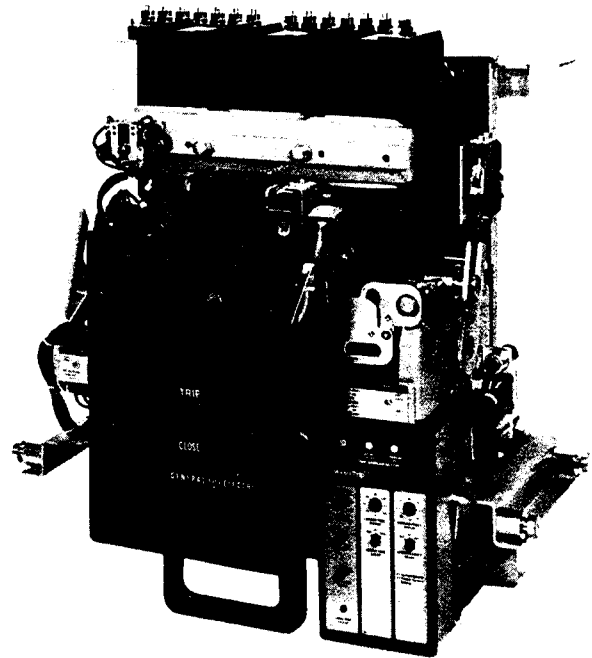
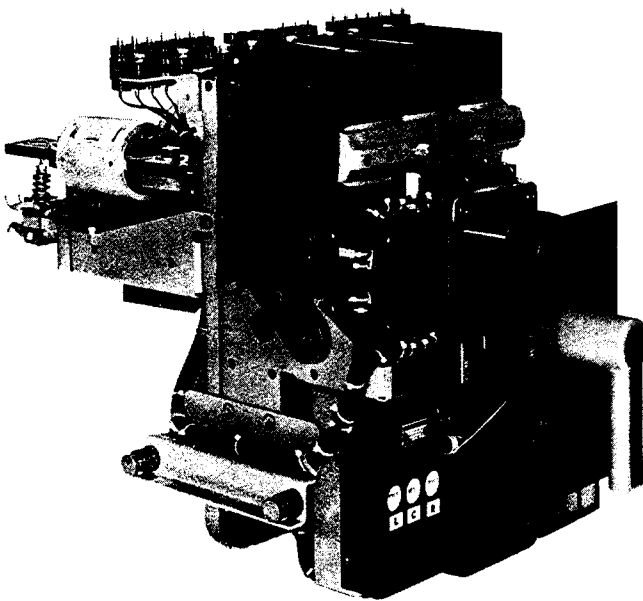


Installation and  
Maintenance  
Instructions



# Power Circuit Breakers

## Types AKR-30S and AKRU-30S



GENERAL  ELECTRIC

# Power Circuit Breakers

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# Power Circuit Breakers

## SECTION 2 — Installation

**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**WITHDRAWN** — With the compartment door open, the breaker can be manually pulled out to the **WITHDRAWN** position.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 Note that the racking mechanism is not employed for movement of the breaker between the **DISCONNECTED** and **WITHDRAWN** positions.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 counterclockwise.*

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.

# Power Circuit Breakers

## 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 auxiliary switch "a" contacts in its circuit. (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.

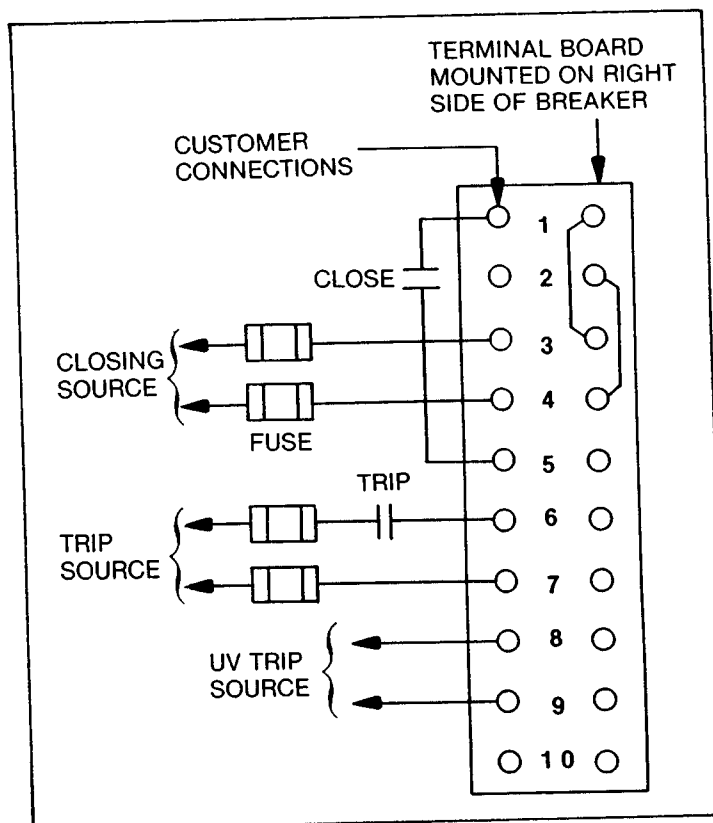


Fig. 2. Control connections to stationary breakers — front view

## 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.

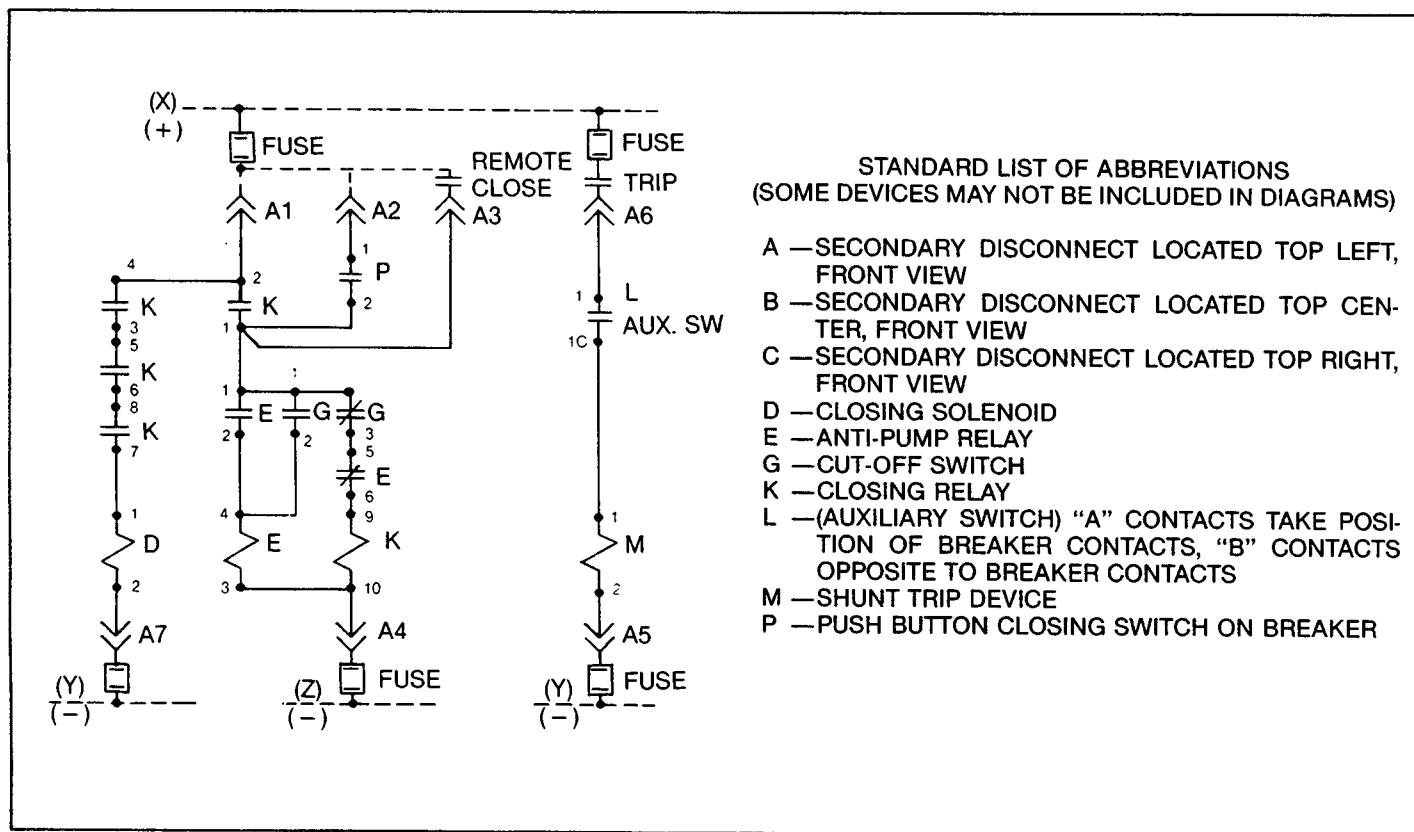


Fig. 1. Typical wiring diagram — electric operation

# 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

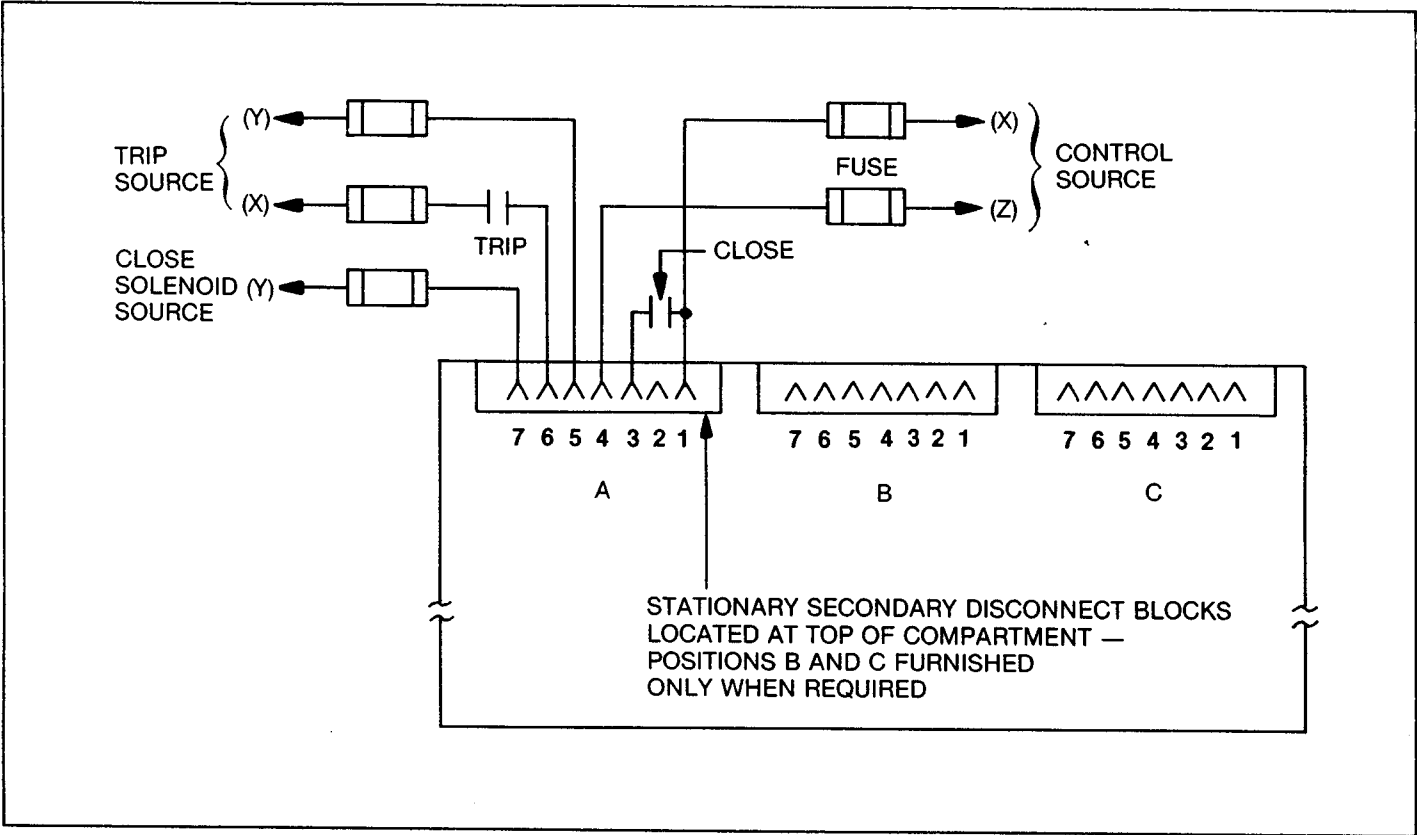


Fig. 3. Control connections to draw out breakers — front view of breaker compartment



# 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 reassembling, 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.

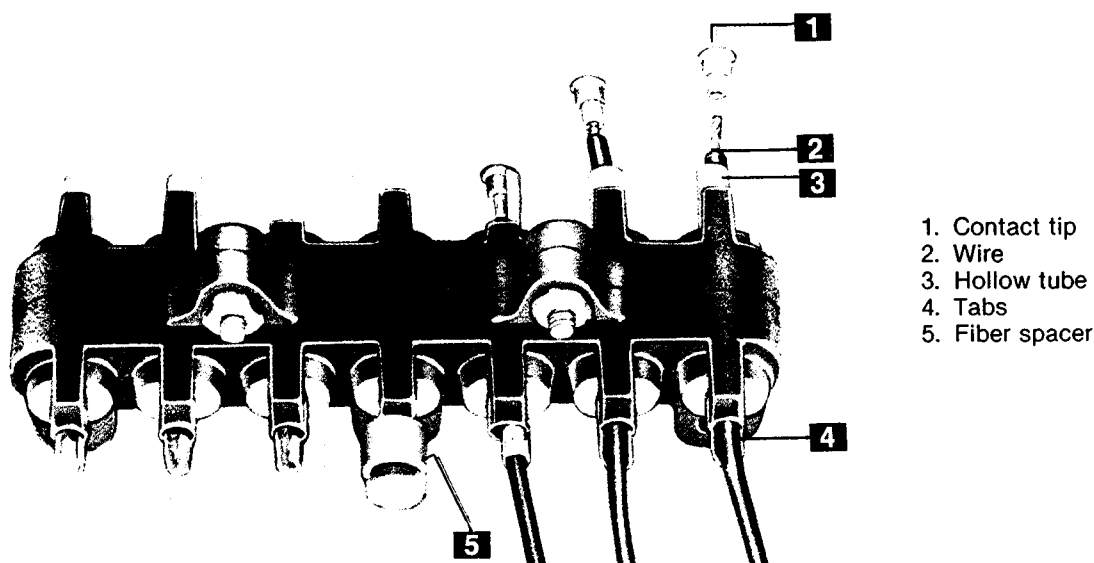


Fig. 4. Movable secondary disconnects

## 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).

# Power Circuit Breakers

## SECTION 5 — Basic Breaker Components

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,

# Power Circuit Breakers

## SECTION 5 — Basic Breaker Components

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.

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-

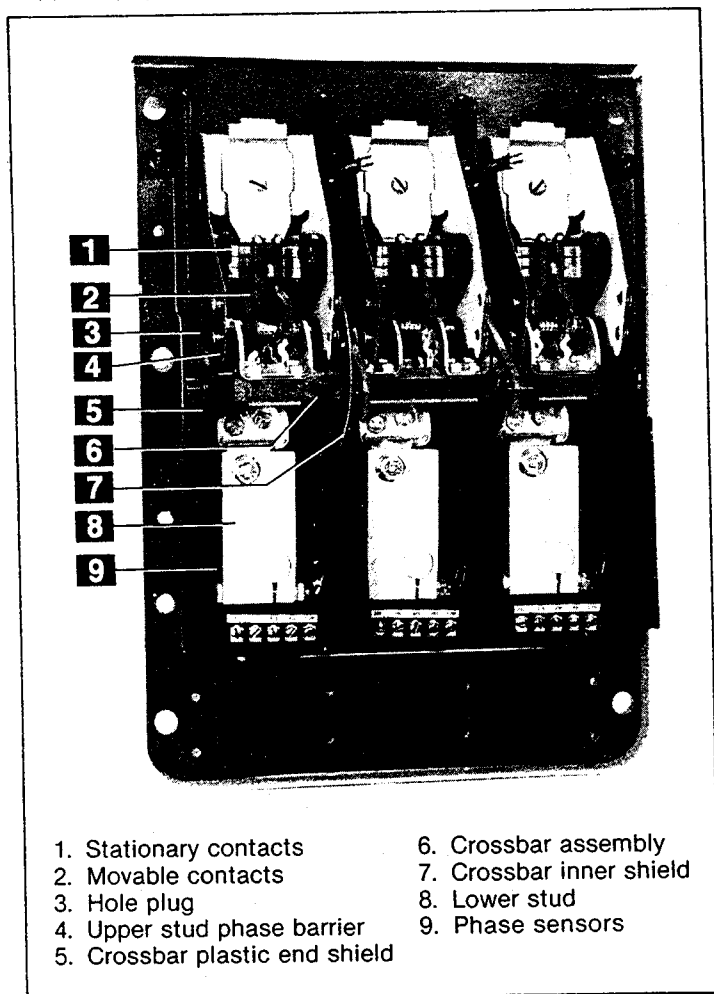
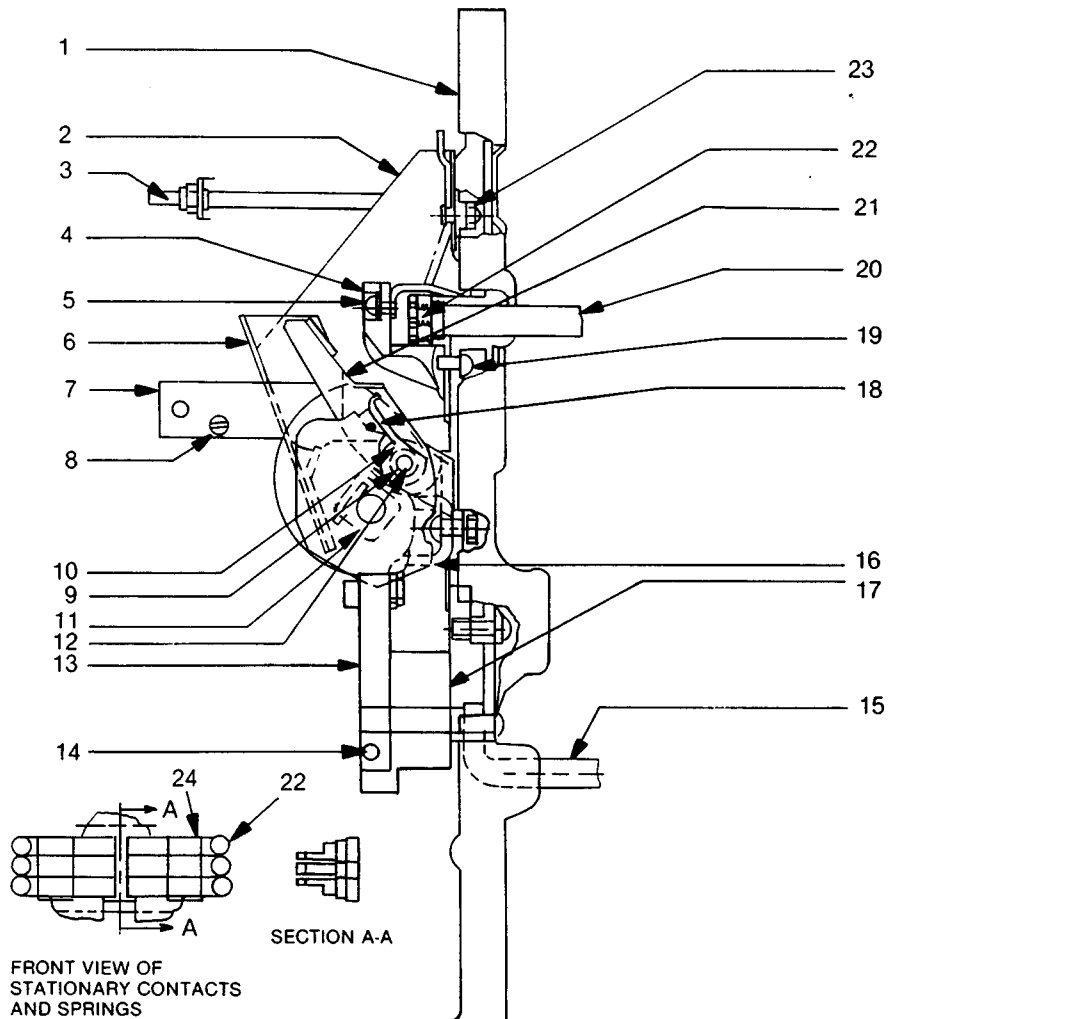


Fig. 6. Back frame — location of crossbar and pole shields

## SECTION 5 — Basic Breaker Components



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

Fig. 5. Back frame/contact assembly

# Power Circuit Breakers

## SECTION 5 — Basic Breaker Components

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.

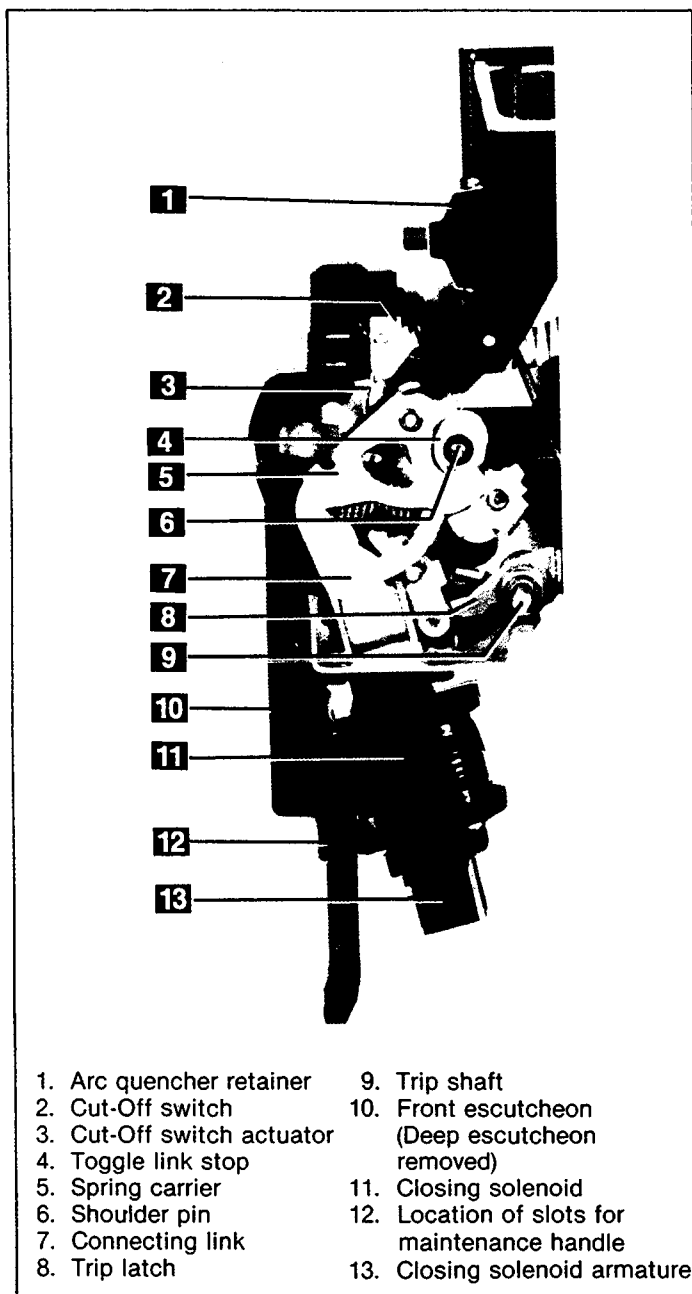
4. Push steel operating shaft through escutcheon bushing.

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

### Auxiliary Switch

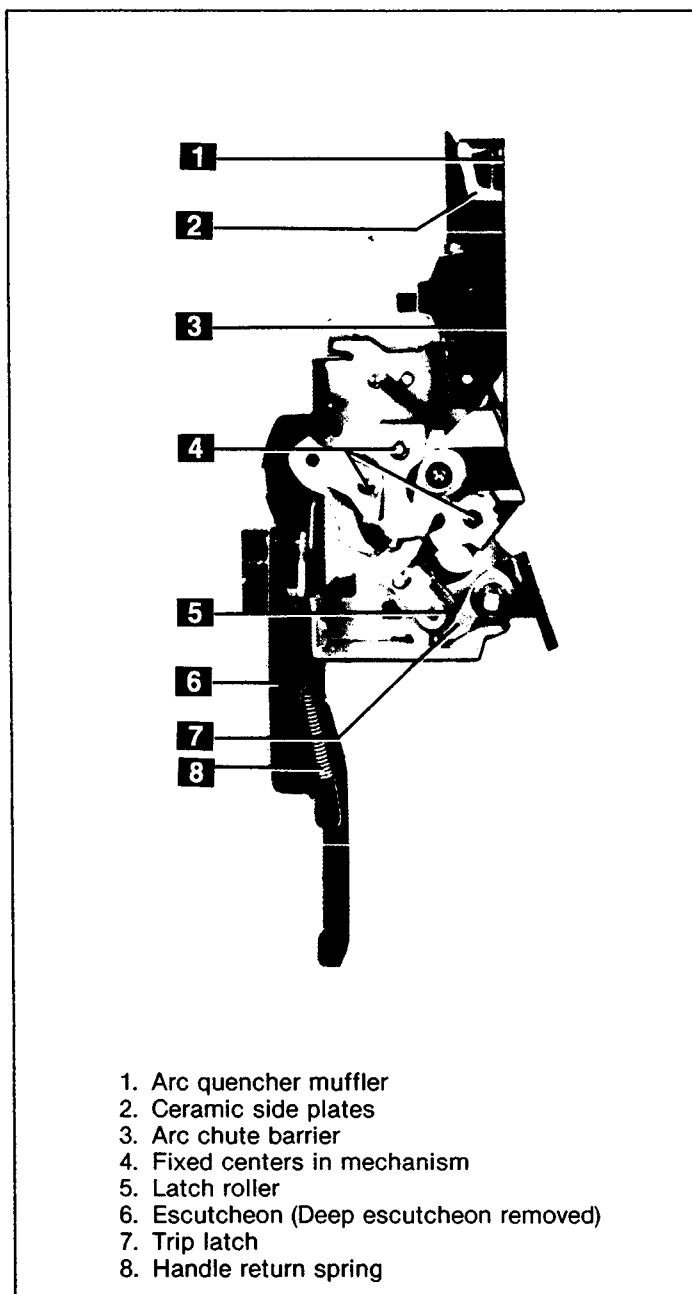
The auxiliary switch is mounted on the left side of the operating mechanism frame. Its operating shaft is linked to the output crank of the breaker mechanism. Through a cam arrangement, the operating shaft of the switch controls the open and closed positions of the individual contact pairs. Each stage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



*Fig. 7. Electric 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.



*Fig. 8. Manual mechanism*

### 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



# Power Circuit Breakers

## SECTION 6 — Electrical Replacement Control Components

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.

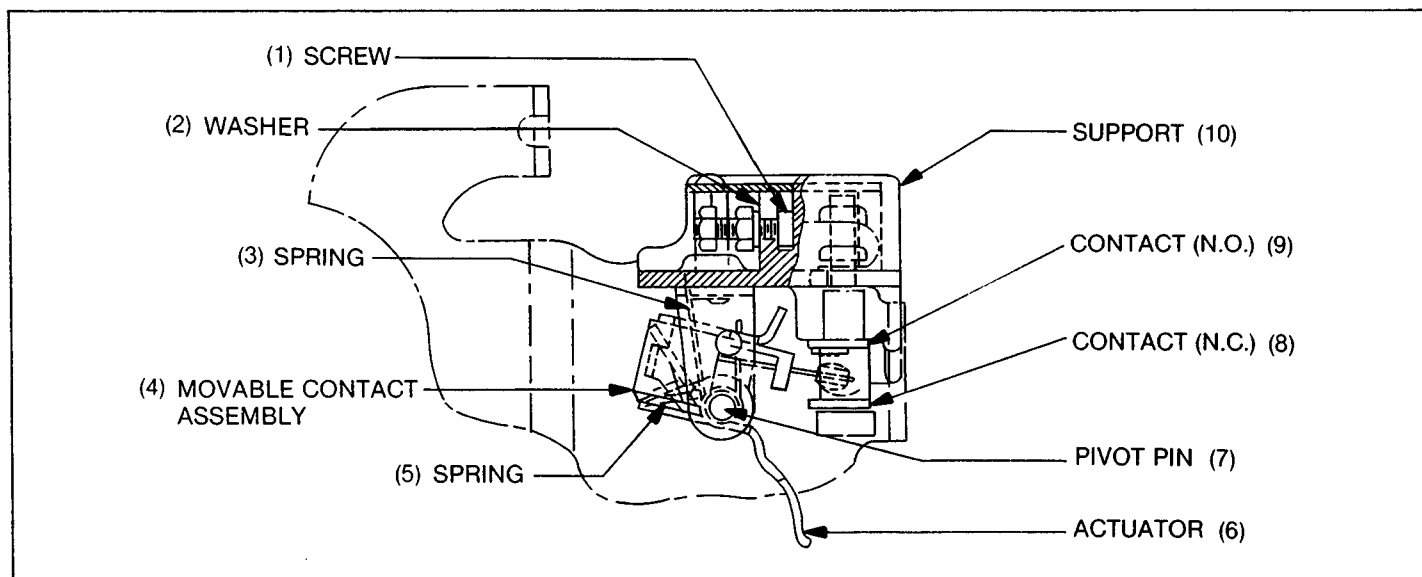


Fig. 9. Cut-off switch

## 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 disconnects.
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

# Power Circuit Breakers

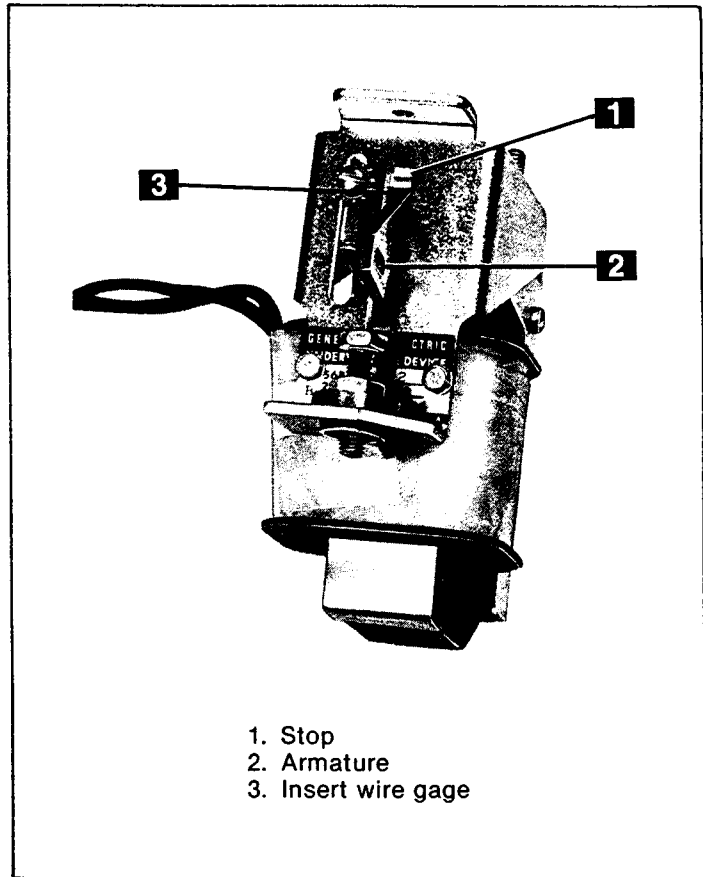
## SECTION 6 — Electrical Replacement Control Components

### Replacement

The entire shunt trip device may be dismantled 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.



*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.

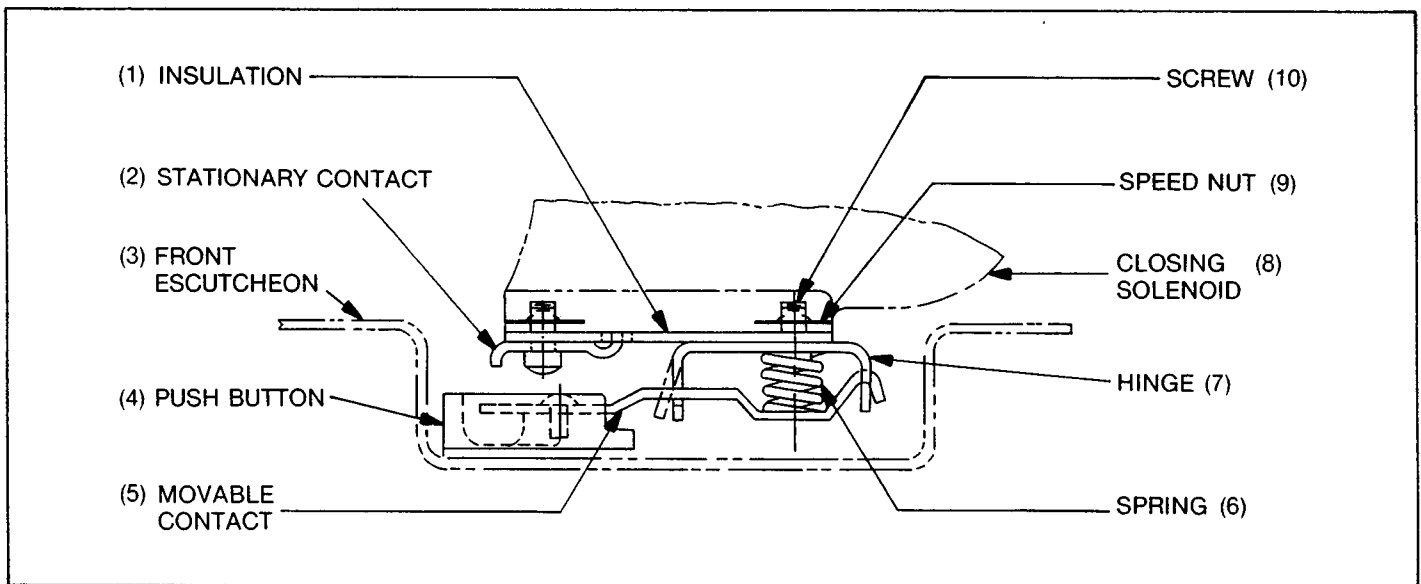


Fig. 10. Closing switch (top view)

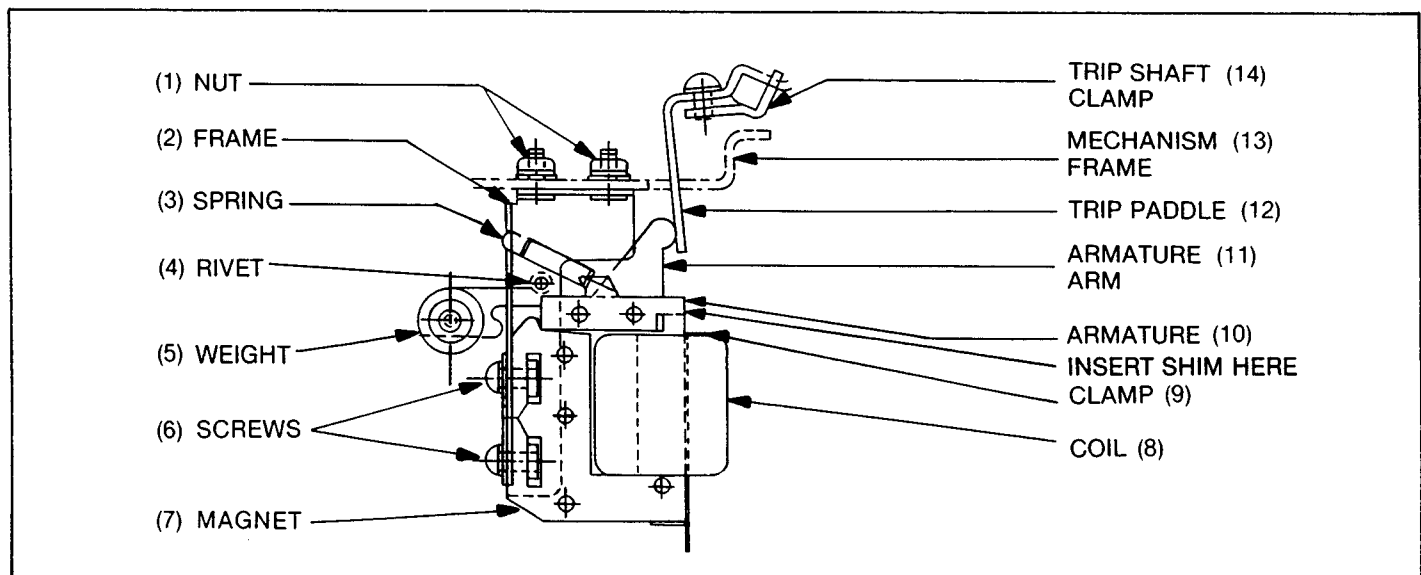


Fig. 11. Shunt trip device

# Power Circuit Breakers

## SECTION 7 — Protective Devices

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.

### 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.

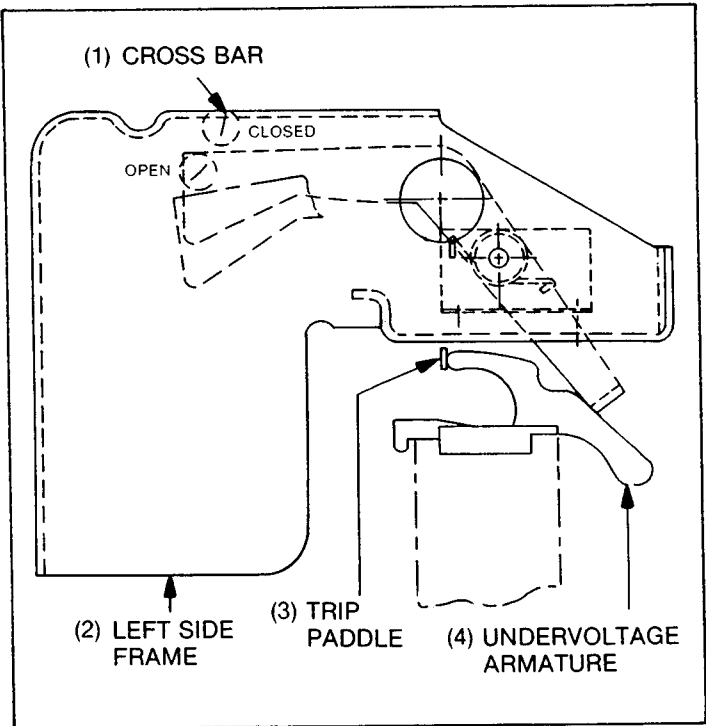


Fig. 14. Electric lockout device

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

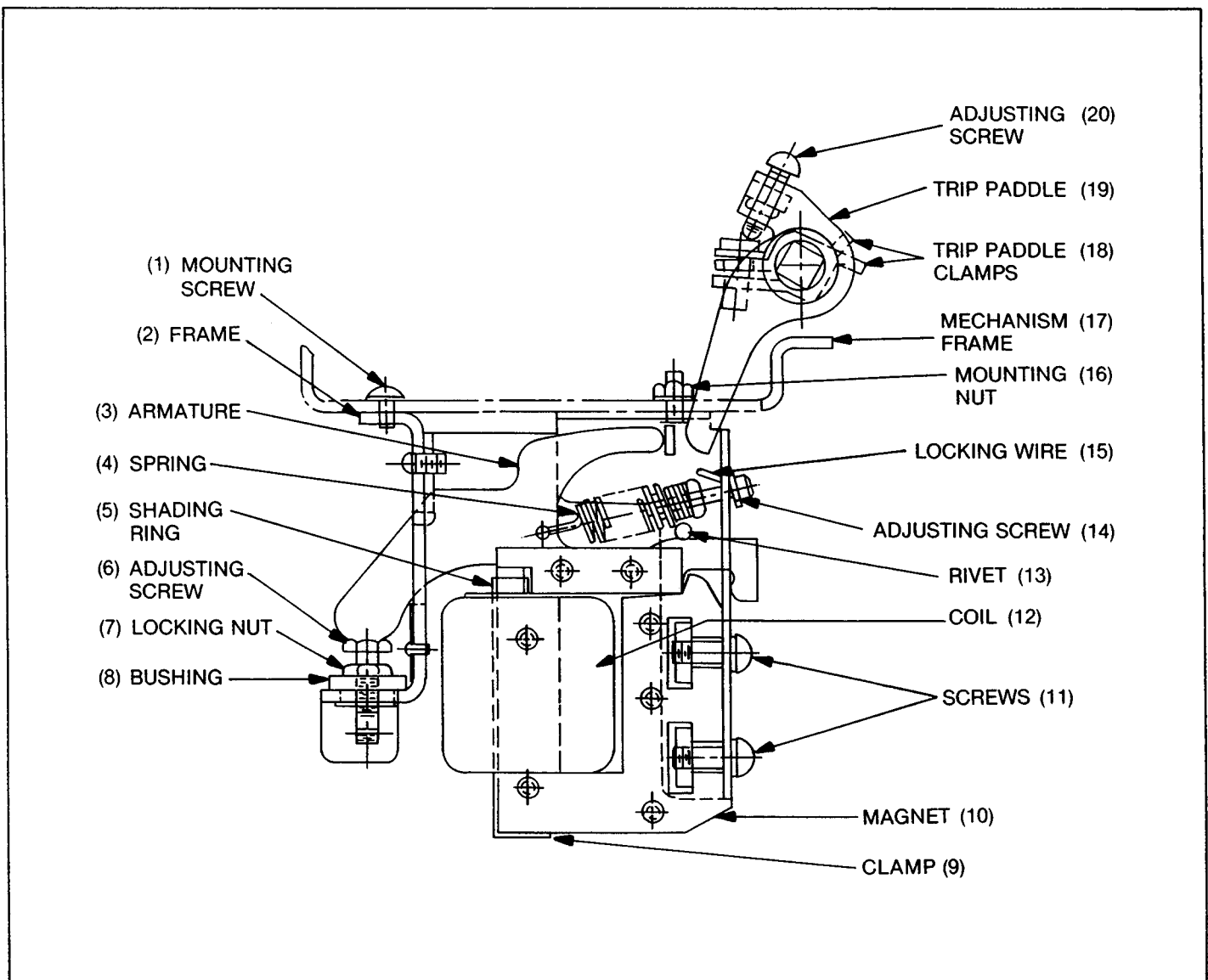


Fig. 13. Undervoltage tripping device

# Power Circuit Breakers

## SECTION 7 — Protective Devices

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.

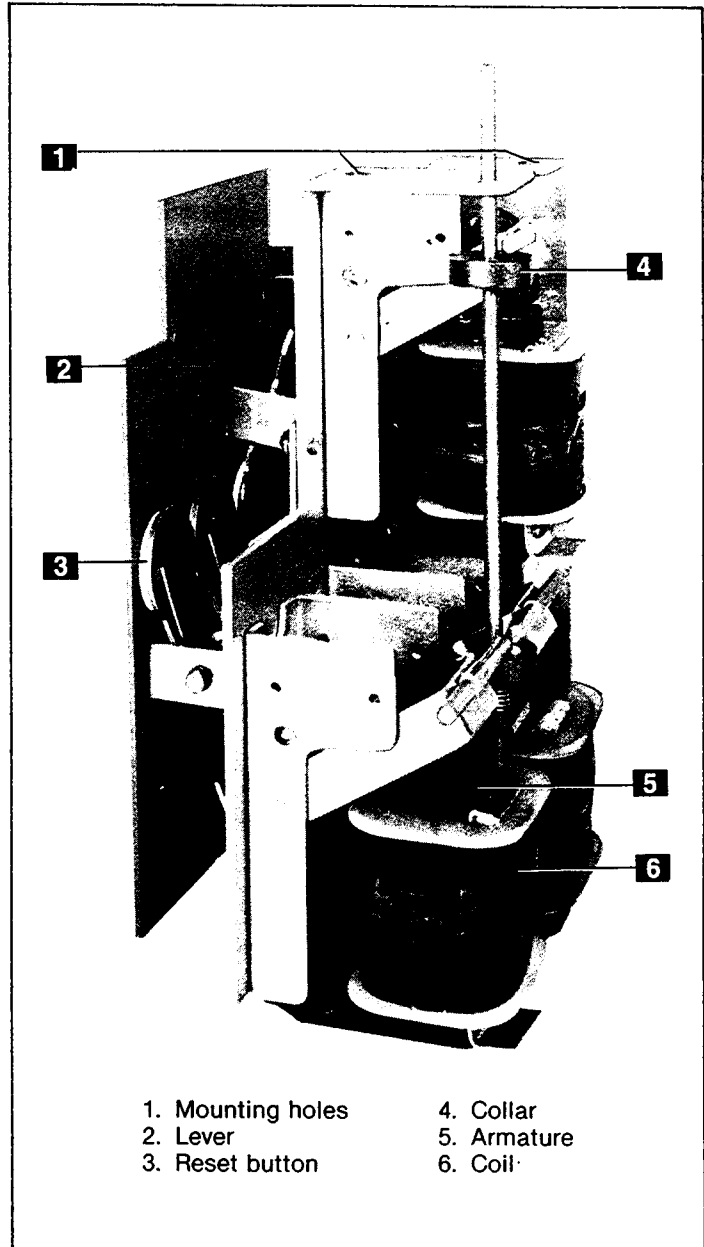
#### Adjustments

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."



*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 (3). 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

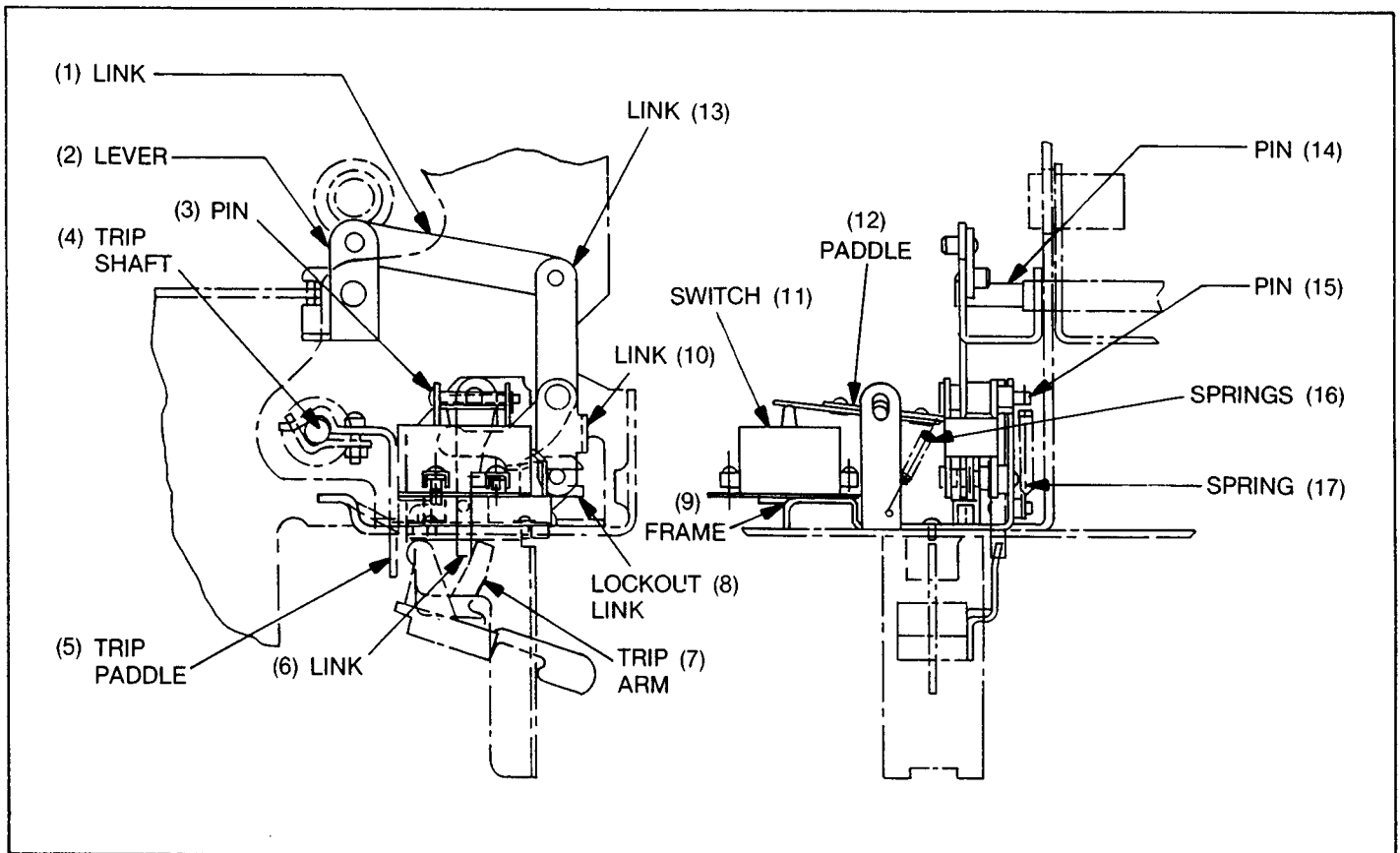


Fig. 15. Bell alarm and lockout device



# 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

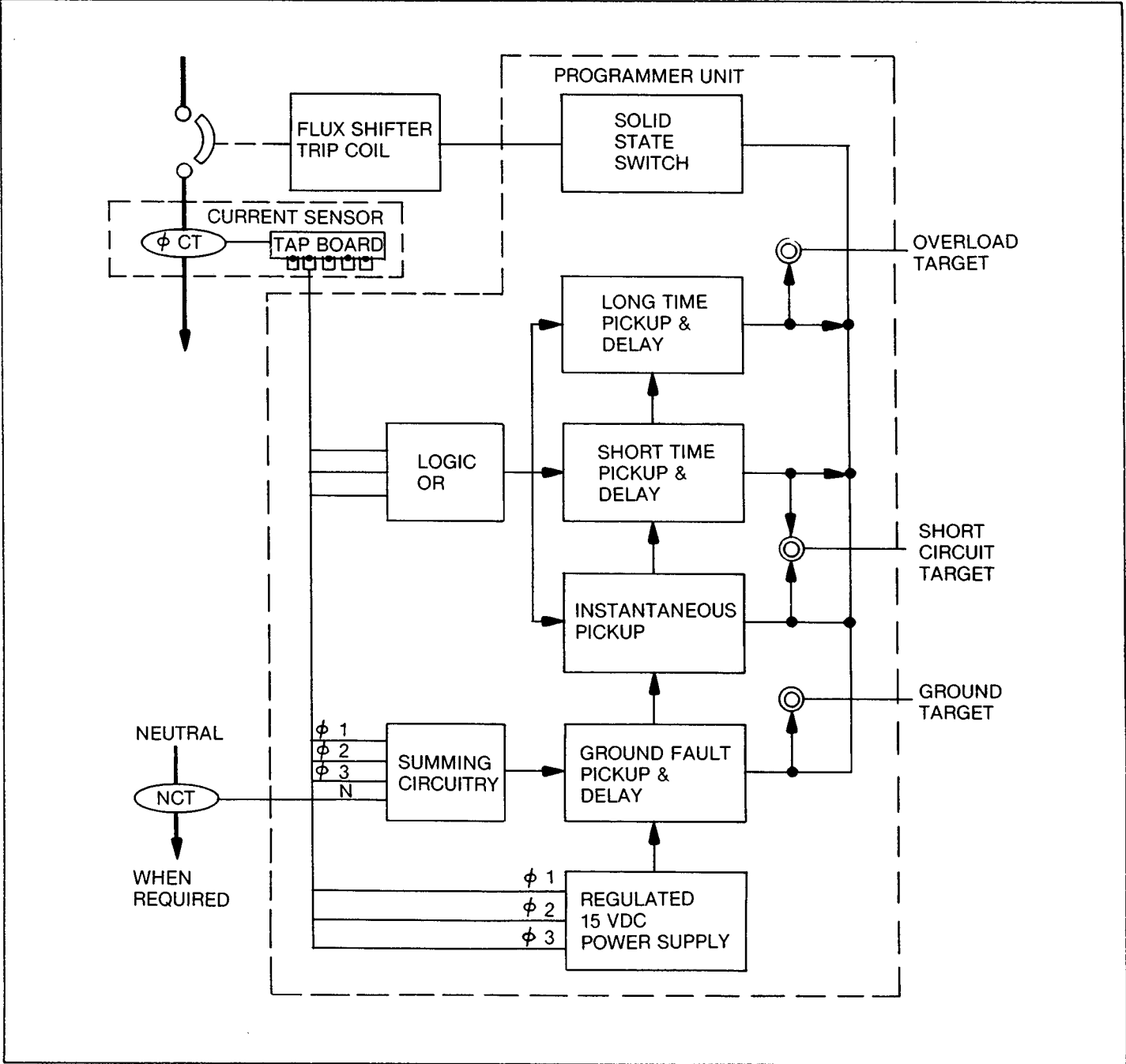


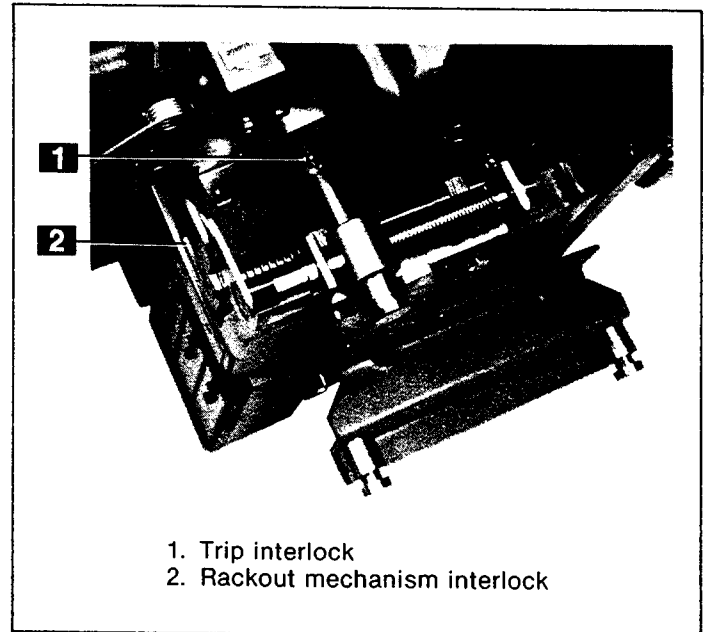
Fig. 18. MicroVersaTrip® block diagram

## 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.



*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 changed 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

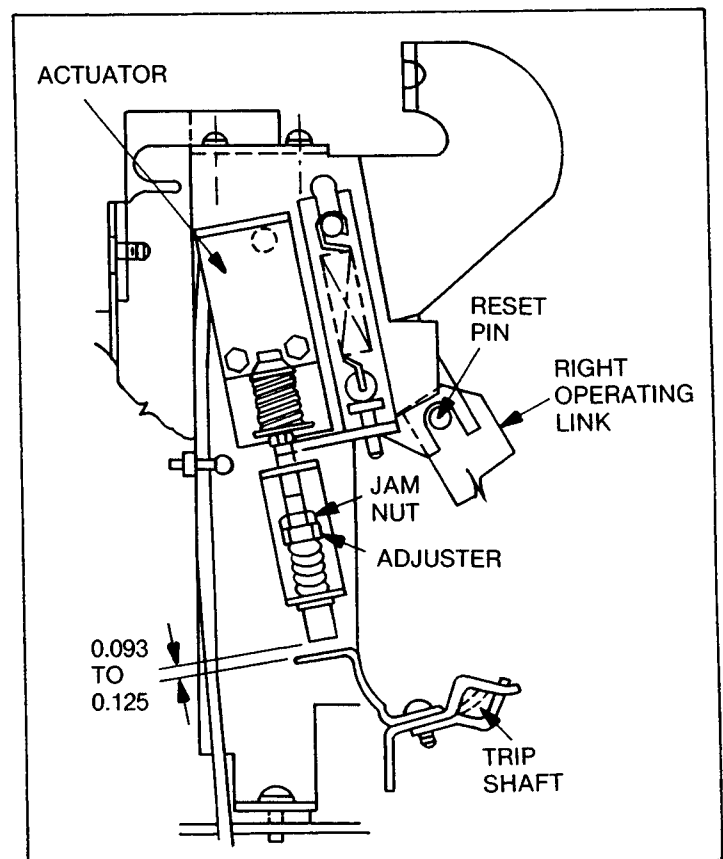


Fig. 21. Flux shifter trip device

## SECTION 8 — MicroVersaTrip® Trip Device

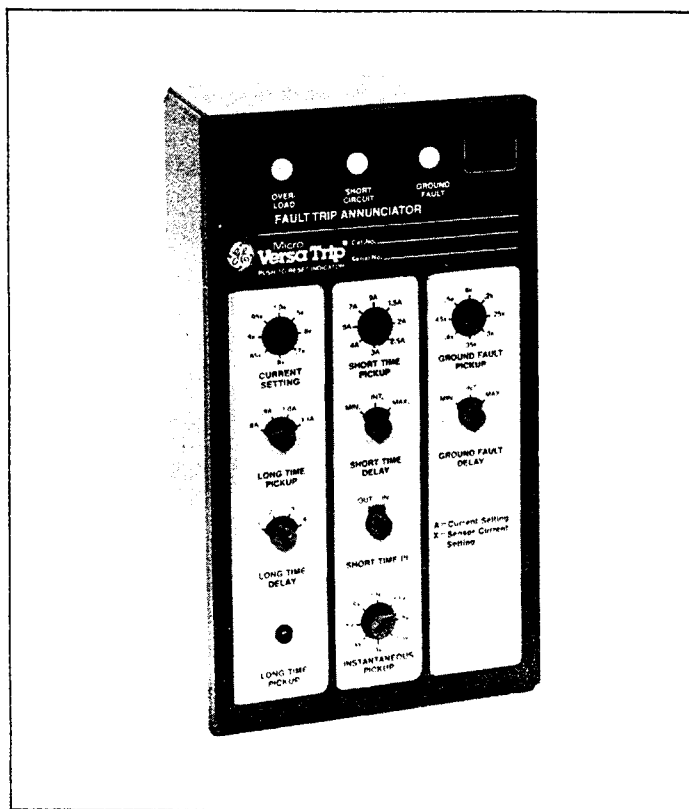


Fig. 19. MicroVersaTrip® Programmer

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.

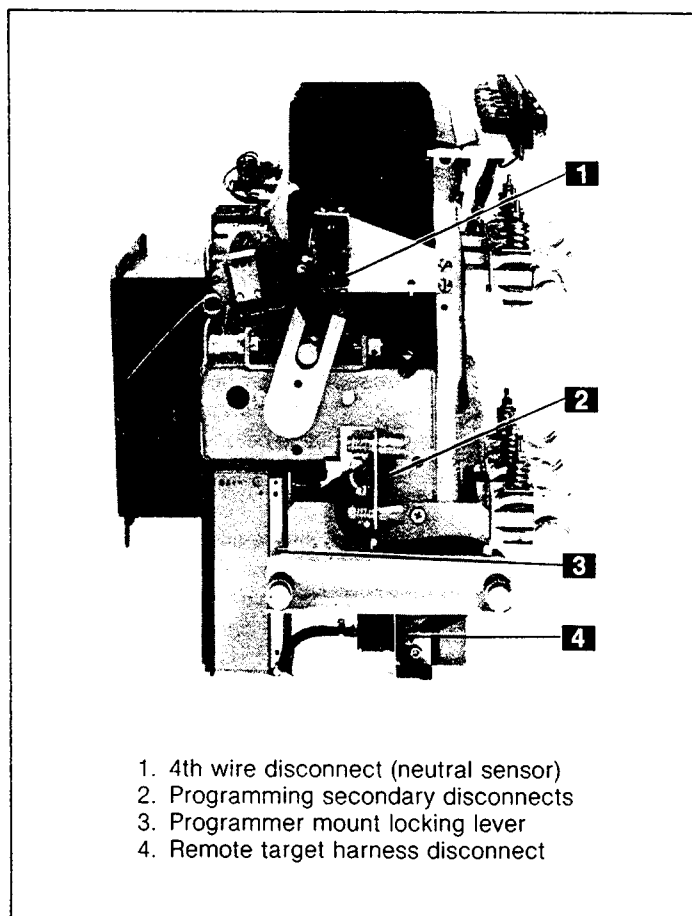


Fig. 20. Programmer installation and secondary disconnects

# Power Circuit Breakers

## SECTION 8 — MicroVersaTrip® Trip Device

### 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.

# Power Circuit Breakers

## SECTION 8 — MicroVersaTrip® Trip Device

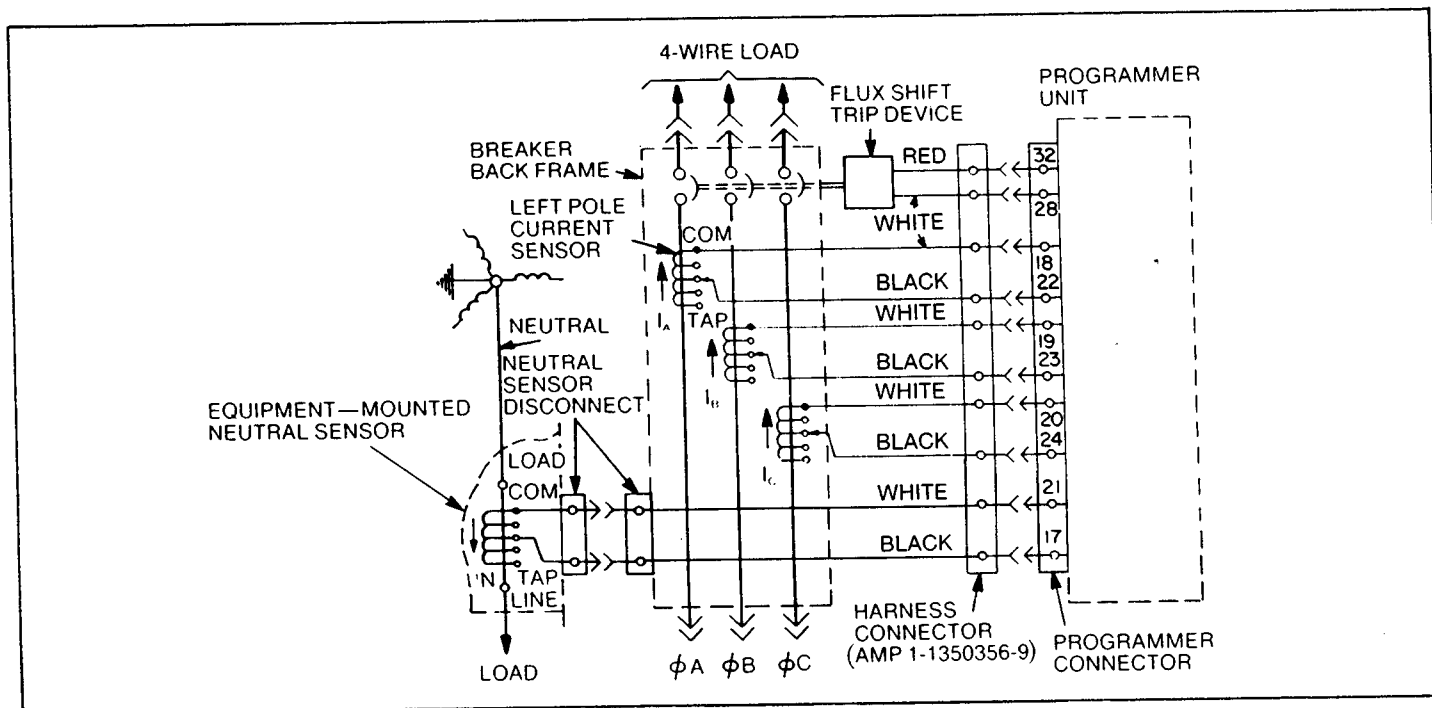


Fig. 25. Cabling diagram — MicroVersaTrip® with ground fault on 4-wire load-breaker reverse feed

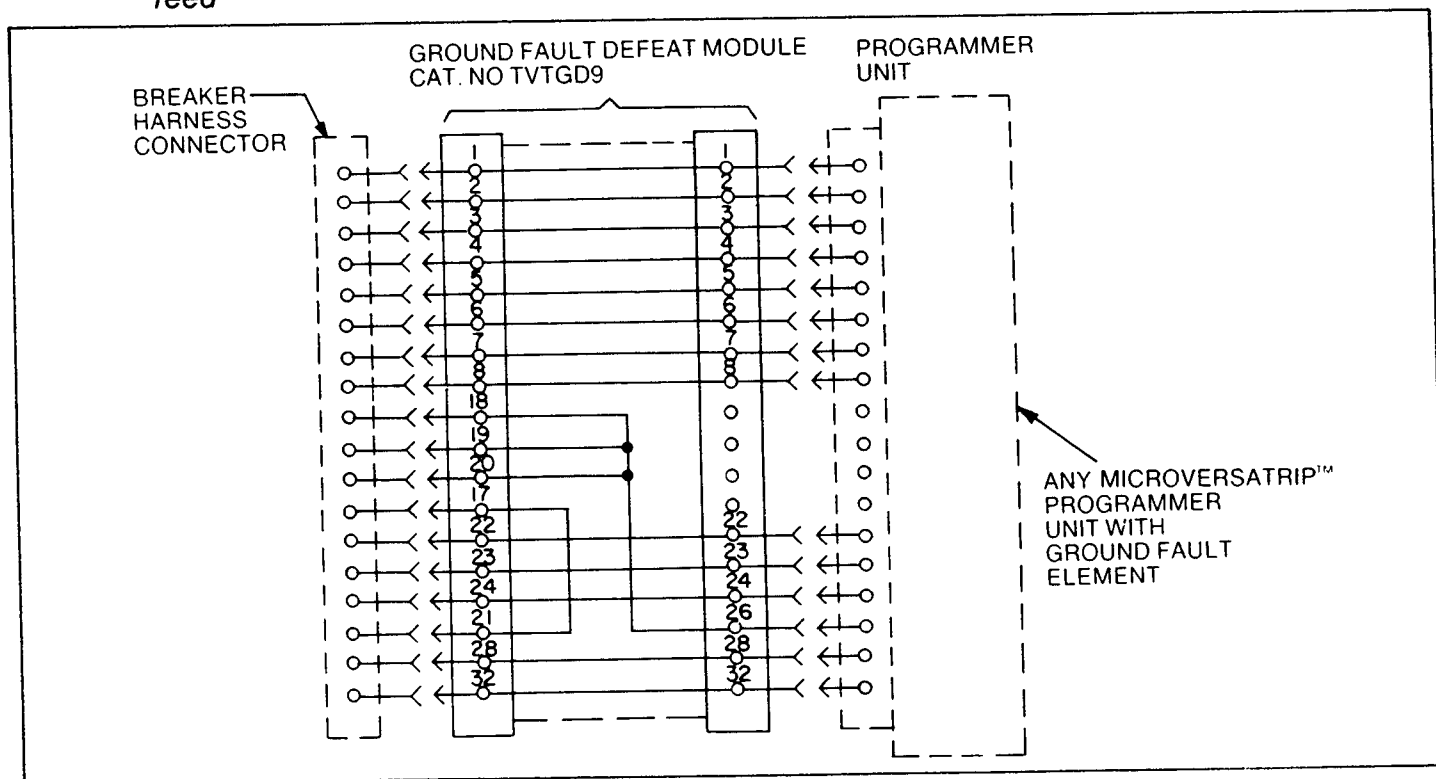


Fig. 26. Cabling diagram with ground fault defeat module inserted between breaker harness and MicroVersaTrip® programmer unit — for use during single-phase high-current low-voltage testing

## SECTION 8 — MicroVersaTrip® Trip Device

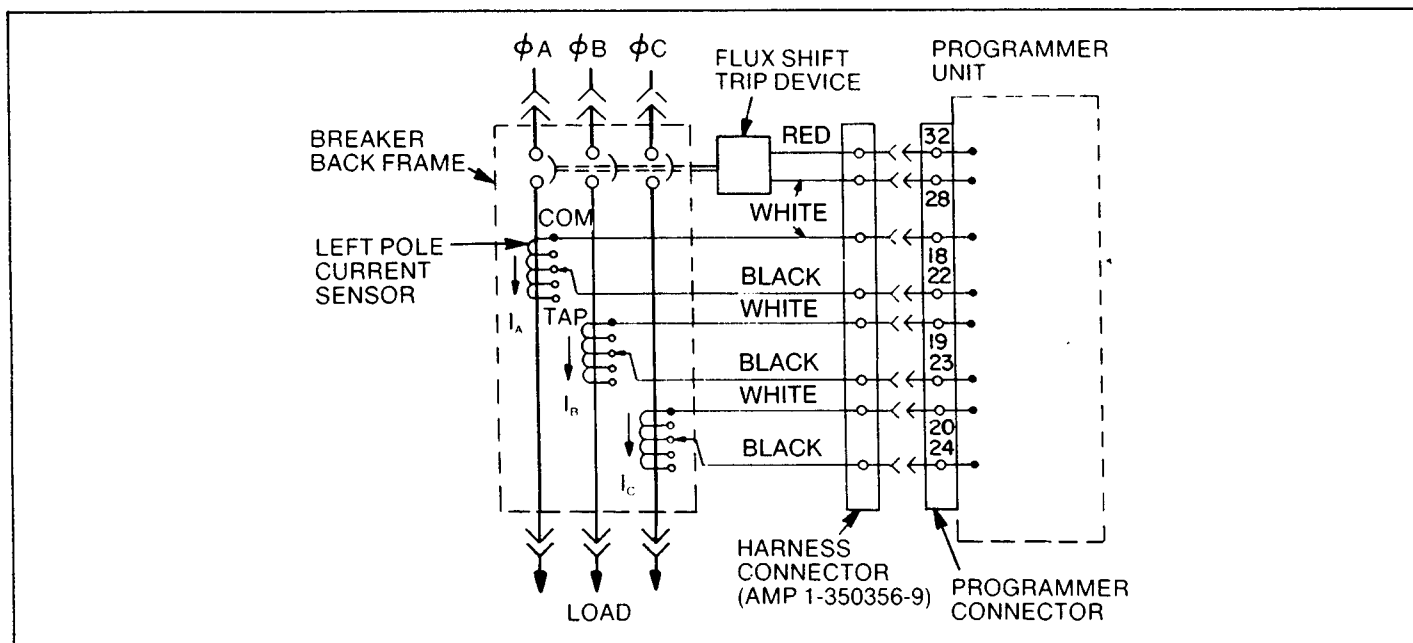


Fig. 23. Cabling diagram — MicroVersaTrip® without ground fault and MicroVersaTrip with ground fault on 3-wire load

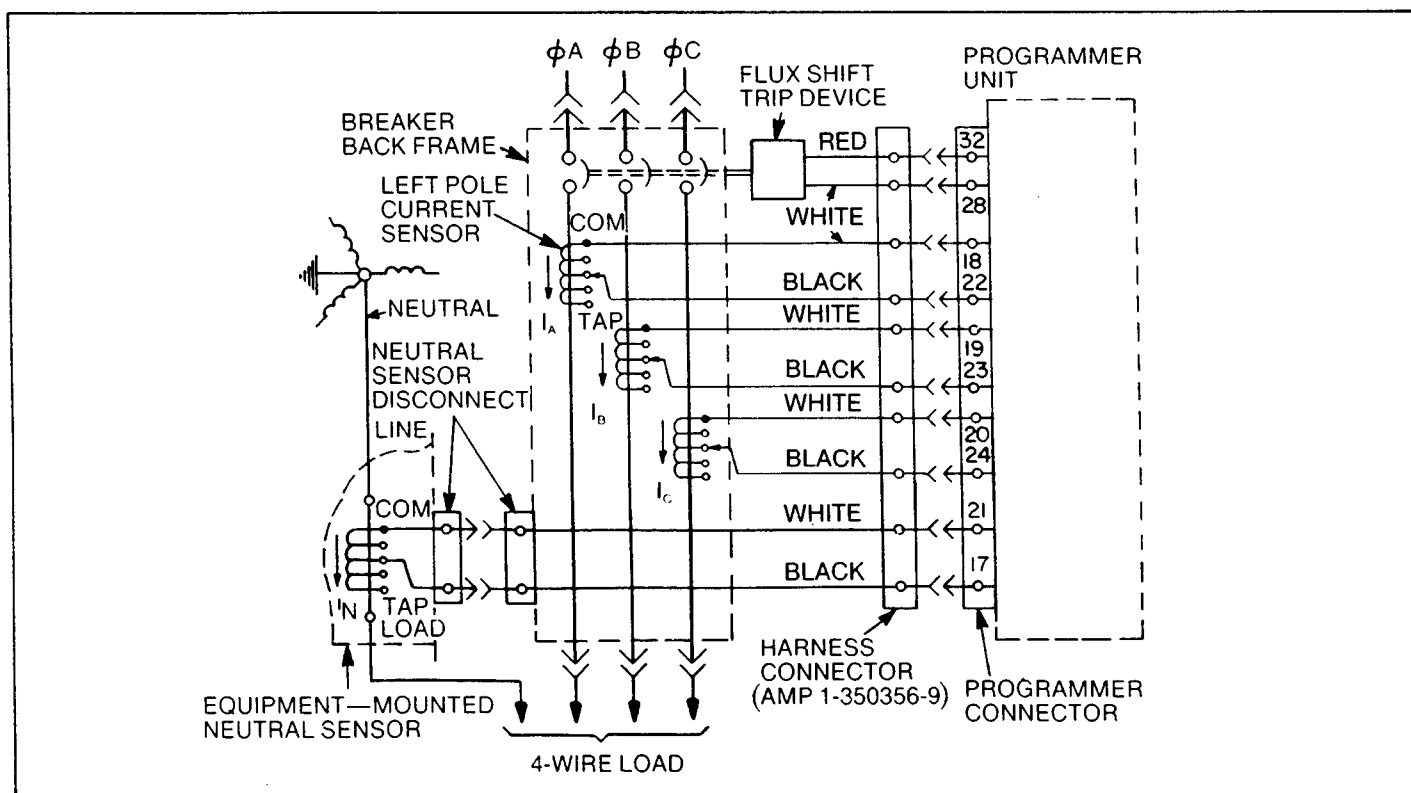


Fig. 24. Cabling diagram — MicroVersaTrip® with ground fault on 4-wire load



# Power Circuit Breakers

## SECTION 8 — MicroVersaTrip® Trip Device

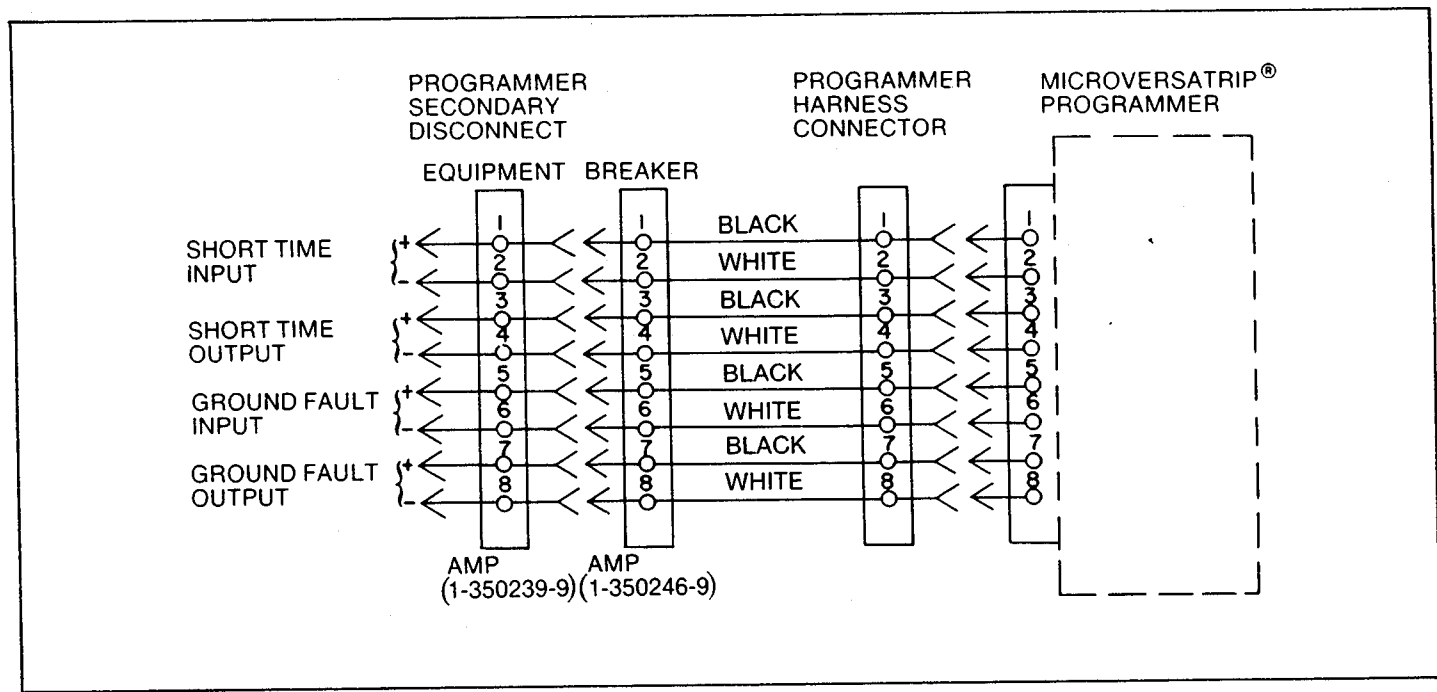


Fig. 29. Cabling diagram — zone selective interlock

## SECTION 8 — MicroVersaTrip® Trip Device

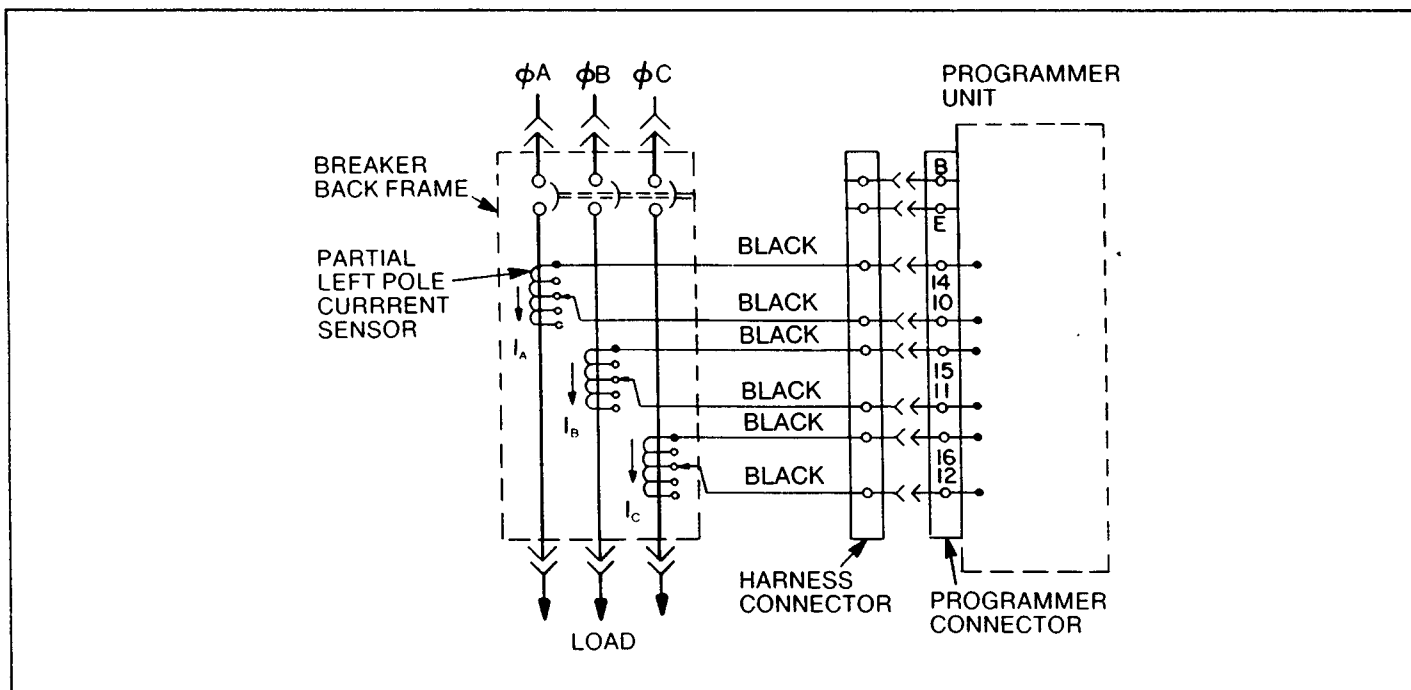


Fig. 27. Partial cabling diagram: Air core phase sequence winding connections

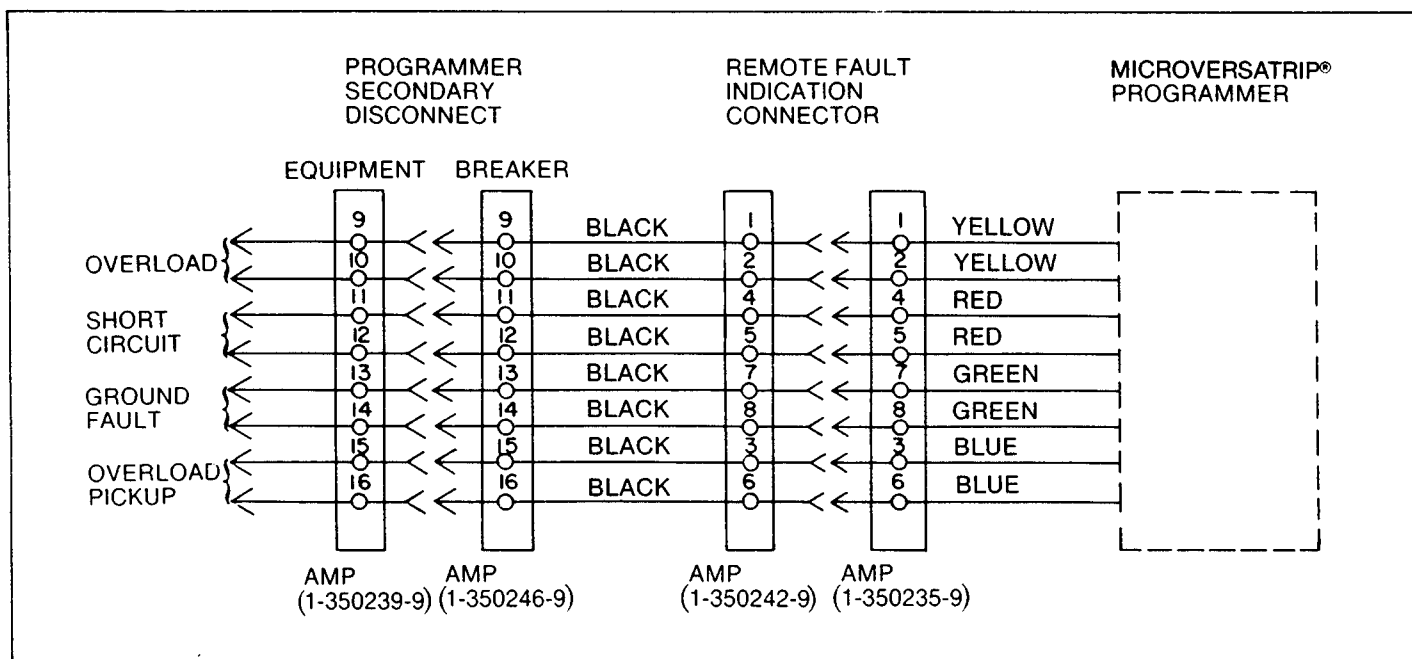


Fig. 28. Cabling diagram — remote fault indication

# Power Circuit Breakers

## SECTION 9 — Electrical Characteristics

**Table 8 — Shunt Trip and Undervoltage Device Operating Currents**

Nominal Control Voltage	Frequency Hz	Shunt Trip				Undervoltage		
		Operating Voltage Range		Current (Amps)		Operating Voltage Range	Current (Amps)	
				Inrush Open	Sealed Closed		Inrush Open	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"		Min (volts) Pick-up	Control Relay "K"		Min (volts) Pick-up	Closing Solenoid		Fuse Selection
				Rated-Amps			Rated Amps			Rated Amps		
				Inrush	Sealed		Inrush	Sealed		Inrush	Sealed	
				Open	Closed		Open	Closed		Open	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.

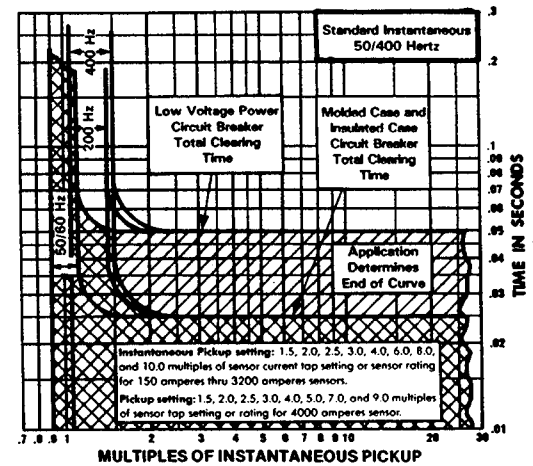
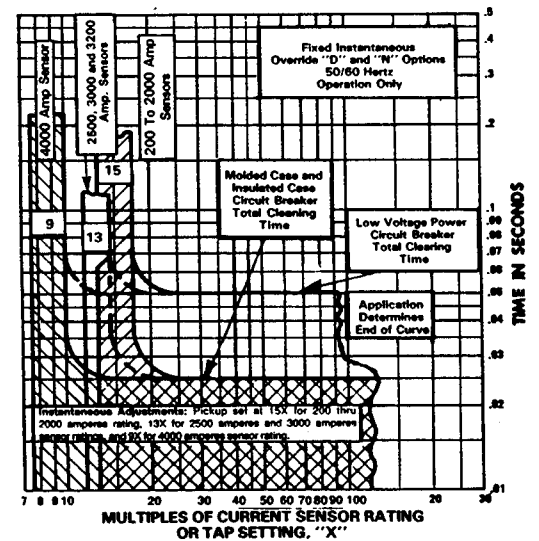
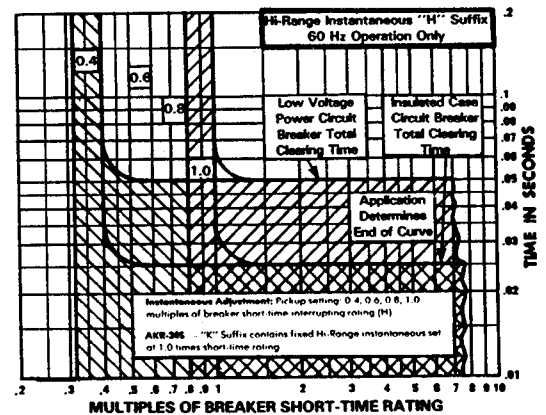
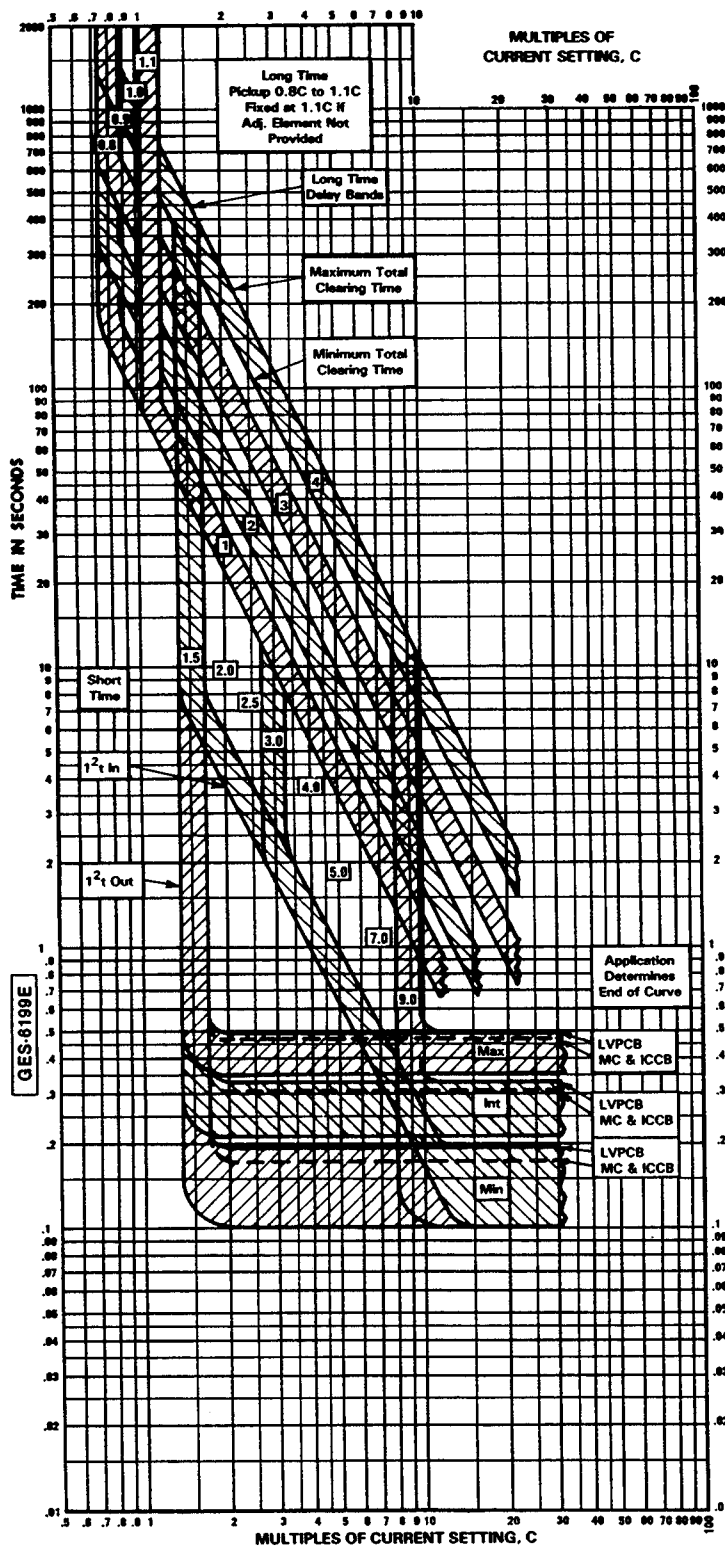
### **Renewal Parts Bulletin**

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**

**X=Current Sensor Tap Setting or Rating**

**Current Sensor Taps (Amperes) LVPCB**

AK-25 70/100/150/225 or 200/300/400/600

AKR-305 100/150/225/300 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-305 100, 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, 400/300, 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

3000/1200, 2500/1800

**3000 Envelope 3000/2400**

**4000 Envelope 4000/3000**

**Fixed Current Sensor Ratings (Amperes) ICCB and AKCB**

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 or right)

**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 -20°C to +55°C breaker ambient or -20°C to +70°C programmer ambient)

**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 top 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; 117° Constant.

Instantaneous Adjustments: See Curves above.

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

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

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