.9 STATIC TIME-DELAY UNDERVOLTAGE

The static time-delay undervoltage system consists of a time-delay unit which controls an instantaneous undervoltage device. The time-delay unit is separately mounted in the switchgear and the undervoltage device is mounted on the breaker. Table 5 lists the catalog numbers available.

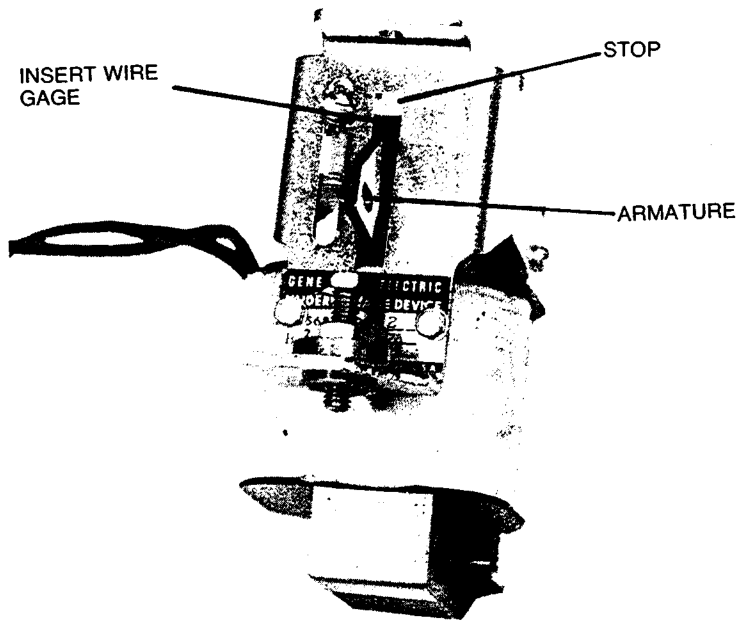


FIG. 32D — POSITIVE TRIP CHECK

If the a-c control voltage is any voltage other than 208/240V ac, a control power transformer (also remotely mounted with respect to the breaker) must be used. This must have a minimum rating of 100 volt-amperes.

When installed, the voltage to be monitored is connected across terminals No. 1 and No. 2 of the static delay box. The coil of the tripping unit is connected across terminals No. 4 and No. 5 of the static box through the secondary disconnects of the breaker. The secondary disconnects to be used will be shown on the breaker wiring diagram.

No more than one undervoltage tripping device should be used in conjunction with one static time-delay unit.

The static time-delay undervoltage can also be furnished with a thermotector control unit. Overheating of motor windings causes the thermotector, imbedded in the motor windings, to open. This de-energizes the undervoltage device on the breaker and drops the motor load.

7.9.1 ADJUSTMENTS

In the event the system fails, the following checks are recommended to determine whether the undervoltage device on the breaker of the static time delay unit is the faulty component.

1. Check input voltages across terminals 1 and 2 on the static box. See Table 5 for these values.

2. Check output voltages on terminals 4 and 5 with the undervoltage device connected. See Table 5 for values.

TABLE 5 TIME-DELAY UNITS

CAT. NO.	CONTROL VOLTAGE TERMINALS 1 & 2	APPROXIMATE STEADY STATE DC OPERATING VOLTAGE TERMINALS 4 & 5	NOMINAL DC COIL RESISTANCE (OHMS) @ 25°C
TAKYUVT-1	125 VDC	50	440
TAKYUVT-2	250VDC	100	1600
TAKYUVT-3	208/240 VAC	110/125	1600

3. Check resistance of the disconnected undervoltage device. See Table 5 for values.

See instruction Sheet GEH-4545 for more detailed information, including schematic diagrams and circuit description.

The undervoltage device must be calibrated through the time-delay unit after the device pick up has been adjusted. A .008 inch minimum closed gap must exist between the armature and magnet as shown in Fig. 32C. Refer to Section 7.8.3 and Table 24.

7.10 ELECTRIC LOCKOUT DEVICE

The electric lockout device utilizes an undervoltage device to keep the breaker from resetting its mechanism if the breaker is open and the undervoltage device coil is not energized. The breaker thus cannot be closed unless voltage is on the coil. Once the breaker is closed, loss of voltage will not trip the breaker because, in the closed position, a mechanical link is used to hold down the armature of the device. See Fig. 33. This arrangement provides a means of electrically interlocking two breakers so that they cannot be closed at the same time. Each undervoltage coil may be wired in series with a "B" auxiliary switch contact on the other breaker for cross-interlock purposes.

On each breaker having an electric lockout, an arrangement is made which *will* allow breaker closing with the coil de-energized. This is provided to allow "start-up" on "dead" systems. Figure 34 shows this device. The push slide shown is located in the opening in the lower part of the escutcheon. This breaker door must be opened to gain access to it.

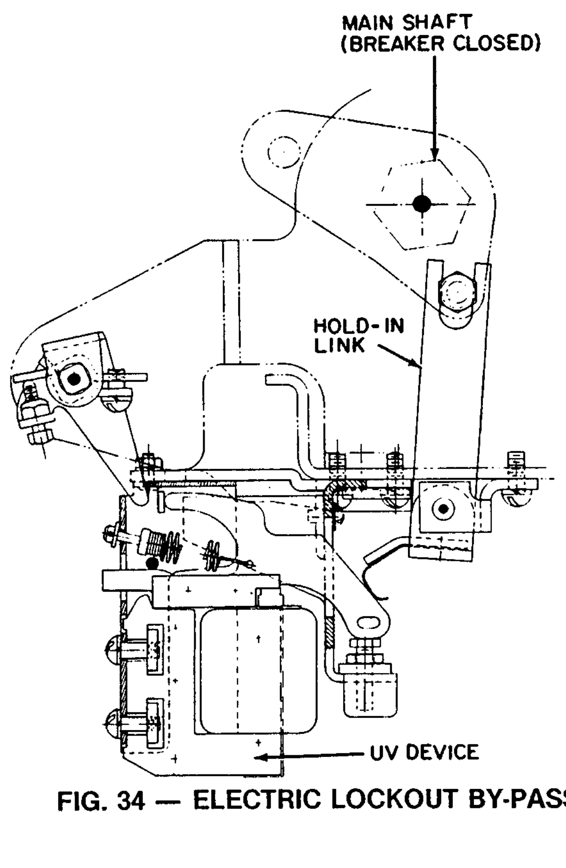


FIG. 34 — ELECTRIC LOCKOUT BY-PASS

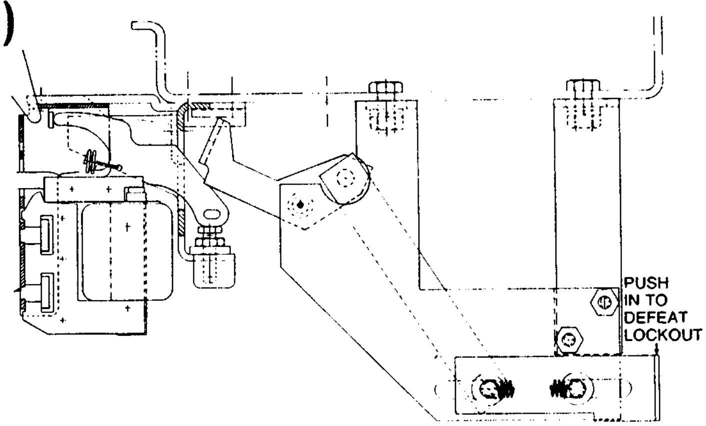


FIG. 33 — ELECTRIC LOCKOUT DEVICE

7.11 BELL ALARM

This device is used to give a remote indication of the breaker's having tripped open through the action of one of its automatic protective devices. It will not be activated by manual tripping or the action of the shunt trip. A remotely mounted protective relay energizing the shunt trip will therefore not result in the remote alarm action.

The bell alarm circuit may be turned off by pushing in the manual trip or by energizing the shunt trip. In the latter case, a normally open contact of the bell alarm switch must be wired in parallel with the "A" auxiliary switch contact in the shunt-trip circuit. Closing the breaker will also turn off the alarm.

The bell alarm device may be equipped with a lockout link which will lock the breaker open until the bell alarm device is reset.

The bell alarm is not a standard device and is supplied only when specified on the breaker order.

7.11.1 OPERATION

Referring to Fig. 35: the bell alarm mechanism is activated by a crank which is assembled to the breaker's main shaft. When the breaker opens, a pin attached to this crank moves the alarm link against the switch and locklever (if provided). This activates the switch contacts. It also moves the locklever adjustment screw against the trip shaft paddle keeping the breaker trip free.

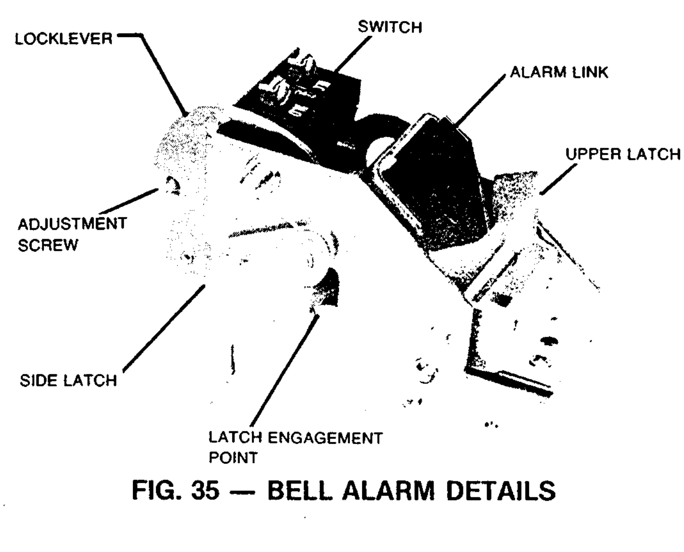


FIG. 35 — BELL ALARM DETAILS

SECTION 7—Breaker Maintenance (Cont.)

The mechanism is reset by disengaging the side latch link from the upper latch link or by closing the breaker if a locklever is not provided. The side latch link, is activated only by pushing the TRIP button or operating the shunt trip.

A slide attachment on the TRIP button shaft moves against the side latch link when the TRIP button is pushed. This slide attachment is factory adjusted to activate the side latch before the breaker is tripped. A second arm on the shunt trip also activates the side latch link when the shunt trip is energized.

7.11.2 ADJUSTMENTS

If a breaker is equipped with a bell alarm/lockout device originally, all the adjustments are made at the time of assembly. Switch operation is controlled by means of shims of insulating material placed between the switch body and the bracket to which it is fastened. The adjustment screw is positioned so that when the locklever is in its activated position, it holds the breaker mechanism latch in the tripped position.

Check that TRIP button shaft and shunt trip operations, besides tripping the breaker, displace the side latch and prevent the bell alarm switch from operating. The other trip devices and interlocks must activate the bell alarm when they open the breaker.

The bracket assembled to the TRIP button shaft must be adjusted so that it will displace the side latch when or before the shaft opens the breaker. Maintain a .030 inch minimum gap between the bracket and the side latch when the breaker is closed. A .187 inch depression of the TRIP button must not trip the breaker, but a .375 inch must trip the breaker and displace the side latch.

7.11.3 REPLACEMENT

The bell alarm is mounted on the right hand side of the breaker at the rear of front frame. It is located under the mechanism's main shaft.

The bell alarm is removed by passing it through a cutout in the rear bend of the front frame, slipping it between the front frame and trip shaft and out through the bottom of the breaker as follows:

1. Remove the 4 bell alarm mounting screws from the bottom of the front frame.

2. If the crank which is part of the main shaft has a bell alarm activating pin assembled to both sides, remove these pins.

3. Insert the flat of the maintenance handle between the top of the left hand side buffer block and the end plate assembly. This should eliminate any interference from the main shaft during the bell alarm removal.

4. The trip shaft must be moved to allow the bell alarm to fit beteen it and the front frame. Remove the retaining ring holding the right hand trip shaft bearing to the mechanism frame. Slide the bearing from the frame and along the trip shaft. There will now be enough trip shaft movement to slip the bell alarm past.

5. Install the replacement bell alarm in reverse order.

6. Check the adjustments given in Section 7.11.2

A bell alarm with a lockout assembly or a bell alarm installed on a 2000 amp frame (AKRT 50/50H) breaker may not work with the above procedure. If this is the case, the breaker front and back frame will have to be seperated.

7.12 ELECTRICAL CONTROL COMPONENTS

The operation of the electrical control components is described in Section 5.2. The location of these components is shown in Fig. 36A.

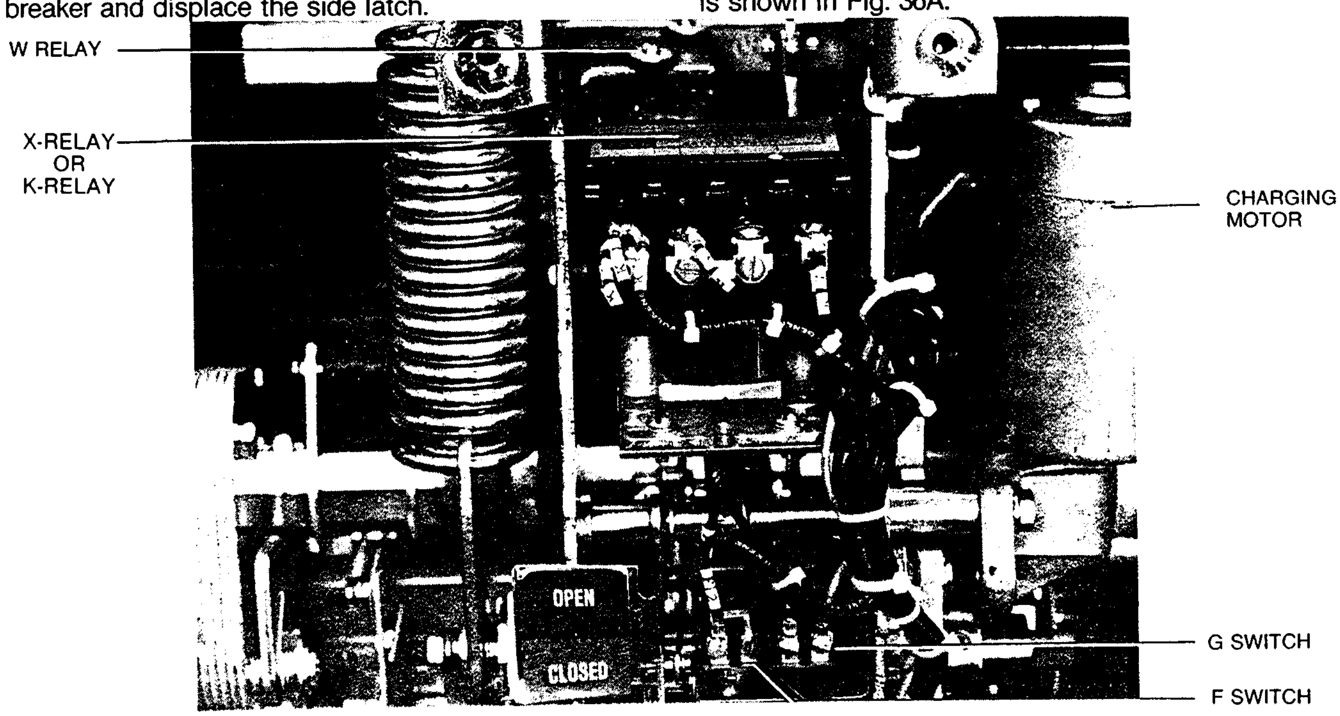


FIG. 36A — ELECTRICAL CONTROL COMPONENTS

7.12.1 COMPONENT REPLACEMENT

To gain access to the electrical control components, the breaker's front escutcheon must be removed. Type B and D breakers require that both the deep molded escutcheon and the shallow steel escutcheon be removed. Before removing the front escutcheon on Type A or B breakers, a supporting block should be placed under the front frame to keep if from tlipping forward.

Referring to Fig. 36A, the X-relay or K-relay and F and G switches are mounted on the same bracket. This mounting bracket is fastened to the right-hand mechanism side frame by two hex-head 1/4-20 screws. Removing these screws allows the bracket to be pulled forward from between the mechanism side plates. The W-relay must also be unfastened from the left side frame to allow enough freedom for all the devices and the wiring harness to be taken from between the side frames. With the bracket removed, individual devices can be replaced easily.

The closing solenoid is mounted by means of mounting bracket to the bottom of the breaker frame. The most convenient way to take off the solenoid is to remove the mounting bracket and then disconnect the solenoid from the bracket. The pin connecting the armature to the closing link must also be removed.

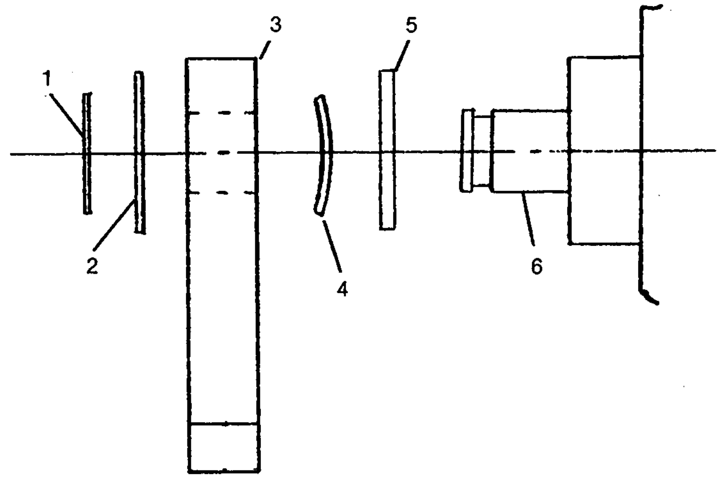
The charging motor is secured through three spacers to the mechanism frame. The front mounting bolt is accessible using a socket and universal joint through the opening in the side of the breaker's frame. The upper rear mounting bolt is accessible using a socket and universal joint over the top of the frame. The lower rear mounting bolt is accessible using a socket and universal joint through the opening in the frame's side by the buffer assembly. Slow-close the breaker to move the flywheel assembly out of the way.

The ratchet on the camshaft is removed by driving out the roll pin which fastens it to the camshaft. Before this can be done, the charging motor must be removed and the closing spring arranged for "slow-closing" as described earlier. Turn the camshaft, using the maintenance handle, until the roll pin is well started, turn the camshaft to gain enough space for the roll pin to clear the breaker frame. Before removing the ratchet note the position of the ratchet's roller or mark the ratchet's hub and the camshaft.

When replacing the ratchet, be sure it is oriented with respect to the camshaft as it was originally and not displaced 180 degrees. Align the mark made on the hub with the mark on the camshaft or position the roller as it was. If the ratchet is displaced 180 degrees, the holes in the ratchet's hub will not completely line up with the holes in the camshaft.

The driving pawl is assembled to the charging motor's drive pin as shown in Fig. 36B. To replace the driving pawl:

1. Remove the charging motor.
2. Remove the retaining ring from the drive pin. Slip off the components.
3. Wipe off any grease or dirt from the drive pin. *DO NOT LUBRICATE.*
4. Install the components as shown.

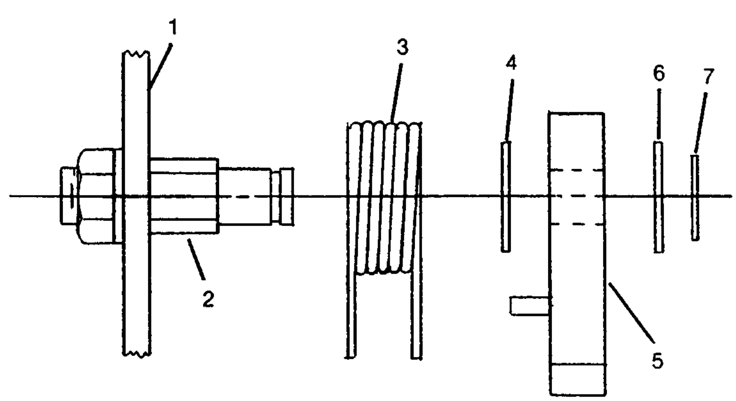


1. RETAINER RING
2. WASHER .010″
3. PAWL ASM
4. SPRING WASHER
5. WASHER .032″
6. MOTOR DRIVE PIN

FIG. 36B — DRIVING PAWL ASSEMBLY DETAILS

The holding pawl pivots on a pin which is assembled to the mechanism frame. Refer to Fig. 36C. To replace the holding pawl:

1. Remove the front escutcheon for accessibility.
2. Using the maintenance handle, rotate the ratchet enough to disengage the holding pawl.
3. Remove the retaining ring and washer from the pivot pin.
4. While holding the spring pressure from the holding pawl, remove the existing pawl and slip on the new pawl.
5. Install the washer and retaining ring.
6. Verify that the holding pawl engages a minimum of 4 ratchet laminations.
7. Verify that the holding pawl pivot pin is perpendicular to the mechanism frame. The hardware which assembles the pivot pin to the frame must be torqued to 250 in-lbs minimum. If this hardware must be retightened, add LOCTITE 290 to the shaft threads.
8. Install the front escutcheon. Tighten the escutcheon hardware to 80 ± 10 in-lbs.



1. MECHANISM FRAME
2. PIVOT PIN
3. SPRING
4. WASHER .032″
5. PAWL ASM
6. WASHER .010″
7. RETAINING RING

FIG. 36C — HOLDING PAWL ASSEMBLY DETAILS

7.12.2 F AND G SWITCH ADJUSTMENT

For proper electrical operation, the F and G mechanically operated switches must operate at the proper point in the closing cycle. If these switches are to be replaced, measure the distance between the tip of the switch button and the bracket on which they are mounted. When the new switch is mounted, duplicate the measured dimension, then check for proper operation.

When a normal closing operation occurs, the ratchet usually comes to a stop with an arbitrarily designated ratchet tooth No. 1, Fig. 37, engaged by the holding pawl. This tooth is the one which is in line with an imaginary line passing through the centers of the camshaft (2) and the rivet opposite the roller on the ratchet assembly. It is matter of no concern if the action stops on a different tooth, but it is important to positively identify tooth No. 1 by the method described.

To check the switch action, after tooth No. 1 has been identified, turn the camshaft with the maintenance handle and count the teeth as they pass the holding pawl. By using a continuity tester, observe when the switches operate as the ratchet turns. The normally open F switch on the left will close, and the G switch will open.

Electrical breakers should operate the switches while moving from tooth No. 10 to tooth No. 11.

If this check shows that an adjustment is needed, the switch to be corrected can be moved closer to or farther away from the paddle which operates the switches. A very thin open-end 5/8-inch wrench will be needed to loosen or tighten the nuts which fasten the switches to the bracket.

7.13 DRAWOUT MECHANISM

The drawout mechanism shown in Fig. 38 moves the breaker through the DISCONNECTED, TEST, and CONNECTED positions. Fig. 39 shows how the drawout mechanism is mounted to the breaker.

As the racking handle is turned, the internally threaded trunnion moves on the screw threads, rotating the hex shaft, on the ends of which are fastened the arms which engage the fixed pins in the drawout enclosure.

The trunnion travels between the two jamb nuts on the end of the screw, and the adjustment sleeve, which stops the trunnion movement at the other extreme point of its travel. The trunnion is against the jamb nuts when the breaker is fully racked out and against the sleeve when fully racked in.

The racking mechanism is adjusted at the factory assembly operation so that the action is stopped in either direction at the precisely correct point. The jamb nuts are set so that when the trunnion is against them the relation between the arms and the equipment pins they engage is shown in Fig. 38. The length of the sleeve, which is free to slide on the threaded shaft, is controlled by the amount of thread engagement between the sleeve and its collar. This length is adjusted to stop the trunnion when the distance between the ends of the equipment and breaker studs is .032″ to .218″. After this adjustment is made, the sleeve and its collar are locked together by the set screw.

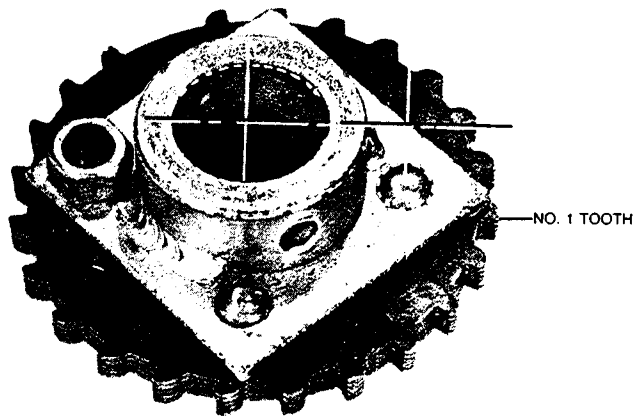


FIG. 37 — LOCATION OF RATCHET TOOTH NO. 1

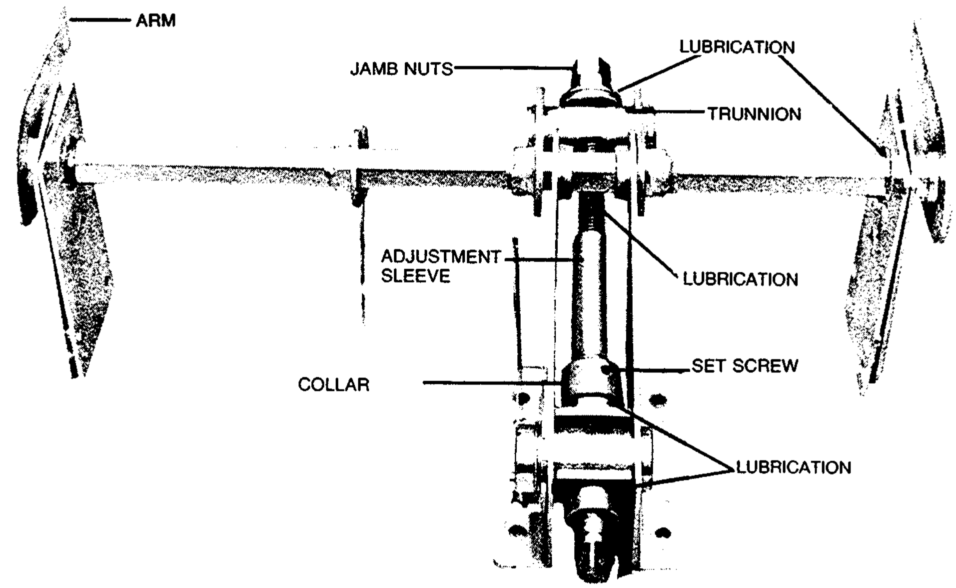


FIG. 38 — DRAWOUT MECHANISM DETAILS

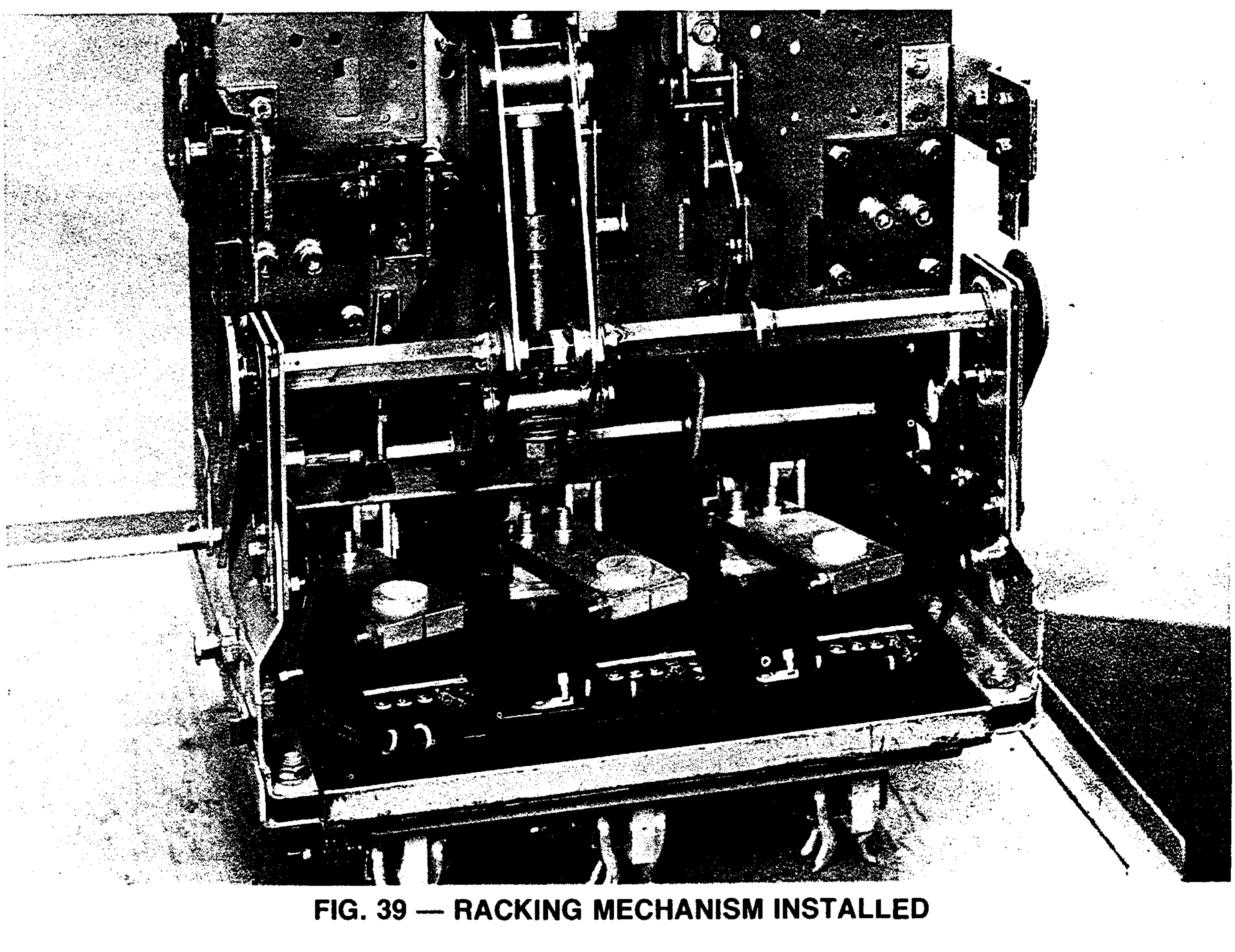


FIG. 39 — RACKING MECHANISM INSTALLED

SECTION 7—Breaker Maintenance (Cont.)

7.14 BUFFER ASSEMBLY

When the breaker is closed, the energy in the closing spring is transferred to the main shaft through the mechanism. The main shaft then drives the contacts closed. The end plate assembly on each end of the main shaft is driven against the buffer assembly shown in Fig. 40. This prevents the mechanism from overdriving the contacts.

When the breaker is opened, the end plate assembly is driven against the opposite end of the buffer assembly. The buffer is a stop absorbing the opening energy of the mechanism. See Fig. 41.

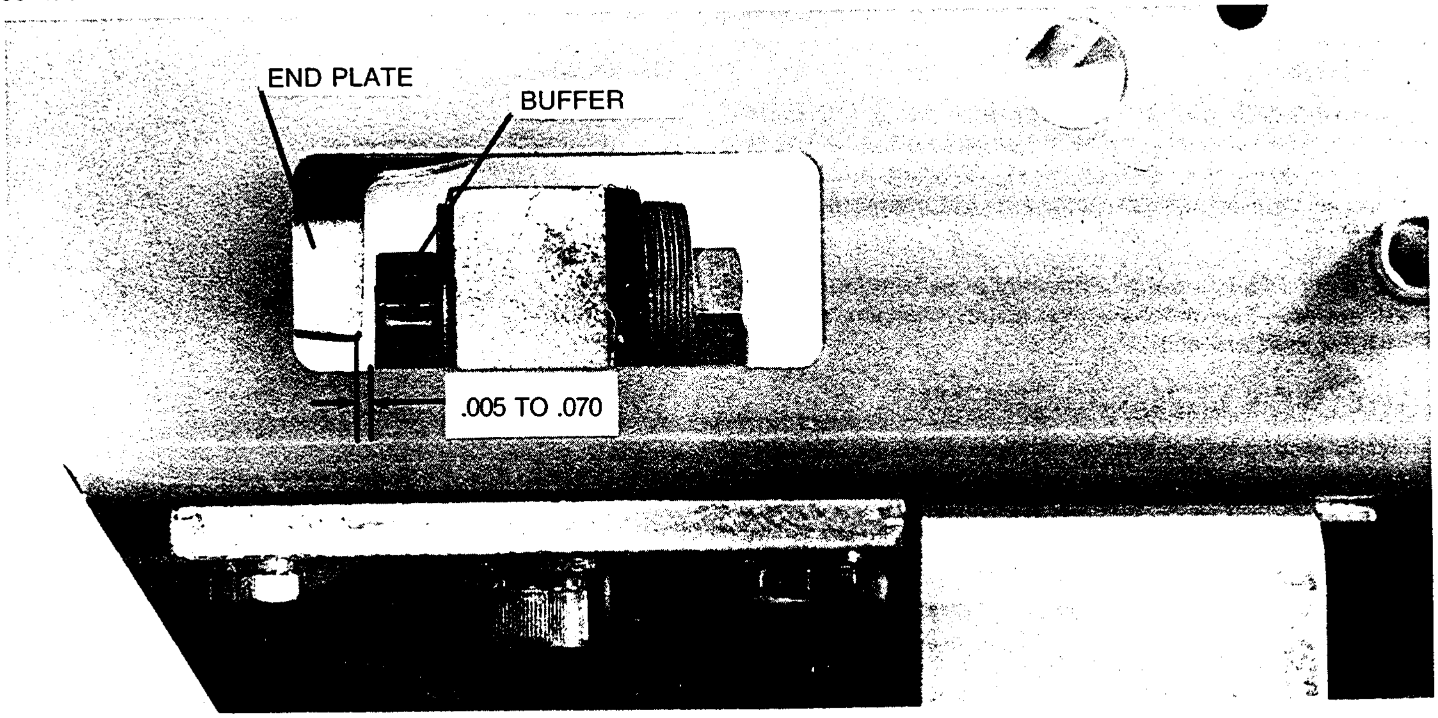


FIG. 40 — BUFFER/END PLATE RELATIONSHIP—BREAKER CLOSED

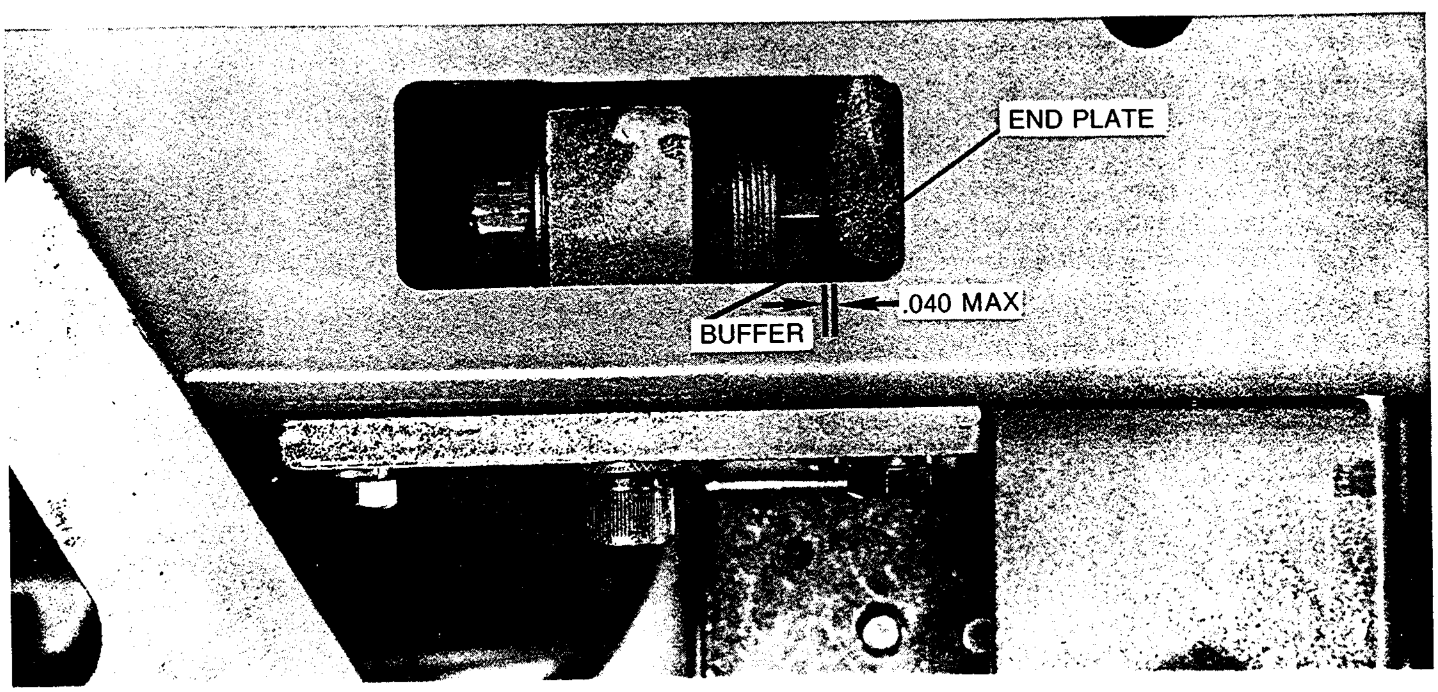


FIG. 41 — BUFFER/END PLATE RELATIONSHIP—BREAKER OPEN

7.14.1 BUFFER ADJUSTMENT

Referring to Fig. 40, with the breaker closed and the mechanism not reset, a .005″ min. clearance must exist between the end plate assembly and the buffer nut as shown. This dimension is factory set. It can be reset by tightening the buffer nut. Hold the nut with a screwdriver and tighten using a socket on the bolt head opposite the nut. When tightening this assembly don't over compress the neoprene washers by overtightening the assembly. These washers absorb the breaker opening shock.

Referring to Fig. 41, with the breaker open, a .040″ maximum clearance can exist between either of the end plate assemblies and the buffer bolt heads as shown. If a larger clearance exists, close it up by unscrewing the buffer assembly involved.

Fig. 42 shows a buffer assembly prior to being installed in a breaker. The dimensions given establish the number of spacers that are used.

7.15 TRIP LATCH ADJUSTMENT

The reset position of the trip latch is set by the adjustment screw shown in Fig. 43. The adjustment is correct if three and one-half turns of the adjustment screw causes a closed breaker to trip. If this check is made, the screw must then be set back, or unscrewed, three and one-half turns.

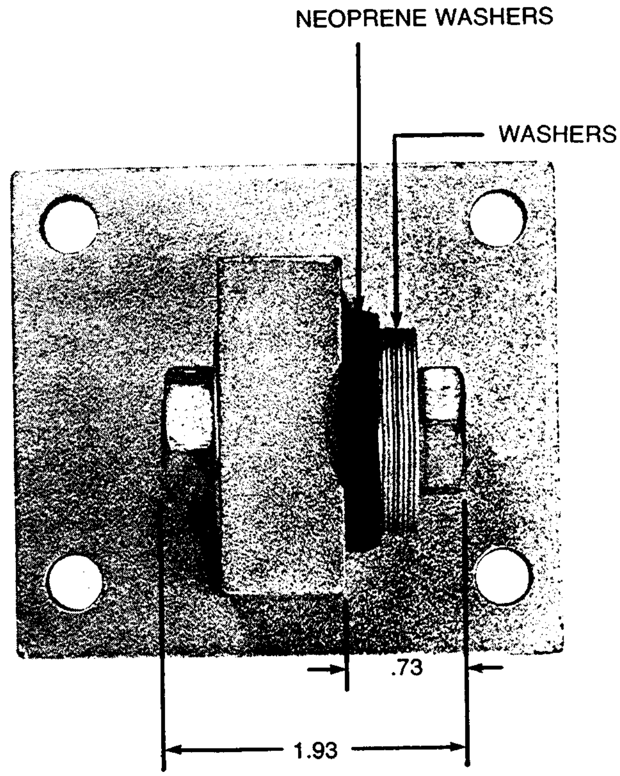


FIG. 42 — BUFFER ASSEMBLY

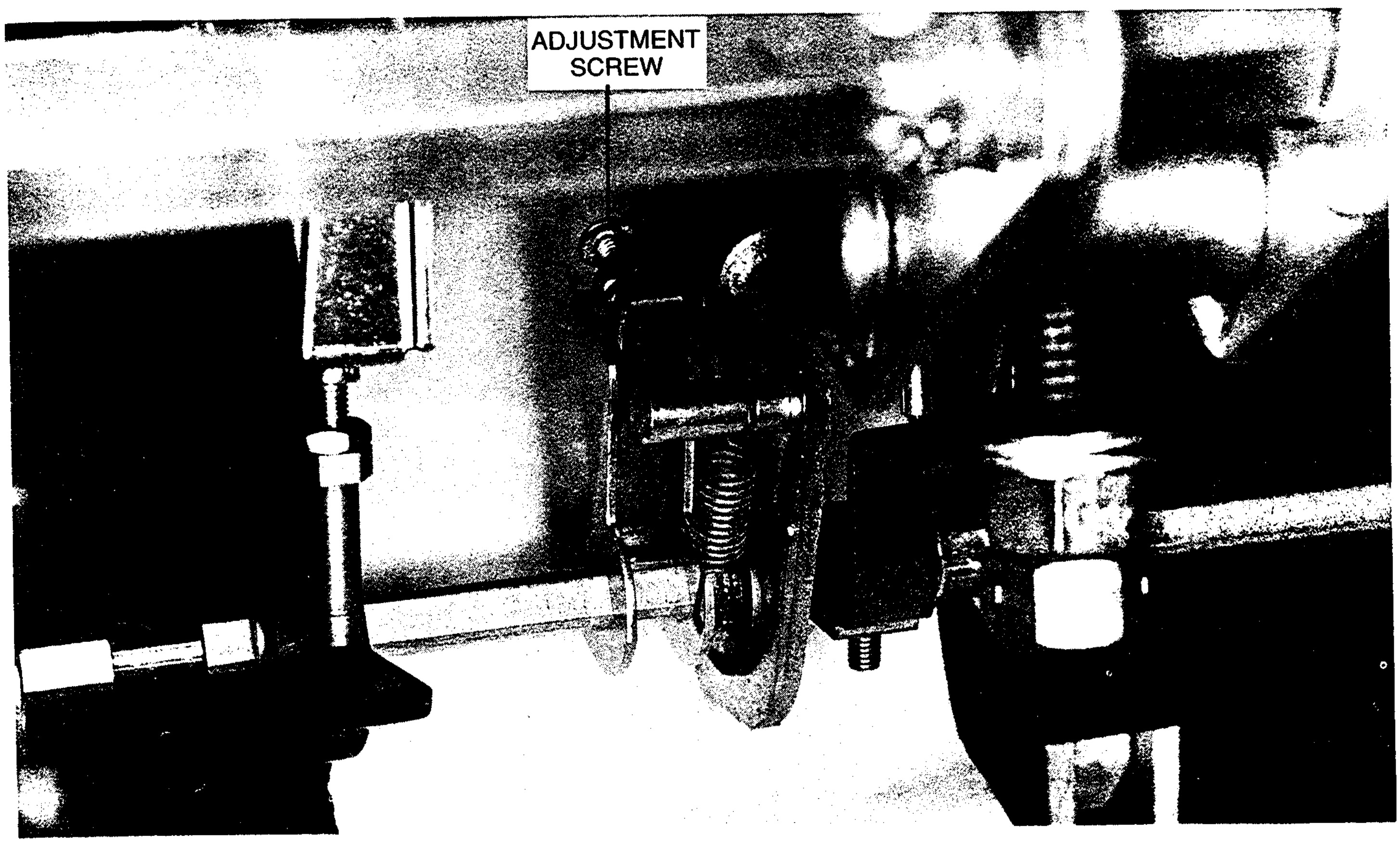


FIG. 43 — TRIP LATCH ADJUSTMENT

SECTION 8—Contact Maintenance

Breakers subjected to frequent interruption of high currents may eventually require replacement of their contacts. The general rule for determining need of replacement is the loss of one-half or more of the mass of the contact tip material. Roughening or light pitting of the contact surface does not indicate loss of ability to carry or interrupt current.

When contacts are replaced, they must be adjusted to ensure that the proper amount of force is developed between the movable and stationary contacts when the breaker is closed. This is called the "wipe" adjustment. "Wipe" is the distance through which the stationary contacts move when the breaker closes. It is measured between the point of contact on a stationary contact when the breaker is open, and the position of the same point when the breaker is closed. The actual wiping motion is greater because the contacts over-travel. "Wiping" imparts a sliding or "scrubbing" action to the contacts.

The wipe adjustment influences proper arc transfer during interruption of fault currents. "Transfer" of the arc is its forced sequential movement from the intermediate contacts to the arcing contacts to the arc runner and finally to the arc quencher where it is dissipated and extinguished. It is recommended that contact wipe be checked periodically during normal maintenance inspections.

> **CAUTION:** *BEFORE DOING ANY OF THE FOLLOWING CONTACT ADJUSTMENT AND REPLACEMENT WORK, MECHANICALLY DISCONNECT THE CLOSING SPRING FROM THE MECHANISM CAM SHAFT AS DESCRIBED UNDER SLOW CLOSING THE BREAKER, SECTION 7.4*

8.1 ARC CHUTE REMOVAL AND INSPECTION

There are two types of arc chute construction used on the 800 thru 2000 ampere breakers. They are the ceramic type shown in Fig. 5 and the molded type shown in Fig. 6. The ceramic type uses a two piece porcelain frame to enclose its internal parts. The molded type uses a one piece, glass-filled polyester frame.

The 800 ampere arc chute is different from the 1600 and 2000 ampere arc chute, which are identical. Therefore, the 800 ampere arc chute cannot be interchanged with the 1600/2000 ampere arc chute. Also note that a breaker must have either all ceramic or all molded type arc chutes installed, do not intermix on the same breaker.

The arc chutes are held in place by retainers secured by bolts through the mechanism frame. The ceramic type uses two retainers and the molded type uses only one. To remove the arc chutes:

1. Loosen and back off the retainer bolt locking nut from the mechanism frame. They do not have to be removed.

2. Loosen the retainer bolts until the retainer(s) can be removed.

3. With the retainer(s) removed, lift the arc chutes off for inspection.

Inspect each arc chute for excessive burning and erosion of the arc plates and arc runner. Also look for fractures, damage to the liner material used in the molded arc chute and damage to the insulation material used in both arc chutes. Check for any missing parts.

To install the arc chutes:

1. Replace the arc chutes over each pole unit.

2. Locate the retainer(s).

3. Tighten the retainer bolts until the arc chutes are secure. There may be some side to side motion of the arc chutes, but there must not be any front to back motion. Torque the retainer bolts to 30 in-lbs for the molded type arc chutes and 60 to 100 in-lbs for the ceramic type. Do not over tighten.

4. Tighten the locknuts against the mechanism frame with 150 to 175 in-lbs torque.

SECTION 8—Contact Maintenance (Cont.)

8.2 CONTACT ADJUSTMENT — AKR 30/30H & AKRU 30

The contact structure of the AKR 30 and the AKRU 30 breakers is slightly different from the AKR 30H. Referring to Fig. 44 A & B, both structures use one moveable contact arm, and two stationary arcing contacts. However, the AKR/AKRU 30 uses three stationary main contacts and the AKR 30H uses four.

The following wipe adjustment procedure is applicable to all AKR-30 types:

1. Open the breaker, remove arc quenchers.
2. Slow-close the breaker. The cam roller must be supported by the cam and not the prop. Refer to section 5.3.
3. Select one pole and, using a flat or wire feeler gage, measure the gap between the top contact and its pivot stud as shown in Fig. 45. As necessary, adjust the gap to 0.060 ± 0.020 inch by turning the wipe adjustment nut shown in Fig. 46.
4. Once the gap dimension is set, verify that the torque required to just turn the adjustment nut is greater than 40 in-lbs. If less torque is required, carefully add LOCTITE 220 to the adjustment nut threads. Wipe off any excess LOCTITE. Once the LOCTITE is set, recheck the torque valve.
5. Repeat above procedure on the other pole units.
6. Trip the breaker.

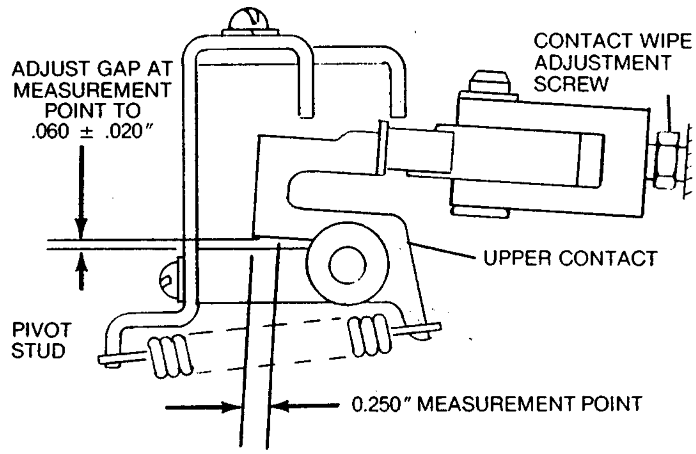


FIG. 45 — WIPE ADJUSTMENT 800 AMP CONTACT STRUCTURE

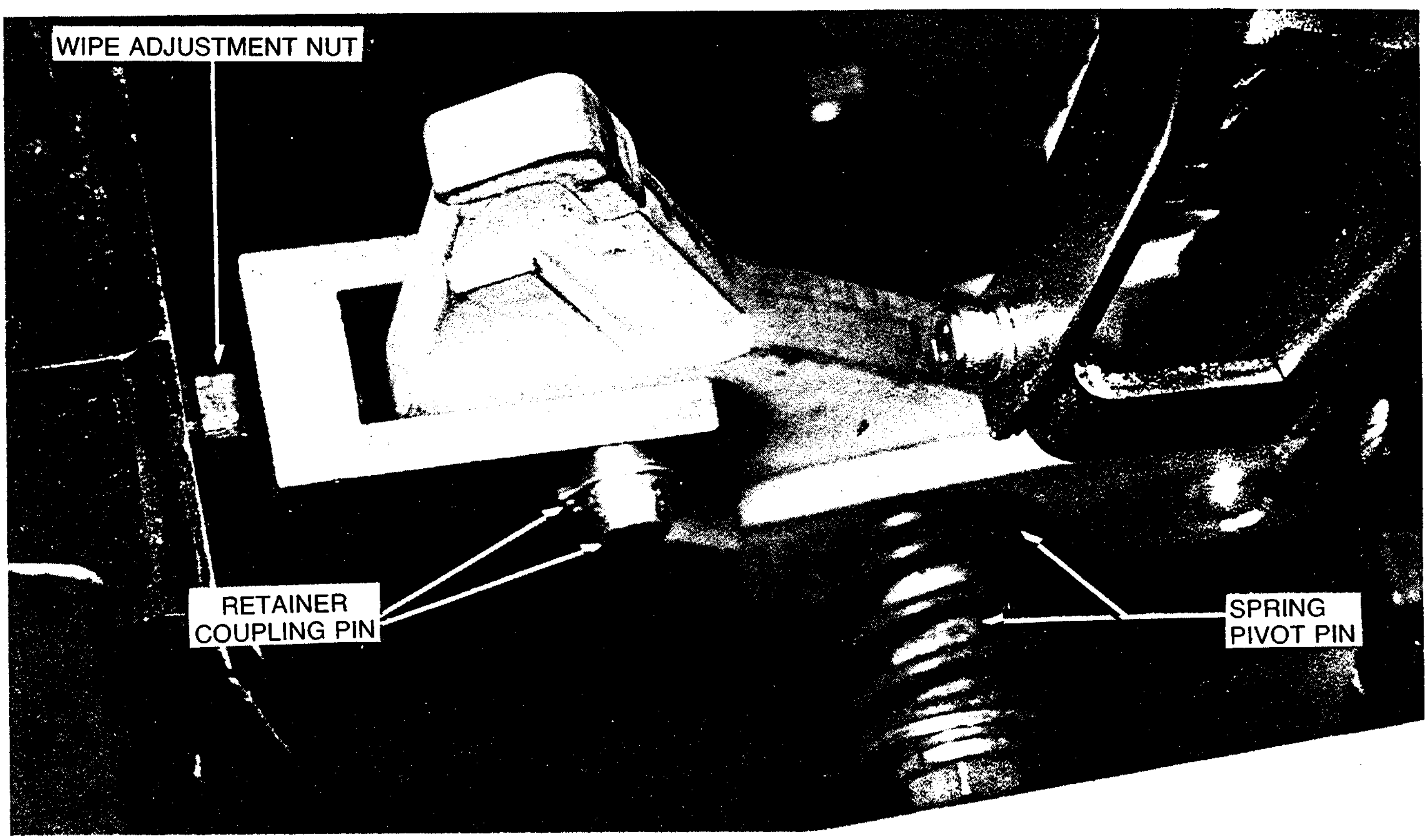
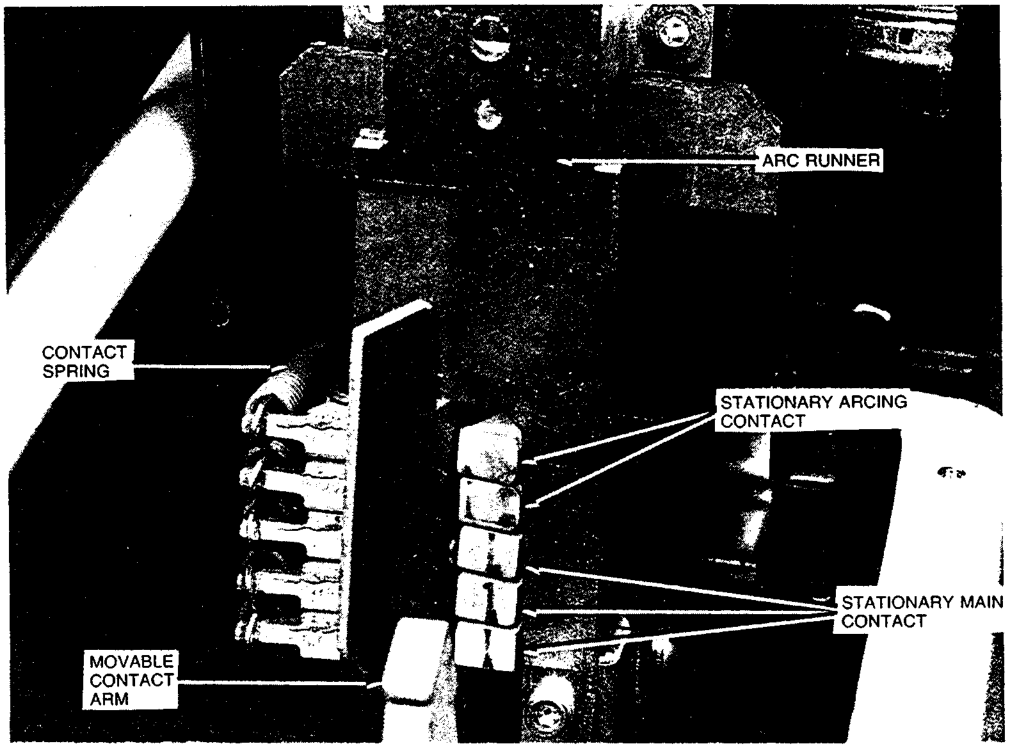


FIG. 46 — WIPE ADJUSTMENT NUT—800 AMP CONTACT STRUCTURE

SECTION 8—Contact Maintenance (Cont.)



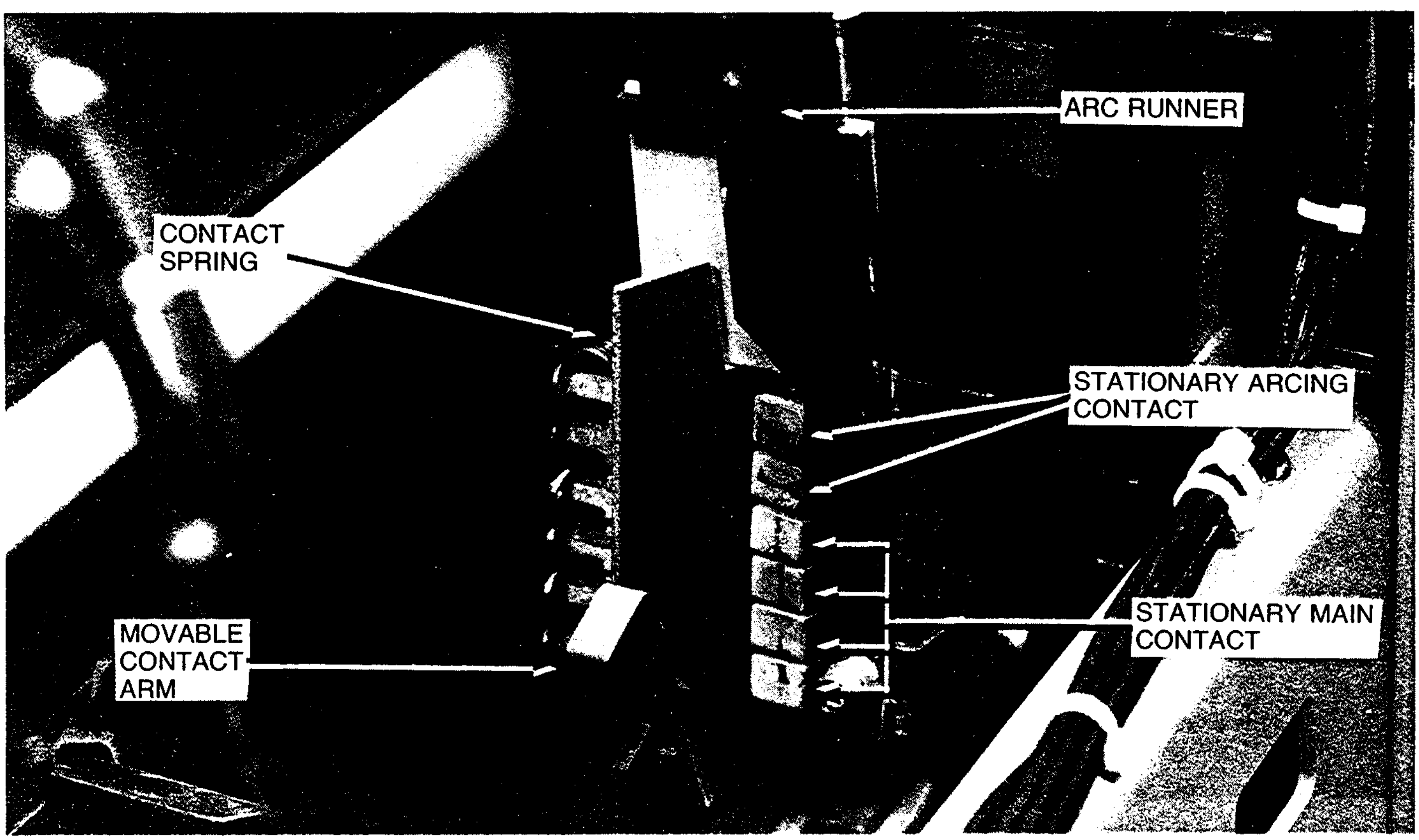


FIG. 44B — AKR 30H
800 AMP CONTACT STRUCTURES

SECTION 8—Contact Maintenance (Cont.)

8.3 CONTACT ADJUSTMENT — AKR 50/50H & AKRU 50

The contact structure shown in Fig. 47 is used by all AKR50 breaker types. This structure uses two movable contact arms. Each arm acts against a stationary arcing, a stationary intermediate and three stationary mains.

The following procedure is used to perform the wipe adjustment.

1. Open the breaker, remove arc quenchers.

2. Arrange the breaker for slow-closing. The cam roller must be supported by the cam and not the prop. Refer to Section 5.3.

3. Select one pole of the breaker and place a thin sheet or strip of tough insulating material, such as mylar, over the stationary arcing and intermediate contacts. This strip should be about two inches wide and must prevent the arcing and intermediate contacts from making contact when the breaker is closed.

4. Using the ratcheting maintenance handle, slow-close the breaker with the insulation held in place. Examine the insulation to make sure it "over-hangs" below the intermediate contacts, but not enough to cover the main contacts.

5. Attach a continuity checker (bell-set, light, or ohmmeter) between the upper and lower stud. The checker should indicate continuity exists.

6. Facing the breaker, turn the wipe adjustment stud shown in Fig. 47 clockwise until the checker indicates that the main contacts are separated.

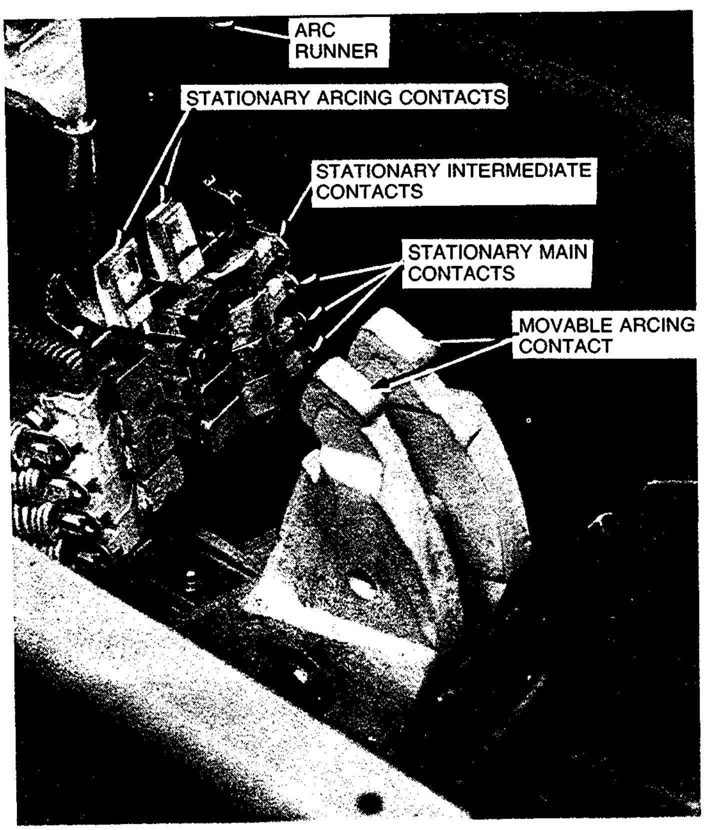
7. Turn the stud counter-clockwise until the main contacts just touch.

8. From this point, advance the stud counter-clockwise 270 degrees. This will be 4-1/2 flats.

9. Once the adjustment is complete, verify that the torque required to just turn the adjustment nut is greater than 40 in-lbs. If less torque is required, carefully add LOCTITE 220 to the adjustment nut threads. Wipe off any excess LOCTITE. Once the LOCTITE is set, recheck the torque valve.

10. Trip the breaker, remove the insulating strips.

11. Repeat the above procedure on the other two poles.



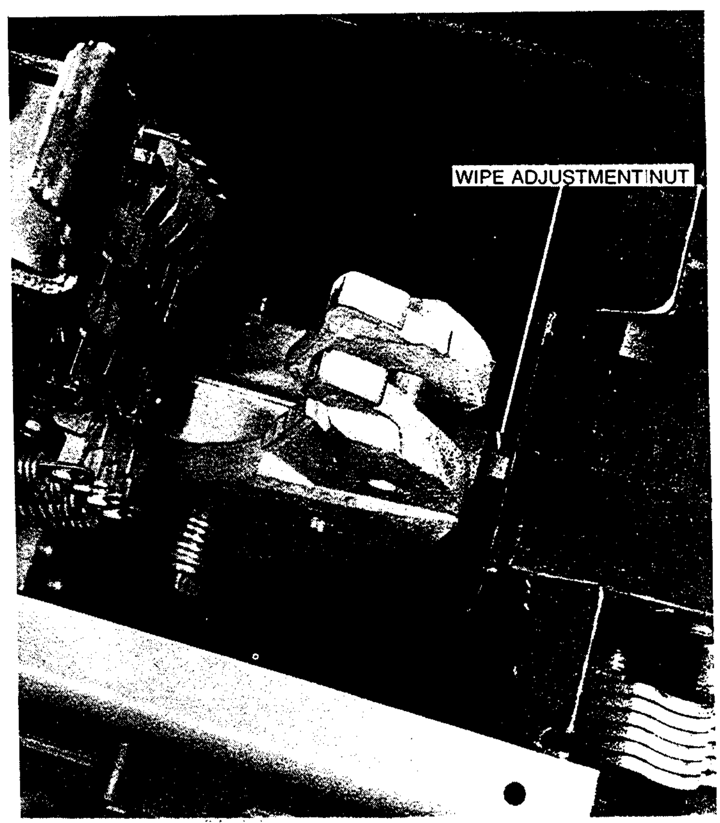


FIG. 47 — 1600 AMP CONTACT STRUCTURE

8.4 CONTACT ADJUSTMENT— AKRT 50/50H

The contact structure shown in Fig. 48 is used by all AKRT 50 breaker types. This structure is similar to the AKR 50 structure. There are two movable contact arms, each acting against single stationary arcing and intermediate contacts and four (not three) stationary mains.

There are two designs used to connect the movable contact arms to the insulated link. This results in two contact adjustment procedures depending on which design the breaker has.

In the original design the two movable contact arms are pin-coupled to a metal driving link whose opposite end is threaded and screws directly into the insulating link. This arrangement omits the wrench-operated wipe adjustment stud provided on the AKR-30 and -50 frames. Instead, wipe is adjusted by detaching the driving link from the movable contact arms and then rotating it with respect to the insulating link.

On the AKRT-50 the proper amount of contact wipe exists if, on a closed breaker, all of the stationary main contacts have moved away from their stops. This condition can be checked visually by removing the arc quenchers, closing the breaker and verifying that all eight stationary main contacts are "lifted off" their stops. Should wipe adjustment appear necessary, proceed as follows:

1. Open the breaker.
2. Arrange the breaker for slow-closing.
3. Selecting one pole, drift out the coupling pin and detach the driving link from the movable contact arms.
4. Screw the driving link completely into the insulating link.
5. Back out the driving link two and one-half turns. Exceed this by whatever amount is necessary to properly position the link within the movable contact arms.
6. Install the coupling pin and retainer rings.
7. Using the maintenance handle, slow-close the breaker and observe that all eight stationary main contacts move away from their stops. If this condition is not achieved, open the breaker, again remove the coupling pin and back out the driving link an additional half turn.
8. Reassemble, reclose the breaker and recheck wipe.
9. Repeat the above procedure on the other two poles.

In the existing design, the metal driving link uses the same adjustment as the AKR 50. To perform the wipe adjustment on this design follow the procedure for the AKR 50, Section 8.3.

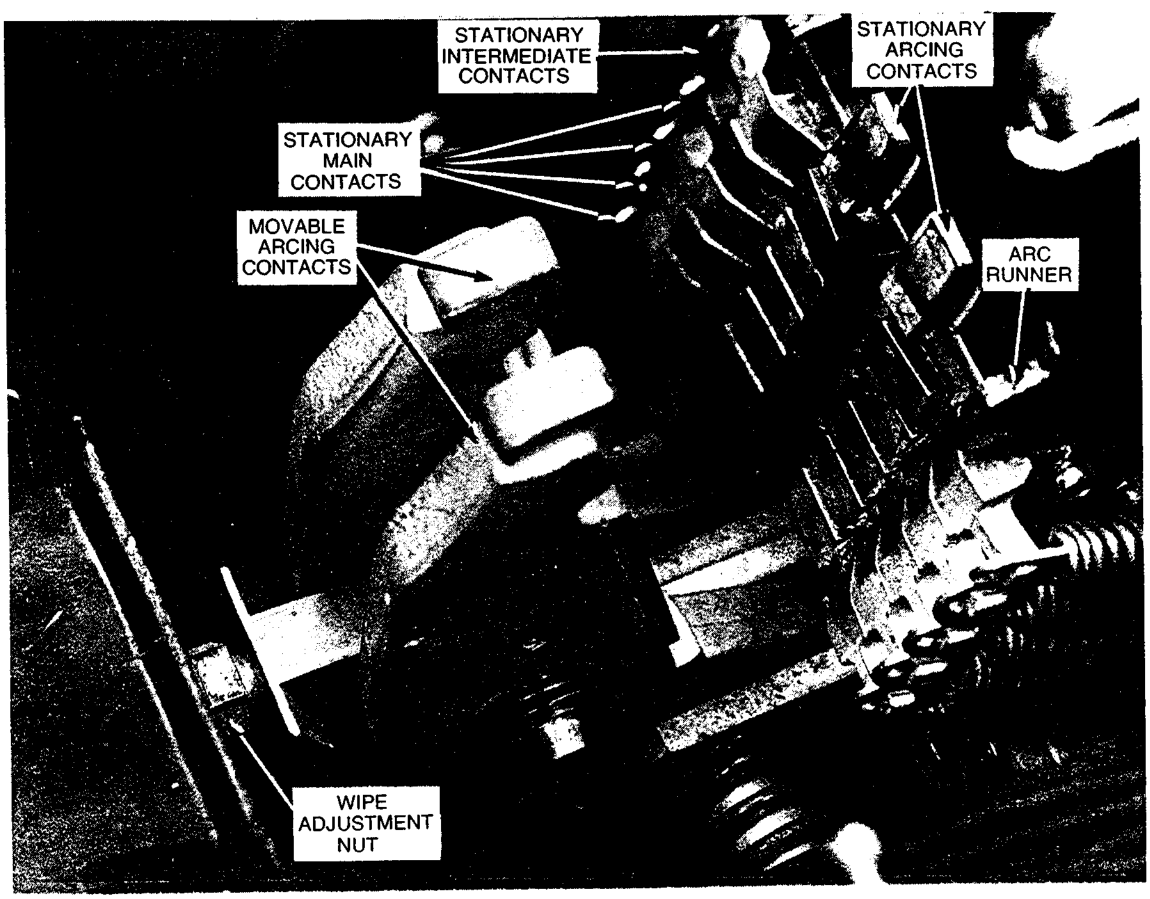


FIG. 48 — 2000 AMP CONTACT STRUCTURE

8.5 STATIONARY CONTACT IDENTIFICATION

The stationary arcing, intermediate, and main contacts each have a different function during current conduction and current interruption. For this reason, these contacts are made using different material compositions. Also, the different functions require that the contacts be replaced in configurations shown in Figs. 44, 47 or 48.

Fig. 49 shows the stationary contacts and how they differ from one another. The 800 amp main and arcing contacts are rectangular, but the arcing contacts have two of their corners notched. The 1600/2000 amp main and intermediate contacts are rectangular, but the main contacts have two of their corners notched. The intermediate contacts have all four corners notched.

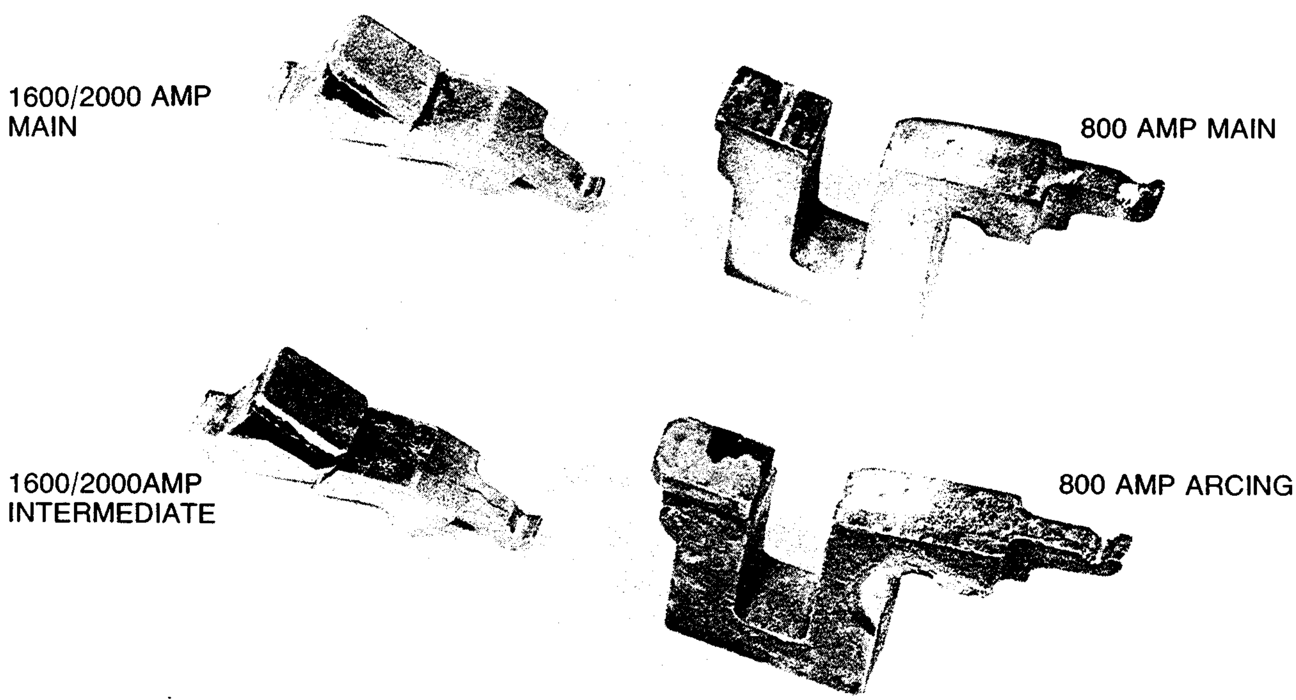


FIG. 49 — STATIONARY CONTACT CONFIGURATION

8.6 CONTACT REPLACEMENT — AKR 30/30H & AKRU 30

Refer to Stationary Contact Identification, Section 8.5 before replacing any stationary contacts.

The stationary contacts are held in place by the contact springs which pivot the contacts against the contact stop, refer to Fig. 45. To replace contacts:

1. Remove the arc runner. It is secured by two screws into the base and one screw into the contact stop.

2. Release each contact spring by holding the contact, extending the spring, and removing it from the contact. The end pieces on each spring have a small hole for inserting a spring puller. A suitable puller can be fashioned by forming a hook on the end of a length of .062" diameter steel wire.

A spring puller is available for this use and may be ordered under Cat. No. 286A8168G1.

3. Clean off the existing lubrication on the stud's pivot area. Replace with a small amount of D50HD38 (MOBIL 28) before installing new contacts.

4. Torque the upper arc runner mounting screws to 45 ± 5 in-lbs. Torque the lower screw to 35-40 in-lbs.

The movable contacts are removed as follows, referring to Fig. 46.

1. Using a right angle tru-arc pliers, remove the tru-arc retainer on the coupling pin. Drift out the coupling pin.

2. Remove the pivot pin hardware and spring from one side of the pivot pin. Carefully remove the pivot pin.

3. Slip out the contact arm.

4. Place a thin film of D50HD38 lubrication on the pivot surfaces of the new arm. Clean any existing lubrication from the pivot pin and place a small amount of D50HD38 on it.

5. Install the new arm, insert the pivot pin, and replace the pivot spring and hardware. Tighten the pivot pin hardware to 90 ± 5 in-lbs.

8.7 CONTACT REPLACEMENT — AKR 50/50H, AKRU 50 & AKRT 50/50H

Refer to Stationary Contact Identification, Section 8.5, before replacing any stationary contacts.

The stationary intermediate and main contacts are replaced just like the stationary contacts on the 800 ampere breakers. Refer to steps 2 & 3 in Section 8.6

Referring to Fig. 50, the stationary arcing contacts are replaced as follows:

1. Remove the arc runner and the flat insulation assembled underneath the arc runner. It is secured with four screws. When removing the lower screws, use care not to damage or misplace the insulating washer found under each of these screws, see Fig. 50A.

2. Remove the arcing contact pivot. Clean off the existing lubrication found on the pivot area. Replace with D50HD38 (MOBIL 28), see Fig. 50B.

3. Remove the insulating spacers, contact pin and arcing contacts, see Fig. 50C.

4. Reassemble the reverse of above. Make sure that the insulating spacers and insulating washers are properly installed. Torque the arc runner hardware to 45 ± 5 in-lbs.

The movable contacts are removed in a similar manner as the 800 ampere breaker movable contacts. Refer to Section 8.6. When removing the pivot pin from a 2000 ampere (AKRT 50/50H) contact assembly, the pivot pin from the opposite contact assembly must be slightly removed. This provides enough clearance to completely remove the pivot pin.

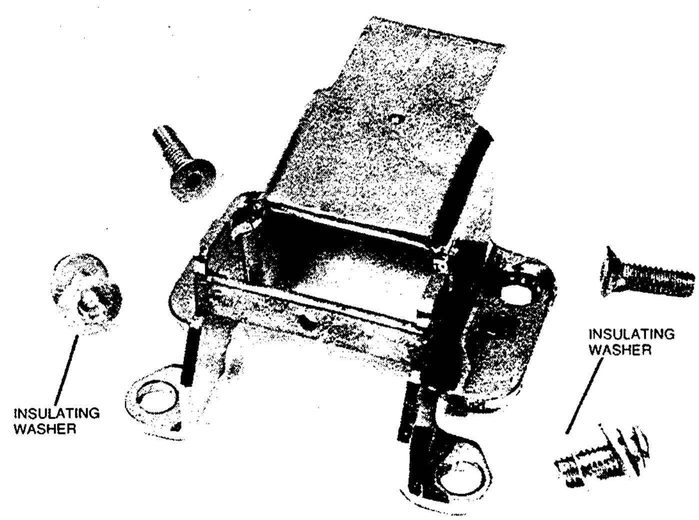


FIG. 50A — ARC RUNNER STATIONARY CONTACT — 1600/200 AMP REPLACEMENT CONTACT STRUCTURE

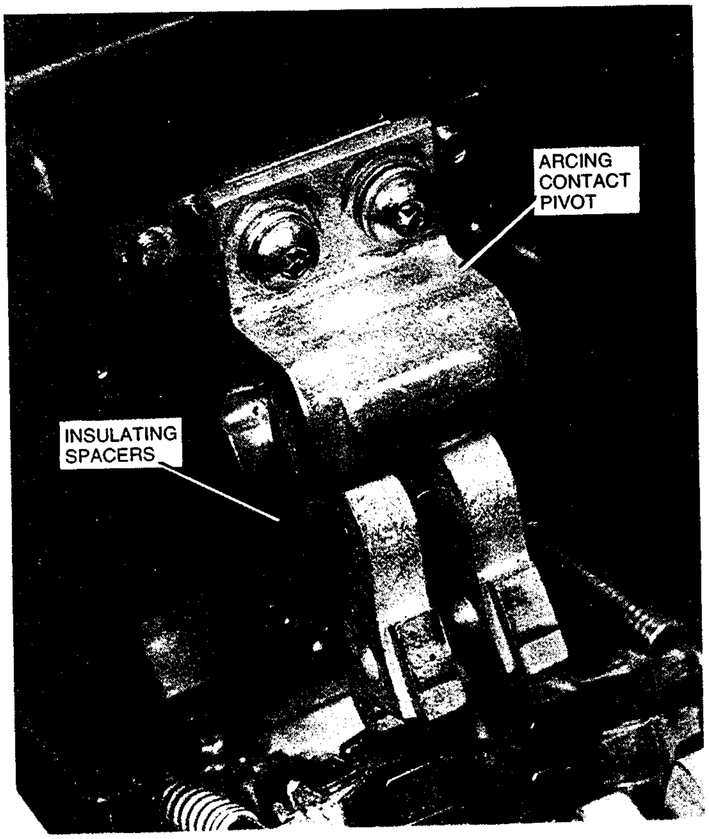


FIG. 50B — ARC RUNNER REMOVED

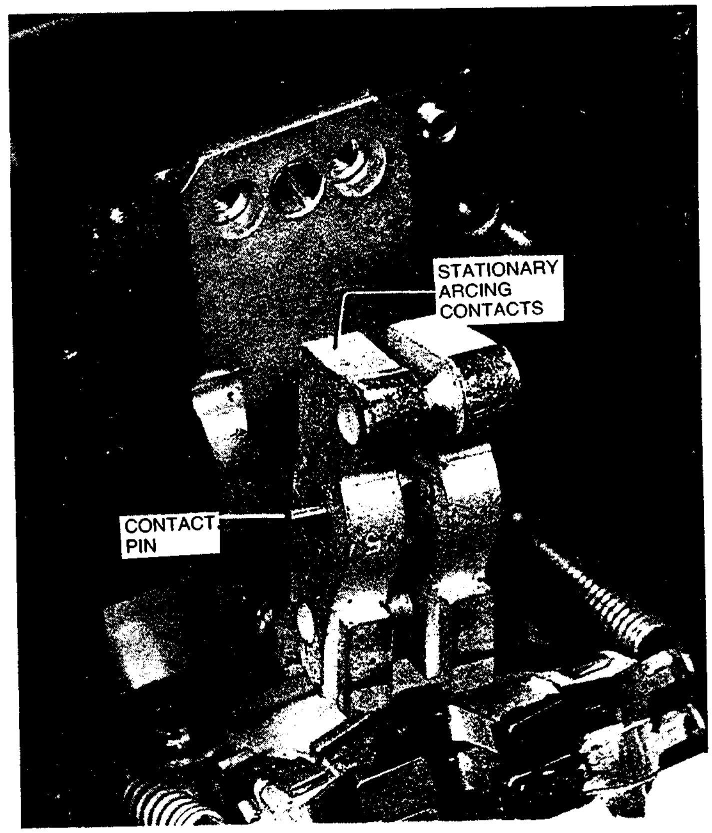


FIG. 50C — ARCING CONTACT PIVOT REMOVED

SECTION 9—Fused Breakers

There are two types of fused breakers; AKRU 30, 800 ampere frame and AKRU 50, 1600 ampere frame. Except for the open fuse lockout device and the integrally-mounted fuses on the upper studs, the AKRU-30 and -50 breakers are identical to the unfused AKR-30 and -50 models. Overcurrent trip devices are the same for both types.

9.1 FUSE SIZES AND MOUNTING

Table 6 lists the range of fuse sizes available for these breakers. The Class L fuses are mounted as shown in Fig. 51. Other than the 800A size, which has a single mounting hole per tang, each L fuse tang has two holes sized for one-half inch bolts.

Class J fuses rated 300 thru 600A have one mounting hole per tang. The 300, 350 and 400A sizes require copper adapter bars per Fig. 52.

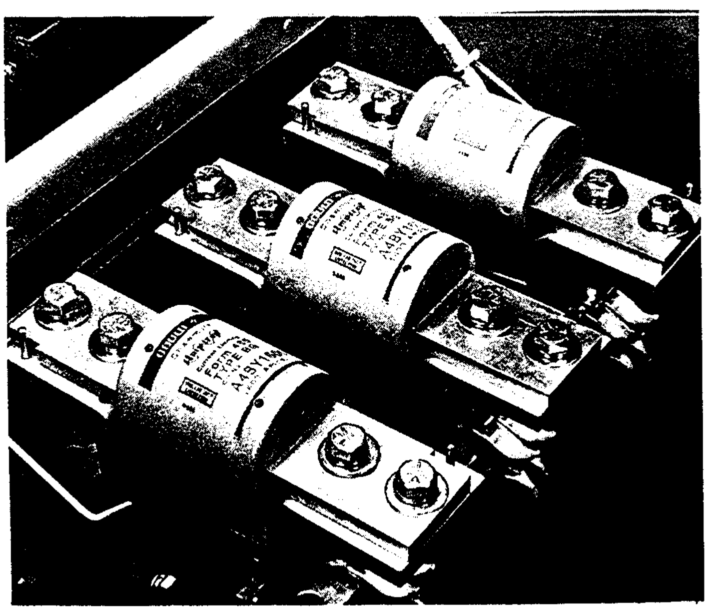


FIG. 51 — TYPICAL MOUNTING CLASS L FUSES

9.2 SPECIAL 2500A FUSE FOR AKRU-50

This fuse provides a melting time-current characteristic that coordinates with 1600A trip devices. Compared physically with a 2500A NEMA Class L fuse, the special fuse is more compact (shorter); its tangs are specially configured and offset to achieve the required pole-to-pole fuse spacing; a special primary disconnect assembly mounts directly on the outboard tang of the fuse. Considering their unique mounting provisions, when replacing these fuses the following procedure should be adhered to (Refer to Fig. 53):

a) Remove the primary disconnect assembly from the fuse tang, accomplished by first loosening the two keys via their holding screw and pulling them upward and out. After the keys are removed, pull the disconnect assembly off the end of the fuse tang.

NOTE: *This removal does not disturb the disconnect's clamping force adjustment.*

b) Remove the upper barrier.

c) Detach the inboard end of the fuse by removing the two 1/2 inch – 13 bolts. A ratchet and socket with a short extension will be requied.

d) Remove the heat sink.

e) Remove the fuse.

f) Install the new fuse by reversing the disassembly procedure. Ensure that the mating faces of the fuse and heat sink are clean.

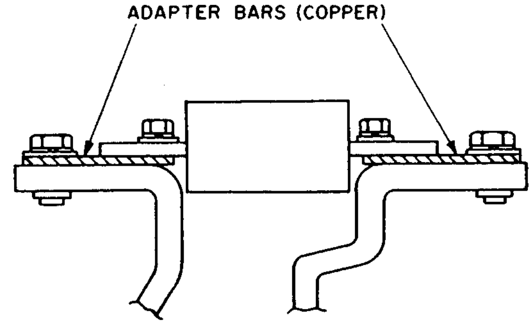
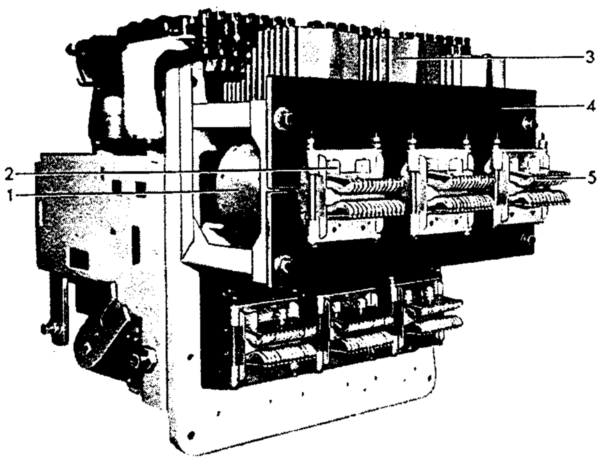


FIG. 52 — 300 THRU 600 AMP CLASS J FUSE MOUNTING

SECTION 9—Fused Breakers (Cont.)



1. Special 2500A Fuse
2. Disconnect Key
3. Heat Sink
4. Upper Barrier
5. Primary Disconnect

FIG. 53 AKRU 50 WITH SPECIAL 2500 AMP FUSE

CAUTION: *WHEN REPLACING THE FUSE IN THE LEFT POLE (FRONT VIEW) OF THE BREAKER, NOTE PARTICULARLY THAT THIS FUSE IS MOUNTED DIFFERENTLY THAN THE OTHER TWO FUSES. AS SHOWN IN FIG. 54, FOR THIS PHASE THE FUSE IS ROTATED 180 DEGREES ABOUT ITS AXIS SO THAT ITS INBOARD TANG IS POSITIONED BENEATH THE BREAKER STUD. THIS TANG IS OFFSET WITH RESPECT TO THE OPPOSITE END SO THAT ROTATING THE FUSE DOES NOT ALTER THE POSITION OF THE PRIMARY DISCONNECT.*

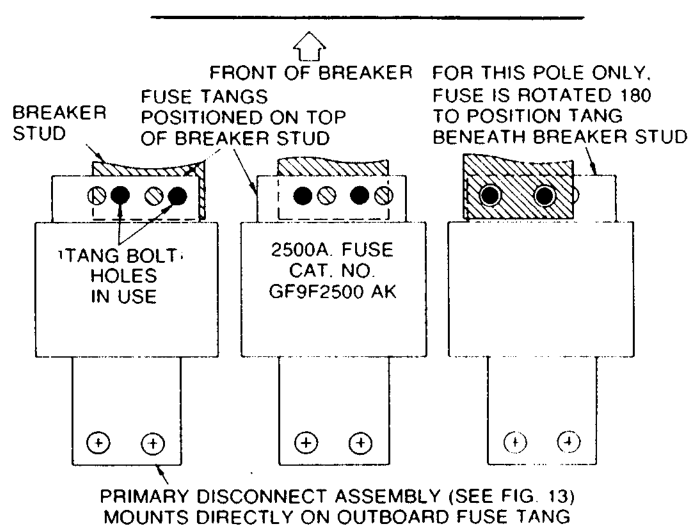


FIG. 54
AKRU 50—2500A FUSE TANG POSITIONS

TABLE 6
FUSES FOR AKRU BREAKERS

NEMA Fuse Class 600V 60 Hz	Breaker Type AKRU- 30	Breaker Type AKRU- 50	Ampere Rating	Gould Shawmut Cat. Nos. Fuse	Gould Shawmut Cat. Nos. Limiter
J	↑	—	300*	A4J 300	—
	│	—	350*	A4J 350	—
	│	—	400*	A4J 400	—
	│	↑	450	A4J 450	—
	│	│	500	A4J 500	—
	│	│	600	A4J 600	—
L	│	│	800	A4BY 800	A4BX 800
	│	│	1000	A4BY 1000BG	A4BX 1000BG
	↓	│	1200	A4BY 1200BG	A4BX 1200BG
	—	│	1600	A4BY 1600BG	A4BX 1600BG
	—	│	2000	A4BY 2000BG	A4BX 2000BG
Special	—	↓	2500	—	A4BX 2500GE

*Mounting adapter required — see Fig. 52

9.3 OPEN FUSE LOCKOUT DEVICE

This device automatically trips the fuse breaker if one of the fuses opens. When this happens, the breaker is locked open until the reset button of the phase involved is pushed. The breaker should not be reclosed, of course, until the opened fuse is replaced.

Type D breakers use the Open Fuse Lockout (OFLO) shown in Fig. 55. Type A and B breakers use the OFLO shown in Fig. 56. Both OFLO's work on the same design. When the fuse opens, the resulting open circuit voltage activates the OFLO's phase solenoid when the voltage level reaches approximately 90 VAC. The solenoid's armature then drives a tripping rod against a trip paddle which is attached to the trip shaft. This causes the breaker to open. The armature also drives the reset button forward indicating what phase is involved. The reset button linkage also holds the tripping rod against the trip paddle. The button must be pushed in to release the tripping rod.

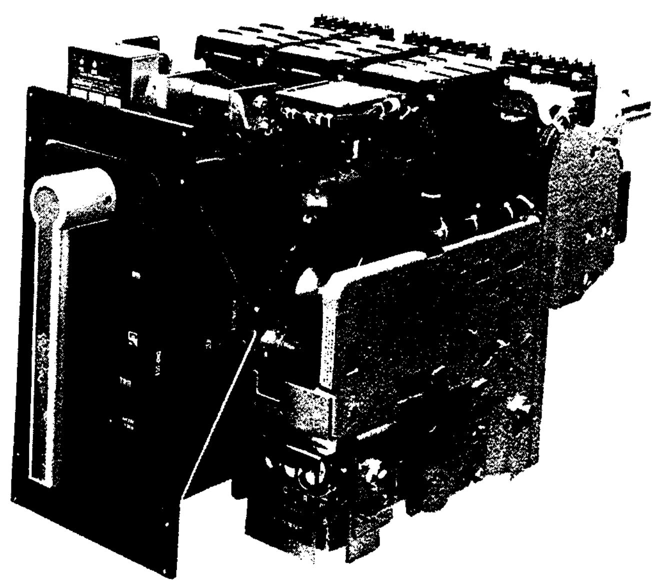


FIG. 55— TYPE D BREAKER OFLO DEVICE

9.3.1 TYPE A AND B BREAKER OFLO ADJUSTMENT

To adjust the Type A and B breaker OFLO (Refer to Fig 56):

a) Back off tripping rod so that it will not hit the trip paddle when a solenoid is activated.

b) Using the maintenance handle, close the breaker.

c) Manually close the Left pole armature. Screw tripping rod forward until it moves the trip paddle enough to open the breaker. Add two full turns.

d) Close the breaker.

e) Manually close the Left pole armature again. The breaker must open and the reset button pop out. In this condition close the breaker, it should trip-free.

f) Reset the OFLO, the breaker must now be able to close.

g) Repeat for Center and Left poles.

h) Check for a .125" minimum clearance between tripping rod and trip paddle with the OFLO reset. Check for .032" minimum overtravel after tripping rod trips breaker.

i) Hold tripping rod in position and tighten its locknut.

9.3.2 TYPE D BREAKER OFLO ADJUSTMENT

To adjust the Type D breaker OFLO:

a) With the breaker in the CHARGED position and the OFLO reset, adjust the dimension between the end of the tripping rod and the trip paddle to .062"-.093".

b) With the OFLO energized, the breaker must TRIP and the RESET button must move forward to the front plate. In this condition, the breaker must be held trip-free.

SECTION 9—Fused Breakers (Cont.)

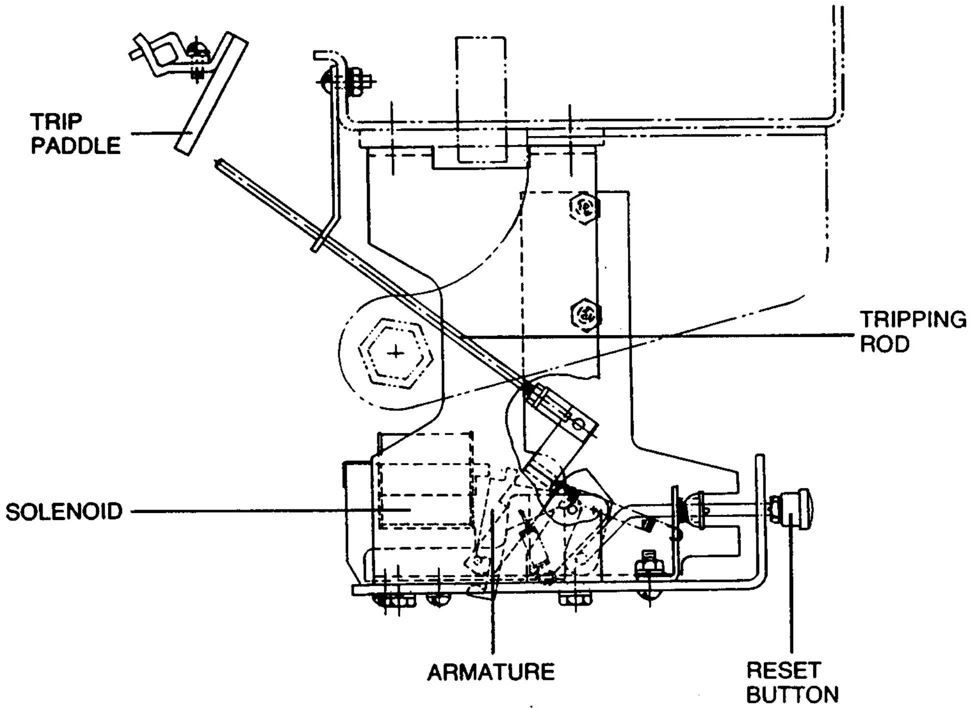


FIG. 56A—DETAILS

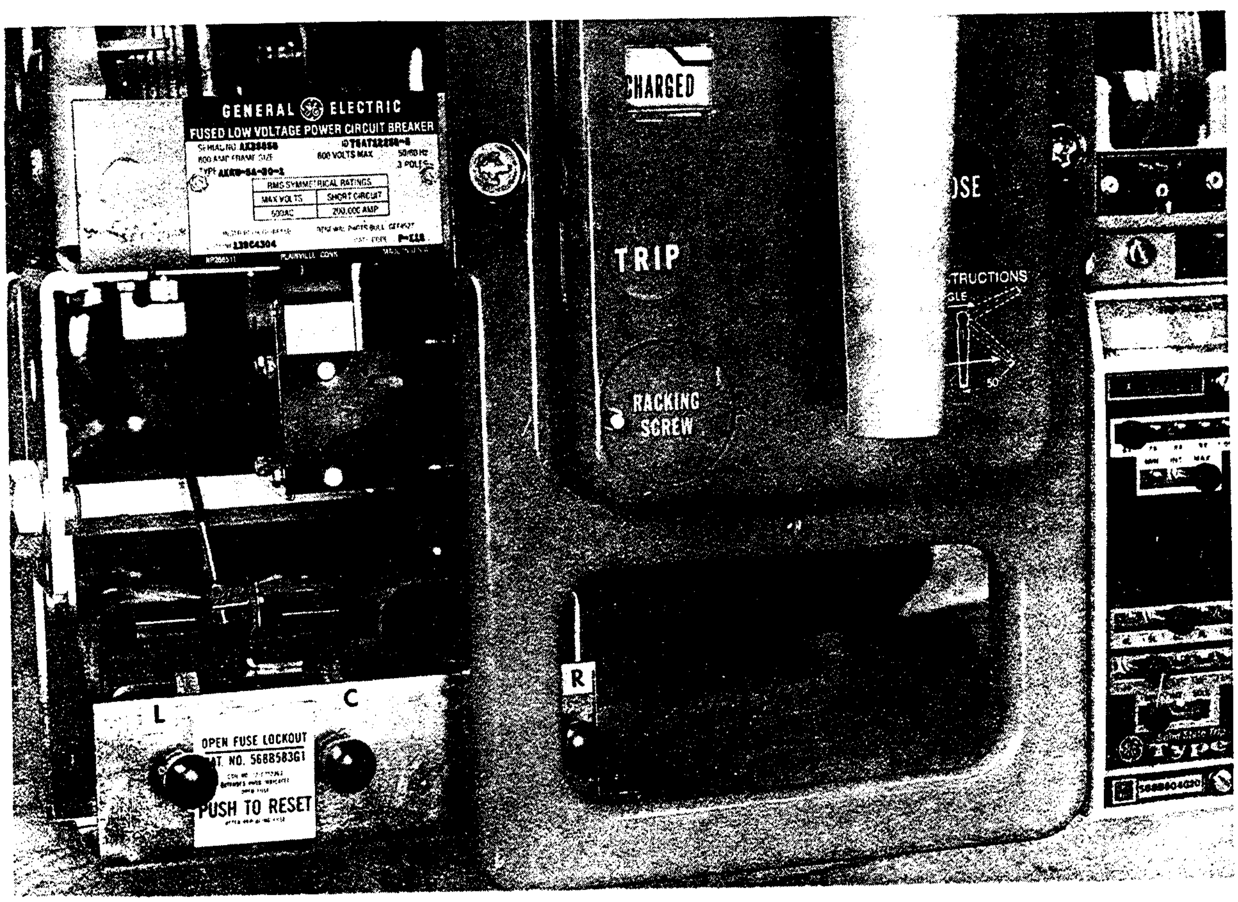


FIG. 56B—INSTALLED TYPE A OR B BREAKER OFLO DEVICE

SECTION 10—Type SST Overcurrent Trip Device

The SST is a solid-state, direct-acting, self-powered trip device system. The SST system consists of the SST programmer unit, current sensors, and a flux shifter trip device. Fig. 57 shows a block diagram of the system.

10.1 PROGRAMMER UNIT

Fig. 58 shows a typical SST programmer unit. The programmer unit provides the comparison basis for overcurrent detection and delivers the energy necessary to trip the breaker. It contains the electronic circuitry for the various trip elements. Their associated pickup and time delay adjustments (set-points) are located on the face plate. Depending on the application, programmer units may be equipped with various combinations of Long Time, Short Time, Instantaneous and Ground Fault trip elements. See Table 7 for available ratings, settings and trip characteristics. Adjustments are made by removing the clear cover over the face plate, unscrewing (counter-clockwise) the set-point knob, moving the set-point along the slot to the new setting, and screwing the set-point knob in. Once all adjustments are made, install the clear cover to the face plate.

The SST programmer units can be optionally equipped with trip indicators (targets). These are pop-out, mechanically-resettable plungers located across the top of the programmer's front. Units with a ground fault element employ three targets: from left to right, the first is for overload, the second for short circuit (actuated by the short time and instantaneous elements) and the third for ground fault. The latter is omitted on units without ground fault.

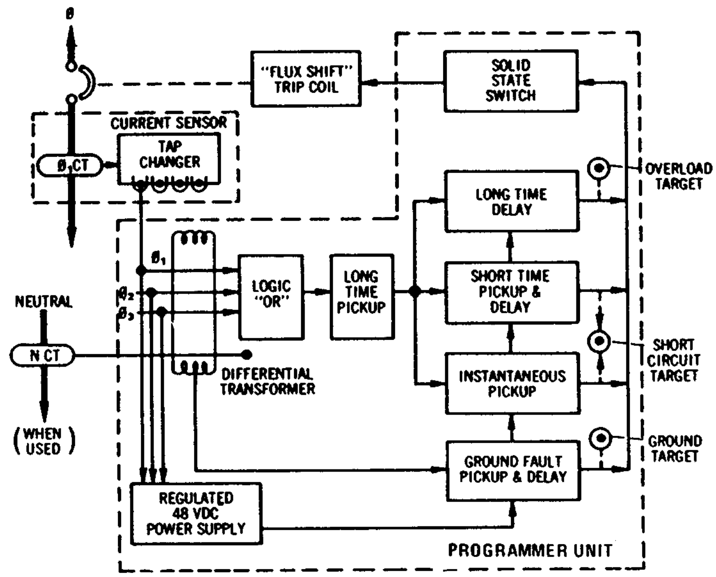


FIG. 57 — SST BLOCK DIAGRAM

Each target pops out when its associated trip element operates to trip the breaker. After a trip, the popped target must be reset by hand. However, neglecting to reset does not affect normal operation of any trip element or prevent the breaker from being reclosed.

The programmer unit is mounted to the lower right of the breaker as shown in Fig. 59. The bracket attached to the top of the programmer, see Fig. 58, engages with a bracket mounted to the underside of the breaker's front frame.

TABLE 7 SST TRIP CHARACTERISTICS

Breaker Type	Frame Size (Amperes)	X = Trip Rating in Amperes = Sensor Tap (Sensor Ampere Taps)	SST PROGRAMMER ADJUSTMENT RANGE (Set Points): Long Time Pickup (=L) ① (Multiple of X)	Long Time Time Delay Band ③ (Seconds)	Short Time Pickup ② (Multiple of L)	Short Time Time Delay Band ④ (Seconds)	Instantaneous Pickup ② (Multiple of L)	GROUND FAULT Pickup ② (Multiple of X)	GROUND FAULT Time Delay Band ④ (Seconds)
AKR-30	800	100, 150, 225, 300 – or – 300, 400, 600, 800			3, 4, 5, 6, 8, 10 (L)			.4, .5, .6, .8, 1.0, 1.2 (X)	
AKR-50	1600	300, 400, 600, 800 – or – 600, 800, 1200, 1600	.6, .7, .8, .9, 1.0, 1.1 (X)	Maximum 22 Intermed. 10 Minimum 4	—or— 1.75, 2, 2.25, 2.5, 3, 4 (L)	Maximum 0.35 Intermed. 0.21 Minimum 0.095	4, 5, 6, 8, 10, 12 (L)	.25, .3, .4, .5, .6, .7 (X)	Maximum 0.30 Intermed. 0.165 Minimum 0.065
AKRT-50	2000	800, 1200, 1600, 2000						.2, .25, .3, .4, .5, .6 (X)	

① Pickup tolerance is ± 9%
② Pickup tolerance is ± 10%
③ Time delay shown at 600% of long time pickup setting (6L), at lower limit of band.
④ Time delay shown at lower limit of band.

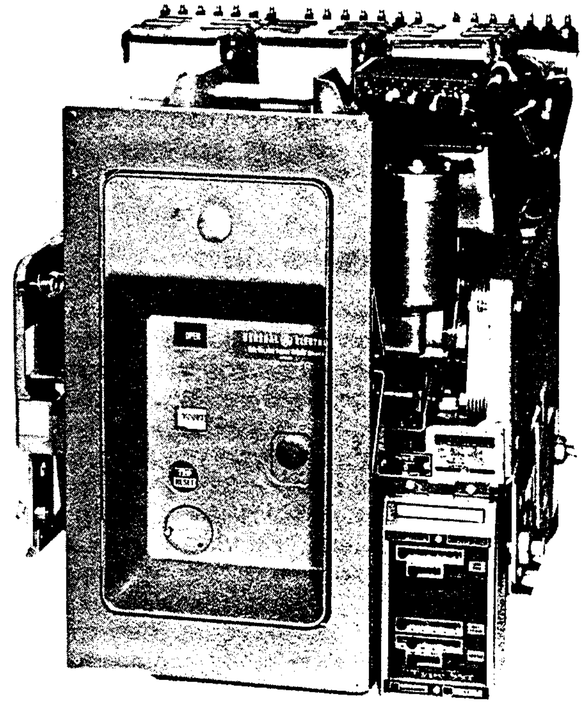


FIG. 59 — AKR-5B-30

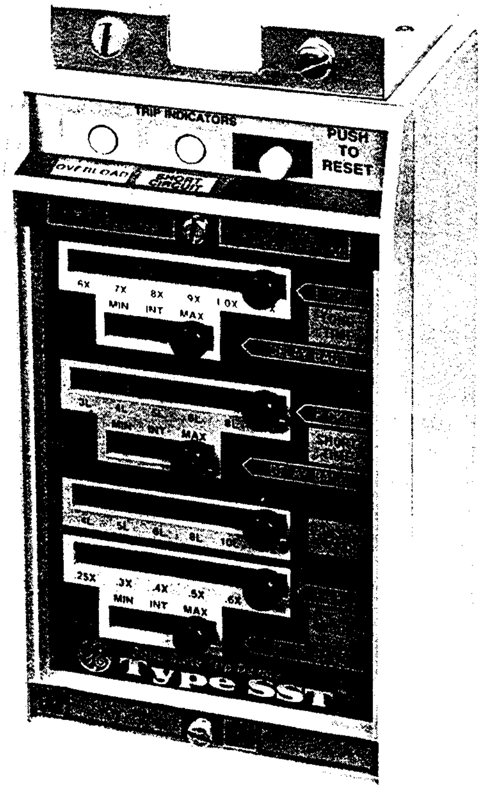


FIG. 58 — SST PROGRAMMER

10.2 CURRENT SENSORS

The SST system uses two types of current sensors, a phase sensor and a neutral sensor. Fig. 60 shows a phase sensor. Fig. 61 shows the neutral sensors available. The current sensor supplies the power and signal inputs necessary to operate the trip system. Each sensor has four taps which provide field adjustment of the trip device's continuous ampere rating.

The SST Ground Fault trip element operates on the principle that the instantaneous values of current in the three conductors (four on 4-wire systems) add to zero unless ground current exists. On SST's equipped with Ground Fault, the ground trip signal is developed by connecting each phase sensor in series with a companion primary winding on a ground differential transformer mounted in the programmer unit. Its secondary output is zero so long as there is not ground current.

Application of the Ground Fault element on 4-wire systems with neutral grounded at the transformer requires the additional, separately mounted neutral sensor (Fig. 61) inserted in the neutral conductor; its secondary is connected to a fourth primary winding on the ground differential transformer. See Fig. 70. This "fourth-wire" neutral sensor is an electrical duplicate of the phase sensor, including taps. Therefore, when taps are changed on the phase sensors, those on the neutral sensor must be correspondingly positioned.

When used, the neutral sensor is separately mounted in the bus or cable compartment of the switchgear. In draw-out construction, its output is automatically connected to the breaker via secondary disconnect blocks. See Fig. 62.

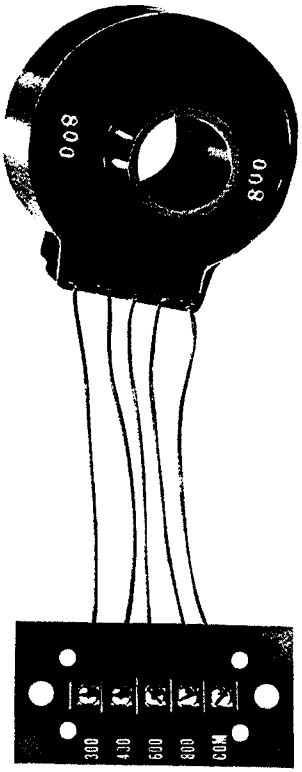
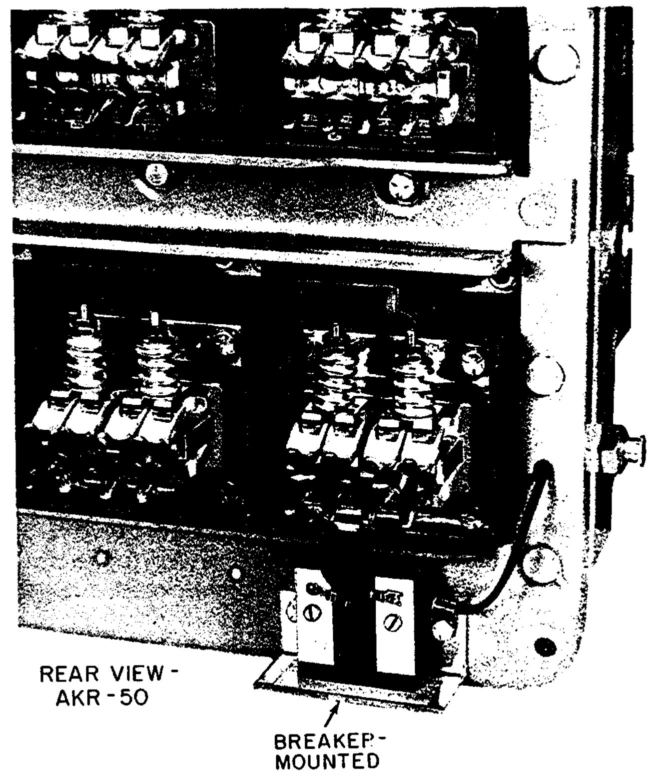


FIG. 60 — SST PHASE SENSOR
WITH TAP BOARD



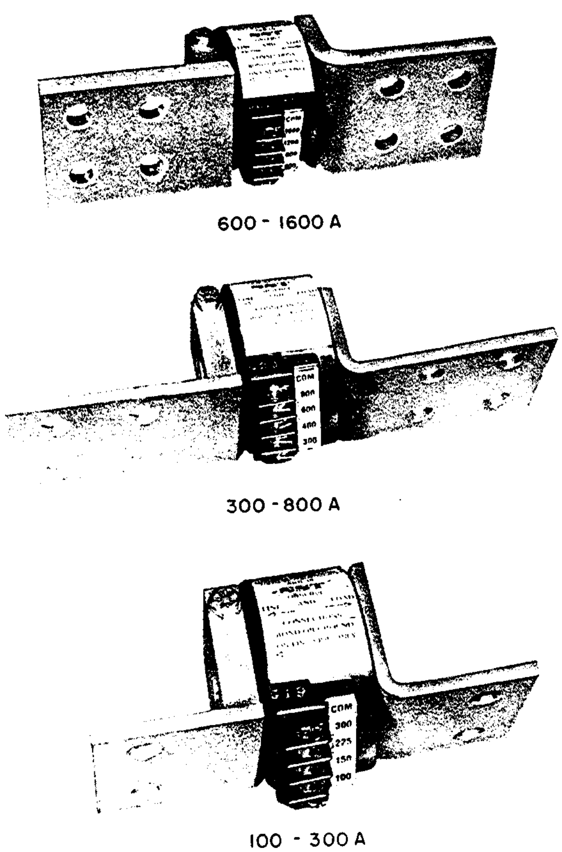


FIG. 61 — SST NEUTRAL SENSORS

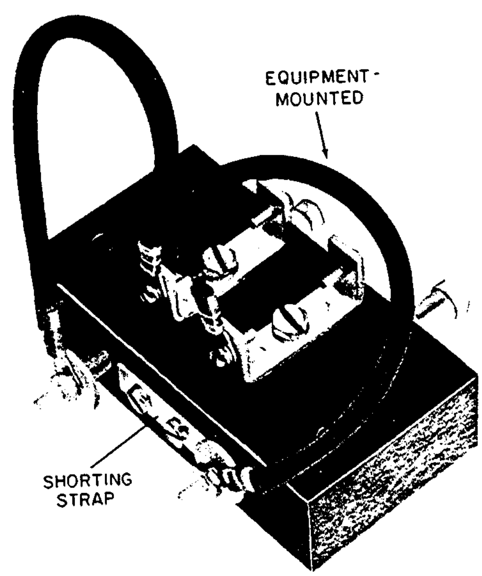


FIG. 62 — NEUTRAL SENSOR
SECONDARY DISCONNECT
BLOCKS

10.2.1 REPLACEMENT OF CURRENT SENSORS

Referring to Fig. 63, replacement of individual SST current sensors is accomplished as follows:

a) Disconnect the breaker harness from the tap terminal board, removing cable ties as necessary. Unfasten the terminal board from the breaker base.

b) At the rear of the breaker, remove the two Allen head screws to separate the stud connector from the contact pivot block.

c) Loosen the clamping bolt and remove the stud connector. Lift out the sensor and its tap terminal board.

The sensor may be prevented from slipping off the sensor stud by adjacent accessories. If this exists, the sensor stud must be removed from the breaker base. The stud assembly is secured to the base with four bolts which are accessible from the rear of the breaker.

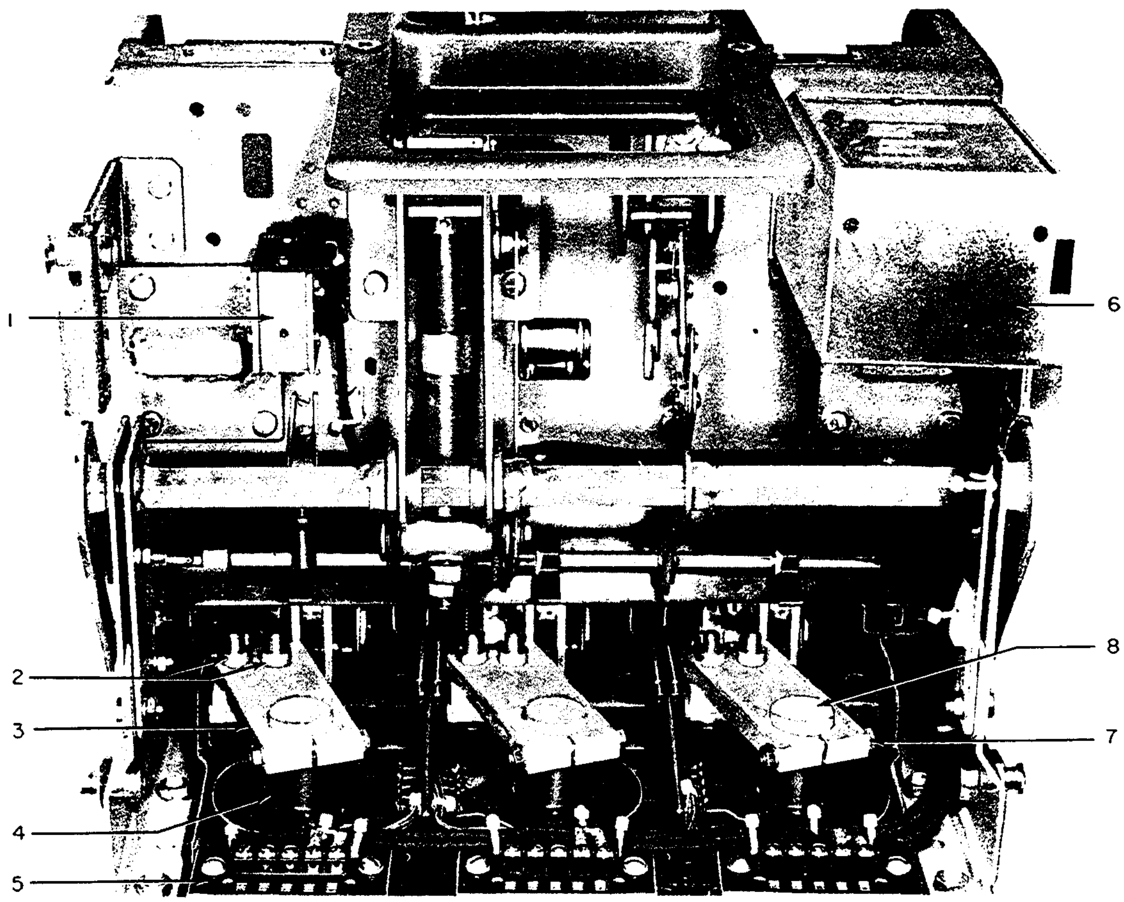
d) When replacing the stud connector, tighten the Allen head screws to 250 ± 10 in-lbs. Tighten the clamping bolt as follows:

AKR 30/30H — 120 ± 10 in-lbs
AKR 50/50H — 470 ± 10 in-lbs
AKRT 50/50H — 470 ± 10 in-lbs

10.3 FLUX SHIFT TRIP DEVICE

The Flux Shift Trip device is a low-energy, electromagnetic device which, upon receipt of a trip signal from the programmer unit, trips the breaker by actuating the trip shaft.

The mounting arrangement of this component is illustrated in Figs. 64 and 65. An electromagnetic actuator located on the underside of the front frame is coupled to the breaker's trip shaft via a trip rod driven by the actuator arm. The actuator is a solenoid whose armature is spring-loaded and held in its normal (Reset) position by a permanent magnet. In this state the spring is compressed.



1. Flux shift Trip Device
2. Allen-head Screws
3. Stud Connector
4. Current Sensor
5. Tap Terminal Board
6. Programmer Unit
7. Clamp Bolt
8. Sensor Stud

FIG. 63 — AKR-5A-30 BREAKER WITH SST TRIP DEVICE

So long as the actuator remains in the Reset position, the breaker can be closed and opened normally at will. However, when a closed breaker receives a trip signal from the programmer unit, the actuator is energized and its solenoid flux opposes the magnet, allowing the spring to release the armature; this drives the trip rod against the trip shaft paddle, tripping the breaker.

As the breaker opens, the actuator arm is returned to its normal (Reset) position via linkage driven by a crank on the breaker's main shaft. The permanent magnet again holds the armature captive in readiness for the next trip signal.

The trip device requires only one adjustment — the trip rod length. As shown in Fig. 66, the clearance between the trip rod and the trip shaft paddle is gaged by a 0.125 inch diameter rod. Adjust gap to 0.125 inch ± 0.015 inch. To adjust, open the breaker and restore the breaker mechanism to its Reset position. Loosen the jamb nut, rotate the adjuster end until the proper gap is attained, then retighten the jamb nut to 35 ± 5 in-lbs.

The actuator is a sealed, factory-set device and requires no maintenance or field adjustment. In case of malfunction, the complete actuator unit should be replaced. When making the electrical connector to the replacement unit, it is recommended that the breaker harness be cut at some convenient point and the new actuator leads solder-spliced thereto.

The preferred method is to remove the flux shifter leads from the AMP connector using the AMP extraction tool, Cat. No. 305183 as follows:

1. Remove the flux shifter leads from the harness.
2. Referring to the cabling diagrams in Section 10.5, the flux shifter leads are RED in point B and BLACK in point E.
3. Insert the extractor tool over the female pin. When the extractor tool bottoms out, depress the plunger and force the wire/socket assembly out of the connector.
4. No tool is required to insert the wire/socket assembly into the connector. Insert the assembly until it snaps into place.
5. Verify all sockets are inserted to the same depth.

CAUTION: *IN THE EVENT THAT THE SST TRIP DEVICE MUST BE RENDERED INOPERATIVE TO ALLOW THE BREAKER TO CARRY CURRENT WITHOUT BENEFIT OF OVERCURRENT PROTECTION, THE RECOMMENDED METHOD IS TO SHORTEN THE TRIP ROD BY TURNING ITS ADJUSTER END FULLY CLOCKWISE. THIS PREVENTS ACTUATION OF THE TRIP SHAFT PADDLE.*

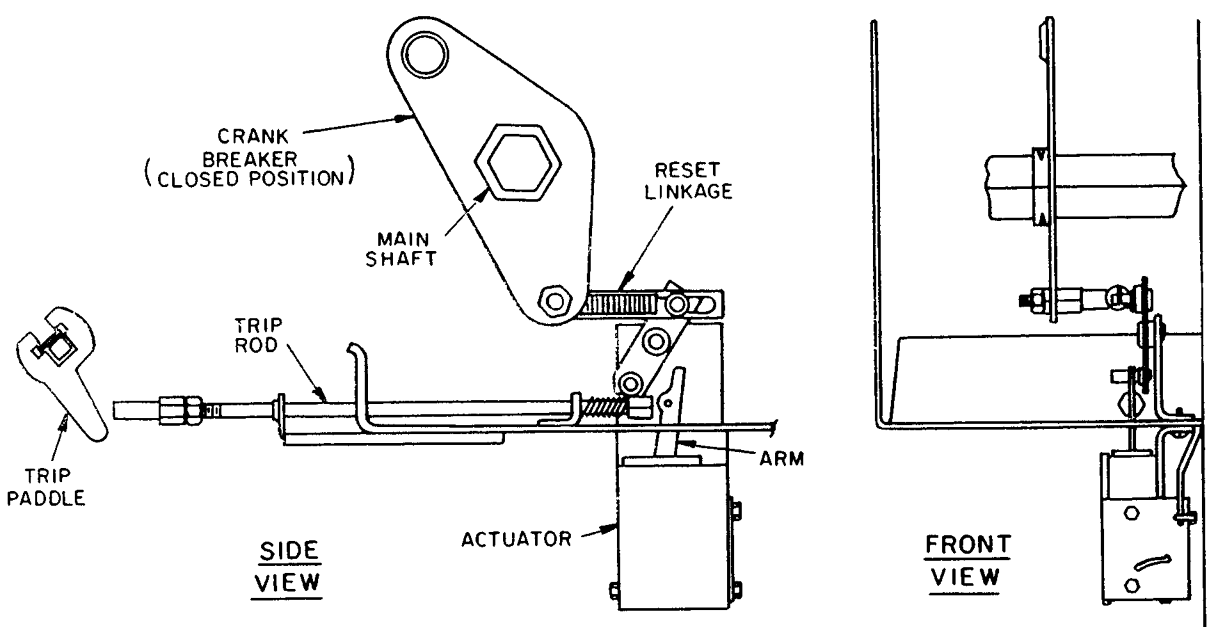
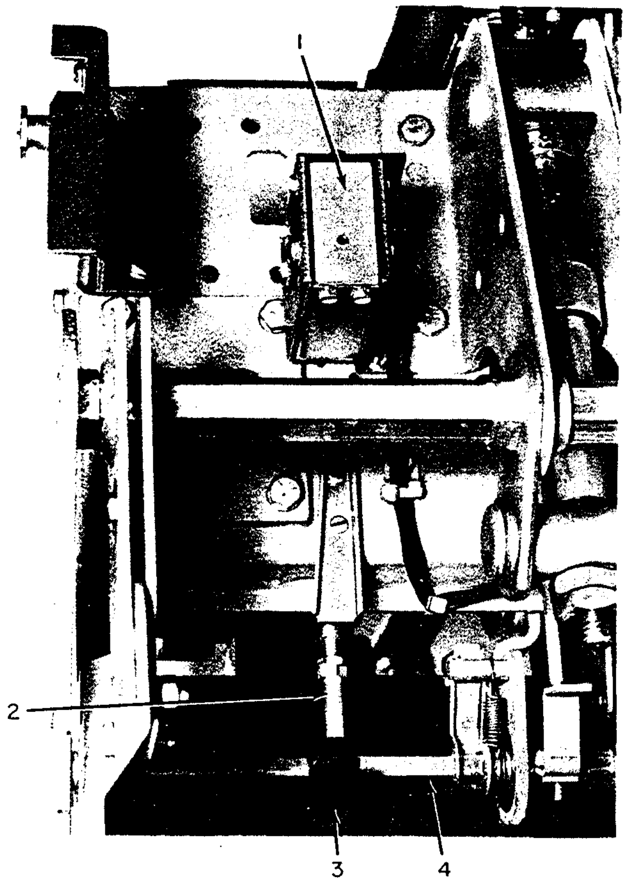
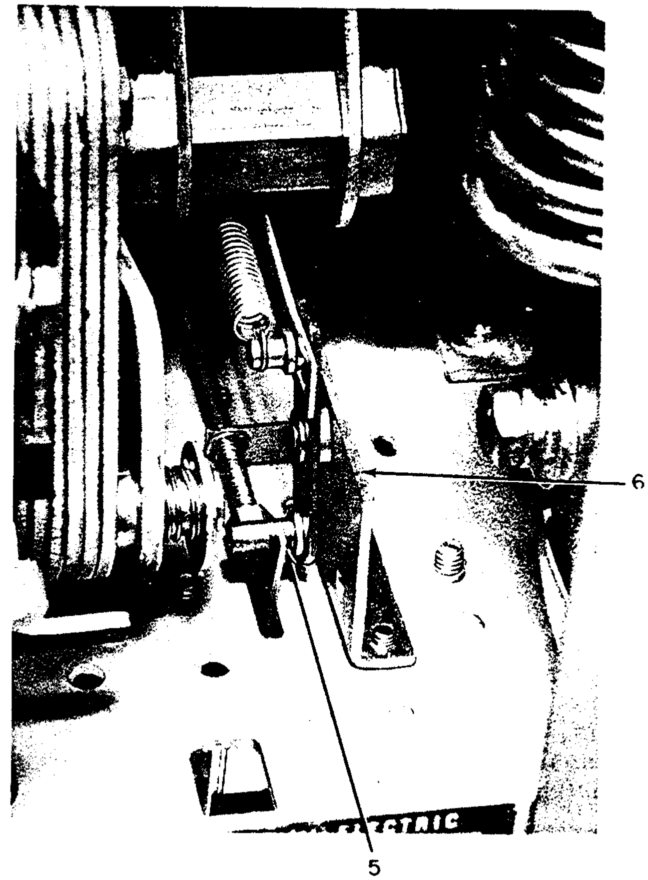


FIG. 64 — FLUX SHIFT TRIP DEVICE AND OPERATING LINKAGES





Bottom view

1. Actuator
2. Trip rod adjuster end
3. Trip paddle

Top view

4. Trip shaft
5. Actuator arm
6. Reset linkage

FIG. 65 — FLUX SHIFT TRIP DEVICE COMPONENTS

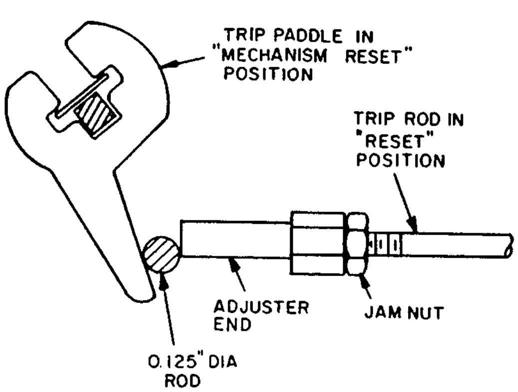


FIG. 66 — TRIP ROD ADJUSTMENT

10.4 TROUBLESHOOTING

When malfunctioning is suspected the first step in troubleshooting is to examine the circuit breaker and its power system for abnormal conditions such as:

a) Breaker tripping in proper response to overcurrents or incipient ground faults.

b) Breaker remaining in a trip-free state due to mechanical interference along its trip shaft.

c) Inadvertent shunt trip activations.

WARNING: *DO NOT CHANGE TAPS ON THE CURRENT SENSORS OR ADJUST THE PROGRAMMER UNIT SET KNOBS WHILE THE BREAKER IS CARRYING CURRENT.*

Once it has been established that the circuit breaker can be operated and closed normally from the test position, attention can be directed to the trip device proper. Testing is performed by either of two methods.

1. Conduct high-current, single-phase tests on the breaker using a high current-low voltage test set.

NOTE: *For these single-phase tests, special connections must be employed for SST breakers equipped with Ground Fault. Any single-phase input to the ground differential transformer will generate an unwanted "ground fault" output signal which will trip the breaker. This can be nullified either by*

a) testing two poles of the breaker in series, or

b) using the Ground Fault Defeat Cable as shown in Fig. 71. This special test cable energizes all the primary windings of the differential transformer in a self-cancelling, series-parallel connection so that its secondary output is always zero.

2. Test the components to the SST system using portable Test Set Type TAK-TS1 (Fig. 67) or TAK-TS2.

The applicable test procedures are detailed in instruction Book GEK-64454 and are summarized in Section 10.4.1.

The TAK-TS1 and TAK-TS2 Test Sets are portable instruments designed for field checking the time-current characteristics and pickup calibration of the SST's various trip elements. It can verify the ability of the Flux-Shift Trip Device to trip the breaker and, in addition, includes means for continuity checking the phase sensors. A TAK-TS1 Test Set is shown in Fig. 67.

The time-current characteristics for the SST Trip Device are given in curves GES-6033, GES-6034 and GES-6035.

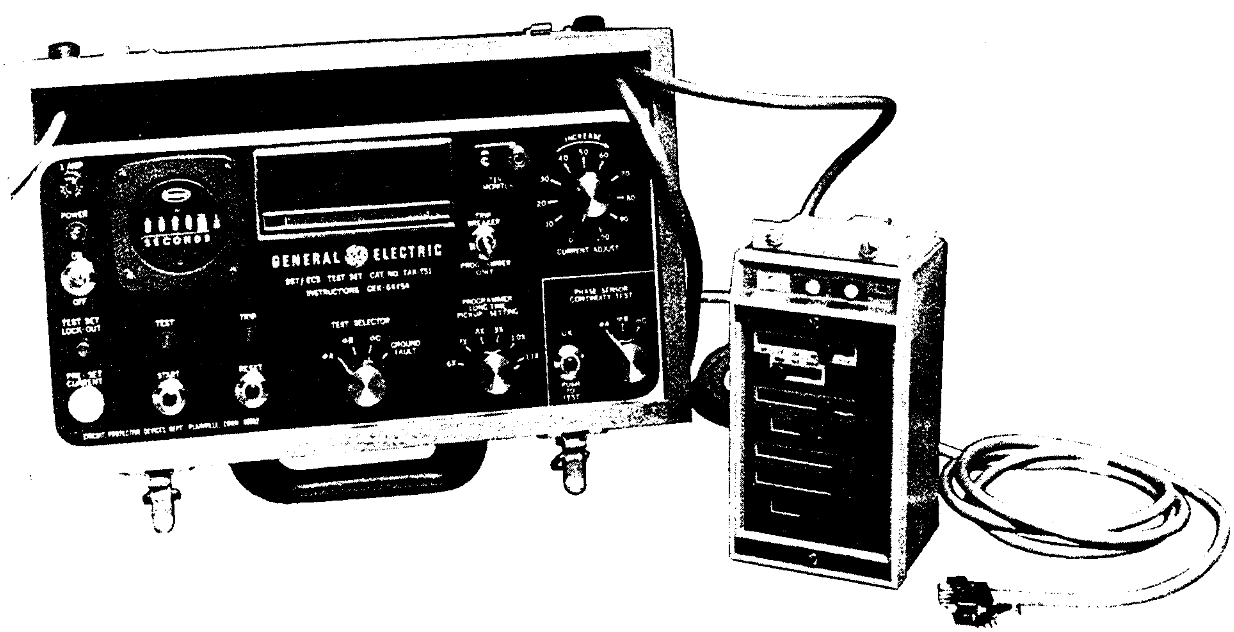


FIG. 67 — SST/ECS TEST SET, CAT. NO. TAK-TS1

10.4.1 SST TEST SET

The TAK-TS1 and TAK-TS2 Test Sets are portable instruments designed for field-checking the time-current characteristics and pickup calibration of the SST's various trip elements. It can verify the ability of the Flux-Shift Trip Device to trip the breaker and, in addition, includes means for continuity checking the phase sensors. A TAK-TS1 Test Set is shown in Fig. 67. The TAK-TS2 functions identically to and supersedes the TAK-TS1 device. The TAK-TS2 can also test the VersaTrip Mod 2 trip device.

WARNING: *BEFORE CONNECTING THE TEST SET TO THE BREAKER TRIP DEVICE SYSTEM, ENSURE THAT THE CIRCUIT BREAKER IS COMPLETELY DISCONNECTED FROM ITS POWER SOURCE. ON DRAWOUT EQUIPMENT, RACK THE BREAKER TO ITS DISCONNECTED POSITION. VERIFY THAT THE BREAKER IS TRIPPED.*

Either of two test modes may be employed:

"A" — Programmer Unit Only. These tests are conducted with the programmer unit disconnected from the breaker. During test, the unit can remain attached to the breaker or may be completely removed from it.

CAUTION: *NEVER DISENGAGE THE HARNESS CONNECTOR FROM THE PROGRAMMER UNIT ON A BREAKER THAT IS ENERGIZED AND CARRYING LOAD CURRENT. THIS WILL OPEN-CIRCUIT THE CURRENT SENSORS, ALLOWING DANGEROUS AND DAMAGING VOLTAGES TO DEVELOP.*

Test scope:

1. Verify the time-current characteristics and pickup calibration of the various trip elements.

2. Verify operation of the SST target indicators on programmer units so equipped.

"B" — Complete Trip Device System. For these tests, the programmer unit must be mounted on the breaker and connected to its wiring harness.

Test scope:

1. All "A" tests previously described, plus provision for optionally switching the programmer's output to activate the Flux-Shift Trip Device and verify its operation by physically tripping the breaker.

2. Check phase sensor continuity.

In the event that any component of the SST system does not perform within the limits prescribed in test instructions GEK-64454, it should be replaced.

10.4.2 RESISTANCE VALUES

For use in troubleshooting, the Common to Tap resistance for SST current sensors is given in Table 8. These values apply to both phase and neutral sensors.

TABLE 8 — SENSOR RESISTANCE VALUES

Ampere TAP	Resistance in Ohms between COMMON and TAP Terminals
100	2.2 — 2.6
150	3.3 — 3.9
225	5.1 — 5.8
300	6.8 — 7.8
300	5.3 — 6.1
400	7.2 — 8.2
600	10.8 — 12.4
800	14.6 — 16.9
600	6.4 — 7.6
800	8.8 — 10.4
1200	13.5 — 15.8
1600	19.4 — 22.8
800	10.2 — 12.4
1200	15.8 — 19.2
1600	22.0 — 26.7
2000	28.5 — 34.7

The coil resistance of the SST/ECS Flux shifter device is approximately 16 ohms.

10.4.3 FALSE TRIPPING—BREAKERS EQUIPPED WITH GROUND FAULT

When nuisance tripping occurs on breakers equipped with the Ground Fault trip element, a probable cause is the existence of a false "ground" signal. As indicated by the cabling diagram of Fig. 69, each phase sensor is connected in a series with a primary winding on the Ground Fault differential transformer. Under no-fault conditions on 3-wire load circuits, the currents in these three windings add to zero and no ground signal is developed. This current sum will be zero only if all three sensors have the same electrical characteristics. If one sensor differs from the others (i.e., different rating or wrong tap setting), the differential transformer can produce output sufficient to trip the breaker. Similarly, discontinuity between any sensor and the programmer unit can cause a false trip signal.

If nuisance tripping is encountered on any breaker whose SST components have previously demonstrated satisfactory performance via the TAK-TS1 Test Set, the sensors and their connections should be closely scrutinized. After disconnecting the breaker from all power sources,

a) Check that all phase sensors are the same type (ampere range).

b) Ensure that the tap settings on all 3-phase sensors are identical.

c) Verify that the harness connections to the sensors meet the polarity constraints indicated by the cabling diagram, i.e., white wire to COMMON, black wire to TAP.

d) On Ground Fault breakers serving 4-wire loads, check that the neutral sensor is properly connected (see cabling diagram Fig. 70). In particular,

(1) Verify that the neutral sensor has the same rating and tap setting as the phase sensors.

(2) Check continuity between the neutral sensor and its equipment-mounted secondary disconnect block. Also check for continuity from the breaker-mounted neutral secondary disconnect block through to the female harness connector (terminals L and N).

(3) If the breaker's lower studs connect to the supply source, then the neutral sensor must have its LOAD end connected to the source.

(4) Ensure that the neutral conductor is carrying only that neutral current associated with the breaker's load current (neutral not shared with other loads).

e) If the preceding steps fail to identify the problem, then the sensor resistances should be measured. Since the phase and neutral sensors are electrically identical, their tap-to-tap resistance should closely agree. See Table 8.

10.5 SST CABLING DIAGRAMS

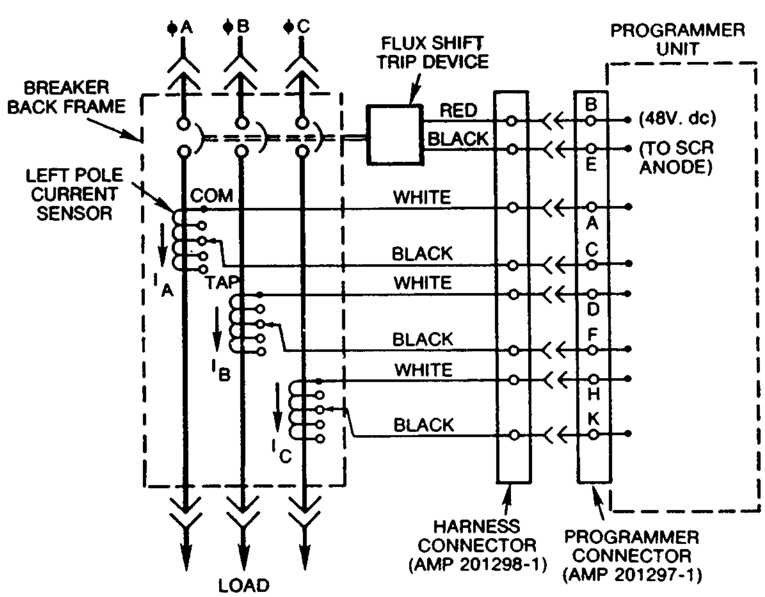


FIG. 68 — CABLING DIAGRAM — SST WITHOUT GROUND FAULT

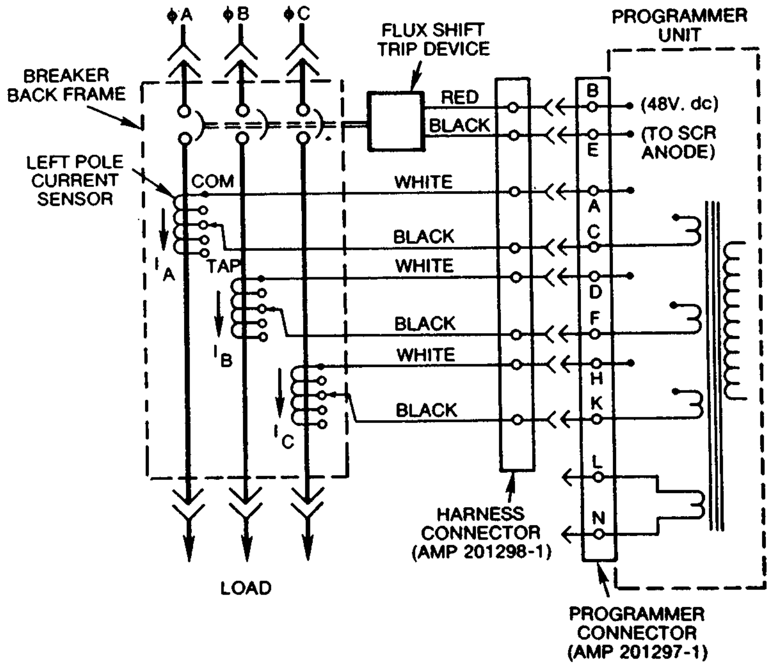


FIG. 69 — CABLING DIAGRAM — SST WITH GROUND FAULT ON 3-WIRE LOAD

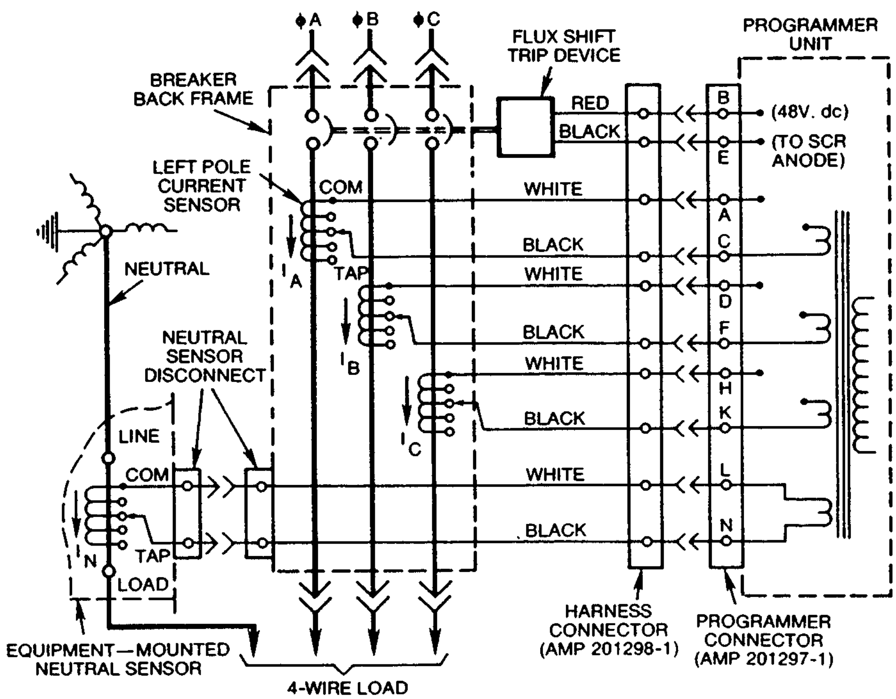


FIG. 70 — CABLING DIAGRAM — SST WITH GROUND FAULT ON 4-WIRE LOAD

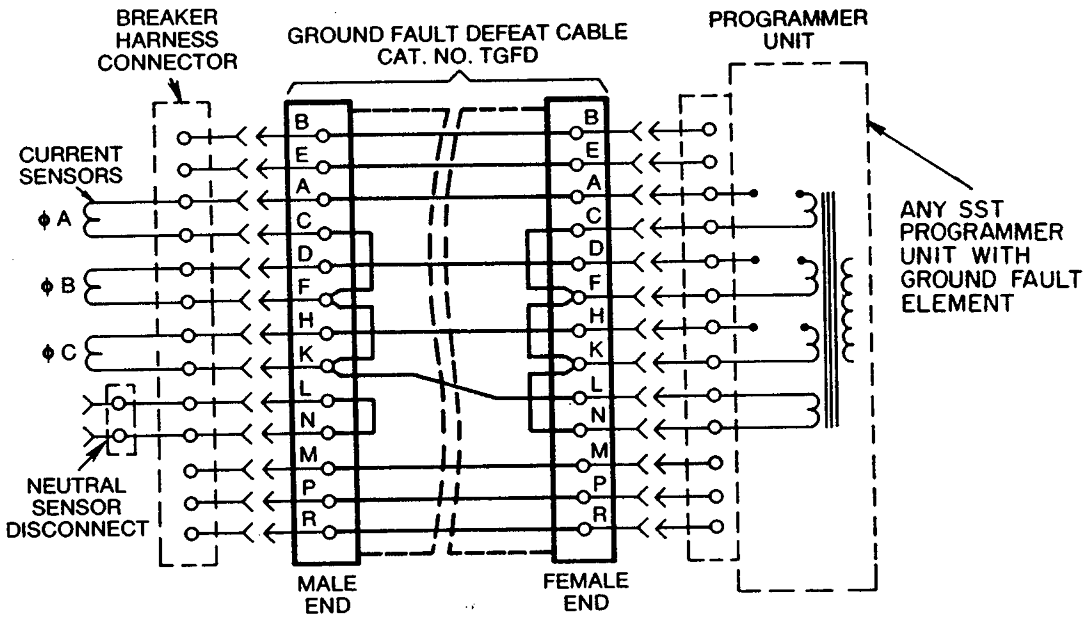


FIG. 71 — CABLING DIAGRAM WITH GROUND FAULT DEFEAT CABLE INSERTED BETWEEN BREAKER HARNESS AND SST PROGRAMMER UNIT — FOR USE DURING SINGLE-PHASE, HIGH CURRENT — LOW VOLTAGE TESTING

SECTION 11—Type ECS Overcurrent Trip Device

The ECS is a solid-state, direct-acting, self-powered trip device system. The ECS system consists of the ECS programmer unit shown in Fig. 72, current sensors, and a flux shifter trip device. Fig. 73 shows a block diagram of the system.

The ECS trip system essentially duplicates the SST trip system described in Section 10 except for the following:

1. Programmer units are limited to combinations of Long Time, Short Time and instantaneous trip elements only. The Ground Fault element is not available.

2. Phase sensors are not tapped. As listed in Table 9, each sensor has only a single ampere rating. A different sensor is available for each of the tabulated ampere ratings, which span the same range as SST, see Fig. 74.

3. Neutral sensors are not required because there is no Ground Fault function.

In all other respects the ECS Trip device system operates and can be treated identically to SST. This includes circuitry, size, construction, component location, programmer unit set points, performance characteristics, operating range, quality, reliability and the flux shift trip device.' Use the same troubleshooting and test procedures for single-phase, high current-low voltage tests or those employing the TAK-TS1 or TAK-TS2 Test Sets. The Ground Fault test procedures, of course, do not apply. ECS phase sensor resistance values are given in Table 10.

The time-current characteristics for the ECS trip device are given in curve GES-6032.

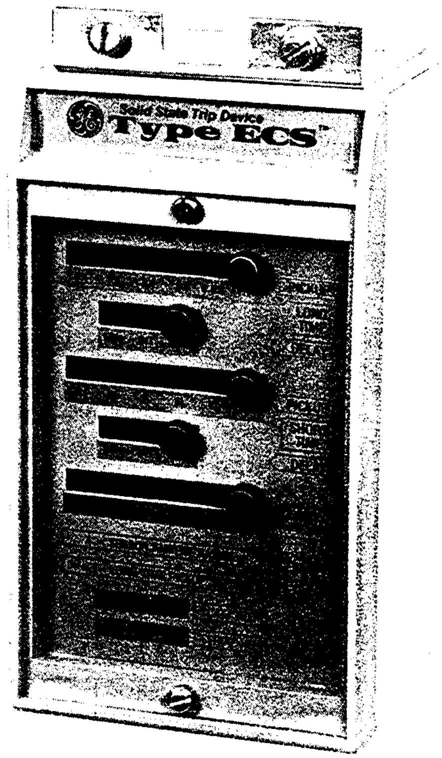


FIG. 72 — ECS PROGRAMMER UNIT

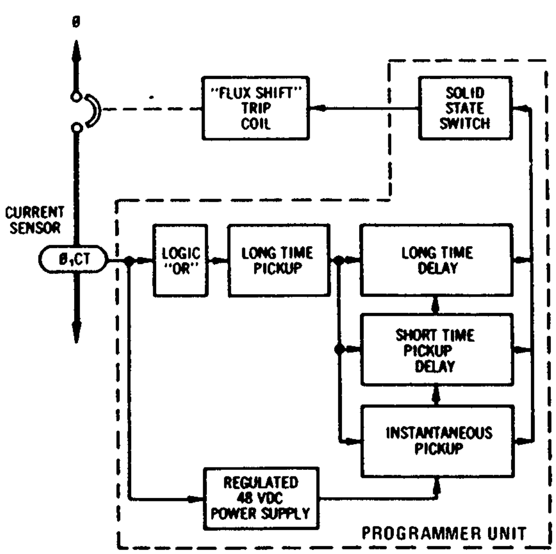


FIG. 73 — ECS BLOCK DIAGRAM

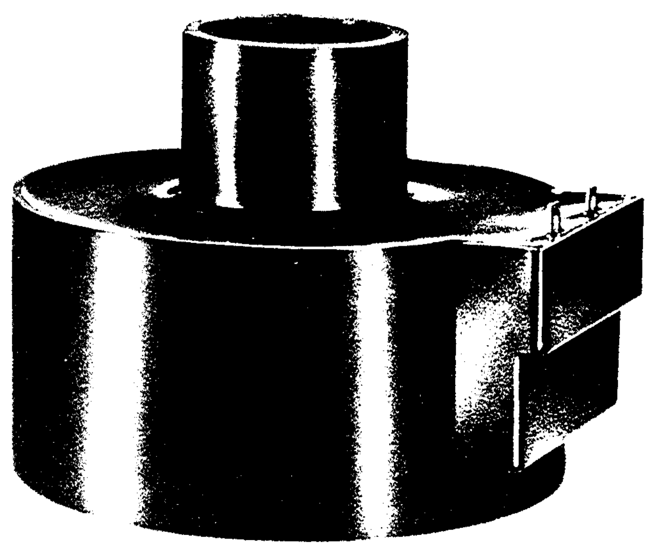


FIG 74 — ECS CURRENT SENSOR

TABLE 9
ECS TRIP CHARACTERISTICS

Breaker Type	Frame Size (Amperes)	X = Trip Rating in Amperes = Sensor Rating (Sensor Ampere Rating)	ECS PROGRAMMER ADJUSTMENT RANGE (Set Points)				
			Long Time		Short Time		Instantaneous Pickup ② (Multiple of L)
			Pickup (=L) ① (Multiple of X)	Time Delay Band ③ (Seconds)	Pickup ② (Multiple of L)	Time Delay Band ④ (Seconds)	
AKR-30	800	100, 150, 225, 300, 400, 600, 800			3, 4, 5, 6, 8, 10 (L)		
AKR-50	1600	300, 400, 600, 800, 1200, 1600	.6, .7, .8, .9, 1.0, 1.1 (X)	Maximum 22 Intermed. 10 Minimum 4	—or—	Maximum 0.35 Intermed. 0.21 Minimum 0.095	4, 5, 6, 8, 10, 12 (L)
AKRT-50	2000	800, 1200, 1600, 2000			1.75, 2, 2.25, 2.5, 3, 4 (L)		

① Pickup tolerance is ± 9%

② Pickup tolerance is ± 10%

③ Time delay shown at 600% of long time pickup setting (6L), at lower limit of band.

④ Time delay shown at lower limit of band.

TABLE 10 — SENSOR RESISTANCE VALUES

Ampere Rating	Resistance in Ohms between Terminals
100	3.0 — 3.4
150	4.4 — 5.0
225	4.8 — 5.6
300	6.4 — 7.2
400	6.7 — 7.8
600	6.4 — 7.6
800	8.8 — 10.4
1200	13.5 — 15.8
1600	19.4 — 22.8
2000	29.5 — 34.5

11.1 ECS CABLING DIAGRAM

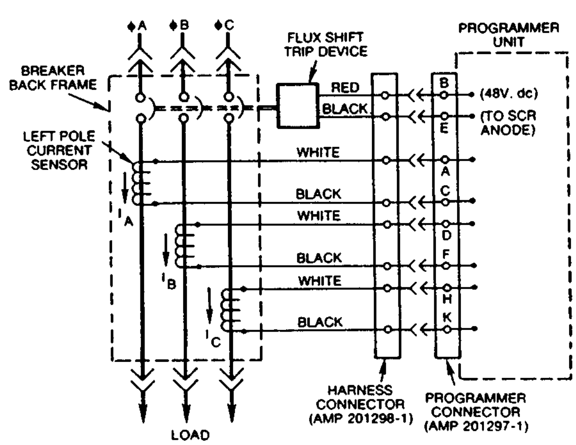


FIG. 75. CABLING DIAGRAM FOR ECS TRIP DEVICE

SECTION 12—MicroVersaTrip™ Trip Device

The MicroVersaTrip is a solid-state, direct-acting, self-powered trip device system. The MicroVersaTrip system consists of the MicroVersaTrip programmer, current sensors, and a flux shifter trip device. Fig. 76 shows a block diagram of the system.

12.1 PROGRAMMER UNIT

Fig. 77 shows a typical MicroVersaTrip programmer unit. Like the SST and ECS units, the MicroVersaTrip provides the comparison basis for overcurrent detection and delivers the energy necessary to trip the breaker. It contains a programmable microelectronic processor which incorporates nine adjustable time-current functions, three mechanical fault indicators (local and remote), a long-time pickup LED indicator (local and remote) and a zone selective interlocking function. All adjustable programmer functions are automatic and self-contained requiring no external relaying, power supply or accessories. See Table 11 for trip functions available and Table 12 for trip function characteristics. A detailed description of each trip function is given in publication GEA 10265 and GEH 4657.

12.1.1 FAULT TRIP INDICATORS

The optional fault trip indicators are similar to the SST indicators. They are mechanical pop-out type for identifying overload or short circuit over-currents faults when breakers are ordered without integral ground fault protection. They are also available to identify overload, short circuit and ground fault trips for breakers supplied with integral ground fault protection.

Each target pops out when its associated trip element operates to trip the breaker. After a trip, the popped target must be reset by hand. However, neglecting to reset does not affect normal operation of any trip element or prevent the breaker from being closed.

12.1.2 REMOTE FAULT INDICATION

Remote fault indication is available in the form of a mechanical contact which may be incorporated directly into the customer's control circuitry. This is a Normally open contact which is activated when its associated target pops out. When the target is reset, the contact is returned to its open position. Each contact is rated 0.25 amp at 125 VDC and 1.0 amp (10 amp in rush) at 120 VAC.

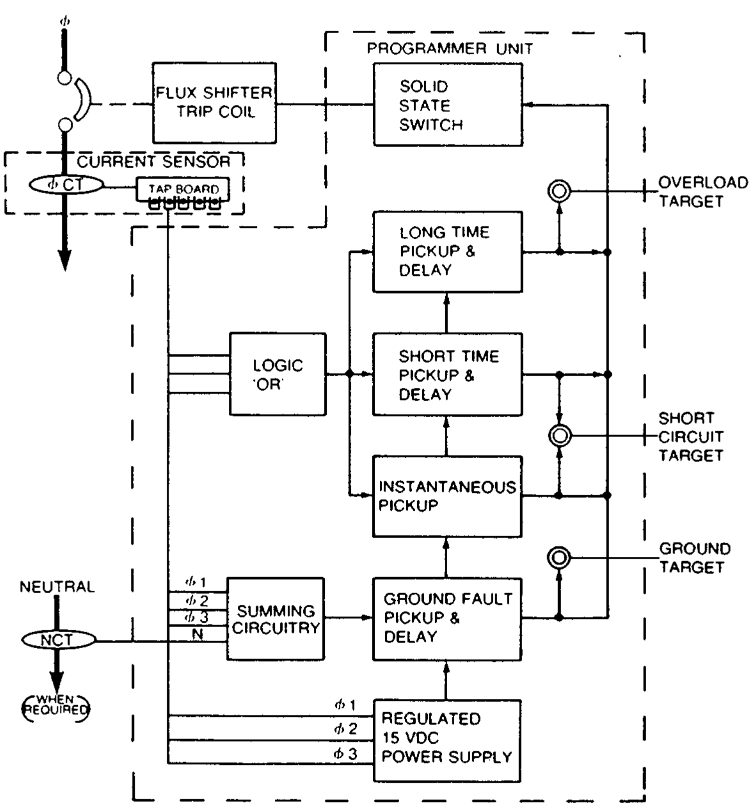


FIG. 76
MICROVERSATRIP BLOCK DIAGRAM

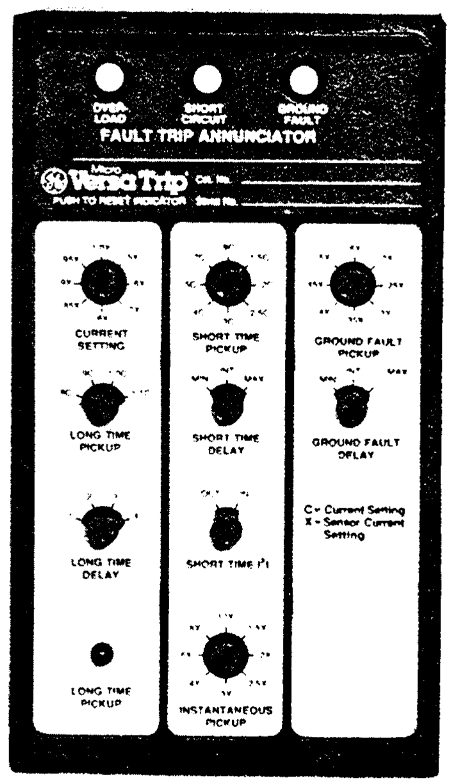


FIG. 77
MICROVERSATRIP PROGRAMMER

The remote fault indication switch leads are brought out the bottom of the MicroVersaTrip programmer as shown in Fig. 78. This switch lead harness is plugged into the mating connector on the breaker, see Fig. 79.

The switch leads are brought out from the breaker through the Programmer Secondary Disconnect shown in Fig. 80. The zone selective interlocking function wiring is also brought out through this disconnect. See Figs. 95 and 96 for the remote fault indication and zone selective interlocking cable diagrams.

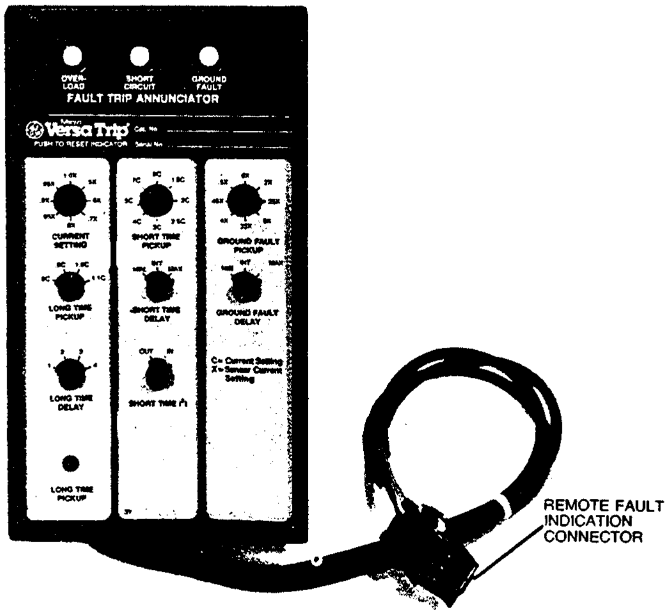


FIG. 78 MICROVERSATRIP W/REMOTE FAULT INDICATION HARNESS

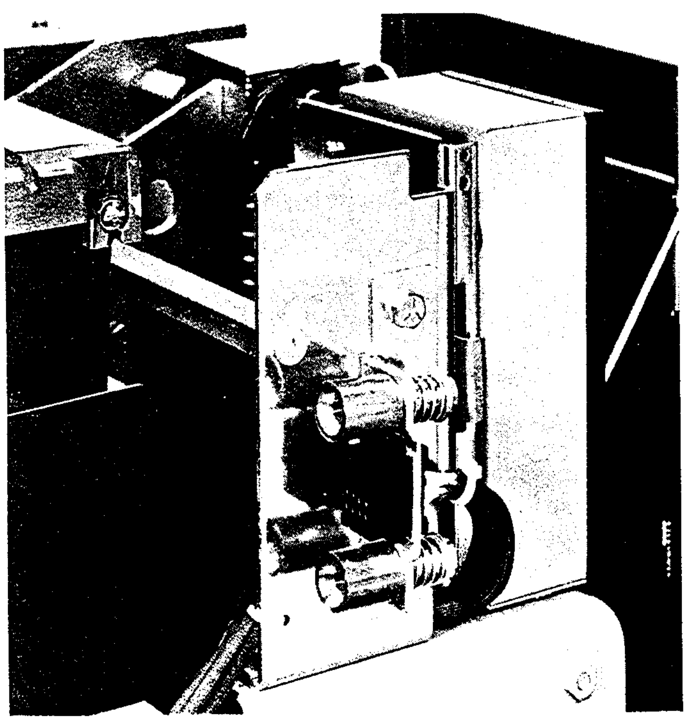


FIG. 79 PROGRAMMER SECONDARY CONNECTOR

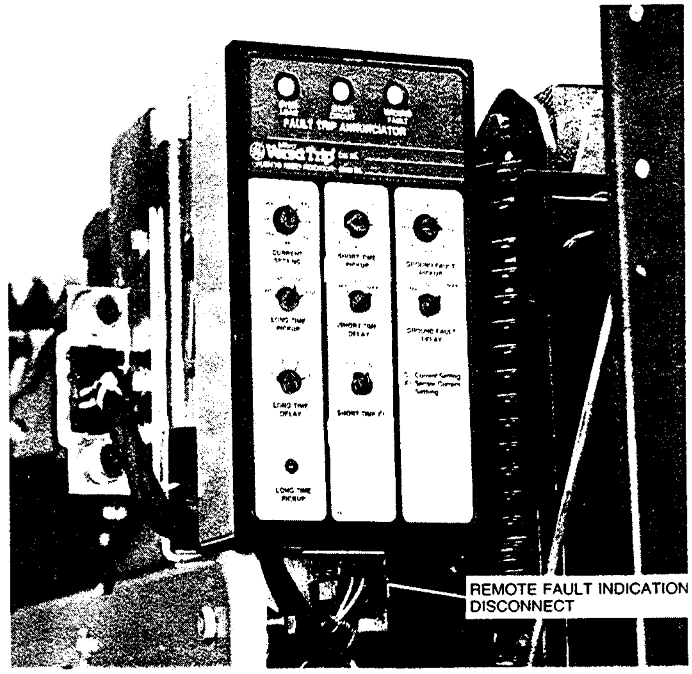


FIG. 80 REMOTE FAULT INDICATOR DISCONNECT

12.1.3 MICROVERSATRIP™ INSTALLATION

The programmer mounts to the upper left of the breaker as shown in Fig. 81. It mounts to the bracket assembly shown in Fig. 82. Referring to Fig. 82, the guide pins mate with the holes on either side of the programmer connector. They provide the necessary alignment for the connector engagement. The locking lever engages with the pin which is assembled to the programmer frame and secures the programmer to the mounting bracket

There are two programmer mounting designs in use. The difference in the designs is in the operation of the locking lever, see Fig. 82.

Installation using each design is as follows:

a. Insert the guide pins into the holes and push on the programmer, engaging the connectors.

b. Original design—push in the locking lever, securing the programmer.

Later design—the locking lever is released, securing the programmer.

c. Verify that the locking lever did engage the programmer pin.

d. Connect remote fault indication harness, if equipped, see Fig. 80.

To remove the programmer:

a. Disconnect the remote fault indication harness, if equipped.

b. Original designs—push in locking lever, which will release the programmer pin. While holding the locking lever in, remove the programmer.

c. Later design—pull out locking lever, which will release the programmer pin. Remove the programmer.

SECTION 12—MicroVersaTrip™ Trip Device (Cont.)

12.2 CURRENT SENSORS

The current sensors supply the power and signal input necessary to operate the trip system. Like the SST system, the MicroVersaTrip uses a phase and neutral sensor.

Fig. 83 shows the phase sensors. Tapped and fixed phase sensors are available. The tapped sensors provide field adjustment of the trip device's continuous ampere rating. See Section 12.5 for cabling diagrams.

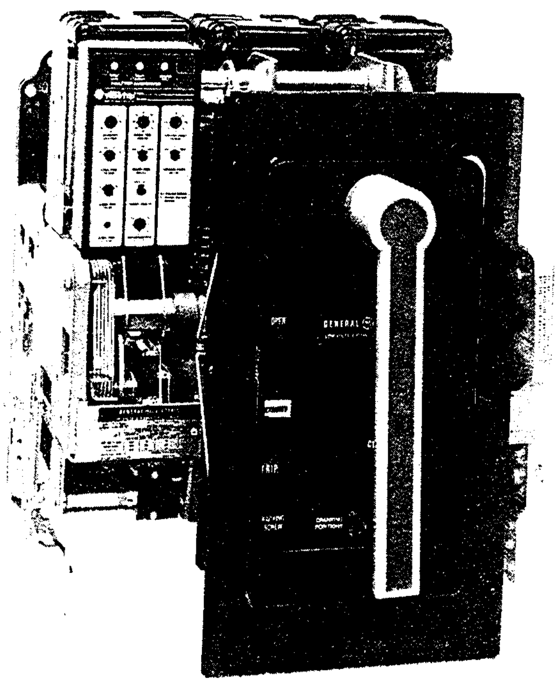


FIG. 81 — AKR-6D-30

The tapped and fixed phase sensors have a polarity associated with their windings. Their COMMON terminal is the right hand terminal as shown in Fig. 83. A white wire with a ring terminal will be connected to this COMMON terminal. All phase sensors must be correctly wired for the programmer summing circuit to function properly.

The tapped or fixed phase sensors are available with an additional winding. This winding is brought out to separate flag terminals rather than the screw terminals. These phase sensors are used when the hi-level instantaneous MicroVersaTrip option ('H'-option) is required. Fig. 84 shows an 'H'-option phase sensor. When the 'H'-option phase sensor is installed, there are four leads connected to it; two flag terminal connections (additional winding) and two screw terminal connections (ampere rating). There is no polarity associated with the flag terminals. Fig. 94 shows the connections for the additional 'H'-option windings.

Fig. 85 shows the neutral sensor. The neutral sensor is required when integral ground fault protection is used on single phase-three wire or three phase-four wire systems. It is inserted into the neutral conductor and therefore is separately mounted in the cable or bus compartment.

The outputs of the phase sensors and neutral sensor are connected to a programmer circuit which sums these values. The total value will remain zero as long as there is no ground current flowing. See cable diagram in Fig. 91.

The neutral sensor is an electrical duplicate of the phase sensor, including taps. Therefore, when taps are charged on the phase sensors, those on the neutral sensor must be correspondingly positioned.

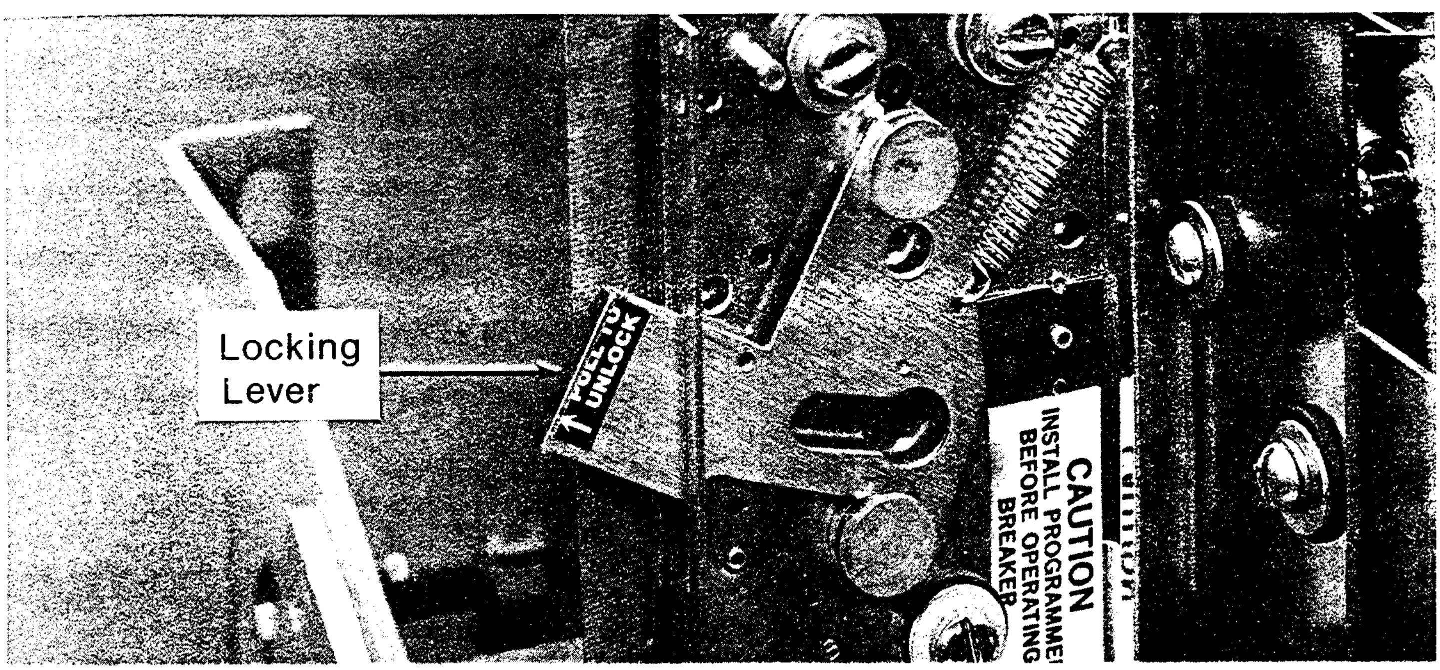


FIG. 82 — MICROVERSATRIP™ MOUNTING BRACKET

TABLE 11 TRIP FUNCTIONS AVAILABLE

		Optional Features														
		BASIC FUNCTIONS				ADD TO BASIC FUNCTIONS										
		STD.-or-S-or-H-or-M				L	T	G-or-GR		A1-or-A2-or-A3-or-A				Z1-or-Z2-or-Z		
LONG TIME	• Adjustable Current Setting	X	X	X	X											
	• Adj Long-Time Pickup	X	X	X	X											
	• Adj Long-Time Delay	X	X	X	X											
	• Long-Time Timing Light	X	X	X	X											
	• Remote Long-Time Timing Light						X									
SHORT TIME	• Adj Short-Time Pickup		X	X	X											
	• Adj Short-Time Delay		X	X	X											
	• Short-Time I^2t Switch①					X										
INSTANTANEOUS	• Adj Instantaneous Pickup	X	X													
	• Adj High Range Instantaneous			X												
GROUND FAULT	• Adj Ground Fault Pickup															
	—1PH, 2-W—3PH, 3/4-W							X								
	—Ground Return								X							
	• Adj Ground Fault Delay							X	X							
OTHER FUNCTIONS	• Trip Indication Targets															
	—Overload & Short Circuit															
	—local only									X						
	—local and remote										X					
	—O/L, S/C and Ground Fault															
	—local only②											X				
	—local and remote												X			
	• Zone Selective Interlock															
	—Ground Fault③													X		X
	—Short Time①														X	X

1 Short-Time Delay is required
2 Standard when Ground Fault specified
3 Ground Fault required

TABLE 12 MICROVERSATRIP™ TRIP CHARACTERISTICS

Frame Size	Maximum Rating (Amps)	(X) Fixed Sensors	(X) Tapped Sensors	Current Setting (Multiple of Sensor Current Rating) (X)	Long-Time Pickup (Multiple of Current Rating) (C)	Long-Time Delay ① (Seconds)	Short-time Pickup (Multiple of Current Rating) (C)	Short-time Delay ② (Seconds)	Adjustable Instantaneous Pickup (Multiple of Sensor Rating) (X)	Short-time I^2t ① (Seconds)	Ground Fault Pickup (Multiple of Sensor Current Rating) (X)	Ground Fault Delay ② (Seconds)
		Sensor Current Rating (Amps)										
AKR-30	800	100, 150, 225, 300, 400, 600, 800	100, 150, 225, 300 or 300, 400 600, 800	.5, .6, .7, .8, .85, .9, .95, 1.0 (X)	.8, .9, 1.0, 1.1 (C)	2.5, 5, 10, 21	1.5, 2, 2.5, 3, 4, 5, 7, 9 (C)	0.10, 0.22, 0.36	1.5, 2, 2.5, 3, 4, 6, 8, 10 (X)	0.4	.2, .25, .3, .35, .4, .45, .5, .6 (X)	0.10, 0.22, 0.36
AKR-50	1600	300, 400, 600, 800 1200, 1600	300, 400, 600, 800 or 600, 800 1200, 1600	"	"	"	"	"	"	"	"	"
AKRT-50	2000	800, 1200, 1600, 2000	800, 1200 1600, 2000	"	"	"	"	"	"	"	"	"
AKR-75	3200	1200, 1600, 2000, 3200	1200, 1600 2000, 3200	"	"	"	"	"	"	"	.2, .22, .24, .26, .28, .30, .34, .37 (X)	"
AKR-100	4000	1600, 2000, 3000, 4000	1600, 2000 3000, 4000	"	"	"	"	"	1.5, 2, 2.5, 3, 4, 5, 7, 9 (X)	"	.2, .22, .24, .26, .28, .3 (X)	"

1 Time delay shown at 600% of ampere setting at lower limit of each band.
2 Time delay shown at lower limit of each band.
All pickup tolerances are ± 10%
Ground Fault pickup not to exceed 1200 amperes.

C = current setting
X = sensor current

SECTION 12—MicroVersaTrip™ Trip Device (Cont.)

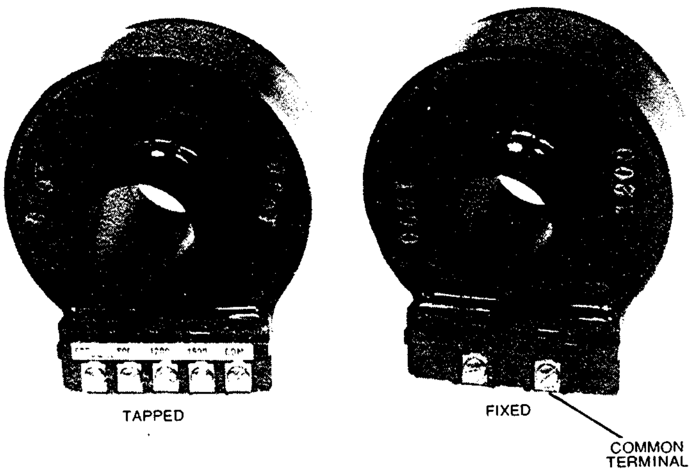


FIG. 83 — MICROVERSATRIP™ PHASE SENSORS

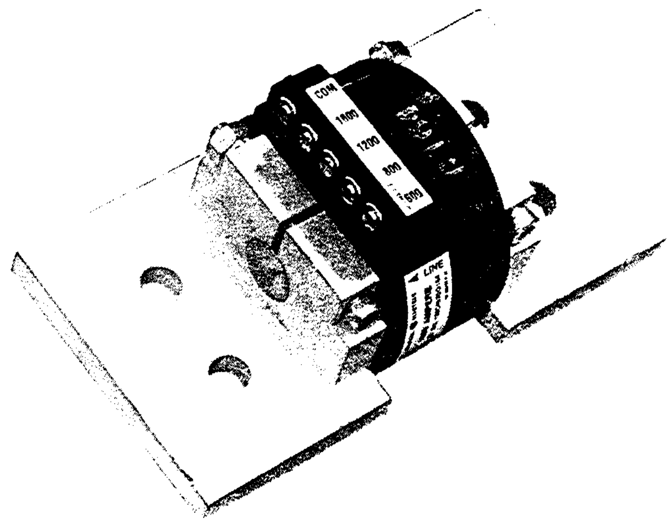


FIG. 85 — TYPICAL NEUTRAL SENSOR

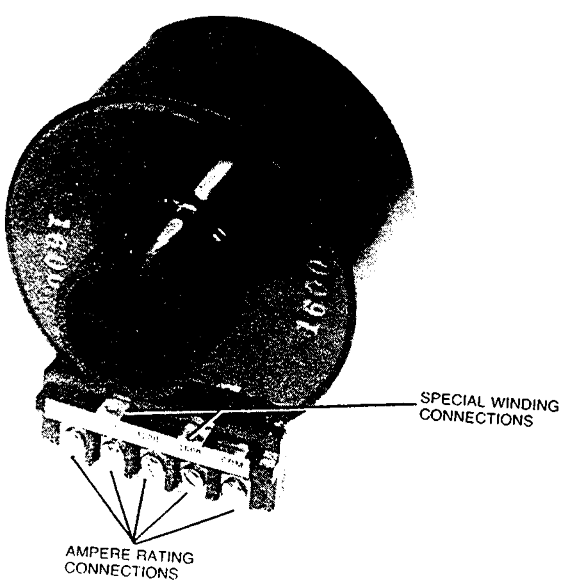
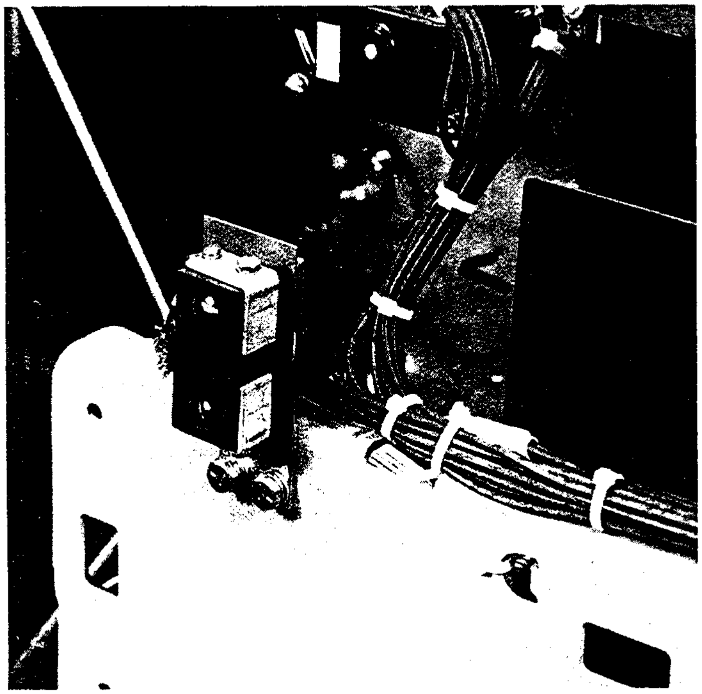
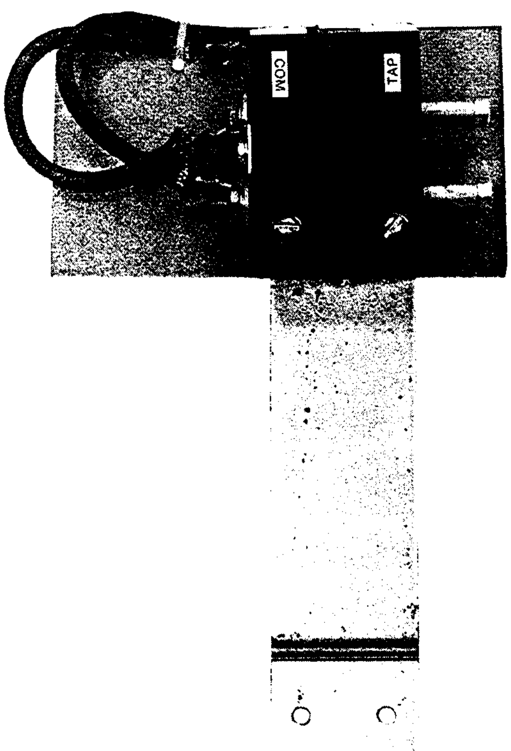


FIG. 84 — 'H'-Option Phase Sensor



A BREAKER MOUNTED — RIGHT SIDE



B EQUIPMENT MOUNTED

FIG. 86 — NEUTRAL SENSOR SECONDARY DISCONNECT

Since the neutral sensor is mounted separately from the breaker, a disconnect means is required to connect its output to the breaker. Fig. 86 shows the breaker and equipment mounted 4th wire secondary disconnect used with the MicroVersaTrip system.

12.2.1 REPLACEMENT OF CURRENT SENSORS

Referring to Fig. 87, replacement of MicroVersaTrip current sensors is accomplished as follows:

a) Disconnect the programmer harness from the terminal board, removing cable ties as necessary.

b) At the rear fo the breaker, remove the two Allen head screws to separate the stud connector from the contact pivot block.

c) Loosen the clamping bolt and remove the stud connector. Lift out the sensor and its tap terminal board.

The sensor may be prevented from slipping off the sensor stud by adjacent accessories. If this exists, the sensor stud must be removed from the breaker base. The stud assembly is secured to the base with four bolts which are accessible from the rear of the breaker.

d) When replacing the stud connector, tighten the Allen head screw to 250 ± 10 in-lbs. Tighten the clamping bolt as follows:

AKR 30/30H 120 ± 10 in-lbs
AKR 50/50H 470 ± 10 in-lbs
AKRT 50/50H 470 ± 10 in-lbs

e) When replacing the programmer harness to the phase sensors verify that the winding polarity is maintained, white wire with ring terminal to COMMON terminal (right hand terminal, see Fig. 83).

12.3 FLUX SHIFTER TRIP DEVICE

The only difference between the MicroVersaTrip and SST flux shifter trip devices is the solenoid winding. Refer to Section 10.3 for details.

When replacing a MicroVersaTrip flux shifter, AMP extraction tool Cat. No. 455822-2 is required to remove the socket leads from the AMP connector.

12.4 TROUBLESHOOTING

When malfunctionion is suspected, the first step in troubleshooting is to examine the circuit breaker and its power system for abnormal conditions such as:

a) Breaker tripping in proper response to overcurrents or incipient ground faults.

b) Breaker remaining in a trip-free state due to mechanical maintenance along its trip shaft.

c) Inadvertent shunt trip activations.

WARNING: *DO NOT CHANGE TAPS ON THE CURRENT SENSORS OR ADJUST THE PROGRAMMER UNIT SET KNOBS WHILE THE BREAKER IS CARRYING CURRENT.*

Once it has been established that the circuit breaker can be opened and closed normally from the test position, attention can be directed to the trip device proper. Testing is performed by either of two methods:

1. Conduct high-current, single-phase tests on the breaker using a high current-low voltage test set.

NOTE: *For these single-phase tests, special connections must be employed for MicroVersaTrip breakers equipped with Ground Fault. Any single-phase input to the programmer circuit will generate an unwanted "ground fault" output signal which will trip the breaker. This can be nullified either by*

a) Using the Ground Fault Defeat Cable as shown in Fig. 93. This special test cable energizes the programmer circuit in a self-cancelling, series-parallel connection so that its output is always zero.

2. Test the components of the MicroVersaTrip system using portable Test Set Type TVTS1 (Fig. 88). The applicable test procedures are detailed in instruction Book GEK-64464.

The time-current characteristics for the MicroVersaTrip Trip Device are given in curves GES-6195 and GES-6199.

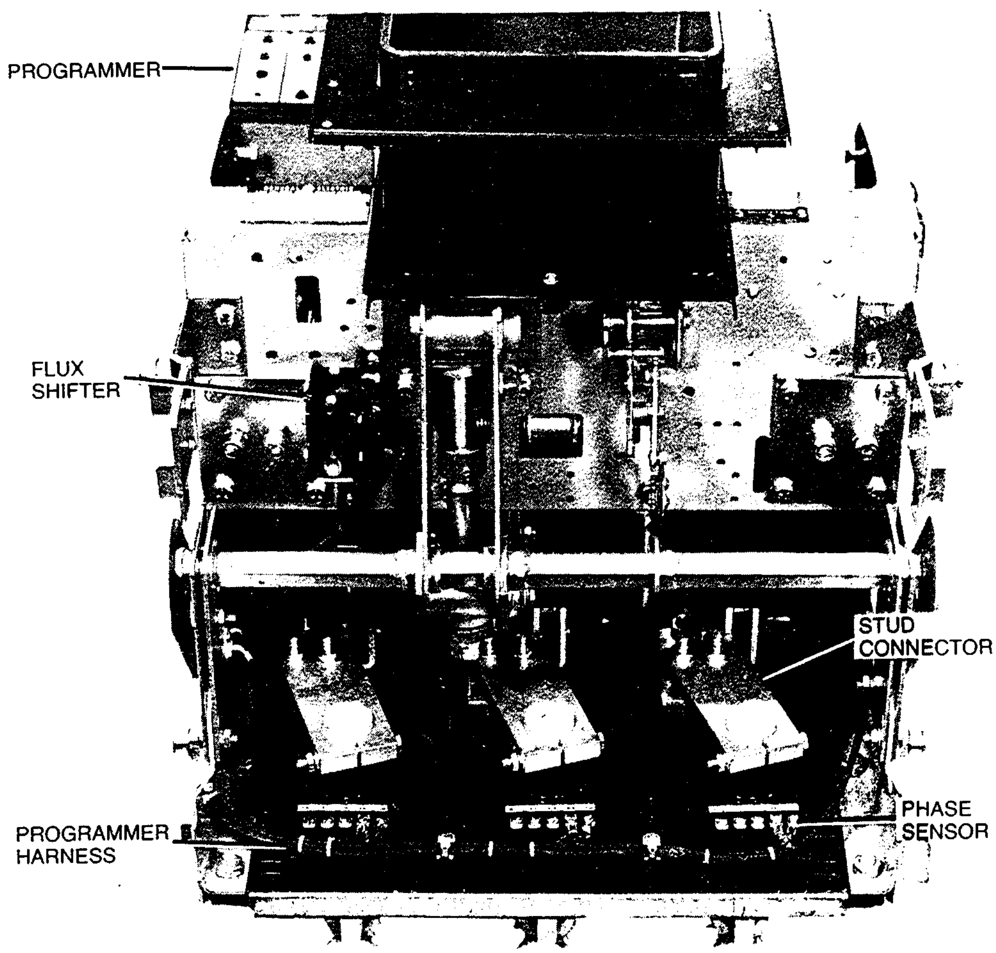


FIG. 87 — MICROVERSATRIP COMPONENT

FIG. 88 TEST SET, CAT. NO. TVTS1

12.4.1 RESISTANCE VALUES

For use in troubleshooting the MicroVersaTrip™ current sensors, the resistance of the tapped and fixed windings is given in Tables 13 and 14 respectively.

TABLE 13 — TAPPED SENSOR RESISTANCE VALUES

Ampere Tap	Resistance in Ohms Between Common and Tap Terminals
100	7.0-8.2
150	10-12
225	15-18
300	20-24
300	20-24
400	27-32
600	42-50
800	58-68
600	42-50
800	53-68
1200	93-109
1600	130-154
800	74-88
1200	116-136
1600	162-190
2000	210-246

TABLE 14 — FIXED SENSOR RESISTANCE VALUES

Ampere Rating	Resistance in Ohms Between Terminals
100	6.7-7.8
150	10-12
225	15-17
300	20-24
400	27-32
600	42-50
800	58-68
1200	92-108
1600	129-151
2000	207-243

The coil resistance of the MicroVersaTrip flux shifter device is approximately 7 ohms.

SECTION 12—MicroVersaTrip™ Trip Device (Cont.)

12.4.2 FALSE TRIPPING—BREAKERS EQUIPPED WITH GROUND FAULT

When nuisance tripping occurs on breakers equipped with the Ground Fault trip element, a probable cause is the existence of a false "ground" signal. As indicated by the cabling diagram of Fig. 90, each phase sensor is connected to summing circuitry in the programmer. Under no-fault conditions on 3-wire load circuits, the currents in this circuitry add to zero and no ground signal is developed. This current sum will be zero only if all three sensors have the same electrical characteristics. If one sensor differs from the others (i.e., different rating or wrong tap setting), the circuitry can produce output sufficient to trip the breaker. Similarly, discontinuity between any sensor and the programmer unit can cause a false trip signal.

If nuisance tripping is encountered on any breaker whose MicroVersaTrip components have previously demonstrated satisfactory performance via the TVTS1 Test Set, the sensors and their connections should be closely scrutinized. After disconnecting the breaker from all power sources.

a) Check that all phase sensors are the same type (ampere range).

b) Ensure that the tap settings on all 3-phase sensors are identical.

c) Verify that the harness connections to the sensors meet the polarity constraints indicated by the cabling diagram.

d) On Ground Fault breakers serving 4-wire loads, check that the neutral sensor is properly connected (see cabling diagram Fig. 91). In particular,

(1) Verify that the neutral sensor has the same rating and tap setting as the phase sensors.

(2) Check continuity between the neutral sensor and its equipment-mounted secondary disconnect block. Also check for continuity from the breaker-mounted neutral secondary disconnect block through to the female harness connector.

(3) If The breaker's lower studs connect to the supply source, then the neutral sensor must have its LOAD end connected to the source. See Fig. 92.

(4) Ensure that the neutral conductor is carrying only that neutral current associated with the breaker's load current (neutral not shared with other loads).

e) If the preceding steps fail to identify the problem, then the sensor resistances should be measured. Since the phase and neutral sensors are electrically identical, their tap-to-tap resistances should closely agree. See Tables 13 and 14.

12.5 CABLING DIAGRAMS

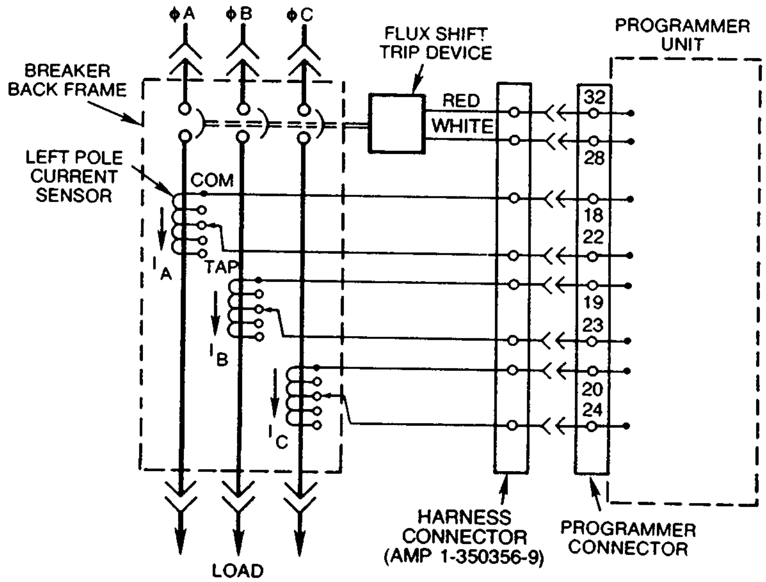


FIG. 89. CABLING DIAGRAM—MICROVERSATRIP™ WITHOUT GROUND FAULT

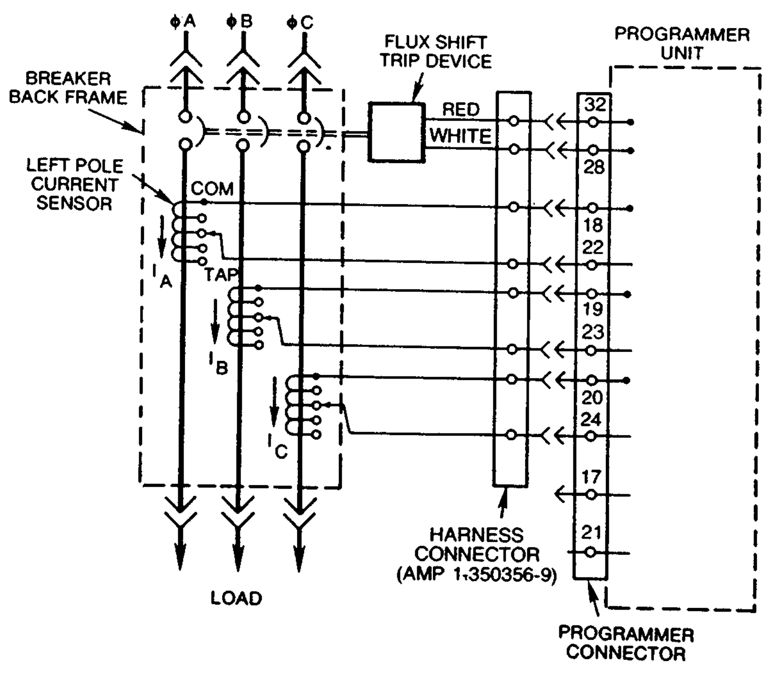


FIG. 90. CABLING DIAGRAM—MICROVERSATRIP™ WITH GROUND FAULT ON 3-WIRE LOAD

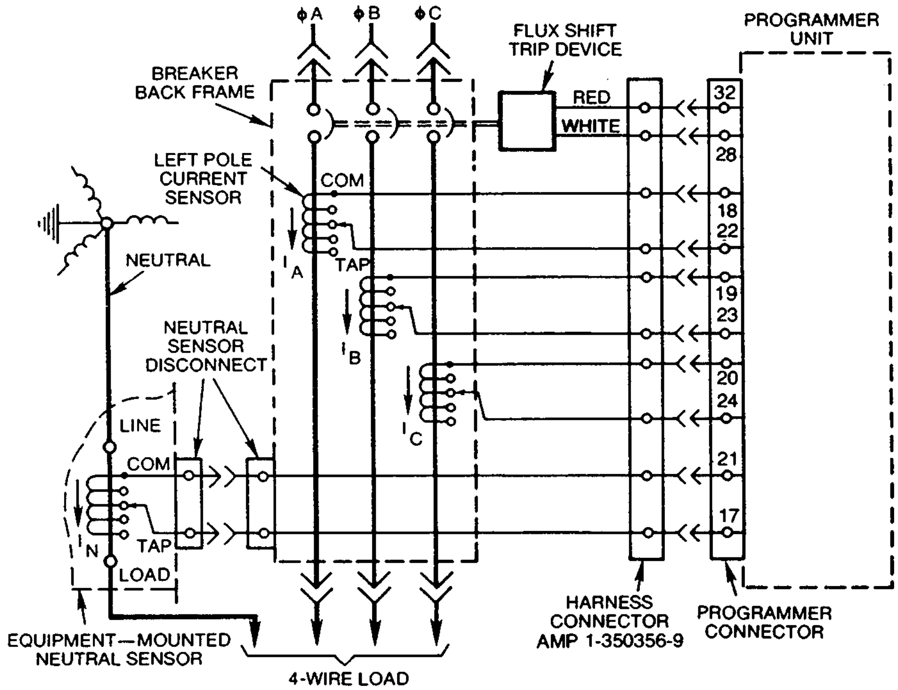


FIG. 91. CABLING DIAGRAM—MICROVERSATRIP™ WITH GROUND FAULT ON 4-WIRE LOAD

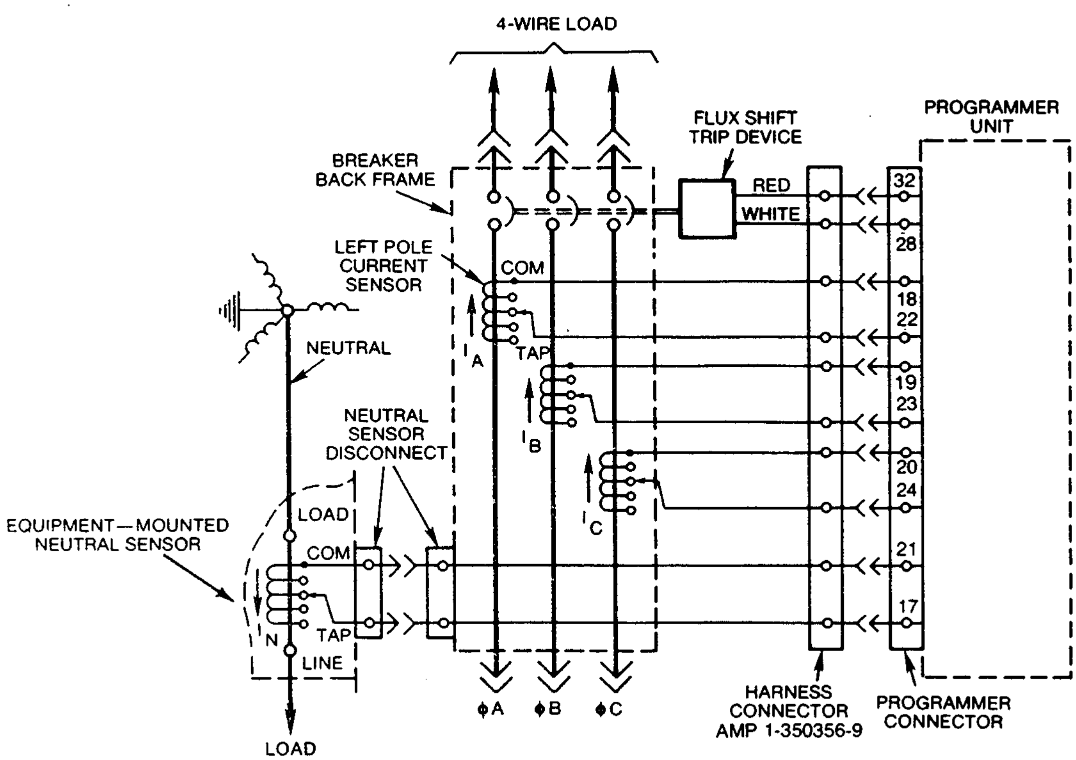


FIG. 92. CABLING DIAGRAM—MICROVERSATRIP WITH GROUND FAULT ON 4-WIRE LOAD—BREAKER REVERSE FEED

SECTION 12—MicroVersaTrip™ Trip Device (Cont.)

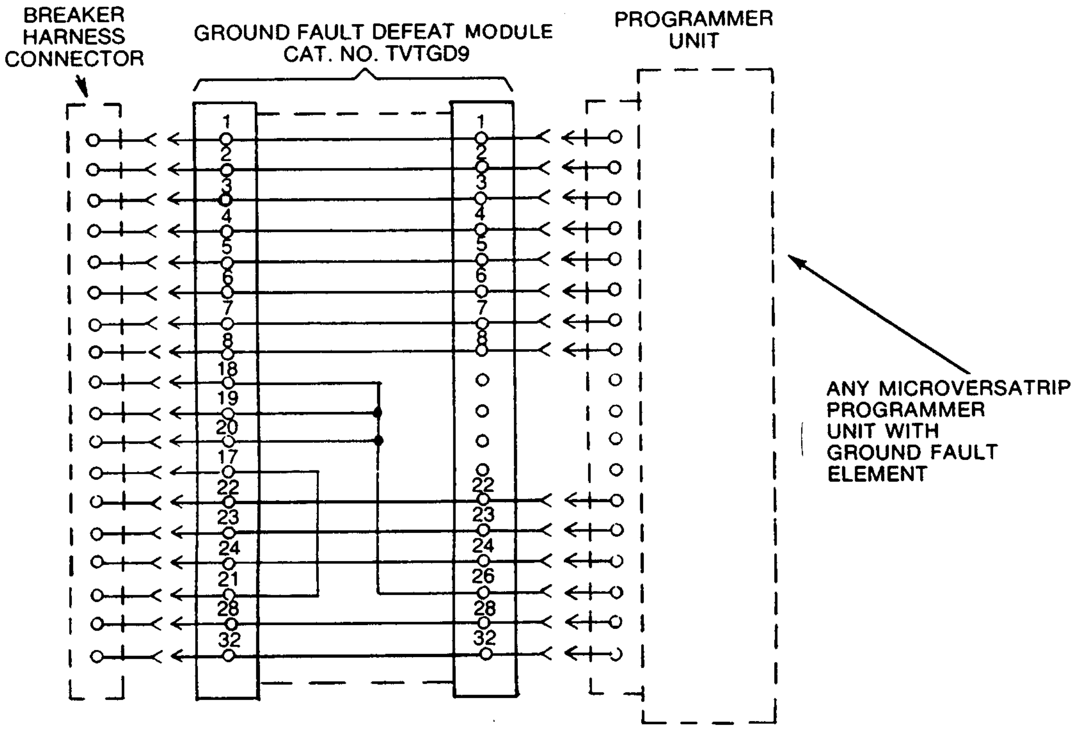


FIG. 93. CABLING DIAGRAM WITH GROUND FAULT DEFEAT MODULE INSERTED BETWEEN BREAKER HARNESS AND MICROVERSATRIP PROGRAMMER UNIT—FOR USE DURING SINGLE-PHASE, HIGH CURRENT—LOW VOLTAGE TESTING.

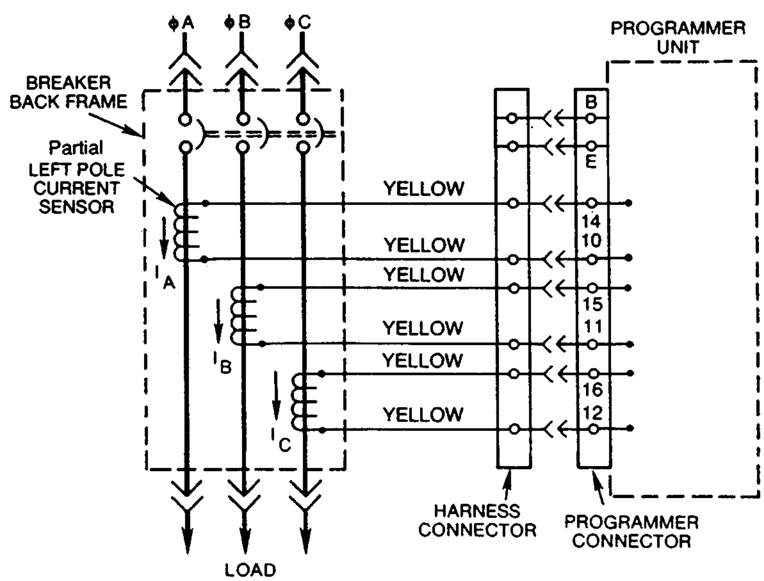


FIG. 94. PARTIAL CABLING DIAGRAM: 'H'-OPTION WINDING CONNECTIONS

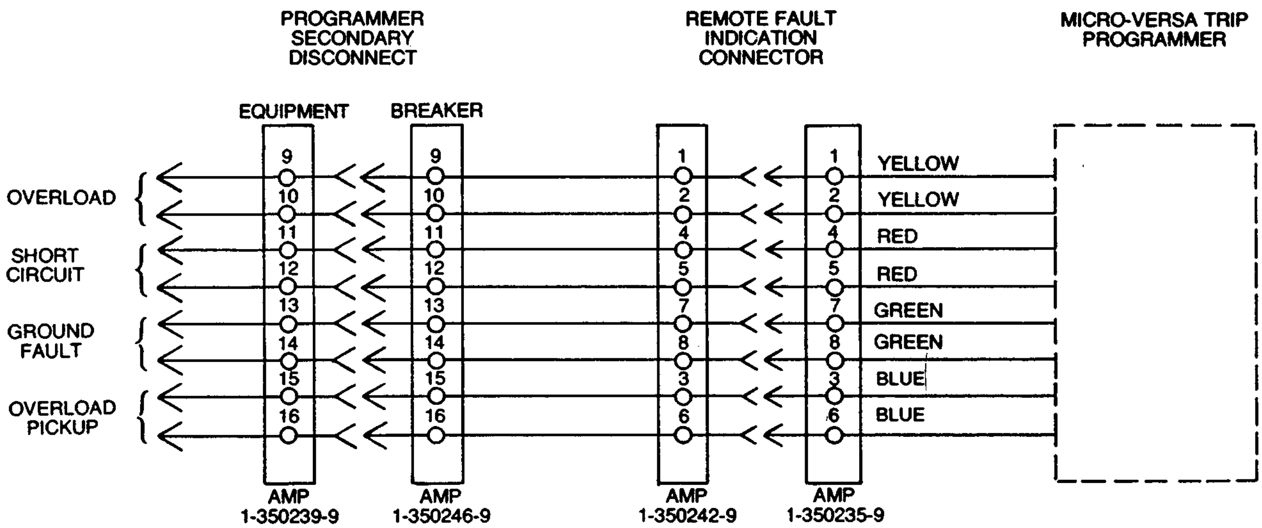


FIG. 95. CABLING DIAGRAM—REMOTE FAULT INDICATION

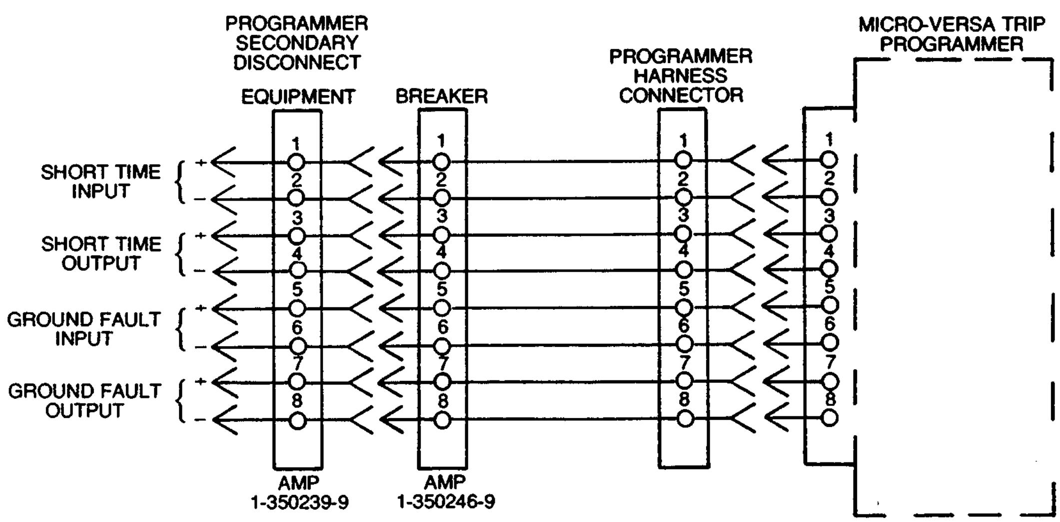


FIG. 96. CABLING DIAGRAM—ZONE SELECTIVE INTERLOCK

SECTION 13—EC Trip Device

Type EC overcurrent trip devices are magnetically operated, using a series coil or single conductor, and an associated magnetic structure to provide tripping force.

There are three basic characteristics: long time delay, short time delay and instantaneous, which can be used in various combinations to suit the application.

AKR breakers with EC Trips are for use on DC system voltages. One EC trip device is mounted per breaker pole. This device contains its functional adjustments.

The standard EC trip device for breaker frames up to 2000 amps is the type EC-2A, see Fig. 97. An optional trip device for these frames is the type EC-1, see Fig. 98.

Trip characteristics are for the EC devices are given in Table 15.

The time-current characteristics for the EC trip devices are given in the following curves:

GES-6000 EC-1
GES-6010 EC-2/2A 1A-3
GES-6011 EC-2/2A 1B-3
GES-6012 EC-2/2A 1C-3

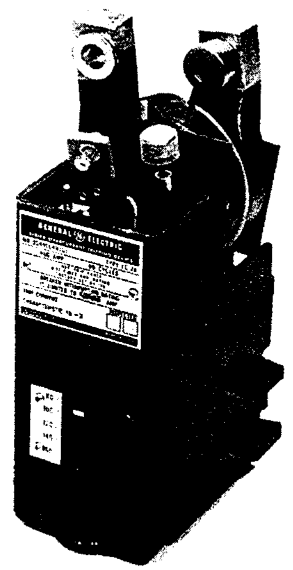


FIG. 97 EC-2A TRIP DEVICE

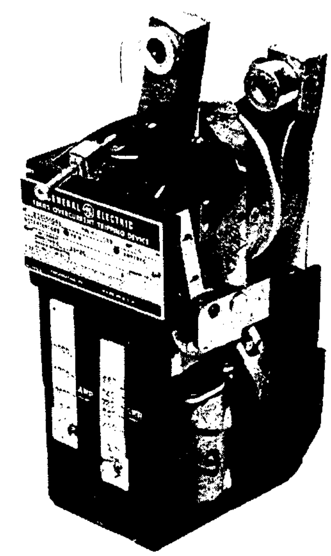


FIG. 98 EC-1 TRIP DEVICE

TABLE 15 EC DEVICE TRIP CHARACTERISTICS

Trip Device	Long Time		Short Time		Instantaneous Pickup
	Pickup ①	Delay ②	Pickup	Delay ③	
EC-2A	80-160% X (± 10%)	(1A) MAX.—adj. 15-38 sec. or (1B) INTER.—adj. 7.5-18 sec. or (1C) MIN.—adj. 3.3-8.2 sec.			4-9X, 6-12X, 9-15X or 80-250%X ④
EC-1	80-160% X (± 10%)	(1A) MAX.—30 sec. or (1B) INTER.—15 sec. or (1C) MIN.—5 sec.	2-5X, 3-7X or 4-10X	(2A) MAX.—.23 sec. or (2B) INTER.—.15 sec. or (2C) MIN.—.07 sec.	High Set up to 15X, Non-Adjustable
EC-1B	80-160% X (± 15%)	(1BB) MAX.—4.5 sec. or (1CC) MIN.—2 sec.	2-5X, 3-7X or 4-10X	(2AA) MAX.—.20 sec. or (2BB) INTER.—.13 sec. or (2CC) MIN.—.07 sec.	4-9X, 6-12X, 9-15X or 80-250% X ④

1 X = Trip device ampere rating. If trip devices are set above 100% for coordination purposes, such settings do not increase the breaker's continuous current rating.
2 At lower limit of band at 6 times pickup setting.
3 At lower limit of band at 2½ times pickup setting.
4 Low-set instantaneous. Not available in combination with long time delay.

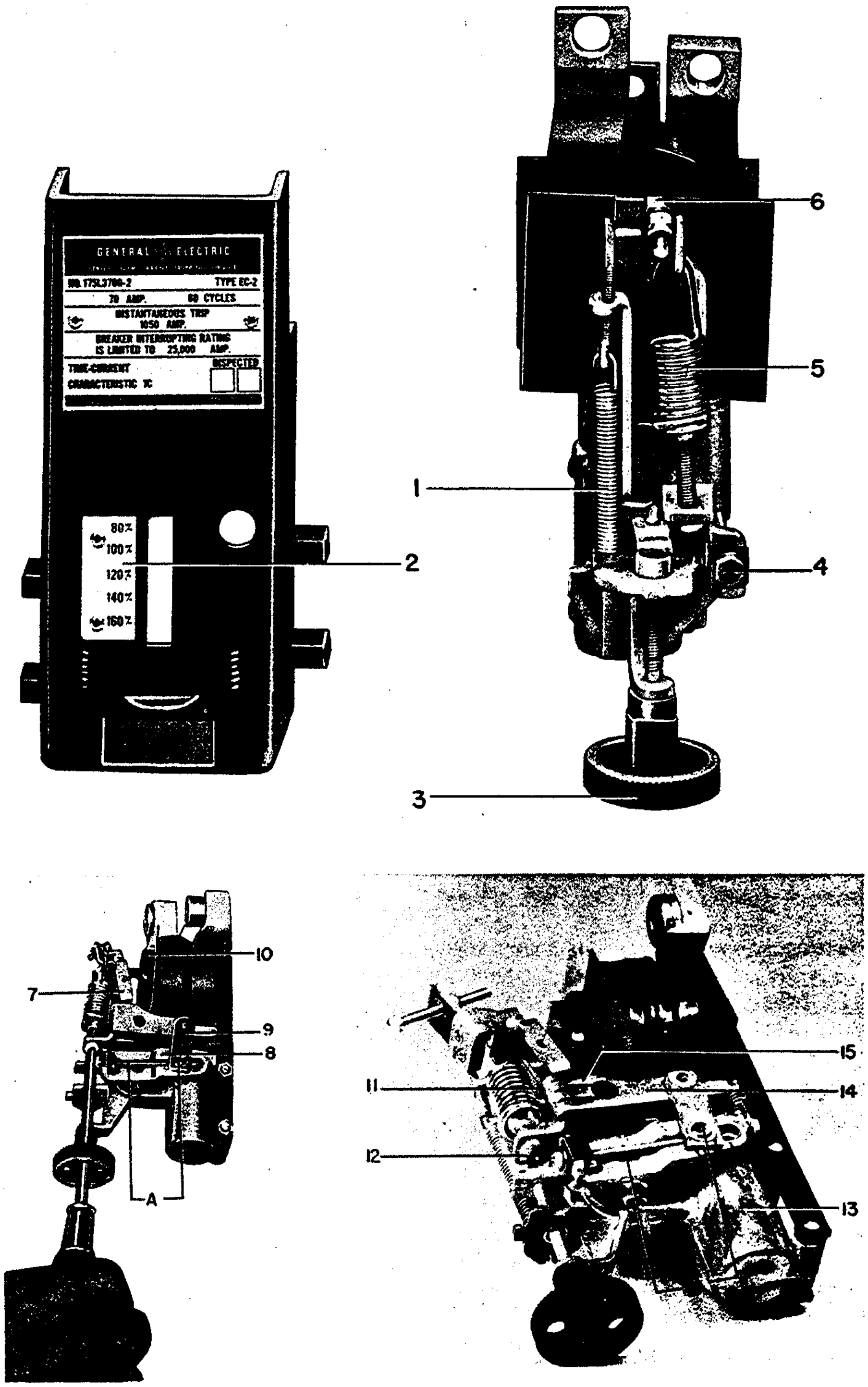


FIG. 99 OVERCURRENT TRIPPING DEVICE — EC-2A

13.1 SERIES OVERCURRENT TRIPPING DEVICE EC-2A

The Type EC-2A 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 trip have adjustable pick-up settings.

ADJUSTMENT NOTE

Before attempting any checks or adjustments on breaker with EC trip devices, the breaker mechanism and trip latch should be checked to assure their proper functioning so that the breaker trip shaft is free of high friction loads. The trip latch of the breaker should also be checked for proper trip latch engagement. See Section 7.15

Refer to Fig. 99 for the discussions given below.

13.1.1 LONG TIME-DELAY AND HIGH-SET INSTANTANEOUS TRIPPING

By means of the adjustment knob (3), 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 (2) 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.

As in the case of the EC-1 over-current trip, 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 percent of the pick-up value of current. (See time-current characteristic curves).

The tripping time may be varied within the limits shown on the characteristic curves by turning the time adjustment screw (4). Turning in a clockwise direction increases the tripping time; counterclockwise motion decreases it. The dashpot arm (8) is indexed at four points, MIN-1/3-2/3-MAX, as indicated in Fig. 100. When the index mark on the connecting link (9) 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 these 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", Fig. 99, is greatest. The time adjustment screw (4) may be turned by inserting a Phillips head screwdriver through the hole in the front of the case. 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.

13.1.2 INSTANTANEOUS LOW-SET TRIPPING

The low-set instantaneous pick-up point may be varied by the adjustment knob (3). The calibration in this case usually ranges from 80 percent to 250 percent of the series coil rating, with the calibration plate indexed at values of 80, 100, 150, 200, and 250 percent of the rating.

13.1.3 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 time coil rating. The pick-up setting may be varied by turning the instantaneous pick-up adjusting screw (12).

Three calibration marks (15) will appear on the operating arm (14) and the value of these calibration marks will be indicated by stampings on the arm as follows: (4X - 6.5X - 9X) or (6X - 9X - 12X) or (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 (5). Turning the adjustment screw changes the position of the movable nut (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 (11) serves as an index pointer and should be lined up with the center of the desired calibration mark (15) to obtain the proper instantaneous trip setting.

The trip screw (6) on the end of the armature (7) should be set so that it does not contact the trip paddle on the trip shaft until the air gap between armature and pole piece is reduced to 3/32 in. or less, measured at the rivet in the pole piece. Also, the armature must have a minimum of 1/32 in. of travel beyond the point in its motion at which the breaker is tripped.

Replacement of the EC-2A device is accomplished by the same procedure described for the EC-1 series trip device; however, in some cases, when replacing an EC-1 device with an EC-2A it will be necessary to replace the trip paddles on the trip shaft with ones which are slightly longer. When required these will be provided with the replacement trip units.

NOTE: Pick-up settings on the calibration plate of the EC-2A device are calibrated for the specific device. When replacing covers, replace on associated device.

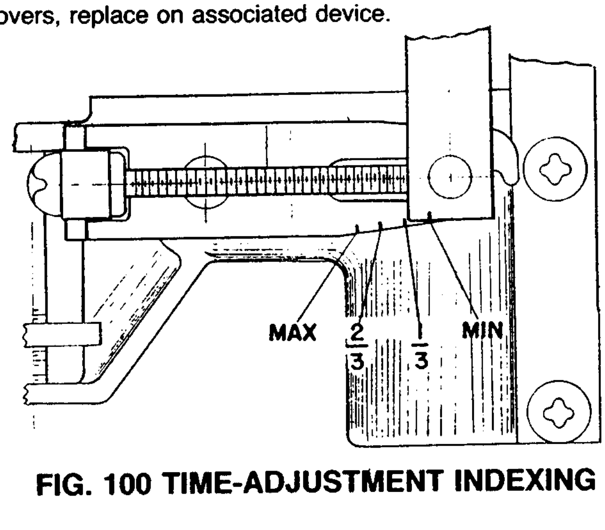


FIG. 100 TIME-ADJUSTMENT INDEXING

13.2 SERIES OVERCURRENT TRIPPING DEVICE EC-1

Each series overcurrent tripping device is enclosed in a molded case and mounted by screws and a bracket to the lower part of the pole unit base.

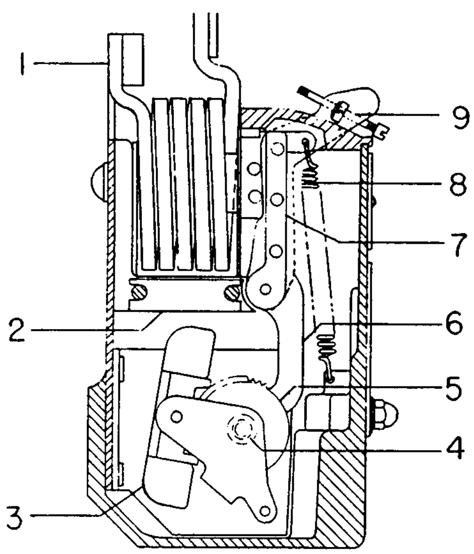
Refer to Fig. 101 for the discussions below.

13.2.1 SHORT TIME-DELAY TRIPPING

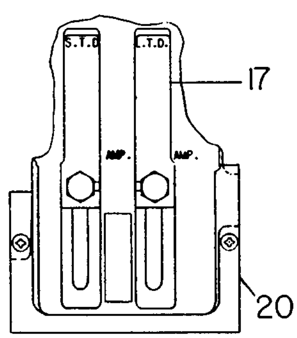
The armature (7) is restrained by calibrating spring (8). After the magnetic force produced by an overcurrent condition overcomes this restraining force, the armature movement is further retarded by an escapement mechanism which produces an inverse time delay characteristic. The mechanism is shown on Fig. 101.

13.2.2 LONG TIME-DELAY TRIPPING

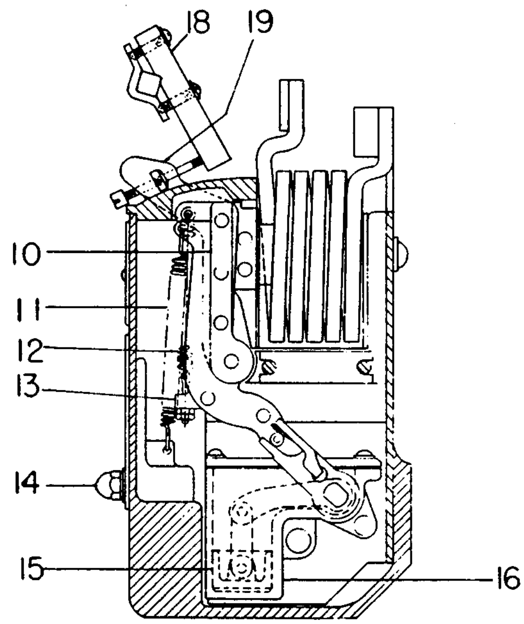
The armature (10) is restrained by the calibration spring (11). After the magnetic force produced by an overcurrent condition overcomes this restraining force, the armature movement is further retarded by the flow of silicone oil in a dashpot, which produces an inverse time delay characteristic. The mechanism is shown on Fig. 101.



Left Side View Showing Short Time Delay Mechanism



Front View Showing Mounting Bracket



Right Side View Showing Long Time Delay Mechanism

1. Series Coil
2. Magnet
3. Pallet
4. Pinion
5. Escape Wheel
6. Driving Segment
7. S.T.D. Armature
8. S.T.D. Calibration Spring
9. Trip Paddle Adjusting Screw
10. L.T.D. Armature
11. L.T.D. or Low-set Inst. Calibration Spring
12. Inst. Trip Spring (High Set)
13. Spring Holder
14. Calibration Clamp Nut
15. Plunger
16. Cylinder
17. Calibration Plate
18. Trip Paddle
19. Trip Arm
20. Clamping Bracket

FIG. 101 SERIES OVERCURRENT TRIPPING DEVICE EC-1

13.2.3 INSTANTANEOUS TRIPPING

(a) Adjustable instantaneous tripping takes place after the magnetic force produced by an overcurrent condition, overcomes the restraining force of the calibration spring which can be adjusted by the calibration clamp nut (14).

(b) Non-adjustable instantaneous tripping takes place after the magnetic force produced by an overcurrent condition overcomes the restraining force of a non-adjustable spring.

13.2.4 EC-1 ADJUSTMENTS

Before attempting any checks or adjustments on breaker with EC trip devices, the breaker mechanism and trip latch should be checked to assure their proper functioning so that the breaker trip shaft is free of high friction loads. The trip latch of the breaker should also be checked for proper trip latch engagement. See Section 7.15

EC-1 Devices may have their pick-up settings varied by changing the positions of the sliding calibration plates on the front of each device. The clamping nut holding the plate must be loosened to make the change, and then retightened.

If a new device is installed, the adjusting screw on the tripping arm must be set to give 1/32nd of an inch overtravel in tripping. The method for making this check is demonstrated in Figure 102. The rod shown is used for pushing the armature of device closed. If this is done with the device mounted on a closed breaker, it will simulate the action which occurs when the device reacts to an overload condition.

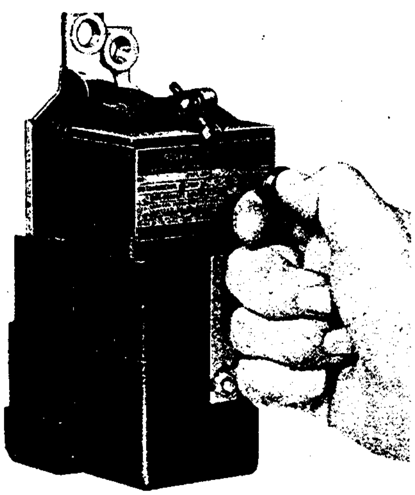


FIG. 102 CHECKING TRAVEL DISTANCE OF SERIES OVERCURRENT TRIPPING DEVICE.

13.3 POSITIVE TRIP ADJUSTMENT

Before attempting any checks or adjustments on breaker with EC trip devices, the breaker mechanism and trip latch should be checked to assure their proper functioning so that the breaker trip shaft is free of high friction loads. The trip latch of the breaker should also be checked for proper trip latch engagement. See Section 7.15

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 (9) Figure 101 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 screws (9), Figure 101, 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 (9), Figure 101 can best be manipulated by an extended 1/4 inch hex socket wrench.

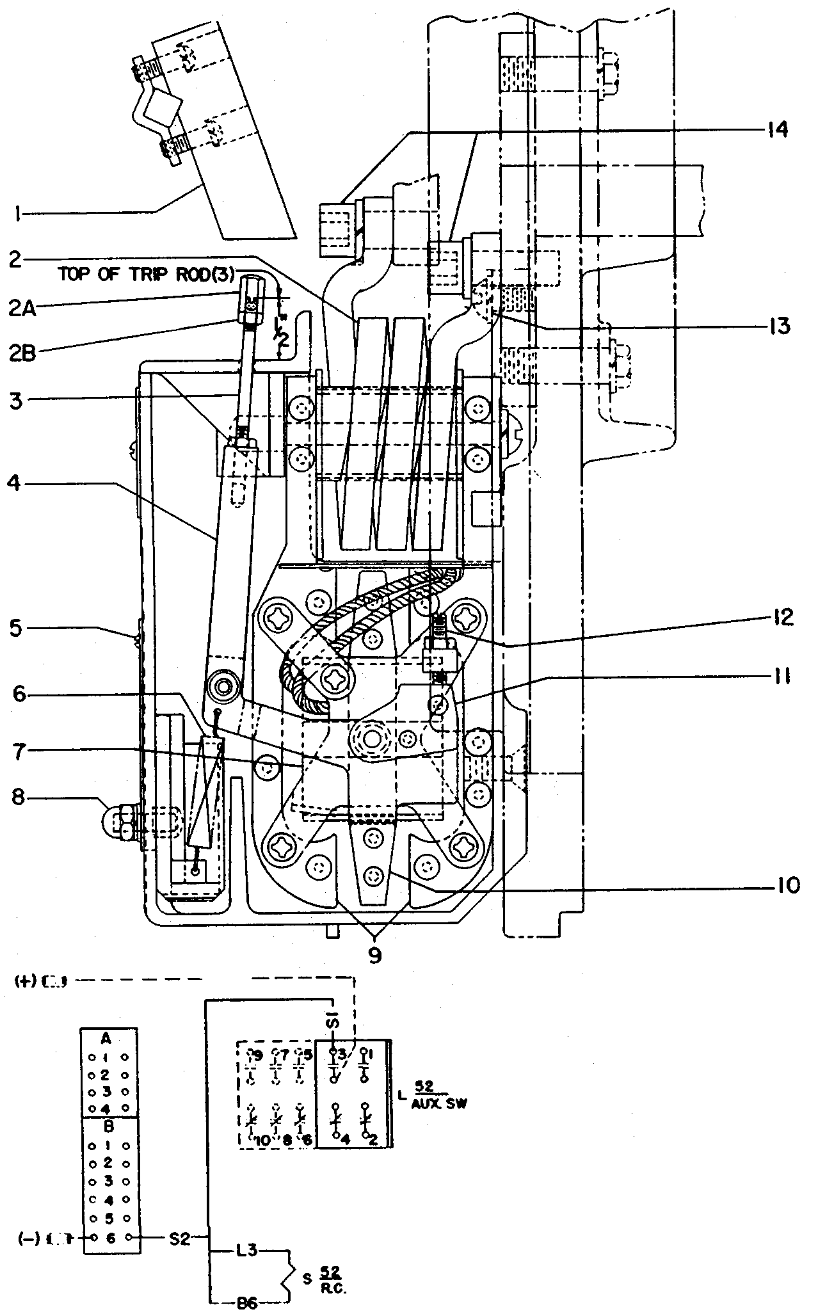
13.4 REVERSE CURRENT TRIPPING DEVICE

The device is enclosed in a molded case and is mounted on the right pole base similar to the series overcurrent tripping device.

The reverse current tripping device (see Fig. 103) consists of a series coil (2) with an iron core mounted between two pole pieces (9), also a potential coil (7) connected across a constant source of voltage and mounted around a rotary-type armature (10). Calibration spring (6) determines the armature pick-up 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 also tends to rotate the armature in the same direction. This torque causes the armature to rest against the stop screw (12) attached to a bearing plate on the right side of the device.

If the current through the series coil (2) is reversed, the armature (10) tends to move in the clockwise direction against the restraint of the calibration spring (6). When the current reversal exceeds the calibration setting, the armature revolves clockwise causing the trip rod (3) to move upward engaging the trip paddle (1), thereby tripping the breaker.



1. Trip Paddle
2. Series Coil
2A. Adjusting Nut
2B. Locking Nut
3. Trip Rod
4. Trip Crank
5. Setting Sealing Screw
6. Calibration Spring
7. Potential Coil
8. Calibration Nut
9. Pole Pieces
10. Armature
11. Counter Weight
12. Stop Screw
13. Mounting Screw
14. Screw

FIG. 103 ED-1 REVERSE CURRENT TRIPPING DEVICE

13.4.1 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 in. beyond the point of tripping the breaker. This adjustment should have to be made only 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 (3) will extend 1/2 in. above the top of the device case, and no additional adjustments of the trip rod should be required. To obtain the proper 1/32 in. overtravel, close the breaker and proceed as follows:

1. Loosen the locking nut. (2B).
2. Manually lift the trip rod and vary the position of the adjusting nut (2A), this establishing the position of the adjusting nut where the breaker is just tripped.

NOTE: Be sure to keep clear of moving breaker parts when tripping the breakers.

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-in. overtravel of the trip rod should be obtained.

13.4.2 REPLACEMENT

After removing the wiring for the potential coil the reverse current device can be removed and replaced by following the procedure outlined for replacing the series overcurrent device. See Section 13.6. For wiring, see Fig. 103.

13.5 SWITCHETTE FEATURE

The switchette is operated by the long-time delay function. Its purpose is to provide a set of contacts that will close before an overload occurs. This device will not trip the breaker on overload it will trip on instantaneous only.

The switchette feature is available only in type EC-1 devices.

The switchette is used in one pole and EC-1 trips in the other poles. For the alarm to be effective in indicating the overload before the other poles trip the breaker, the device must have less time delay than the other two poles; this is accomplished by using a lower characteristic on the alarm device than the other poles or setting the alarm devices long time setting at 80%.

13.6 TRIP DEVICE REPLACEMENT

Overcurrent devices on AKR30 & AKR50 breakers may be dismounted by removing the fastening hardware at the rear of the breaker and withdrawing the device. EC devices, after being unfastened as shown in Figures 104 and 105, and having the clamps on the case in the front removed, may be lowered clear of the breaker. You do not have to separate frames on these breakers.

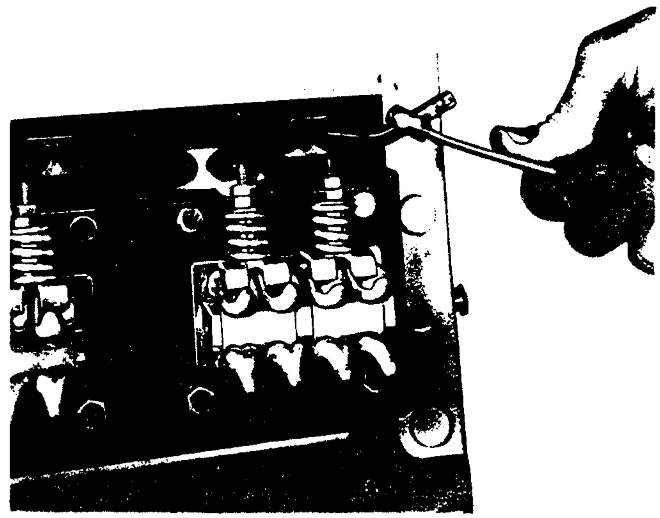


FIG. 104 DISCONNECTING EC COIL

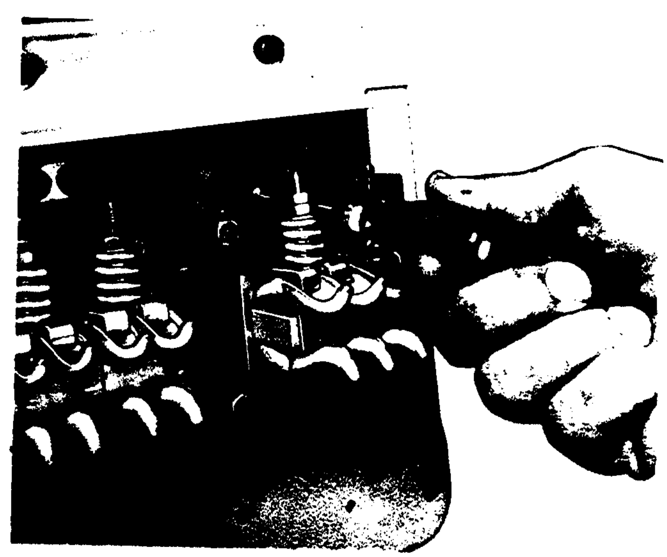


FIG. 105 DISCONNECTING EC FRAME

SECTION 14—Electrical Characteristics

TABLE 16 CHARGING AND CLOSING OPERATING CURRENTS

Nominal Control Voltage	Frequency Hz	Voltage Range	MOTOR Current (Amps) Inrush	MOTOR Current (Amps) Sustained	ANTI-PUMP RELAY "W" Min (volts) Pick-up	ANTI-PUMP RELAY "W" Rated-Amps Inrush Open	ANTI-PUMP RELAY "W" Rated-Amps Sealed Closed	CONTROL RELAY "X" Min (volts) Pick-up	CONTROL RELAY "X" Rated Amps Inrush Open	CONTROL RELAY "X" Rated Amps Sealed Closed	CLOSING SOLENOID Min (volts) Pick-up	CLOSING SOLENOID Rated Amps Inrush Open	CLOSING SOLENOID Rated Amps Sealed Closed	FUSE SELECTION
48V	DC	38-56	40	10	38	.063	.063	30	4.1	4.1	38	5.2	5.2	15A
125V	DC	100-140	27	5	85	.024	.024	90	1.05	1.05	100	1.75	1.75	6A
250V	DC	200-280	13	3	170	.015	.015	180	.53	.53	200	.88	.88	6A
120V	60					.090	.052		1.0	.14		2.6	.35	6A
120V	50	104-127	25	5	95	.090	.052	95	1.0	.15	98	2.2	.29	6A
120V	25					.047	.032		6.85	1.27		1.1	.17	6A
208V	60					.050	.029		.45	.063		1.5	.19	6A
208V	50	180-220	15	3.5	175	.050	.029	175	.55	.083	177	1.2	.16	6A
208V	25					.032	.018		3.86	.76		.60	.08	6A
250V	60					.064	.036		.50	.07		1.3	.17	6A
250V	50	208-254	12	3	190	.064	.036	190	.50	.08	196	1.1	.15	6A
250V	25					.035	.023		3.42	.64		.54	.08	6A

TABLE 17 BELL ALARM CONTACT RATING

Control Voltage		Bell Alarm Contact Rating (amperes) Inrush	Bell Alarm Contact Rating (amperes) Continuous
Dc	125	2.5	2.5
	250	0.9	0.9
60 Hz. Ac	120	30	10
	240	15	5
	480	7	3

TABLE 18 AUXILIARY SWITCH CONTACT SEQUENCE

CB Main Contacts	Auxiliary Switch Position "a" Contact	Auxiliary Switch Position "b" Contact
Open or Tripped	Open	Closed
Closed	Closed	Open

TABLE 19 AUXILIARY SWITCH CONTACT RATINGS

Control Voltage		Auxiliary Switch Interrupting Ratings (Amperes)(1) Non-Inductive	Auxiliary Switch Interrupting Ratings (Amperes)(1) Inductive
Dc	48	25	—
	125	11	6.3
	250	2	1.8
Ac	115	75	50
	240	50	25
	480	25	12

(1) Limited to 20A continuous rating of switch on all breakers and to 5A continuous rating of #16 wire on drawout breakers.

TABLE 20 CHARGING TIMES

Nominal Voltage	Time (sec.)
48VDC	1.5
120VDC 250VDC	1.0
120VAC 208VAC 240VAC	0.09

TABLE 21 SHUNT TRIP AND UNDERVOLTAGE DEVICE OPERATING CURRENTS

Nominal Control Voltage	Frequency Hz	SHUNT TRIP				UNDER VOLTAGE		
		Operating Voltage range		Current (Amps) Inrush	Current (Amps) Sealed	Operating Voltage range	Current (Amps) Inrush	Current (Amps) Sealed
				Open	Closed		Open	Closed
24	DC	14	30	8.3	8.3	SEE TABLE 23	.38	.38
48	DC	28	60	4.5	4.5		.19	.19
125	DC	70	140	2.0	2.0		.08	.08
250	DC	140	280	1.0	1.0		.04	.04
70	60	59	132	—	—		N/A	N/A
120	60	95	127	12.3	10.8		.66	.24
120	50	95	127	7.6	6.7		.75	.25
120	25	95	127	4.7	4.1		.31	.10
208	60	175	220	3.2	2.6		.51	.17
208	50	175	220	3.8	3.1		.30	.10
208	25	175	220	2.1	1.9		.14	.05
240	60	190	254	3.9	3.4		.37	.12
240	50	190	254	4.7	4.1		.34	.11
240	40	190	254	5.8	5.1		N/A	N/A
240	25	190	254	2.1	1.9		.16	.06
380	50	315	410	2.9	2.6		.22	.08
480	60	380	508	3.4	3.1		.23	.08
480	50	380	508	7.5	7.3		.17	.06
480	25	380	508	3.5	3.3		.11	.05
575	60	475	625	2.8	2.5		.16	.06
575	50	475	625	5.1	4.7		.14	.06
575	25	475	625	3.1	3.0		.10	.05

TABLE 22 COIL RESISTANCE—DC OHMS @ 25°C

Nominal Control Voltage	Frequency Hz	Anti-Pump Relay "W"	Control Relay "X"	Shunt Trip	Undervoltage
24V	DC	N/A	N/A	3	64
48V	DC	802	12	11	240
125V	DC	5000	119	64	1600
250V	DC	16400	476	260	6700
120V	60	450	54	3.9	25.4
120V	50	450	75	7.15	33
120V	25	1450	75	25.4	146
208V	60	1450	216	25.4	64
208V	50	1450	300	25.4	146
208V	25	3900	300	64	580
240V	60	1450	300	25.4	100
240V	50	1450	300	25.4	146
240V	25	6000	300	64	580
380V	50	N/A	N/A	64	370
480V	60	N/A	N/A	64	370
480V	50	N/A	N/A	32	580
480V	25	N/A	N/A	100	1600
575V	60	N/A	N/A	100	580
575V	50	N/A	N/A	64	918
575V	25	N/A	N/A	146	3200

TABLE 23 INSTANTANEOUS UNDERVOLTAGE DEVICE SETTINGS

COIL RATING	PICK UP VOLTAGE RANGE		DROP OUT RANGE
	UVR ONLY	UVR INSTALLED MECHANISM RESET	
24 VDC	18 - 20	16 - 20	7 - 8.3
48 VDC	36 - 41	32 - 41	14 - 17
125 VDC	106 - 110	104 - 110	38 - 43
155 VDC	109 - 132	101 - 132	47 - 93
250 VDC	212 - 221	209 - 221	75 - 85
120 VAC	102 - 106	100 - 106	36 - 72
208 VAC	156 - 176	136 - 176	62 - 125
240 VAC	206 - 212	200 - 212	72 - 144
380 VAC	285 - 323	247 - 323	114 - 223
480 VAC	360 - 408	312 - 408	144 - 288
575 VAC	431 - 488	374 - 488	173 - 345

TABLE 24 TIME-DELAY UNDERVOLTAGE DEVICE SETTINGS

DELAY UNIT VOLTAGE	PICK UP RANGE UVR ONLY VDC	UVR INSTALLED MECHANISM RESET		DROP OUT RANGE
		NO PICK UP	PICK UP	
125 VDC	77 - 85	50	90 - 95	MINIMUM POSSIBLE
250 VDC 208/240 VAC	125 - 140	90	160 - 165	

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