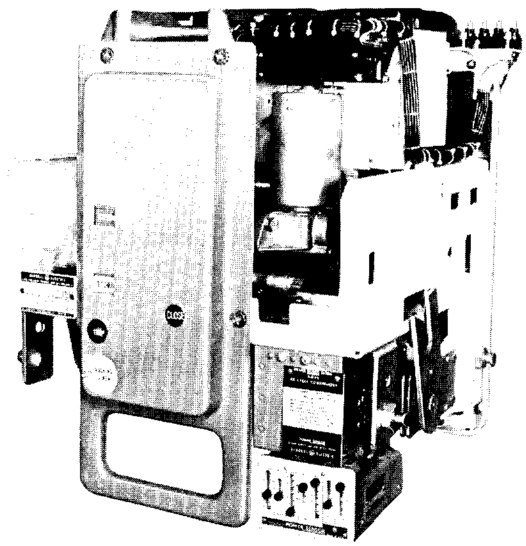
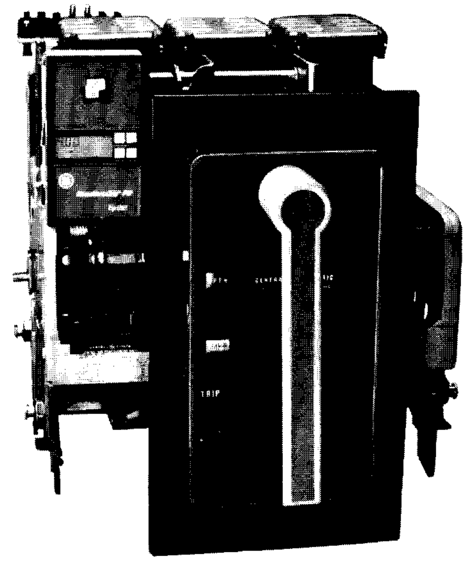
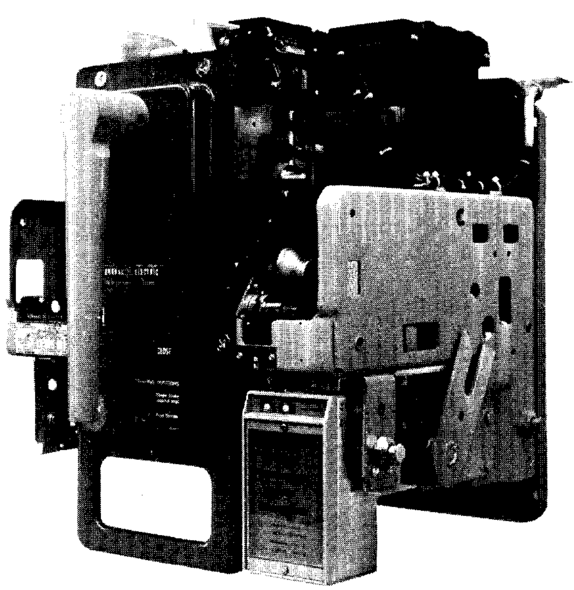
GEK-64459D Maintenance Manual

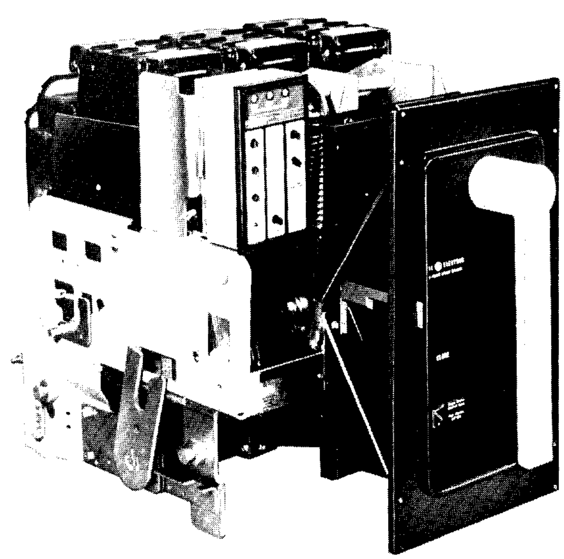
Low Voltage Power Circuit Breakers

Types AKR-30/50 and AKRT-50









Low Voltage Power Circuit Breakers
Table of Contents

Breaker operation

This is an insert to the maintenance manuals for AKR 30/50 (GEK 64459D) and AKR 75/100 (GEK64460A). The insert describes the operation of the breaker with the newly introduced electronic closing system.

For the AKR 30/50 insert to section 5 starting on page 11.

For the AKR 75/100 insert to section 4 starting on page 10

Replacement Parts

Replacement printed circuit board assembly for 48 VDC applications: #10060125G1

Replacement printed circuit board assembly for all other voltage applications: #10060125G2

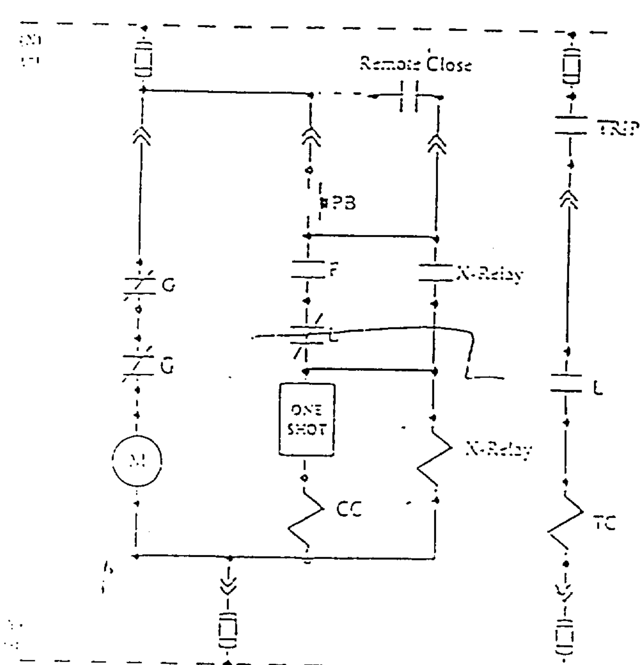


FIG.E1 - ELEMENTARY DIAGRAM FOR ELECTRICALLY OPERATED DRAWOUT BREAKER. CONTACT POSITIONS ARE SHOWN WITH BREAKER OPEN AND CLOSING SPRINGS DISCHARGED. TYP # [illegible] "E" SERIES

E.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. E1. The motor, through the gear reduction output crank, compresses the closing spring 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 One-Shot electronic.

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

As the One-Shot electronic is energized through a closing contact, the "X" relay is energized as well. The "X" relay will latch in and therefore prevent a second closing operation on the breaker in the event it is tripped open automatically. The closing signal must be released and reapplied before a second closing operation can occur.

The closing springs on the electrically operated breakers can be manually charged.

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 PUSH-BUTTON ON BREAKER ESCUTCHEON, OPTIONAL.
X	CONTROL RELAY
OS	ONE-SHOT ELECTRONIC, PULSES THE CLOSING SOLENOID FOR 250 MSEC.

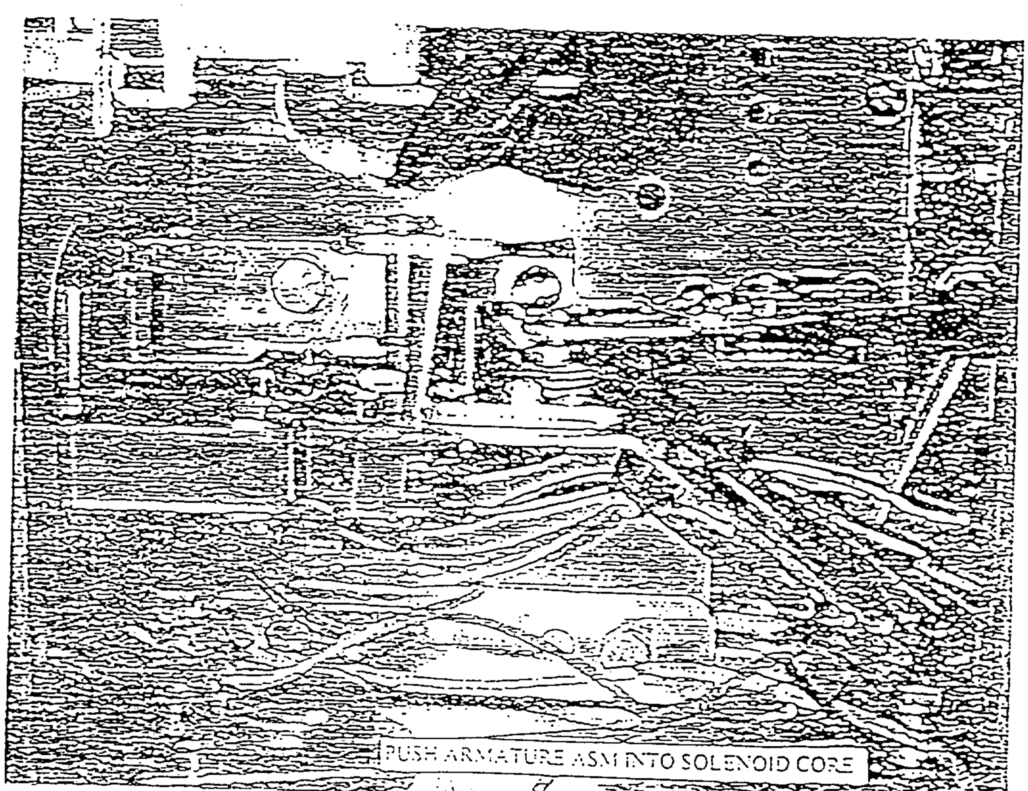


FIG. 13 - MANUAL OPERATION OF CLOSING SOLENOID

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 bottom of the breaker compartment. Loose or damaged control wiring and similar problem areas should also be checked.

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 it be opened and closed 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 when the breaker is closed.

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				DEEP ESCUTCHEON	FUSED BREAKER
		DRAWOUT					
		AKD-5	AKD-8	SUB-STRUCTURE	STATIONARY		
800 AC	AKR-(*)A 30, 30H	X					
	AKR-(*)B 30, 30H			X		X	
	AKR-(*)D 30, 30H, 30L		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
5 – SST } 50/60 Hertz Only
6 – MicroVersa Trip
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
7 – RMS-9
9 – MVT-PLUS or MVT-PM

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 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.

An outline drawing is available for each breaker frame size showing critical dimensions. The drawing number appears on the breaker nameplate and can be obtained from GE.

2.1 FRAME SIZE

The breakers are available in 5 frame sizes — 800 amperes A.C. (AKR 30/30H, 30L, AKRU 30), 1600 amperes A.C. (AKR 50/50H, AKRU 500), 2000 amperes A.C. (AKRT 50/50H), 800 amperes D.C. (AKR 30) and 2000 amperes D.C. (AKR 50).

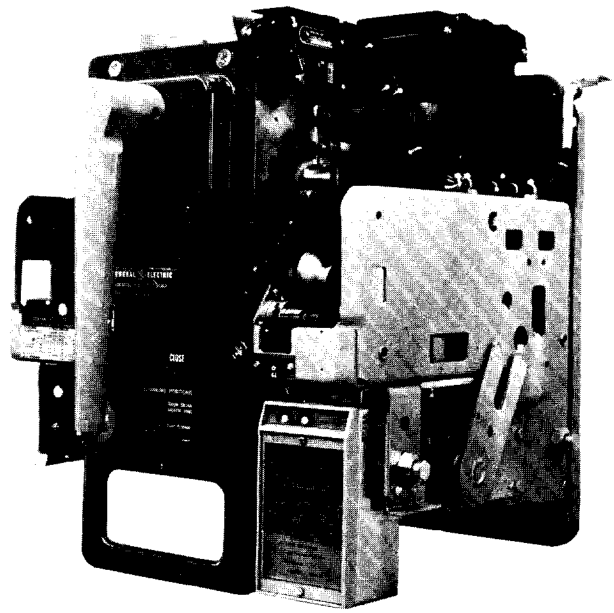


FIG. 1 — Manually Operated AKR-4A-50-1

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 maximum 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 and trip and close coils.

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.

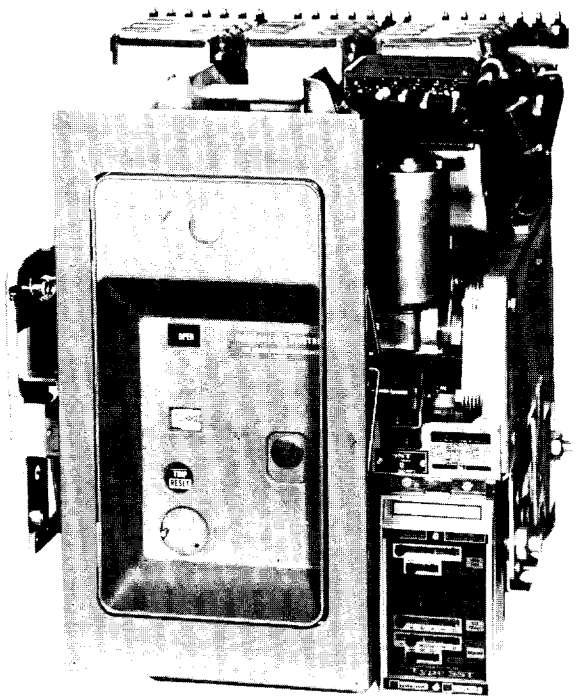


FIG. 2 — Electrically Operated AKR-7D-30

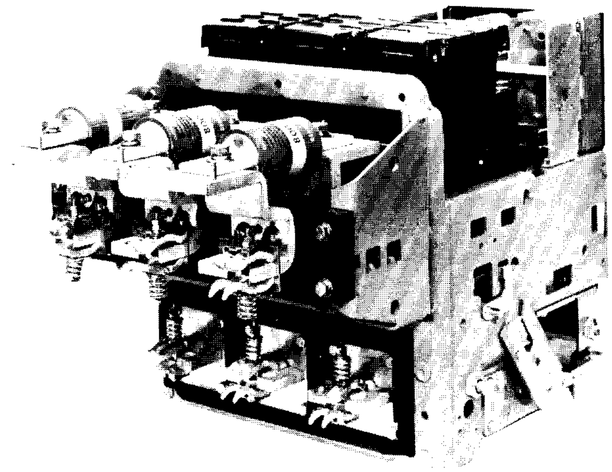


FIG. 3 — Fused Breaker AKRU-6D-30

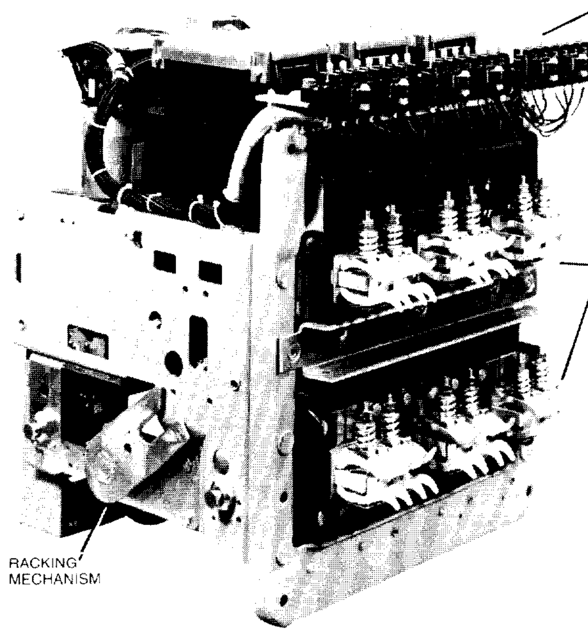


FIG. 4 — Drawout Breaker

SECTION 2—General Description (Cont.)

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	Stationary
A	AKD-5 AKD-6	—
B	Substructure	—
D	AKD-8 Substructure	— —
S	——	X

2.5 TRIP DEVICE

There are several 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 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	MicroVersaTrip	AC
7	RMS-9	AC
9	MVT-PLUS or MVT-PM	AC

[1]For Power Sensor devices. 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 or "-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.

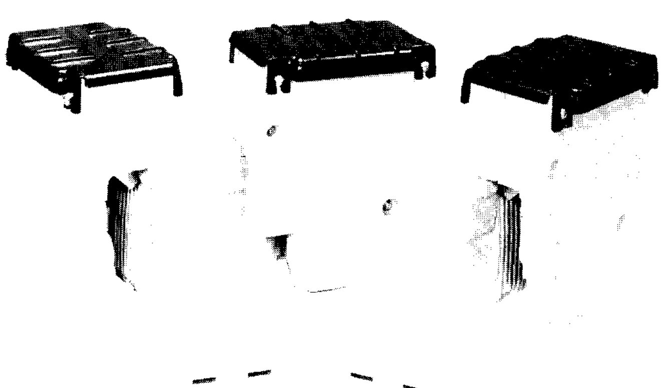


FIG. 5 — CERAMIC ARC CHUTES

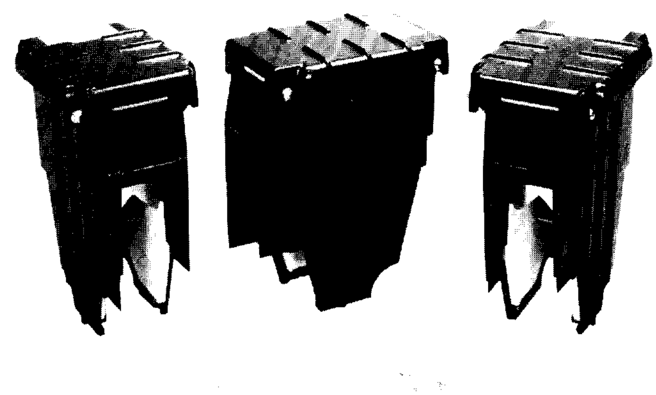


FIG. 6 — MOLDED ARC CHUTES

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

<table>
<tr><th rowspan="2">FRAME SIZE (AMPERES)</th><th rowspan="2">BREAKER TYPE</th><th rowspan="2">RATED MAXIMUM VOLTAGE (60 HZ AC)</th><th colspan="2">3φ INTERRUPTION RATING KA RMS SYMMETRICAL</th><th rowspan="2">SHORT TIME</th></tr>
<tr><th>WITH INSTANTANEOUS TRIP</th><th>WITHOUT INSTANTANEOUS TRIP</th></tr>
<tr><td rowspan="9">800 AC</td><td rowspan="3">AKR 30</td><td>635</td><td rowspan="2">30</td><td rowspan="3">30</td><td rowspan="3">30</td></tr>
<tr><td>508</td></tr>
<tr><td>254</td><td>42</td></tr>
<tr><td rowspan="3">AKR 30H</td><td>635</td><td rowspan="2">42</td><td rowspan="3">42</td><td rowspan="3">42</td></tr>
<tr><td>508</td></tr>
<tr><td>254</td><td>50</td></tr>
<tr><td rowspan="3">AKR 30L</td><td>635</td><td>50</td><td>50</td><td>50</td></tr>
<tr><td>508</td><td rowspan="2">65</td><td rowspan="2">65</td><td rowspan="2">65</td></tr>
<tr><td>254</td></tr>
<tr><td rowspan="9">1600 AC</td><td rowspan="3">AKR 50</td><td>635</td><td>42</td><td>42</td><td>42</td></tr>
<tr><td>508</td><td>50</td><td rowspan="2">50</td><td rowspan="2">50</td></tr>
<tr><td>254</td><td>65</td></tr>
<tr><td rowspan="3">AKR 50H</td><td>635</td><td>50</td><td>50</td><td>50</td></tr>
<tr><td>508</td><td rowspan="2">65</td><td rowspan="2">65</td><td rowspan="2">65</td></tr>
<tr><td>254</td></tr>
<tr><td rowspan="3">AKR 50H-1</td><td>635</td><td rowspan="3">65</td><td rowspan="3">65</td><td rowspan="3">65</td></tr>
<tr><td>508</td></tr>
<tr><td>254</td></tr>
<tr><td rowspan="6">2000 AC</td><td rowspan="3">AKRT 50</td><td>635</td><td>50</td><td>50</td><td>50</td></tr>
<tr><td>508</td><td rowspan="2">65</td><td rowspan="2">65</td><td rowspan="2">65</td></tr>
<tr><td>254</td></tr>
<tr><td rowspan="3">ARKT 50H</td><td>635</td><td rowspan="3">65</td><td rowspan="3">65</td><td rowspan="3">65</td></tr>
<tr><td>508</td></tr>
<tr><td>254</td></tr>
<tr><td>800</td><td>AKRU 30</td><td>600</td><td rowspan="2">200</td><td rowspan="2">200</td><td rowspan="2">—</td></tr>
<tr><td>1600</td><td>AKRU 50</td><td>600</td></tr>
<tr><td>800 DC</td><td>AKR 30</td><td>300VDC</td><td>25[1]</td><td rowspan="2">[3]</td><td>25</td></tr>
<tr><td>2000 DC</td><td>AKR 50</td><td>300VDC</td><td>50[2]</td><td>50</td></tr>
</table>

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

SECTION 3.0—Storage, Safety, Maintenance

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 compartment 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.*

3.1 Safety

Each user must maintain a safety program for the protection of personnel, as well as other equipment, from the potential hazards associated with electrical equipment.

The following requirements are intended to augment the user's safety program, but **NOT** supplant the user's responsibility for devising a complete safety program. The following basic industry practiced safety requirements are applicable to all major electrical equipment such as switchgear or switchboards. General Electric neither condones nor assumes any responsibility for practices which deviate from the following:

1. ALL CONDUCTORS MUST BE ASSUMED TO BE ENERGIZED UNLESS THEIR POTENTIAL HAS BEEN MEASURED AS GROUND AND SUITABLE GROUNDING CONDUCTORS HAVE BEEN APPLIED TO PREVENT ENERGIZING. Many accidents have been caused by back feeds from a wide variety of sources.

2. Although interlocks to reduce some of the risks are provided, the individual's actions while performing service or maintenance are essential to prevent accidents. Each person's knowledge; his mental awareness; and has planned and executed actions often determine if an accident will occur. The most important method of avoiding accidents is for all associated personnel to carefully apply a thorough understanding of the specific equipment from the viewpoints of it's purpose, it's construction, it's operation and the situations which could be hazardous.

All personnel associated with installation, operation and maintenance of electrical equipment, such as power circuit breakers and other power handling equipment, must be thoroughly instructed, with periodic retraining, regarding power equipment in general as well as the particular model of equipment with which they are working. Instruction books, actual devices and appropriate safety and maintenance practices such as OSHA publications, National Electric Safety Code (ANSI C2), The National Electrical Code, and NFPA 7 0B Electrical Equipment Maintenance must be closely studied and followed. During actual work, supervision should audit practices to assure conformance.

3. Excellent maintenance is essential for reliability and safety of any electrical equipment. Industry publications of recommenced maintenance practices such as ANSI/NFPA 70B, Electrical Equipment Maintenance, should be carefully studied and applied in each user's formation of planned maintenance.

3.2 Maintenance

Both long and short term maintenance of all electrical equipment is essential for reliability and safety. Maintenance programs must be tuned to the specific application, well planned and carried out consistent with both industry experience and manufacturer's recommendations. Local environment must always be considered in such programs, including such variables as ambient temperatures, extreme moisture, number of operations, corrosive atmosphere or major insect problems and any other unusual or abusive condition of the application.

One of the critical service activities, sometimes neglected, involves the calibration of various control devices. These monitor conditions in the primary and secondary circuits, sometimes initiating emergency corrective action such as opening or closing circuit breakers. In view of the vital role of these devices, it is important that a periodic test program be followed. As was outlined above, it is recognized that the interval between periodic checks will vary depending upon environment, the type of device and the user's experience. It is the General Electric recommendation that, until the user has accumulated enough experience to select a test interval better suited to his individual requirements, all significant calibrations be checked at an interval of one to two years.

To accomplish this, some items, such as "EC" direct operating trip systems for low voltage breakers, must be tested with primary current injection. Others can be adequately tested using test sets. Specific calibration instructions on particular devices typically are provided by supplied instruction books.

Instruction books supplied by manufacturers address components that would normally require service or maintenance during the useful life of the equipment. However, they can not include every possible part that could require attention, particularly over a very long service period or under adverse environments. Maintenance personnel must be alert to deterioration of any part of the supplied switchgear, taking actions, as necessary to restore it to serviceable status.

Industry publications of recommended maintenance practices such as ANSI/NFPA 70B, Electrical Equipment Maintenance, should be carefully studied and applied in each user's formation of planned maintenance.

Some users may require additional assistance from General Electric in the planning and performance of maintenance. The General Electric Company can be contracted to either undertake maintenance or to provide technical assistance such as the latest publications.

The performance and safety of this equipment may be compromised by the modification of supplied parts or their replacement by non identical substitutes. All such design changes must be qualified to ANSI/IEEE Standard C37.59.

The user should methodically keep written maintenance records as an aid in future service planning and equipment reliability improvement. Unusual experiences should be promptly communicated to the General Electric Company.

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 prevent 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.

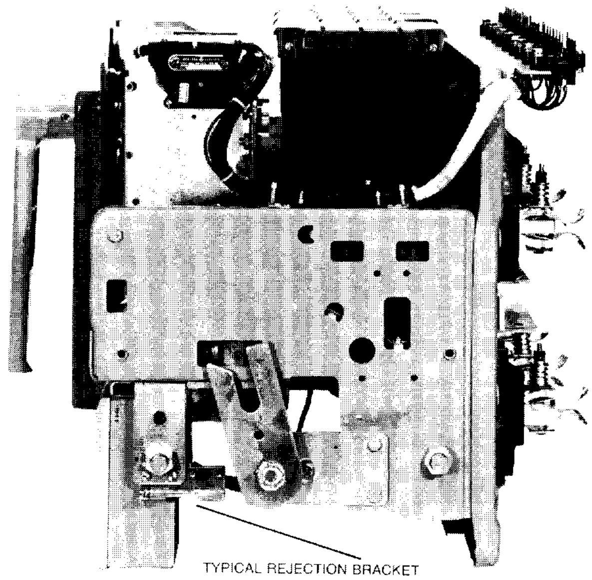


FIG. 7 — DRAWOUT BREAKER REJECTION SYSTEM

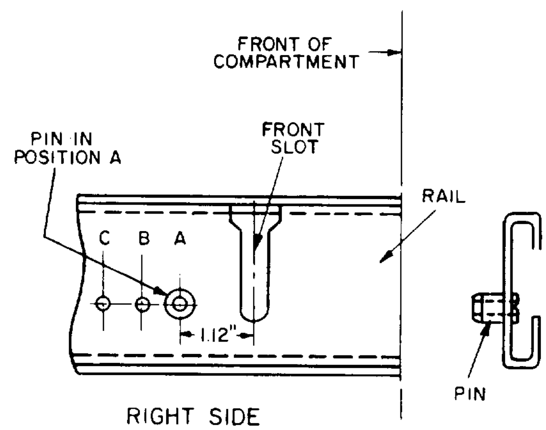


FIG. 8 INSERTING THE BREAKER

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 by cranking the handle through one cycle (135-degree swing). 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.

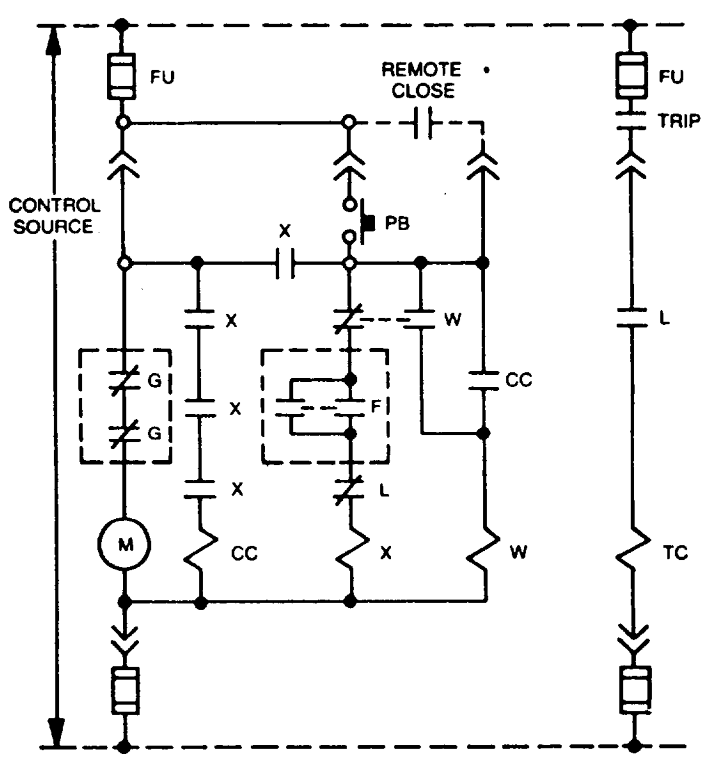
5.2 ELECTRICAL CLOSING

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 "PB" 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 "CC". This removes the prop, releasing the closing springs to close the breaker.

As the closing solenoid 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.



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. 9 — ELEMENTARY DIAGRAM FOR ELECTRICALLY OPERATED DRAWOUT BREAKER. CONTACT POSITIONS ARE SHOWN WITH BREAKER OPEN AND CLOSING SPRINGS DISCHARGED. TYP #183L712 "R" SERIES

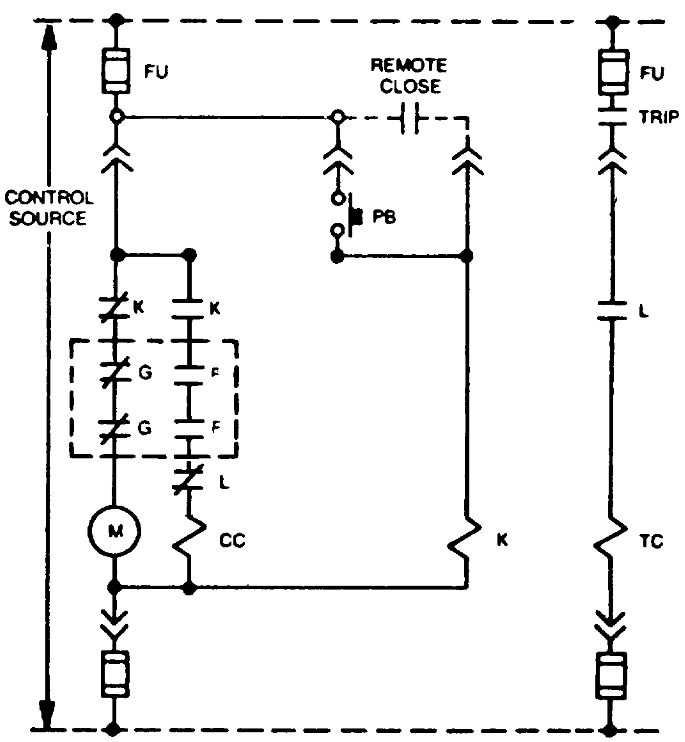
5.2.1 ALTERNATE CONTROL CIRCUIT USED

A second type of electrical control is 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 closing the "PB" 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 "CC". 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.

TYP #183L712 "B" SERIES

5.3 MECHANISM OPERATION

Figures 10A, 10B and 10C show the mechanism components in the Closed, Tripped and Reset positions. The closing spring is in the charged position for all of these details.

Closed Position — As shown in Fig. 10A, the movable contacts are pushed 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/roller item #6 and secondary latch #14 and trip latch #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, shown in Fig. 10 C, causes the breaker contacts to open.

Reset Position — The mechanism is shown in Fig. 10C. The closing 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 item 14 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 trip latch and cam roller.

The breaker closes when the closing spring discharges and rotates the cam item #3 against the cam roller item #5. 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 item #5 is supported by the cam rather than the prop. This is the position the mechanism must be in to check contact adjustment, refer to Section 8.

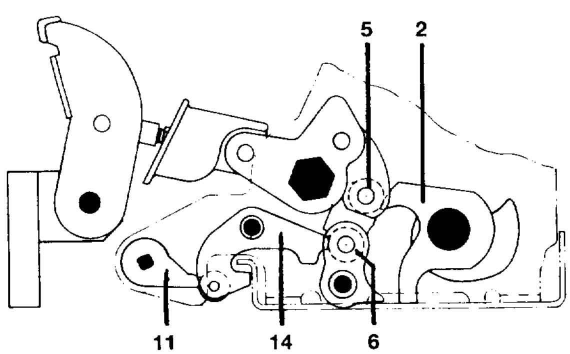


FIG. 10A CLOSED

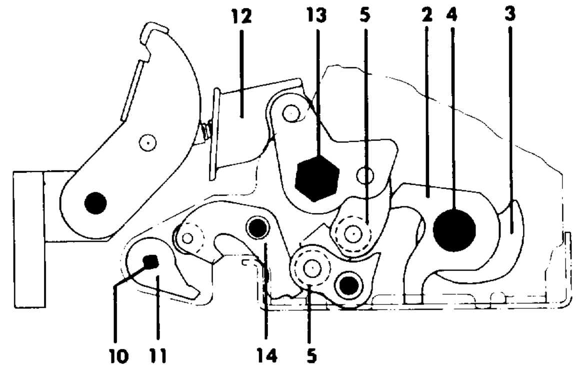


FIG. 10B TRIPPED

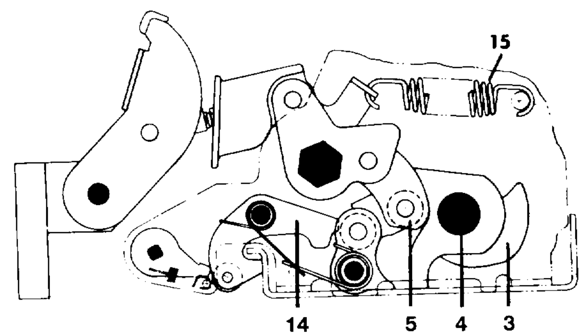


FIG. 10C RESET

2. Prop
3. Cam
4. Camshaft
5. Cam Roller
6. Secondary Latch Roller
10. Trip Shaft
11. Trip Latch
12. Insulated Coupling
13. Main Shaft
14. Secondary Latch
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 camshaft extension on the front right side of the breaker. Using the knob on the handle, it will be necessary to align this socket to fit on the end of the shaft when the handle is positioned as shown.

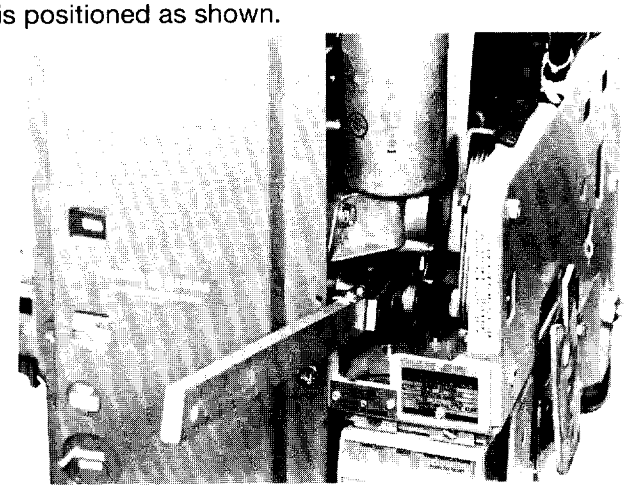


FIG. 11 — MAINTENANCE HANDLE INSTALLED ON CAMSHAFT EXTENSION

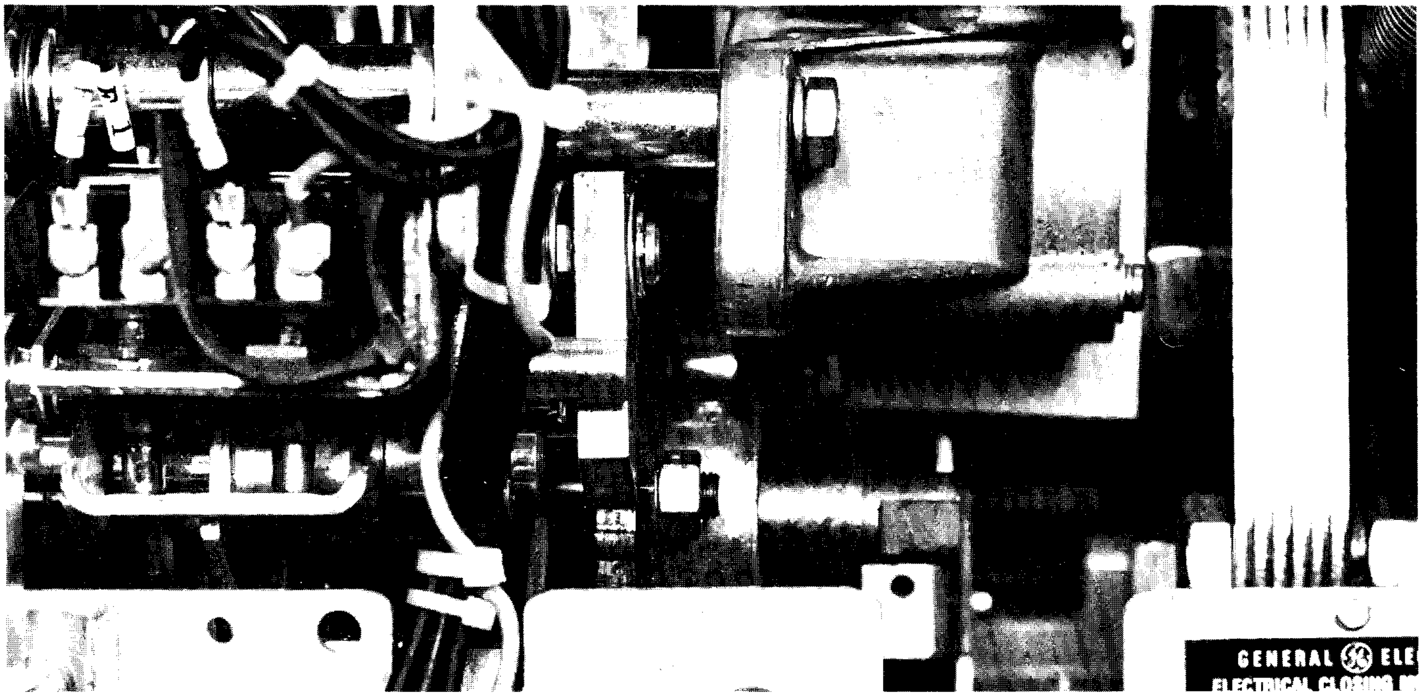


FIG. 12 — ROLLER ENGAGED WITH CLOSING PROP

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 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 armature by pushing the solenoid armature into its windings. See Fig. 13.

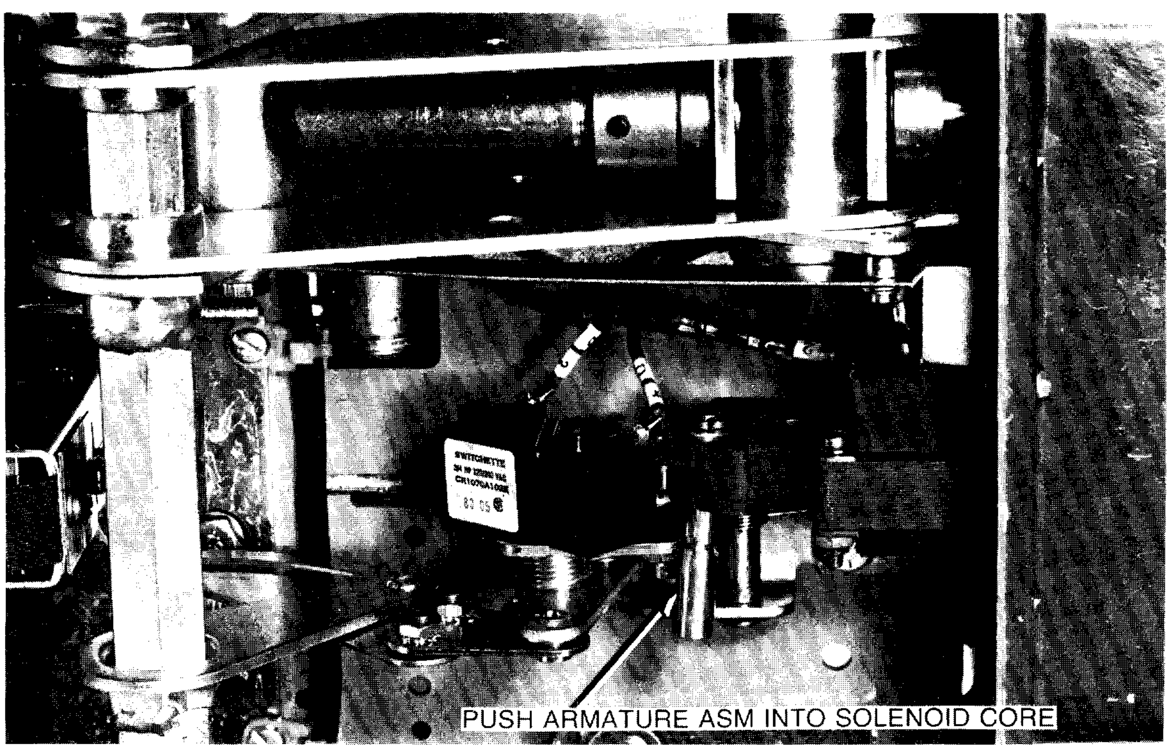


FIG. 13 — MANUAL OPERATION OF CLOSING SOLENOID

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.

Caution must be taken to ensure that any interlock lever is not bent and caused to not function. All interlocks should be operated to confirm that they function as required.

6.1 RACKING MECHANISM INTERLOCK

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

The racking mechanism drive shaft is located behind the RACKING SCREW cover shown in Fig. 14A. This cover must be slid to the right to gain access to the drive shaft as shown in Fig. 14B. When 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.

CAUTION! Prior to moving rack screw cover over to attach racking wrench push the manual trip button above the cover. This will ensure that the breaker is open. Also read breaker position flag to confirm that breaker is open.

Compartment door should be closed and latched when racking a breaker from the connect position.

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 depress 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.

CAUTION! Use only the proper racking mechanism wrench for racking the breaker in or out, otherwise the trip-free interlock feature may not function.

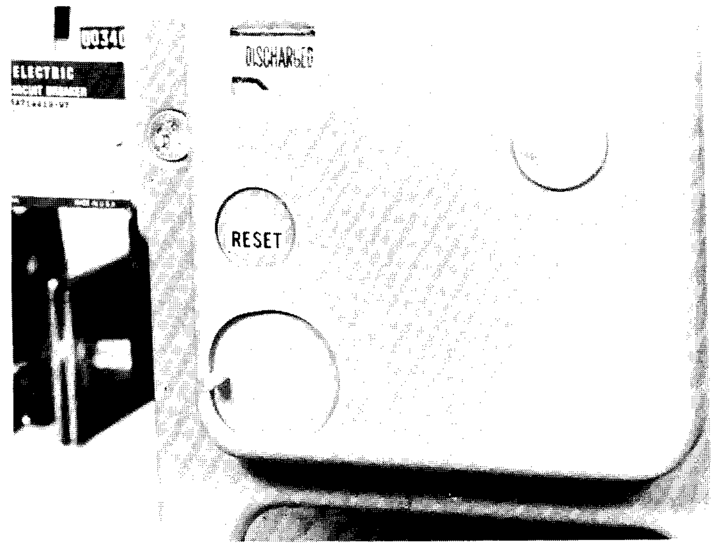


FIG. 14A — RACKING SCREW

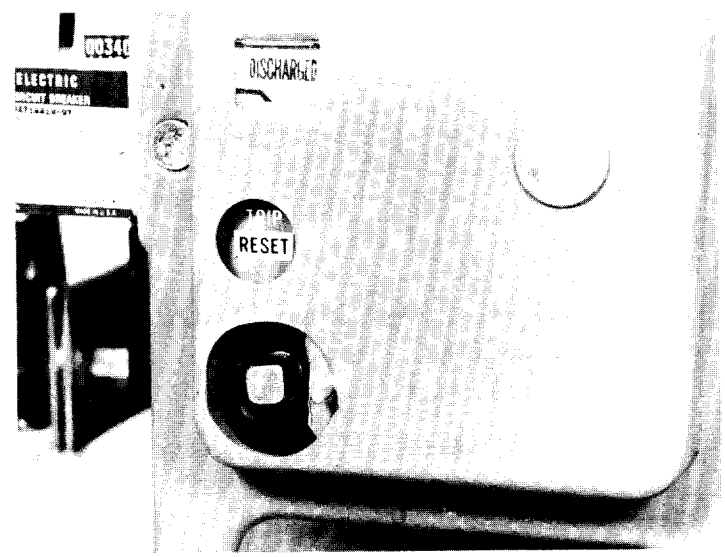


FIG. 14B

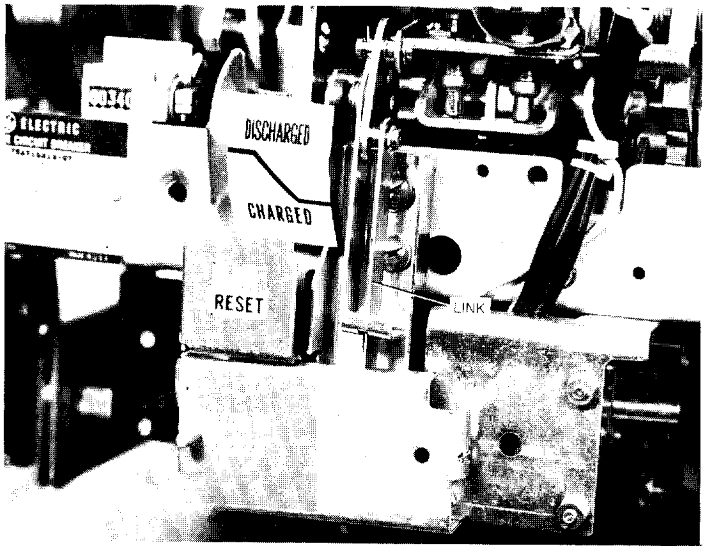


FIG. 15
RACKING SCREW COVER INTERLOCK CLOSED POSITION

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 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 lever assembly causing the trip shaft to rotate and prevent 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 the two pictures for 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 a slot tint he mechanism 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

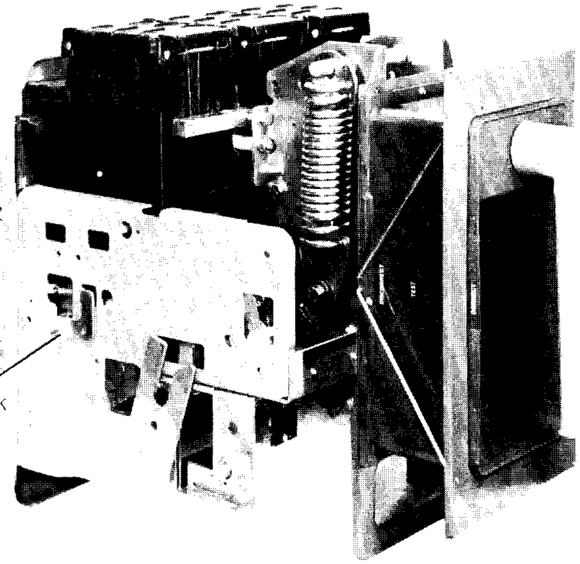
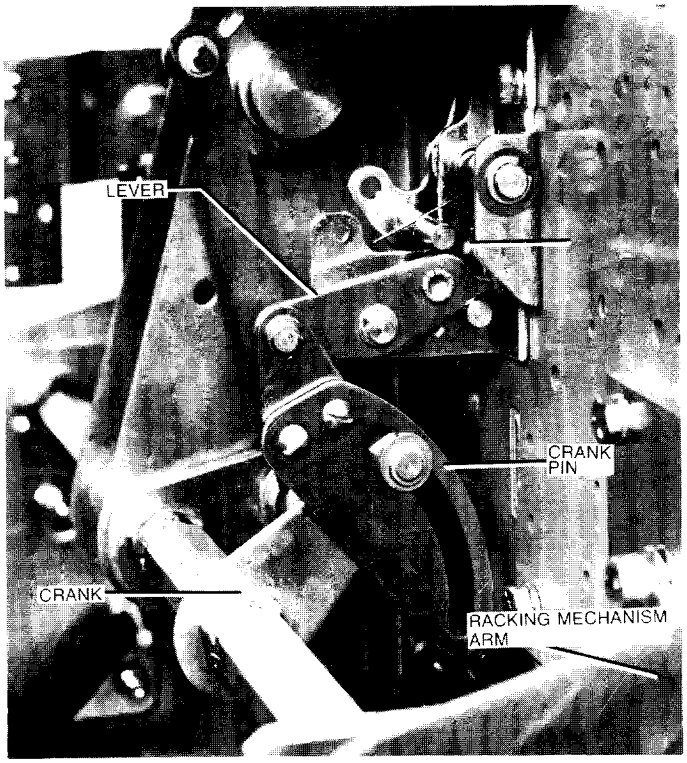


FIG. 16 — POSITIVE INTERLOCK

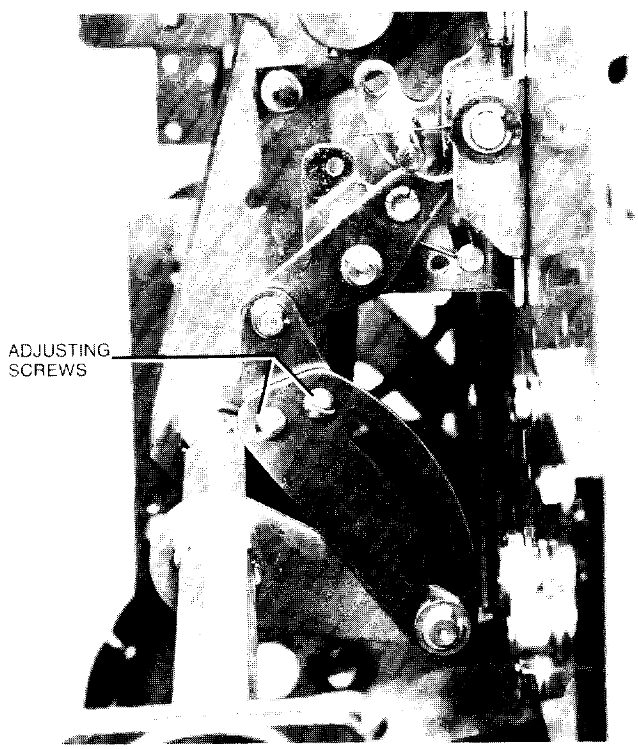
crank pin reaches the end of the slot in the linkage. Continued motion of the racking mechanism causes the linkage to rotate the lever which moves the closing solenoid armature forward. The armature linkage then releases the prop, discharging the closing spring.

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.



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.

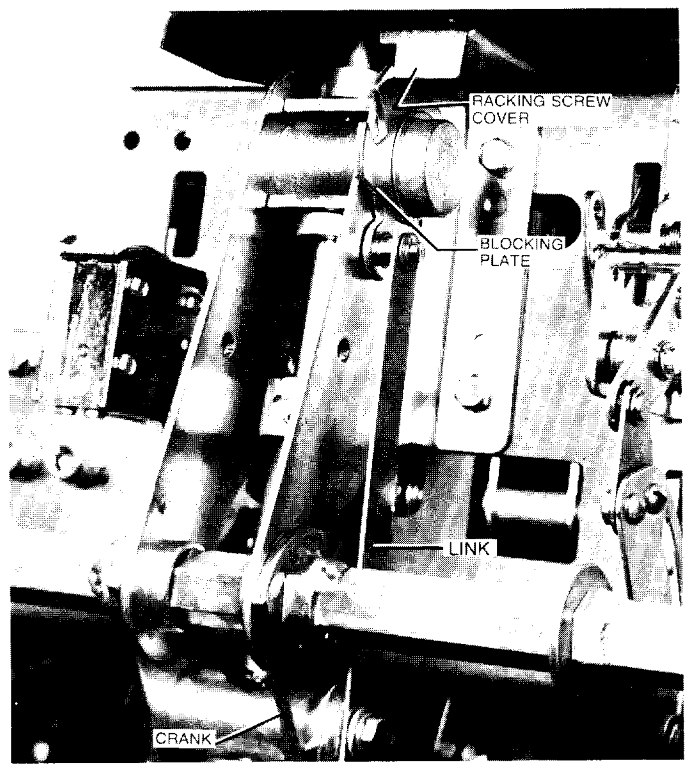


FIG. 18
DISCONNECT POSITION INTERLOCK

6.5 PADLOCKS

Provisions are made on all breakers to use padlocks to prevent the breaker form being closed. For all breakers except Type B or D 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 item #2 on the main shaft pivots the lever item #6 counter-clockwise. This removes the pin item #3 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.

When the breaker is in the CLOSED position, the flywheel assembly item #2 is away from the lever item #6. The lever is spring loaded and rotates clockwise causing its pin to block the lock bolt extension.

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.

1. Lock
2. End Plate
3. Pin
4. Lock Bolt
5. Pin
6. Lever

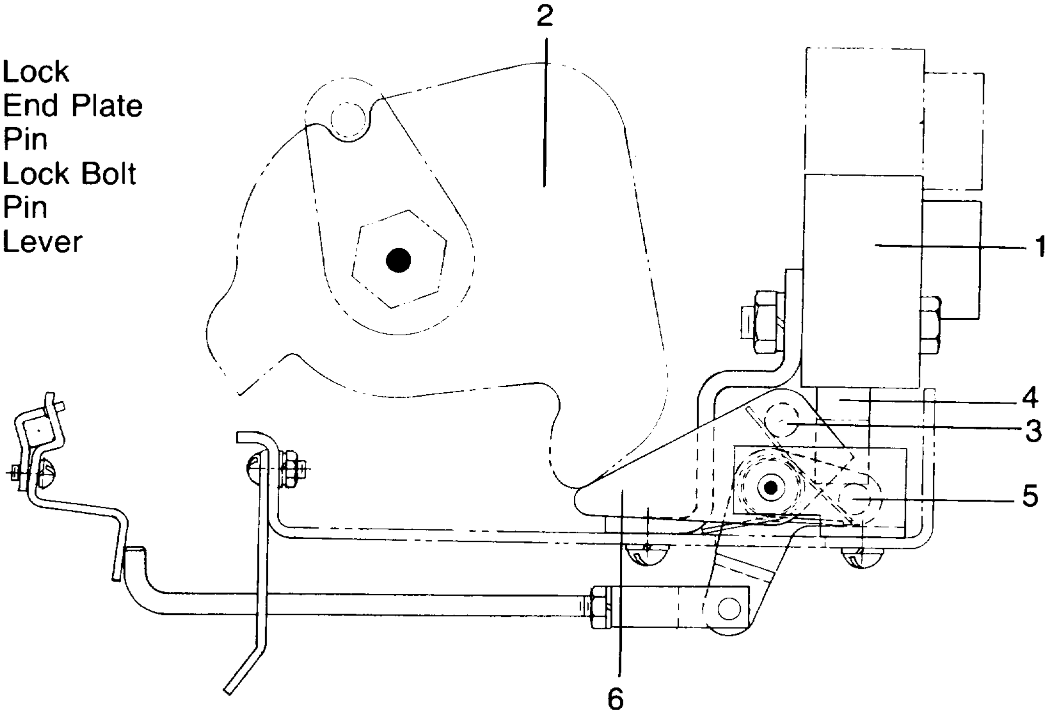


FIG. 19 — KEY INTERLOCK—STATIONARY BREAKERS

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 (D6A15AI Mobilgrease 28 or 32).

The areas requiring lubrication are:

1. Contacts Pivots — A thin film on the stationary and movable contact assembly pivot surfaces. Refer to Section 8. Do not lubricate the contact tips.
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 to stop accumulation 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

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, charging is not possible.

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.

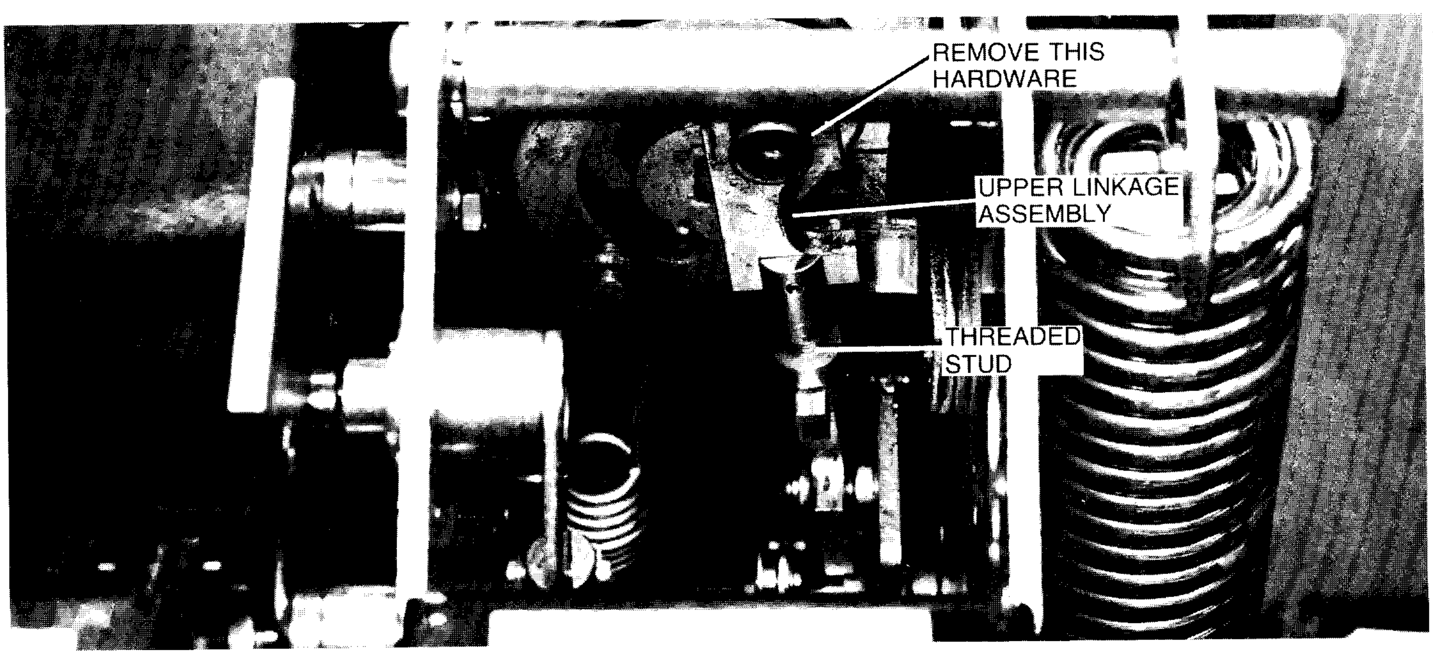


FIG. 20 — MANUAL HANDLE ADJUSTMENT

SECTION 7—Breaker Maintenance (Cont.)

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 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 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. When the contacts and mechanism are in the 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.

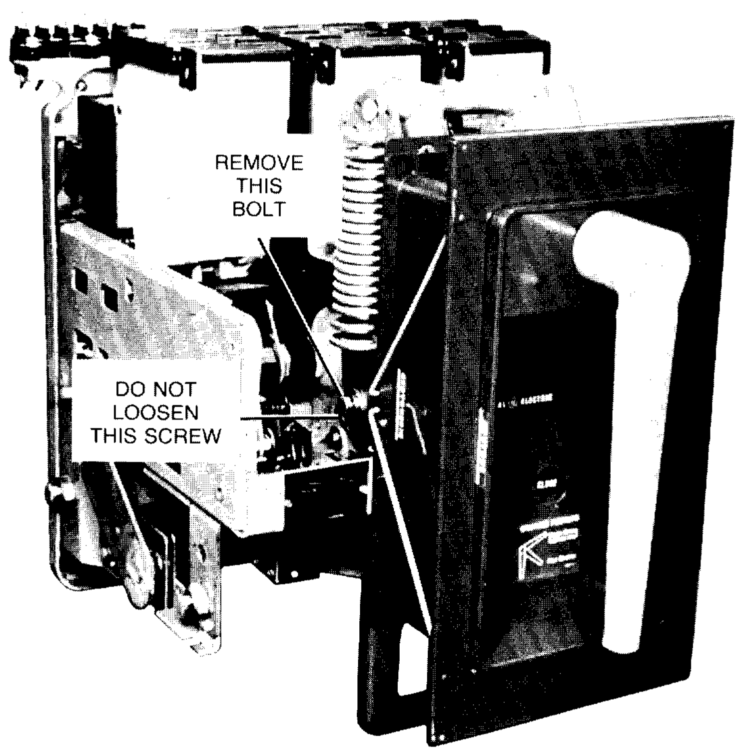


FIG. 21 — SLOW CLOSING—LOWER SPRING ASM HARDWARE

7.5 PRIMARY DISCONNECTS

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

The 800 ampere breakers with the exception of AKR 30L use four primary disconnect fingers per terminal. The 1600 amp, 2000 amp and AKR 30L breakers use eight fingers per terminal. Fig. 22 shows a line and load end disconnect assembly. The line end disconnects on fusible breakers have the spring pointing downwards, otherwise the are identical.

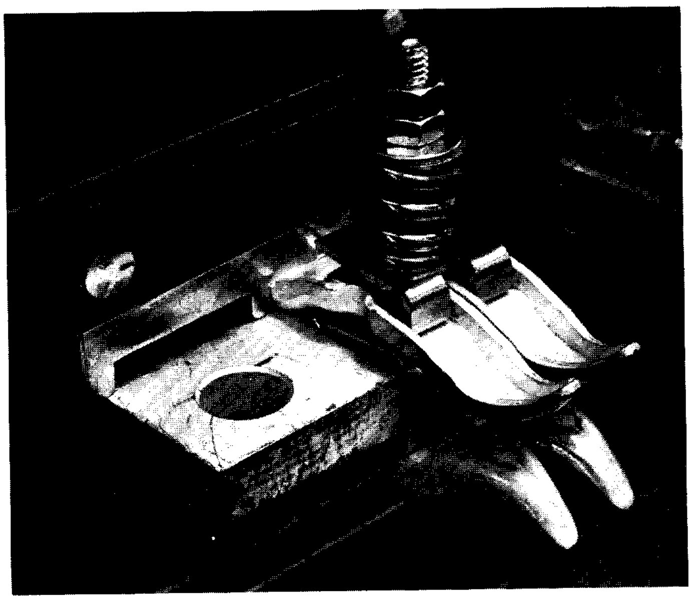


FIG. 22 — PRIMARY DISCONNECT ASSEMBLY

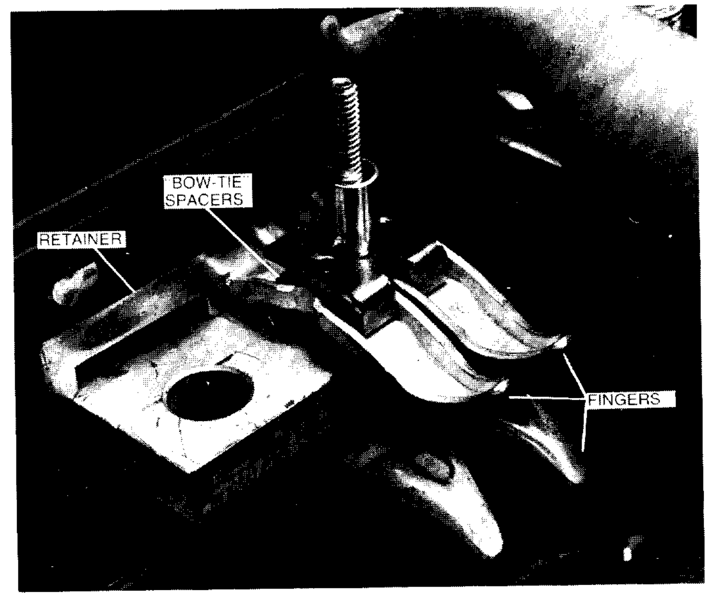


FIG. 23 — PARTIAL PRIMARY DISCONNECT ASM

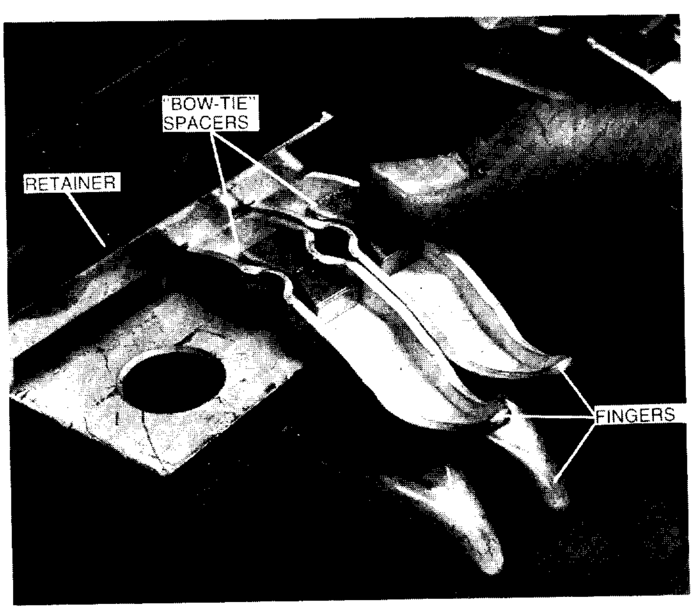


FIG. 24 — PARTIAL PRIMARY DISCONNECT ASM

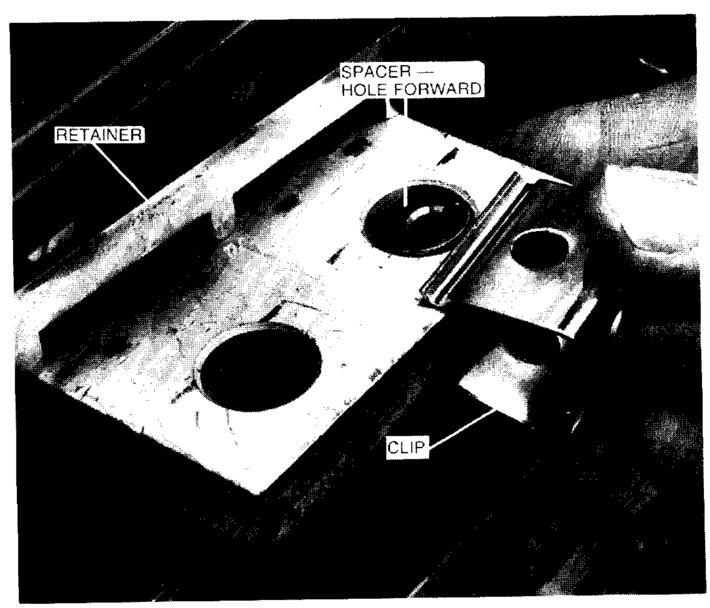


FIG. 25 — PARTIAL PRIMARY DISCONNECT ASM

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 .766" to .797" 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.

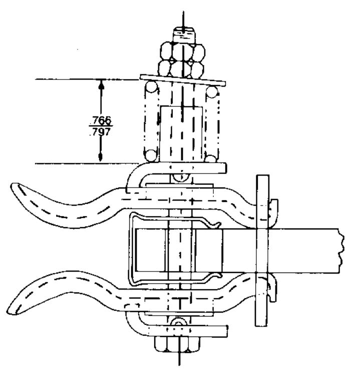


FIG. 26 — PRIMARY FINGER ADJUSTMENT

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. The switch can be a GE type "SB-12" or Electro Switch Type "101".

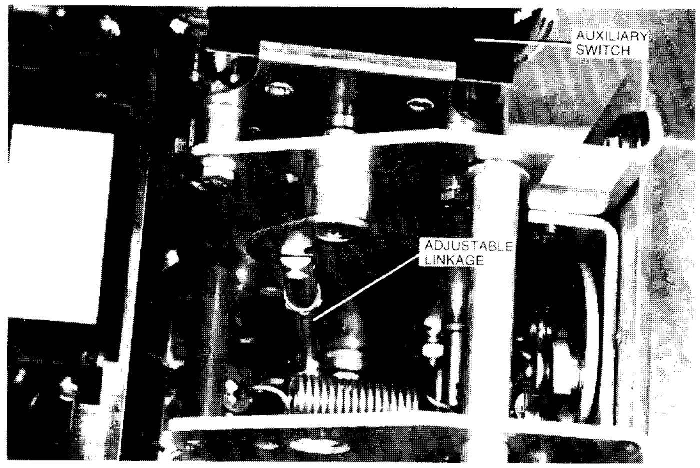


FIG. 27 — AUXILIARY SWITCH LINKAGE

7.6.1 REPLACEMENT

Either switch type may be dismounted by removing the two bolt screws which fasten it to the mechanism frame.

The GE SB-12 replacement switch should have its crank shaft set so that the arrow head on the end of the shaft points as shown in Fig. 28A when the breaker is open.

The Electro Switch replacement should have its crank shaft set so that the horizontal line on the end of the shaft is as shown in Fig. 28B when the breaker is open.

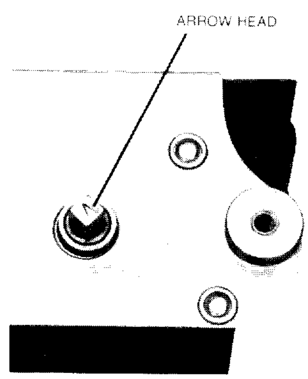


FIG. 28A — GE SB-12 CRANK SHAFT POSITION

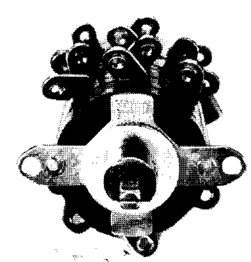


FIG. 28B — ELECTRO SWITCH CRANK SHAFT

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.

7.6.2 ADJUSTMENT

GE SB-12

If a new adjustable link is installed, its length should be set, before installing, at 6.375 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 "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.

ELECTROSWITCH TYPE 101

Adjustment is the same as the GE SB12 except that when the switch "A" contacts touch, the breaker arcing contacts must be within 0 to .250 inches of closing.

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 terminal board on stationary breakers.

The shunt trip is mounted on 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. A gap greater than .050" is permitted and may sometimes be necessary in order to prevent nuisance tripping. Re-verify positive trip as a final check.

7.8 UNDERVOLTAGE DEVICE

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.

Dropout of the armature, with resultant breaker tripping, occurs when the voltage is reduced to a value between 30% and 60% of the coil rating. An open armature will render the breaker incapable of closing. The

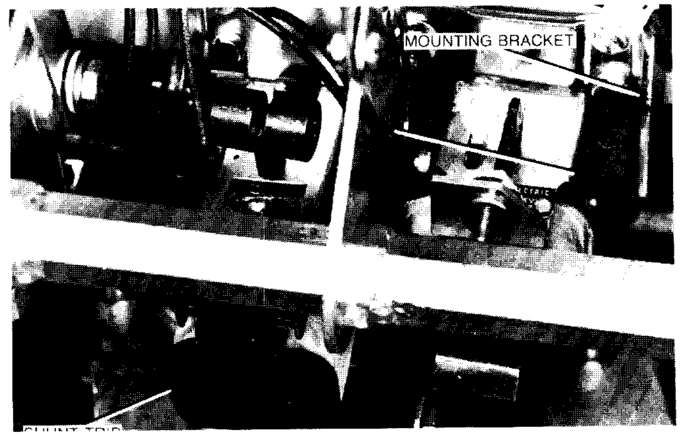


FIG. 29 — SHUNT TRIP AND UNDERVOLTAGE MOUNTING

armature will "pick up" and allow closing if the applied voltage is 85% or more of the coil rating. It may also pick up at a lower voltage. Refer to table 25 for pickup and dropout ranges.

The armature of the undervoltage device may be tied closed in order to permit breaker operation during maintenance.

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

To replace an undervoltage device, remove the mounting bracket (shown in fig. 29) from the breaker frame and remove the device from the bracket. Re-install in reverse order, noting wire routing and securing means.

Set the gap between the trip paddle and device armature to approximately 0.030 inch as a starting point, then proceed with the operational check (7.8.2).

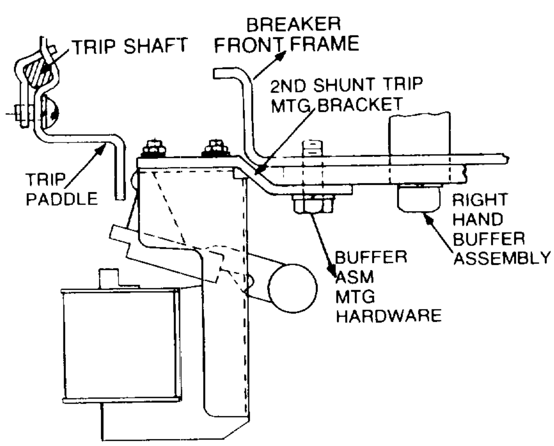


FIG. 30 — 2ND SHUNT TRIP INSTALLATION

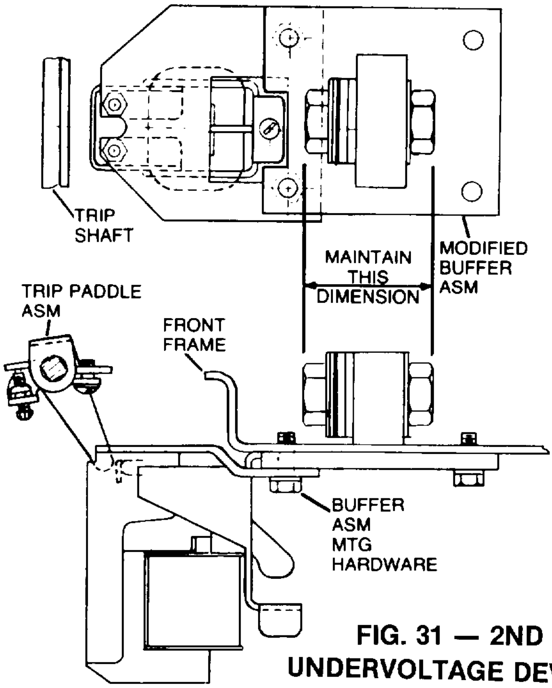


FIG. 31 — 2ND UNDERVOLTAGE DEVICE

7.8.2 OPERATIONAL CHECK (BREAKER WITH UV DEVICE INSTALLED)

Check the pickup and dropout values at room temperature. See table 25.

Check the positive trip ability as follows: With the armature closed, close the breaker. Insert a 0.032 ± .005 inch shim (wire gage or flat stock) against the armature open stop (see Fig. 32D) and release the armature. The breaker must trip.

7.8.3 ADJUSTMENTS

If the operational checks (7.8.2) indicate that adjustments are necessary, these procedures should be followed:

First verify trip latch engagement as described in section 7.15, and verify that the trip shaft torque required to trip a closed breaker is no greater than 24 inch-ounces. Then proceed as follows:

PICKUP VOLTAGE:

The pickup level is changed by turning the adjustment screw shown in Fig. 32A. The screw is secured by either a locking wire or a jam nut inside the frame. Devices with a jam nut require removal of the device to make this adjustment. The pickup voltage at room temperature (approx. 20-24°C) should be 85% or less of coil rating and should be measured at the secondary disconnects with the coil energized. *Note: On DC devices set the gap between the armature and magnet initially to 0.030 inch using the closed gap adjustment screw shown in Fig. 32C before making pickup adjustments.*

Be sure to secure the pickup adjustment screw with the jam nut or lockwire.

DROPOUT VOLTAGE:

On AC devices the dropout level will fall within the required limits (30% to 60% of the coil rating) if the pickup is set properly. On DC devices, the dropout level may need independent adjustment. This is accomplished after the pickup level has been established per the above procedure. If required, use the closed gap adjustment screw shown in Fig. 32C to obtain the dropout setting. A gap must remain between the armature and magnet on DC devices to prevent sealing in upon loss of voltage. Secure the adjustment screw with the locknut and apply RTV to the locknut.

POSITIVE TRIP:

Check positive trip ability per 7.8.2. Adjust the trip paddle screw if necessary to assure positive trip. With the undervoltage device closed (picked up), and the mechanism reset, there must be clearance between the trip paddle and the device armature. If clearance adjustment is necessary, re-verify positive trip ability.

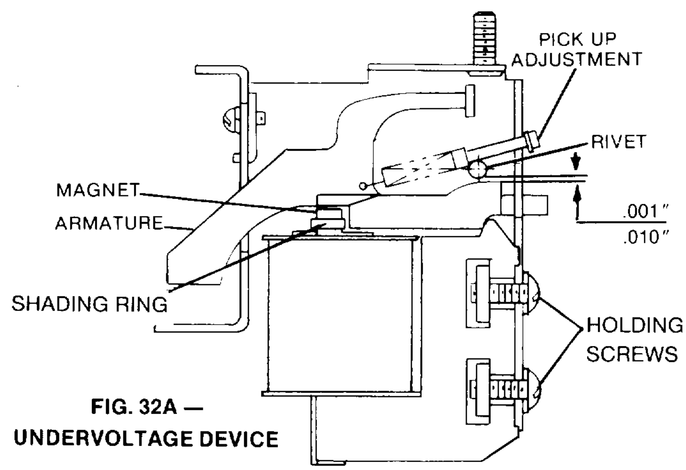


FIG. 32A — UNDERVOLTAGE DEVICE

7.8.4 FACTORY SETTINGS

This section covers certain factory settings as an aid to trouble shooting. They are for reference only, and are not intended to be field adjusted. They should not be considered criteria for acceptance or rejection.

ARMATURE LOCATING RIVET:

The rivet shown in figure 32A serves as a locater for the armature. A clearance of 0.001 to 0.010 inch should exist between the rivet and armature as shown in fig. 32A. The rivet should be able to turn freely.

ARMATURE OPEN GAP:

The air gap between the armature and the magnet with the device de-energized should be approximately 0.250 inches. This is checked by inserting a 0.201 ± .005 inch diameter gage pin between the armature and magnet as shown in Fig. 32B.

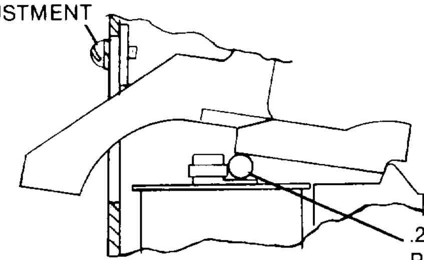


FIG. 32B — OPEN GAP CHECK

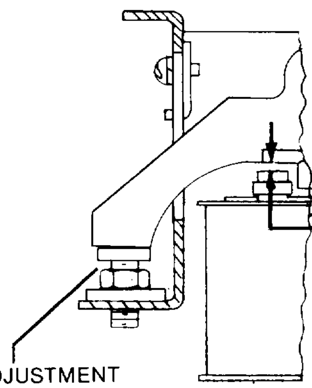


FIG. 32C — CLOSED GAP CHECK

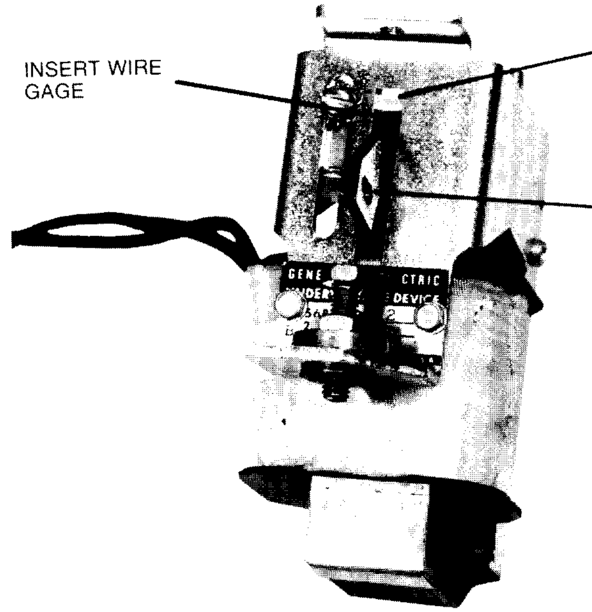


FIG. 32D — POSITIVE TRIP CHECK

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.

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.

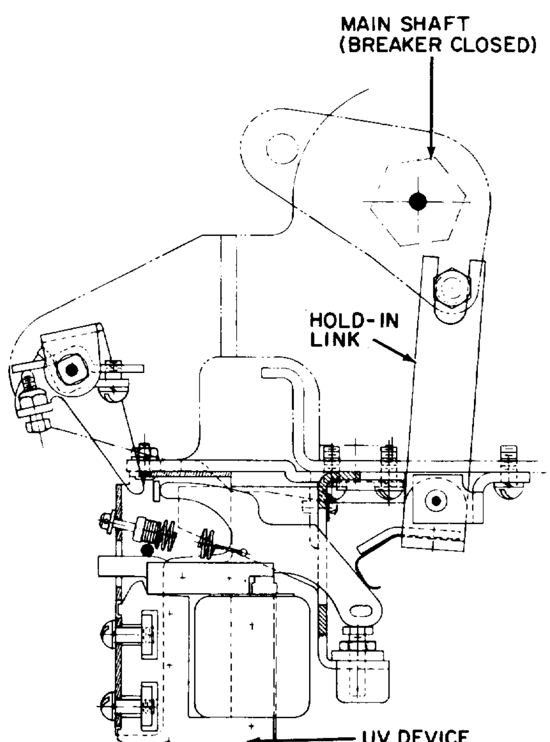


FIG. 34 — ELECTRIC LOCKOUT BY-PASS

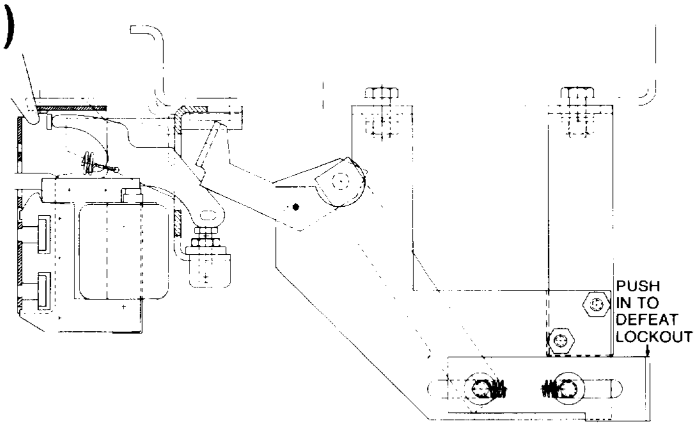


FIG. 33 — ELECTRIC LOCKOUT DEVICE

7.11 BELL ALARM

This device is used to give a remote indication of the breaker 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.

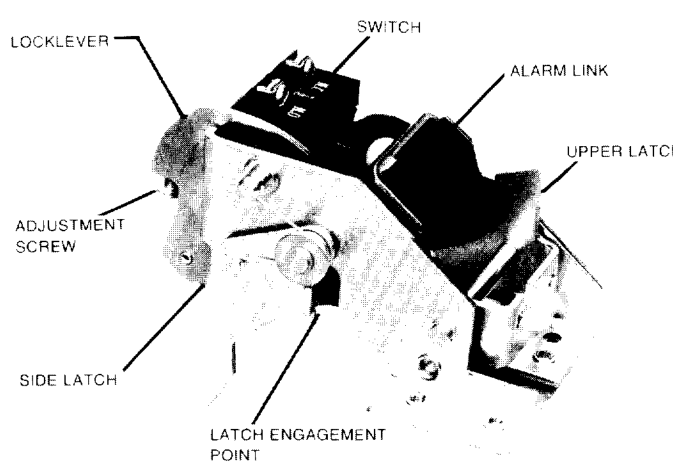


FIG. 35 — BELL ALARM DETAILS

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 depression 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 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.

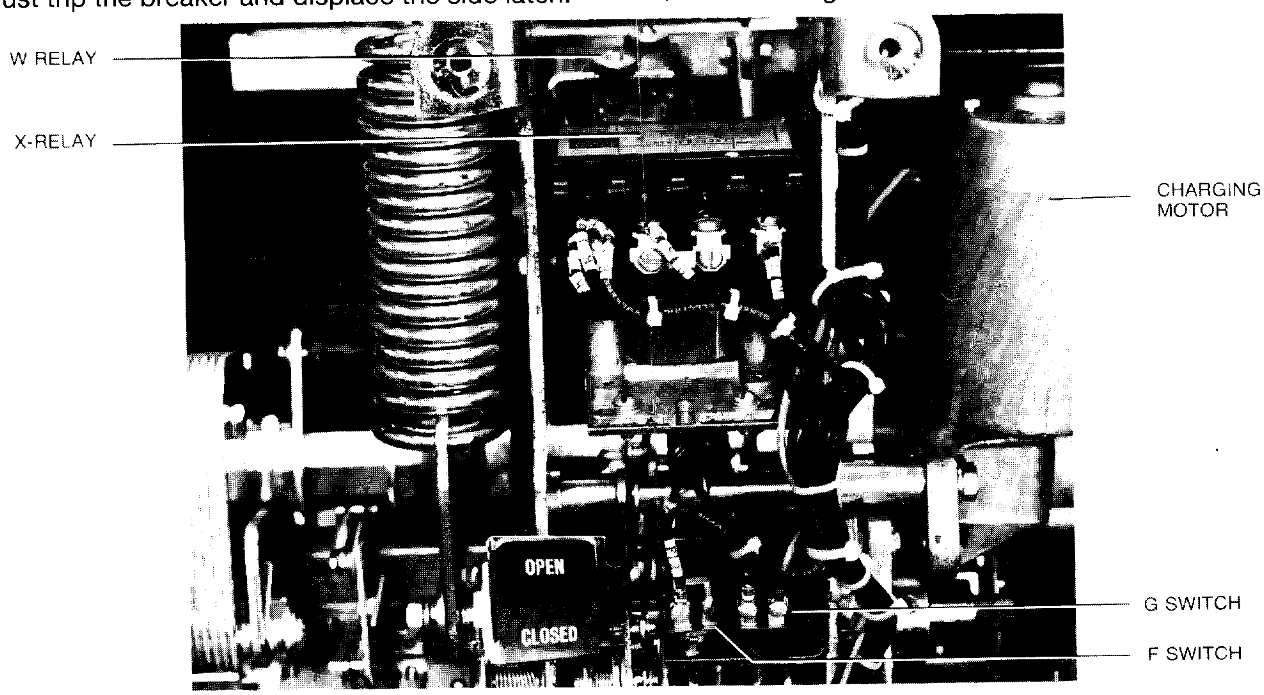


FIG. 36A — ELECTRICAL CONTROL COMPONENTS

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 tipping 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.

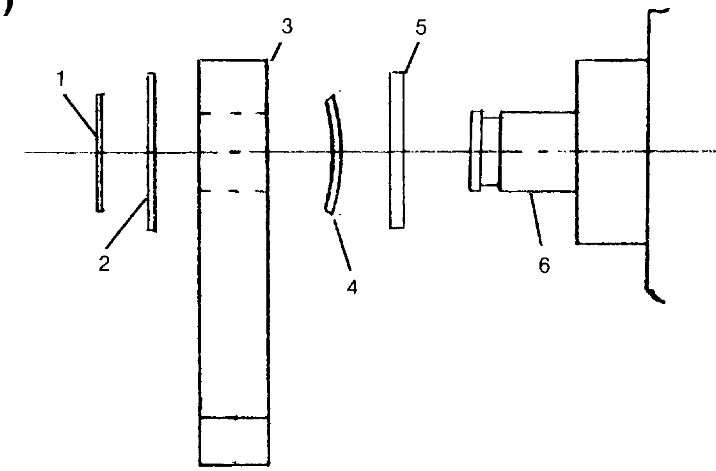
The charging motor is secured through three spacers to the mechanism frame. The front mounting bolt is accessible using a socket and universal joint through the opening in the side of the breaker frame. The upper rear mounting bolt is accessible using a socket and universal joint over the top of the frame. The lower rear mounting bolt is accessible using a socket and universal joint through the opening in the frame 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 situated, 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 roller or mark the ratchet 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 hub will not completely line up with the holes in the camshaft.

The driving pawl is assembled to the charging motor 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.

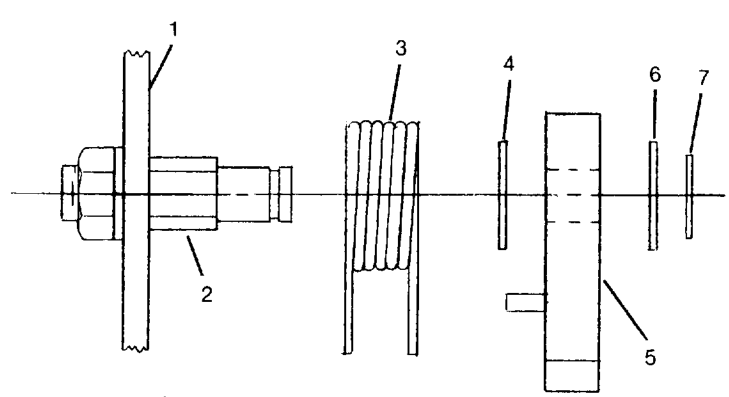


1. RETAINER RING
2. WASHER .010″
3. PAWL ASM
4. SPRING WASHER
5. WASHER .032″
6. MOTOR DRIVE PIN

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 and the rivet opposite the roller on the ratchet assembly. It is a 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.

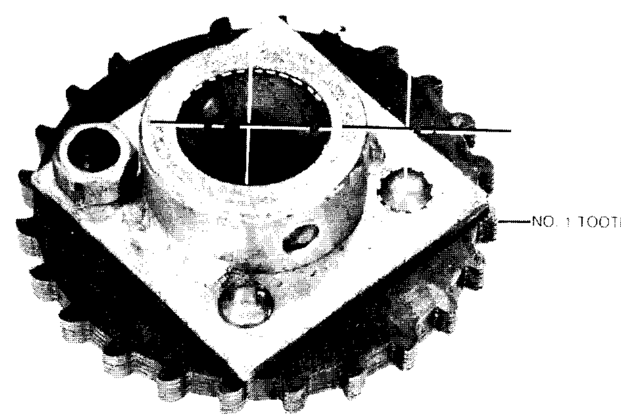
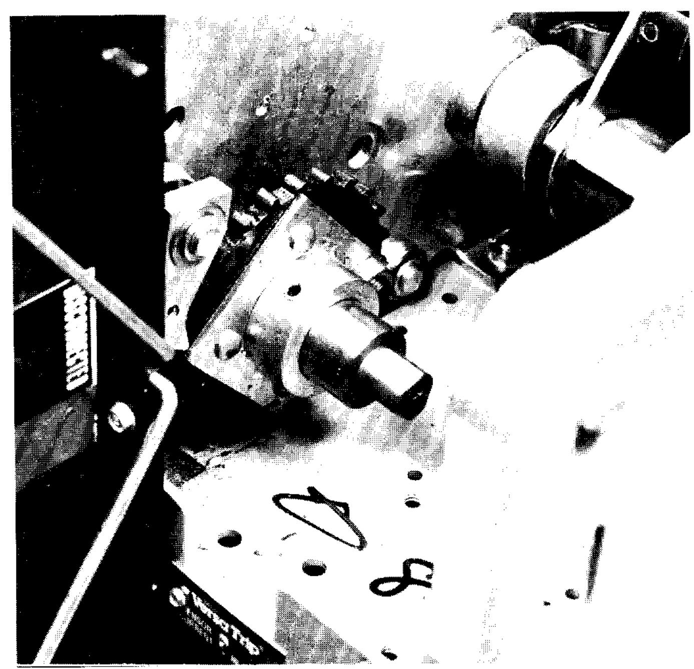


FIG. 37 — LOCATION OF RATCHET TOOTH NO. 1



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.

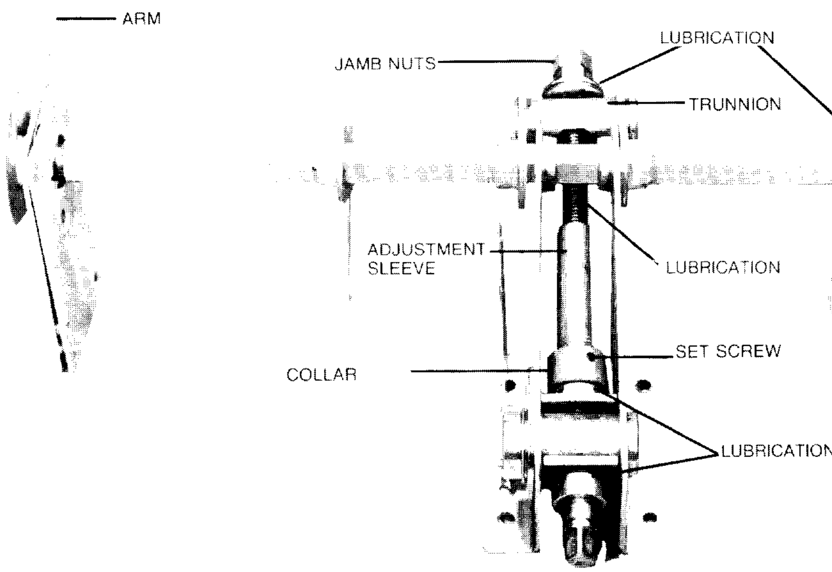


FIG. 38 — DRAWOUT MECHANISM DETAILS

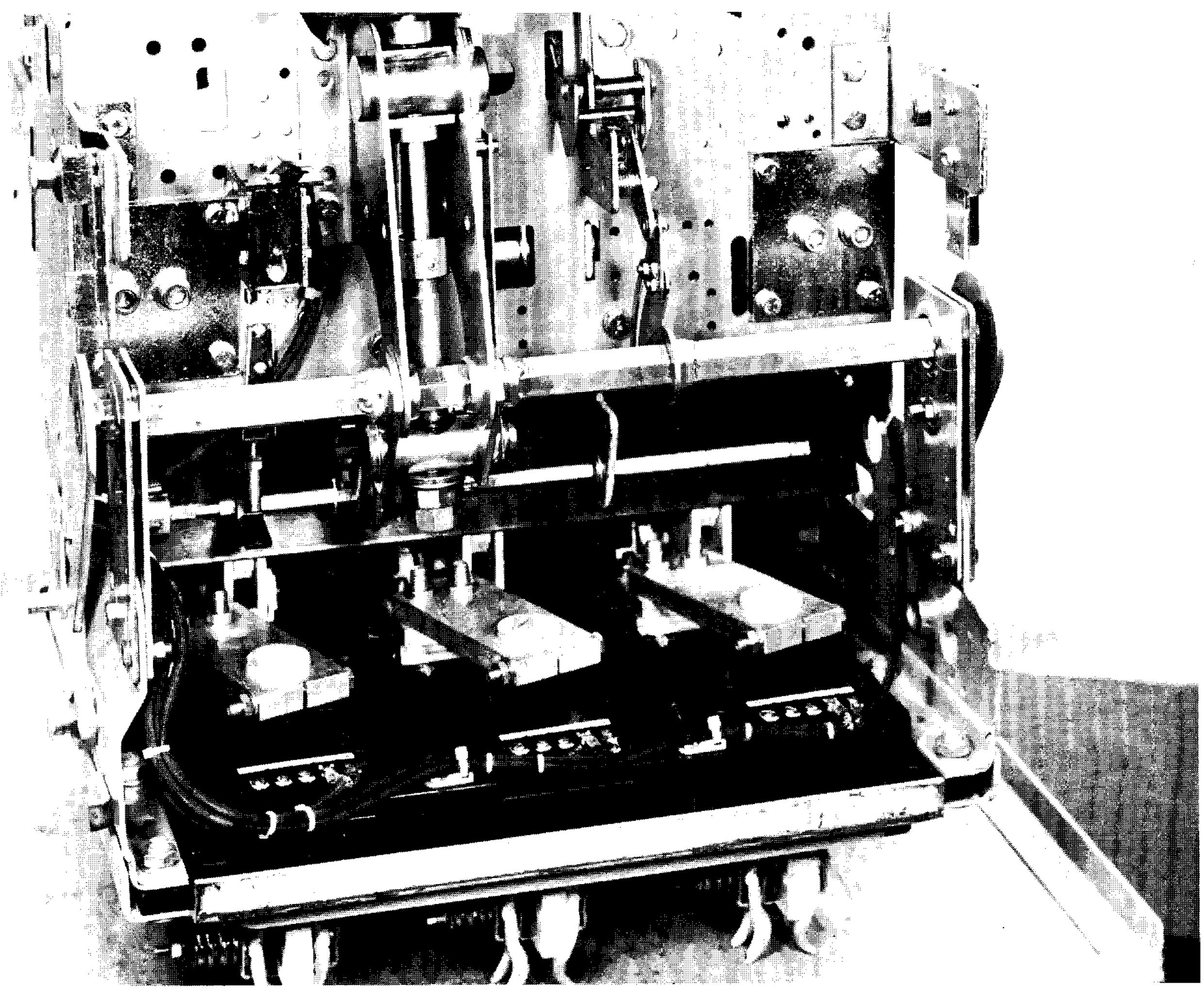


FIG. 39 — DRAWOUT MECHANISM INSTALLED

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.

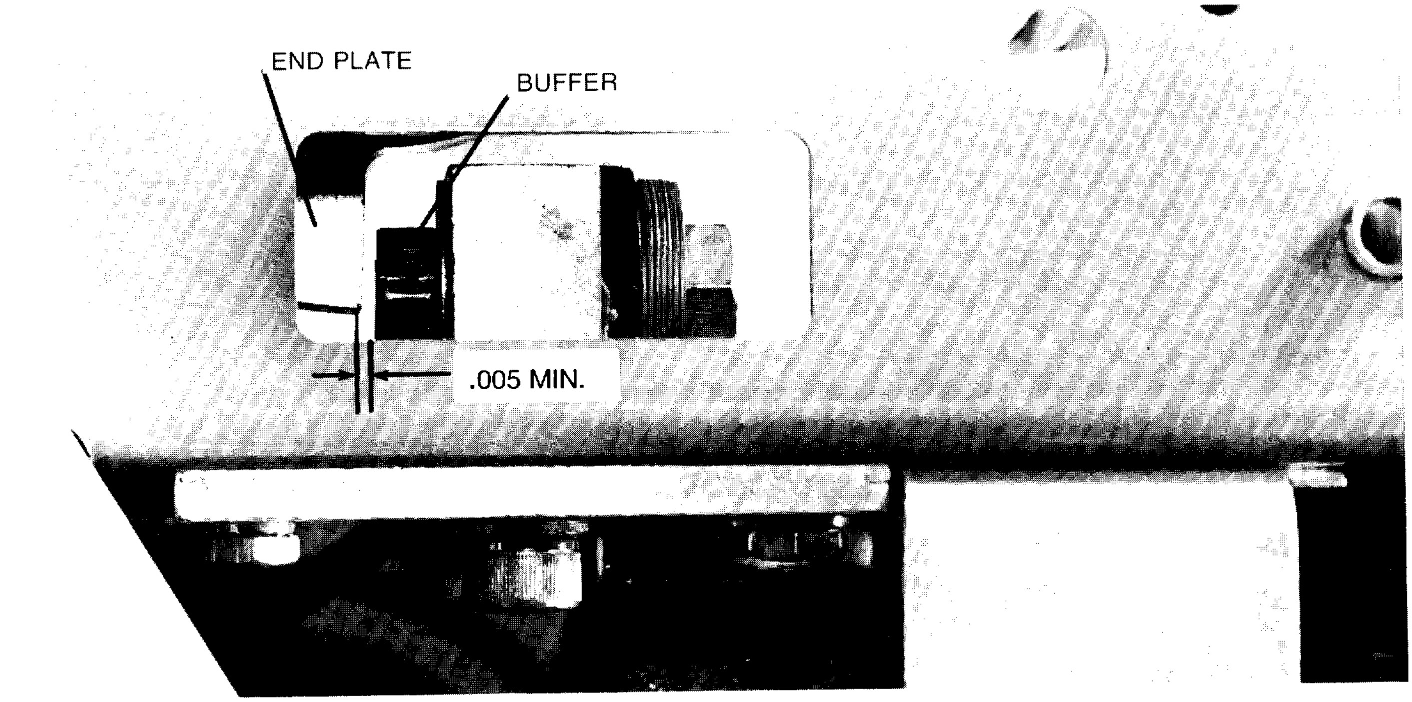


FIG. 40 — BUFFER/END PLATE RELATIONSHIP—BREAKER CLOSED

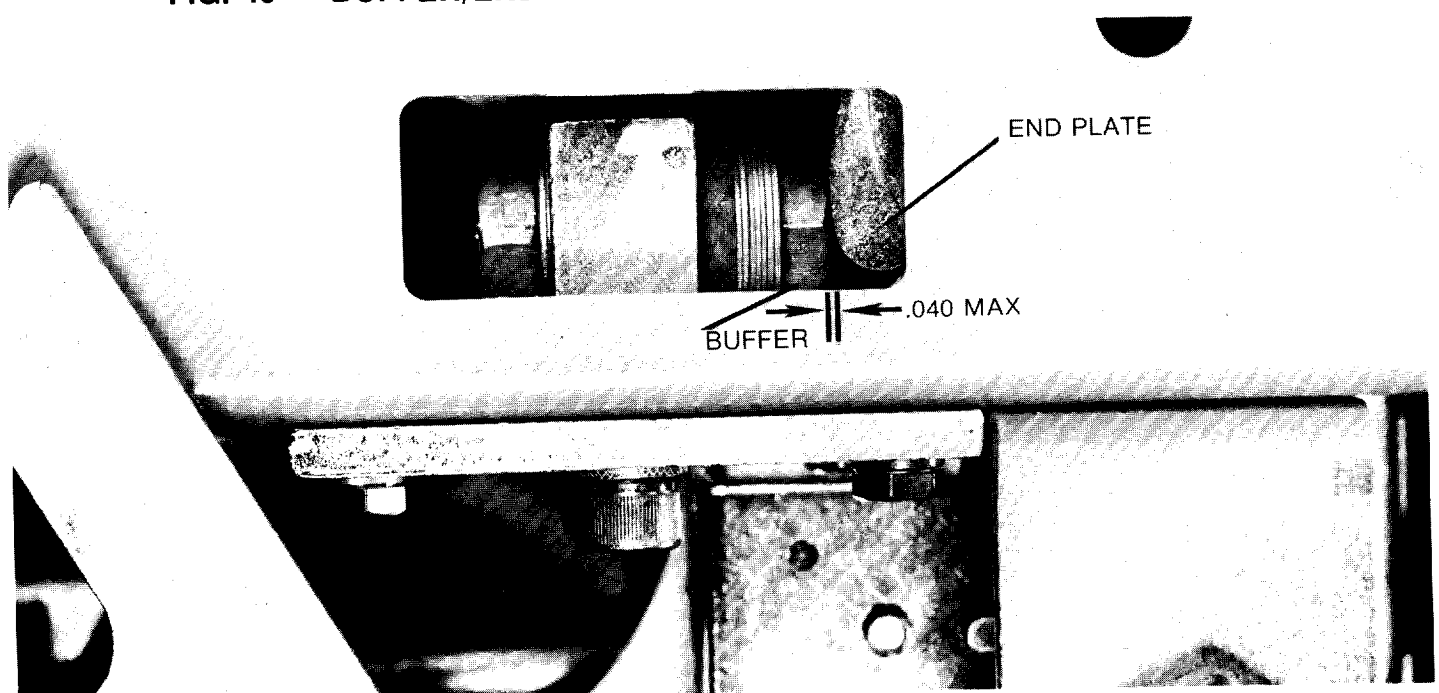


FIG. 41 — BUFFER/END PLATE RELATIONSHIP—BREAKER OPEN

7.14.1 BUFFER ADJUSTMENT

Referring to Fig. 40, with the breaker closed and the mechanism not reset, a .005" 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.

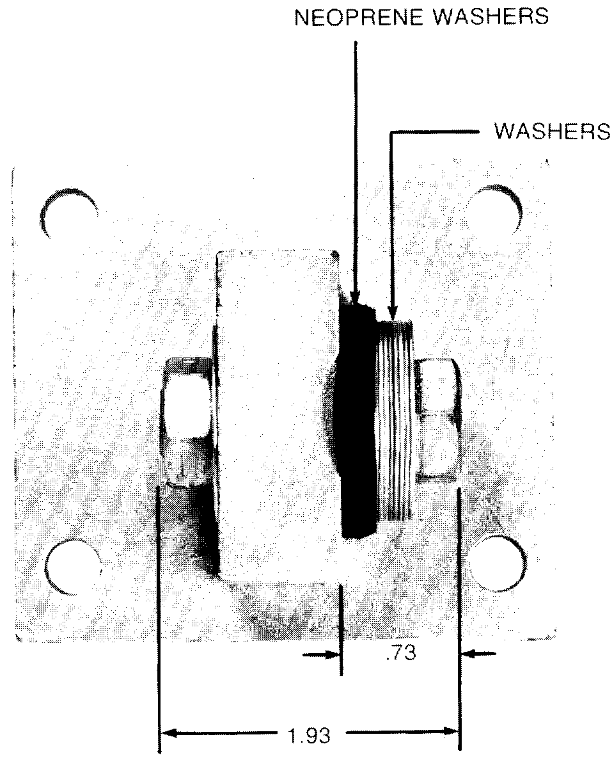


FIG. 42 — BUFFER ASSEMBLY

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.

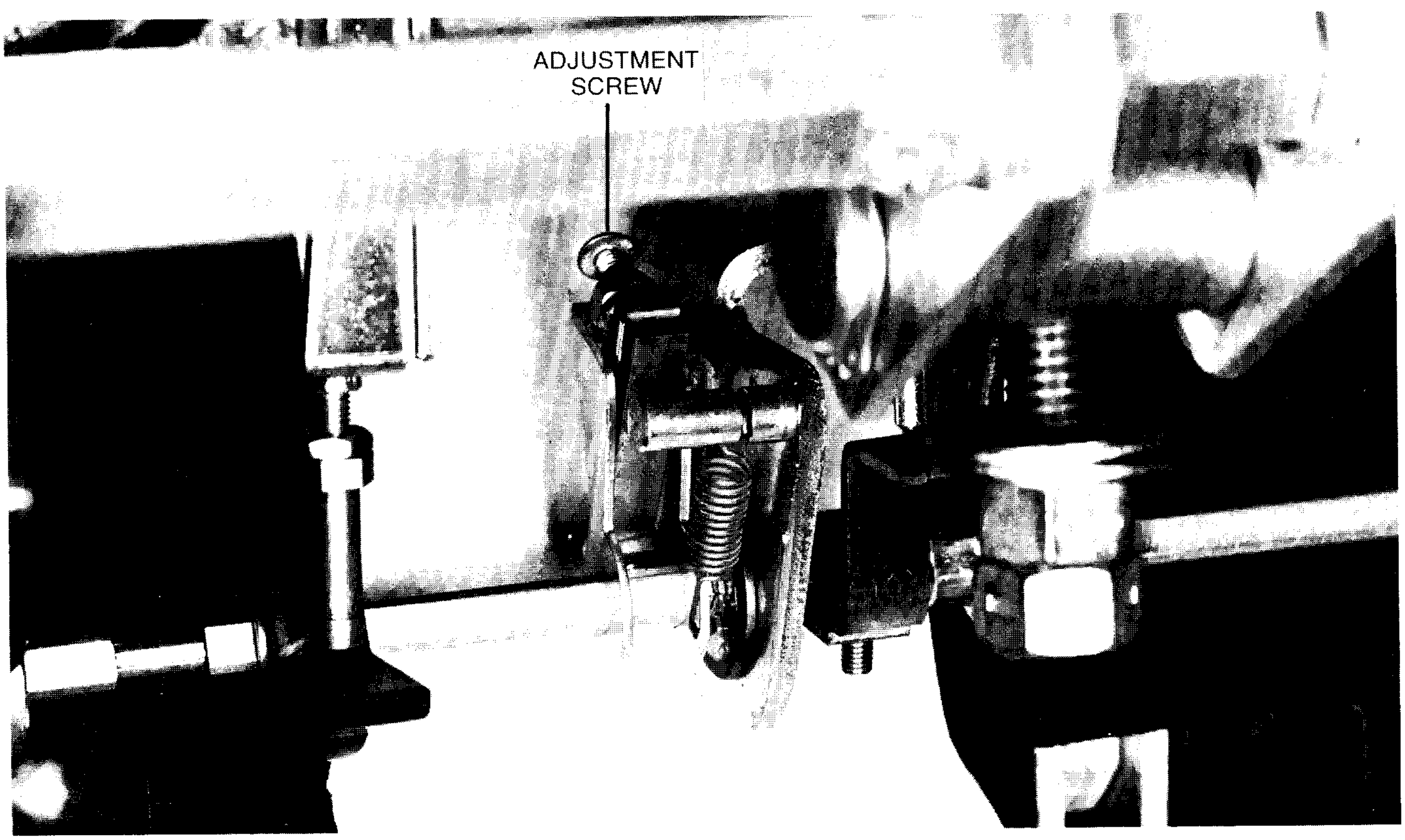


FIG. 43 — TRIP LATCH ADJUSTMENT

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.

Arc chutes should not be interchanged between frame sizes or interrupting ratings.

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.

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-30/30H & AKRU-30.

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. 45 & 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 or 290 to the adjustment nut threads. Wipe off any excess LOCTITE. Once the LOCTITE is set, recheck the torque (value up to 40 in.-lbs.) but do not break loose.
5. Repeat above procedure on the other pole units.
6. Trip the breaker.

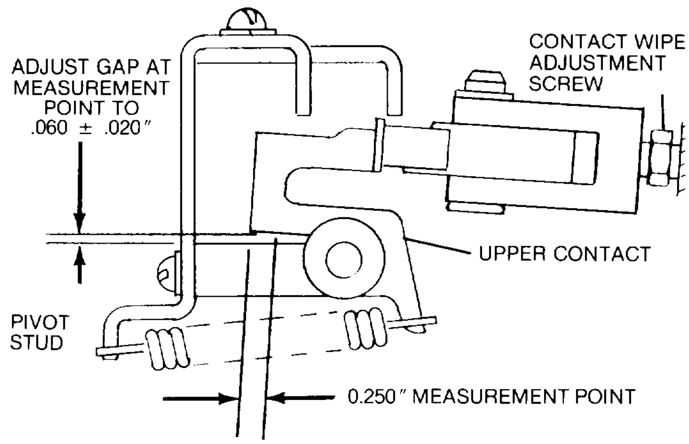


FIG. 45 — WIPE ADJUSTMENT 800A EXCEPT AKR 30L AMP CONTACT STRUCTURE

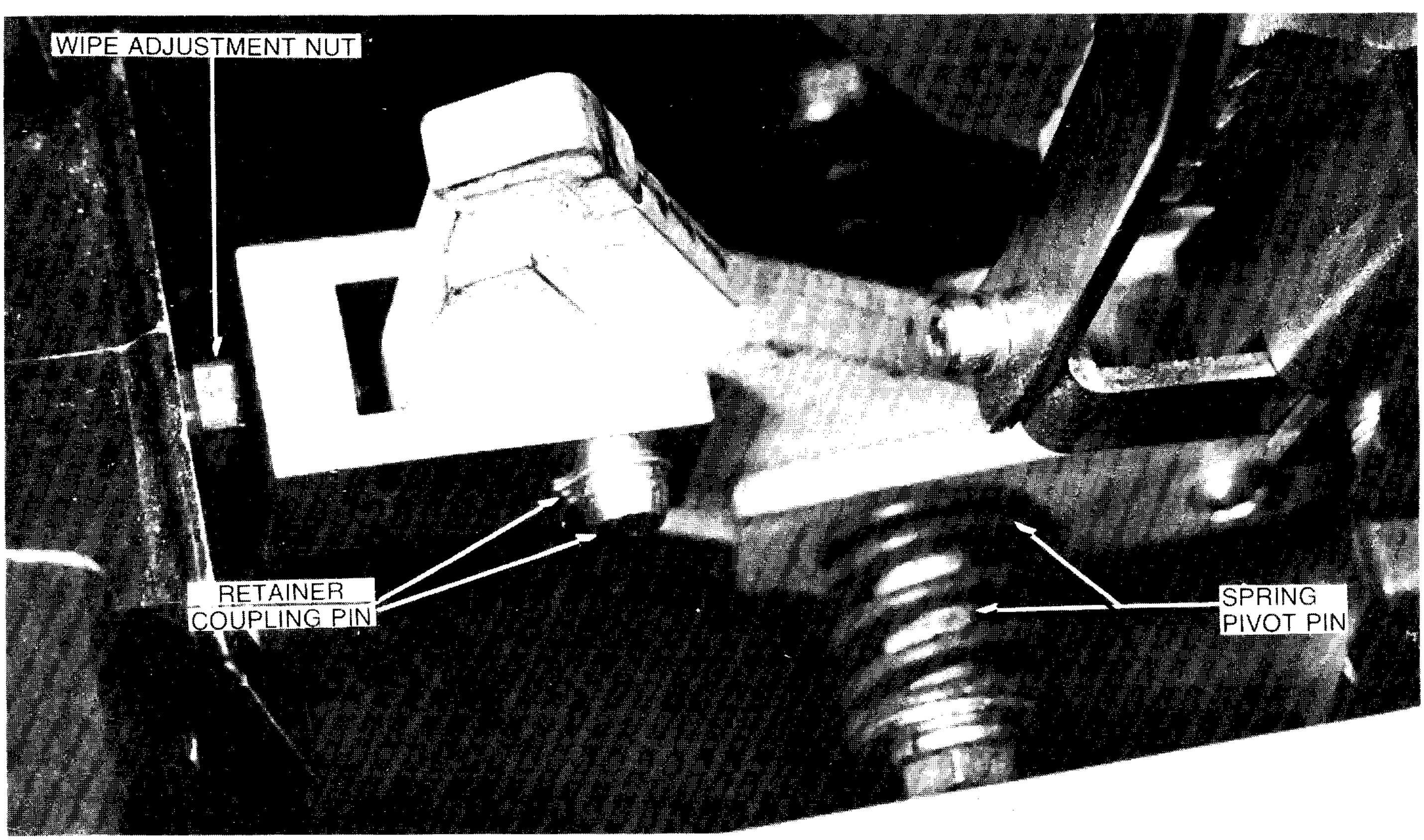


FIG. 46 — WIPE ADJUSTMENT NUT—800 AMP CONTACT STRUCTURE

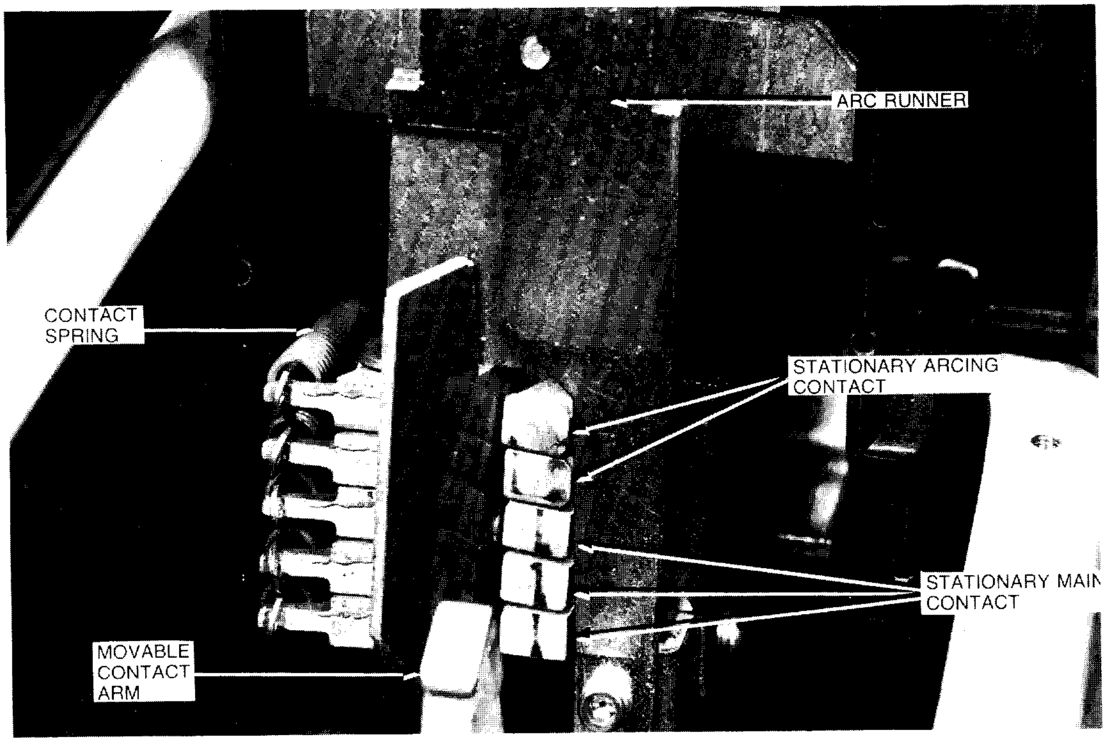


FIG. 44A — AKR30, AKRU30

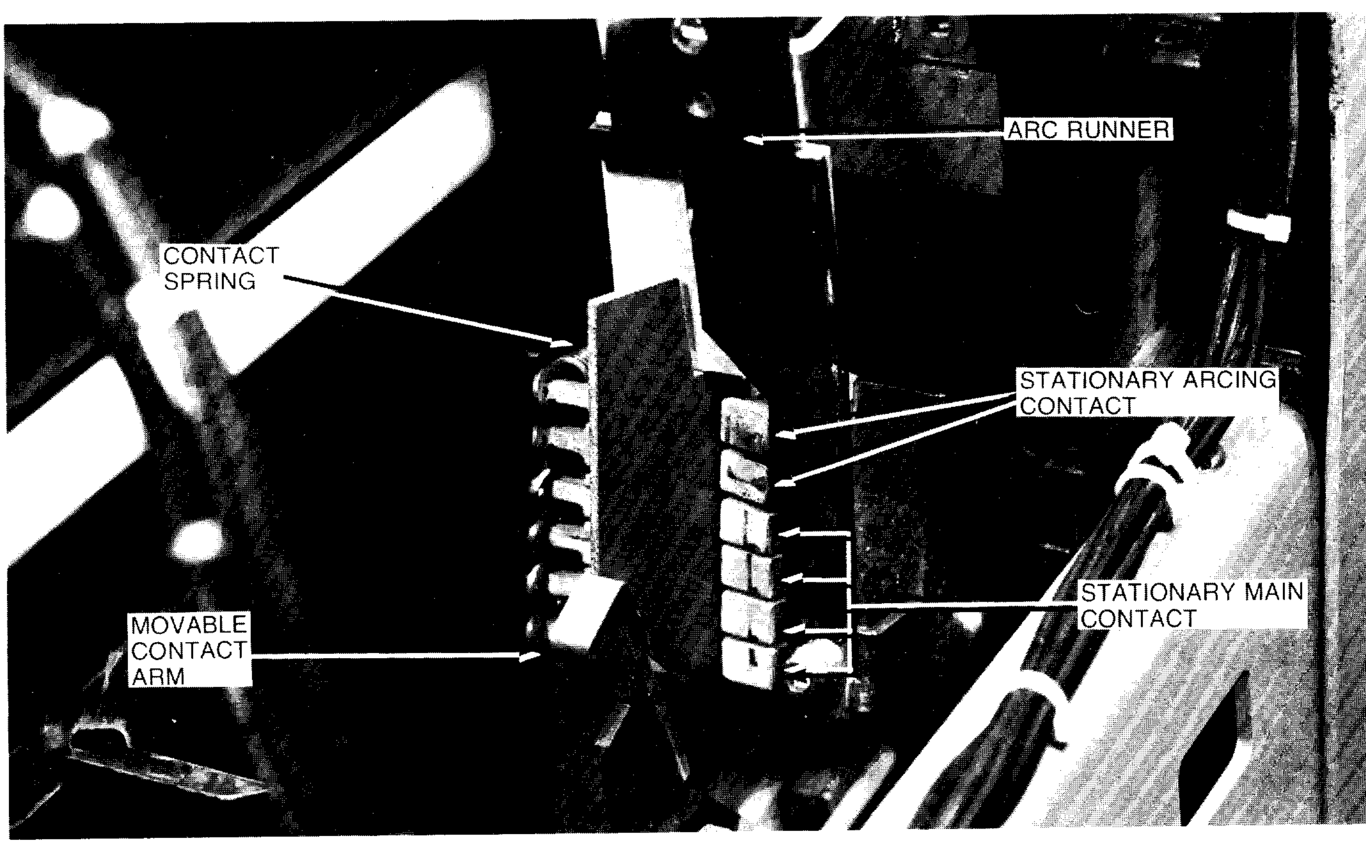


FIG. 44B — AKR 30H

800 AMP CONTACT STRUCTURES

8.3 CONTACT ADJUSTMENT — AKR30L, AKR50/50H & AKRU 50

The contact breaker shown in Fig. 47 is used by AKR30L and 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.
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 ohm-meter) 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 or 290 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.

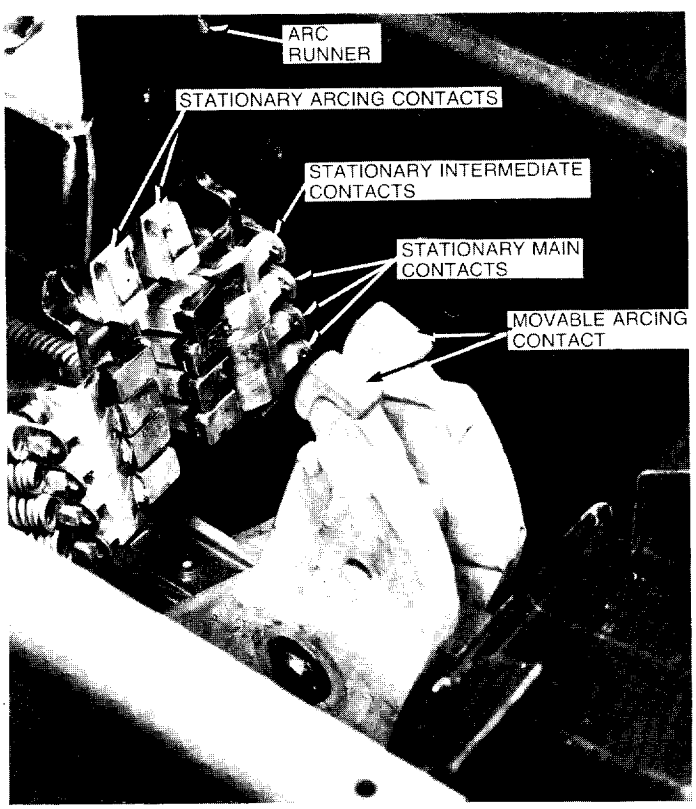


FIG. 47 — 1600 AMP CONTACT STRUCTURE

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 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.

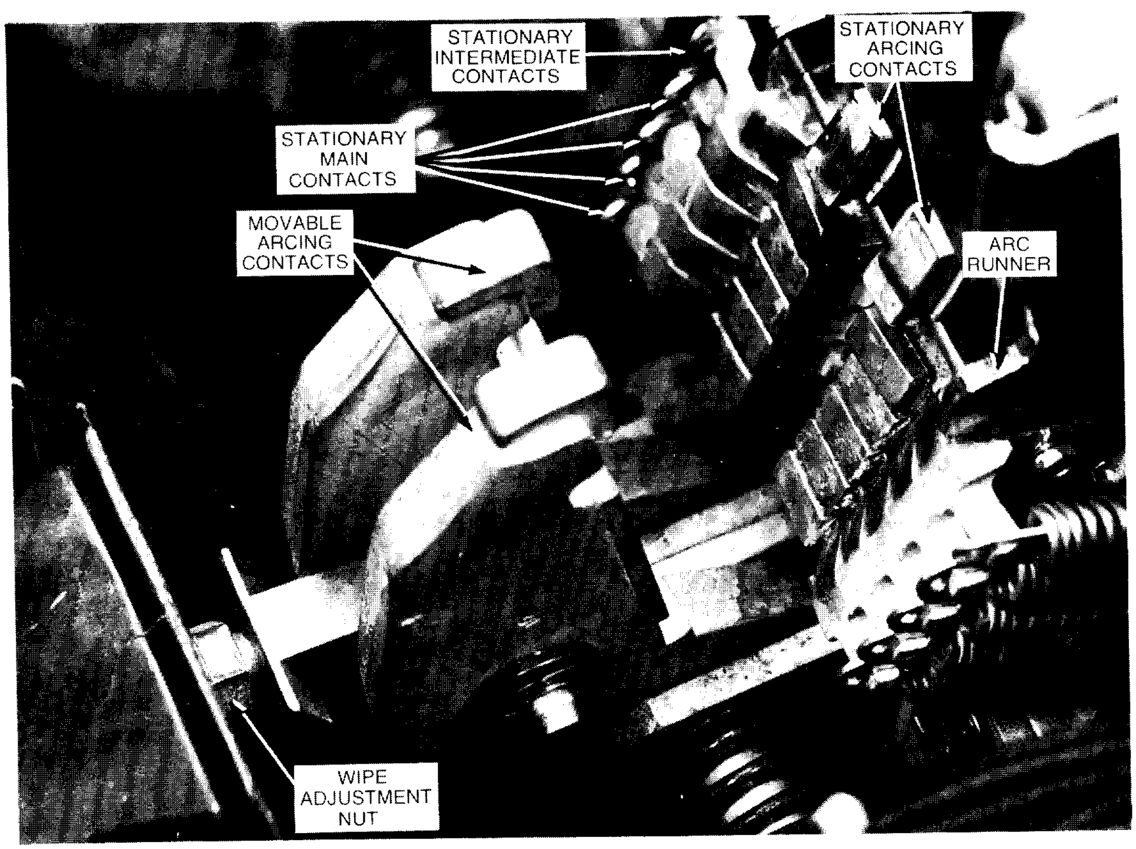


FIG. 48 — 2000 AMP CONTACT STRUCTURE

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 and 48.

Fig. 49 shows the stationary contacts and how they differ from one another. The AKR 30 and 30H main and arcing contacts are rectangular, but the arcing contacts have two of their corners notched. The AKR 30L, AKR 50, AKR 50H, AKRT 50 and AKRT 50H 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/30L & 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.

6. Install the coupling pin and tru-arc retainer.

7. Make the contact adjustment as per section #8.2.

8.7 CONTACT REPLACEMENT— AKR 30L, AKR 50/50H, AKRU 50 & AKRT 50

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. 50A, 50B & 50C, the stationary arcing contacts are replaced as follows.

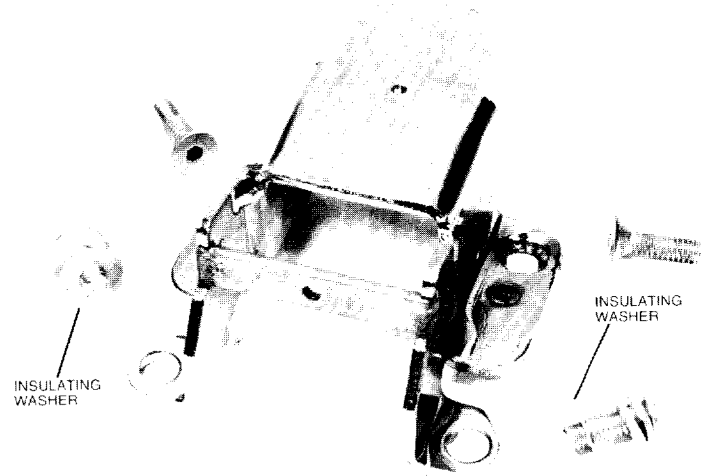
1. Remove the arc runner and the flat insulation assembled underneath the arc runner. It is secured with four screws. When removing the lower screws, use care not to damage or misplace the insulating washer found under each of these screws, see Fig. 50A.

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.



ARC RUNNER

FIG. 50D —

STATIONARY CONTACT —1600/2000 AMP REPLACEMENT CONTACT STRUCTURE

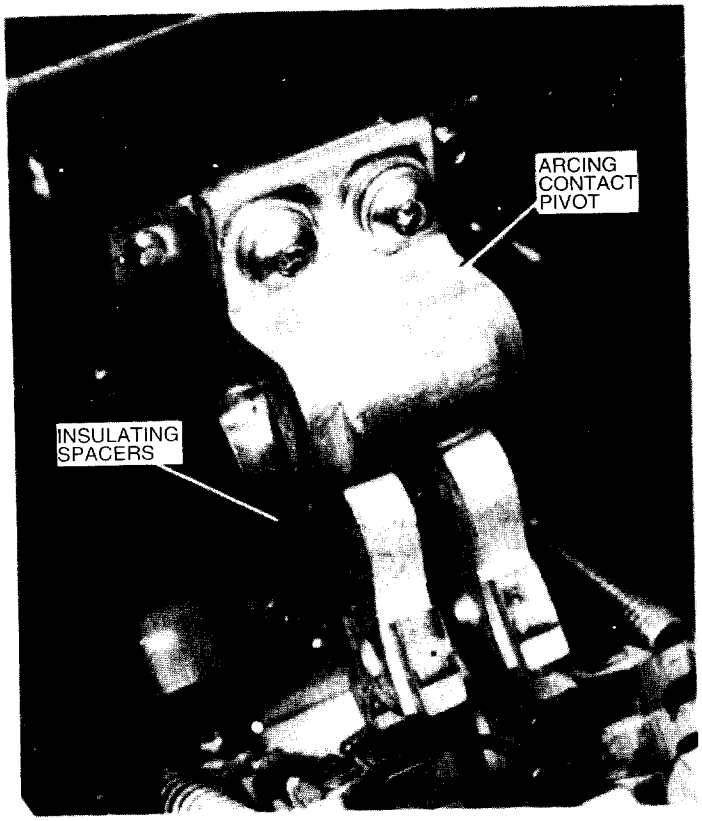


FIG. 50B — ARC RUNNER REMOVED

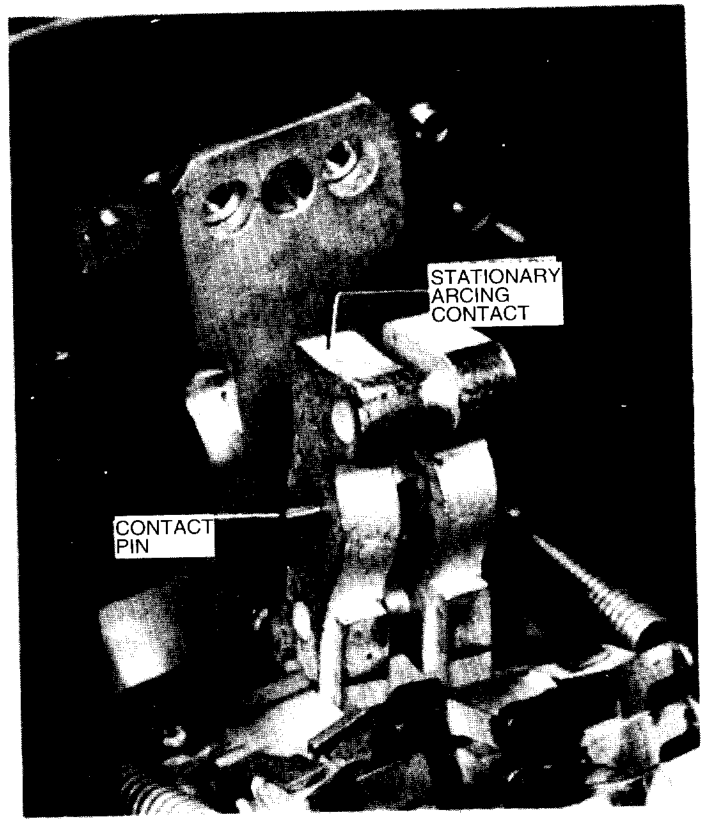


FIG. 50C — ARCING CONTACT PIVOT REMOVED

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 Class L fuse tang has two holes sized for one-half inch diameter 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.

All ½-13 fuse mounting bolts should be torqued to 200-350 in.-lb. The ⅝-11 bolts which attach the C shaped fuse adapters to the breaker studs should be torqued to 300-525 in.-lb.

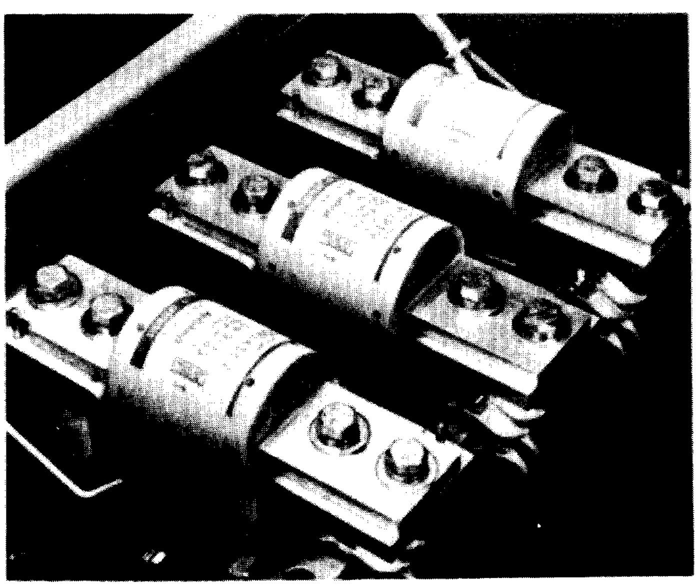


FIG. 51 — TYPICAL MOUNTING CLASS L FUSES

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.

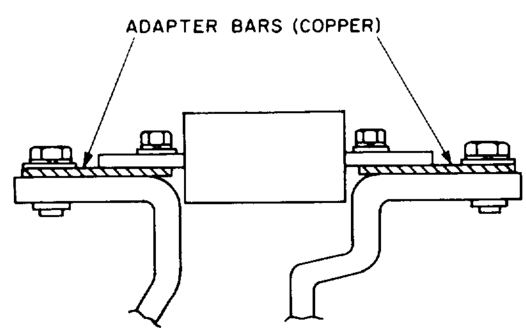
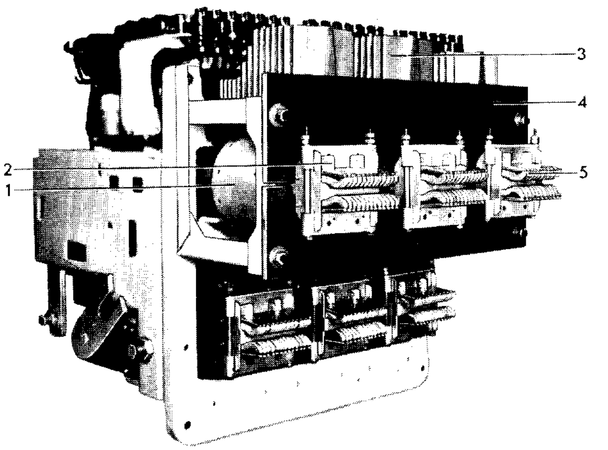


FIG. 52 — 300 THRU 600 AMP CLASS J FUSE MOUNTING

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.*

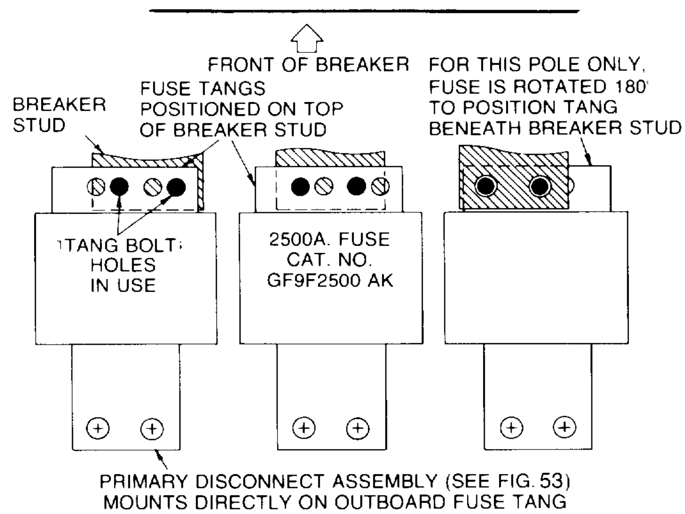


FIG. 54
AKRU 50—2500A FUSE TANG POSITIONS

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. 56A & 56B. Both OFLO's work on the same design. When the fuse opens, the resulting open circuit voltage activates the OFLO phase solenoid when the voltage level reaches approximately 90 VAC (the functional test in the factory is accomplished using 120VAC). The solenoid 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.

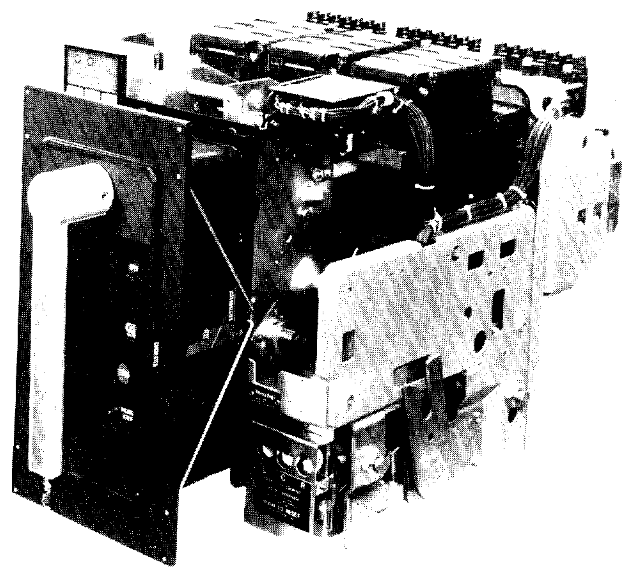


FIG. 55— TYPE D BREAKER OFLO DEVICE

9.3.1 TYPE A AND B BREAKER OFLO ADJUSTMENT

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

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 additional 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 CLOSED position and the OFLO reset, adjust the dimension between the end of the tripping rod and the trip paddle to .100" - .140".

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.

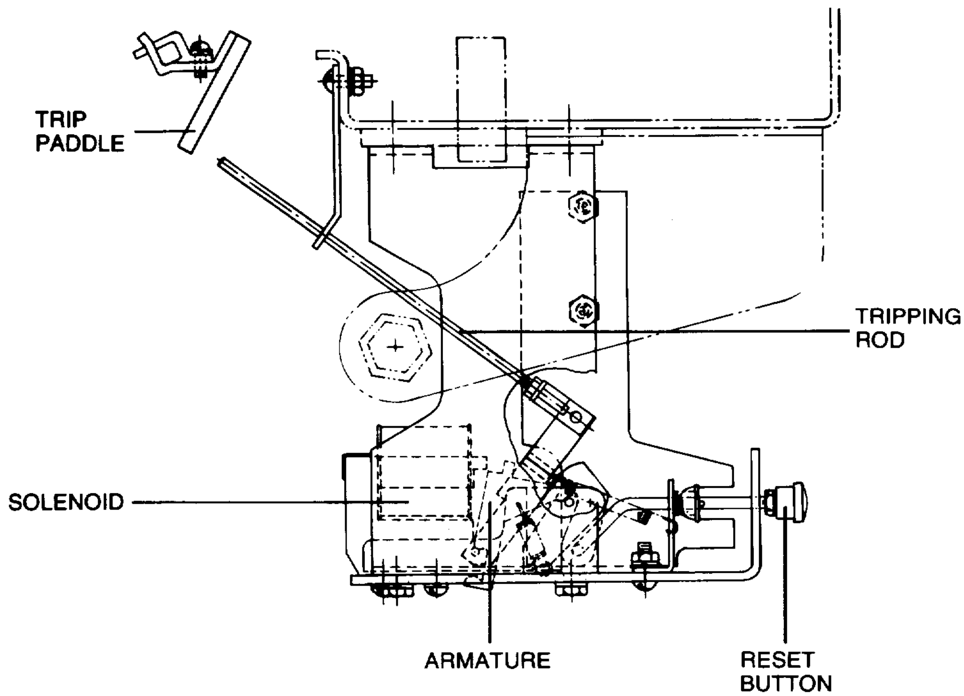


FIG. 56A—DETAILS

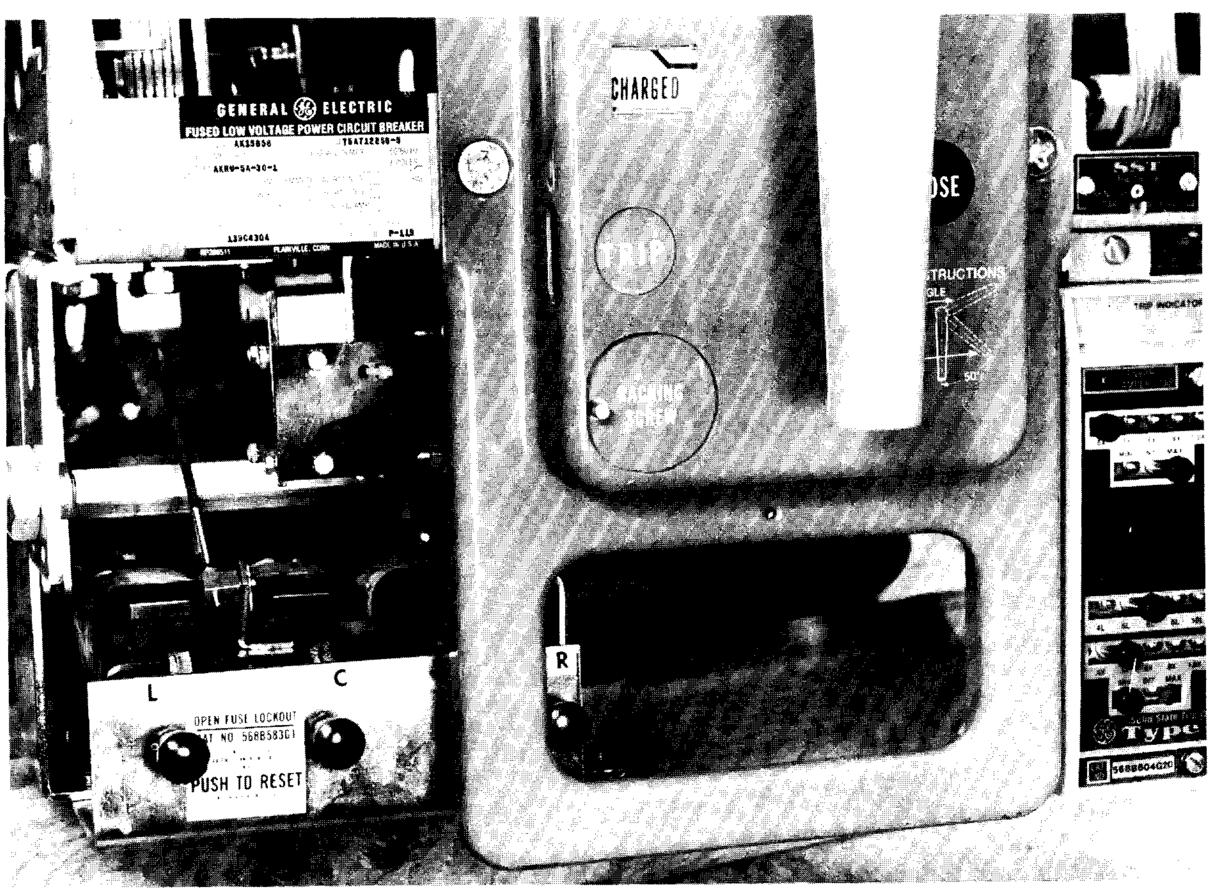


FIG. 56B—INSTALLED TYPE A OR B BREAKER OFLO DEVICE

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.

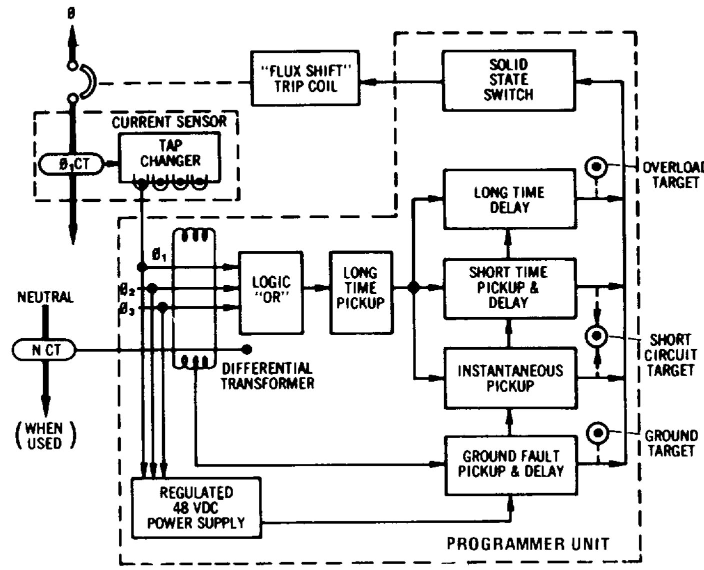


FIG. 57 — SST BLOCK DIAGRAM

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. 58 — SST PROGRAMMER

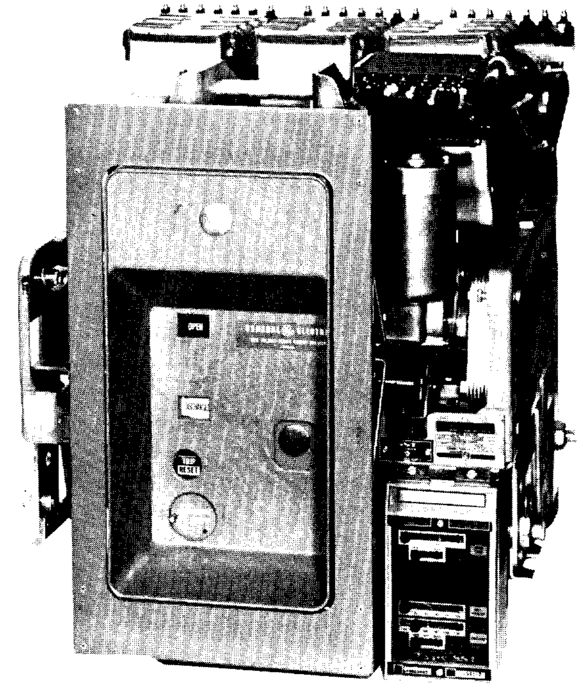


FIG. 59 — AKR-5B-30

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 drawout construction, its output is automatically connected to the breaker via secondary disconnect blocks. See Fig. 62.

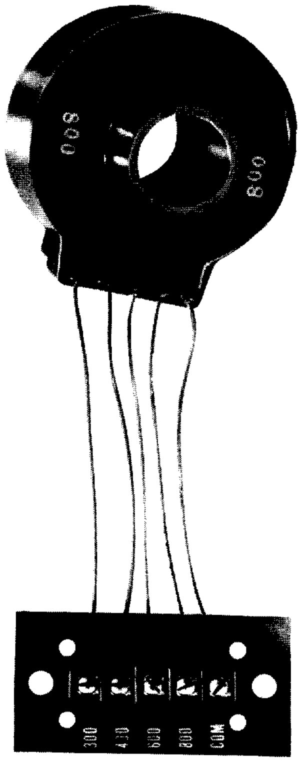
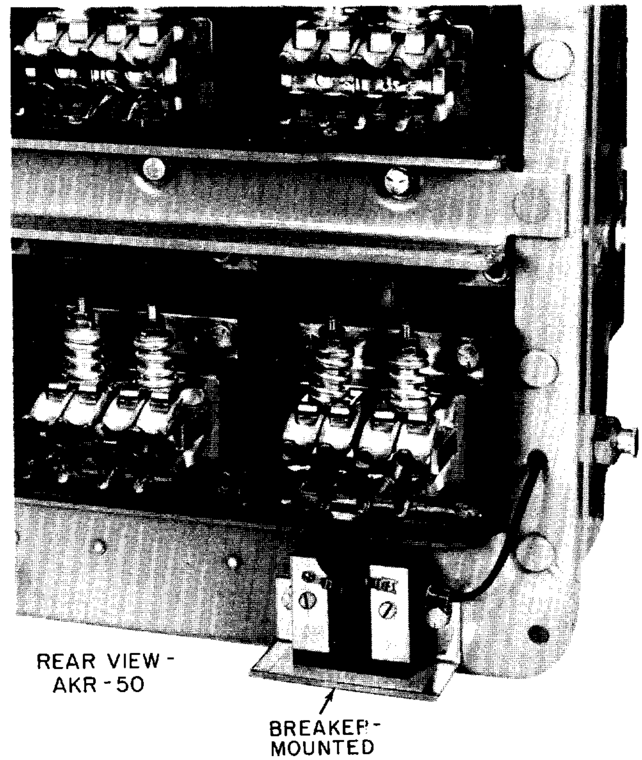


FIG. 60 — SST PHASE SENSOR WITH TAP BOARD



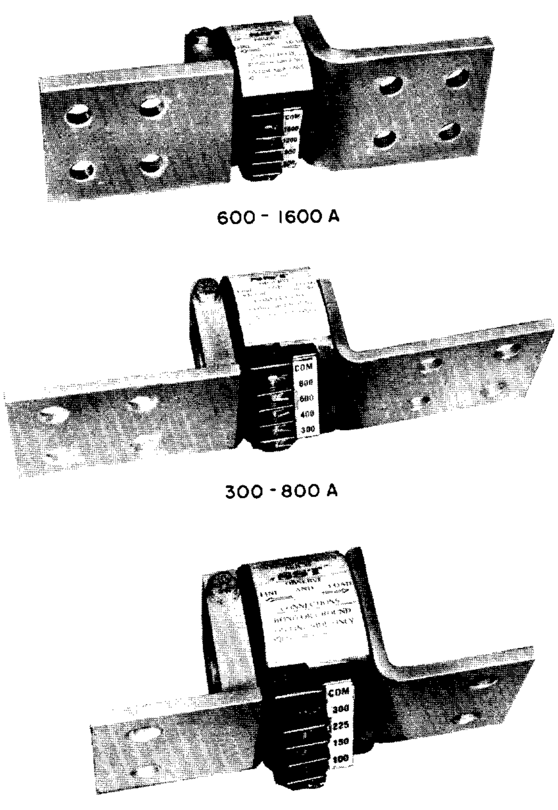


FIG. 61 — SST NEUTRAL SENSORS

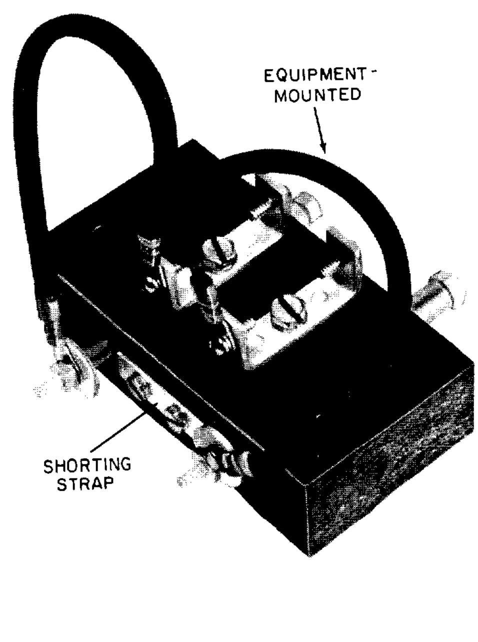


FIG. 62 — NEUTRAL SENSOR SECONDARY DISCONNECT BLOCKS

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.

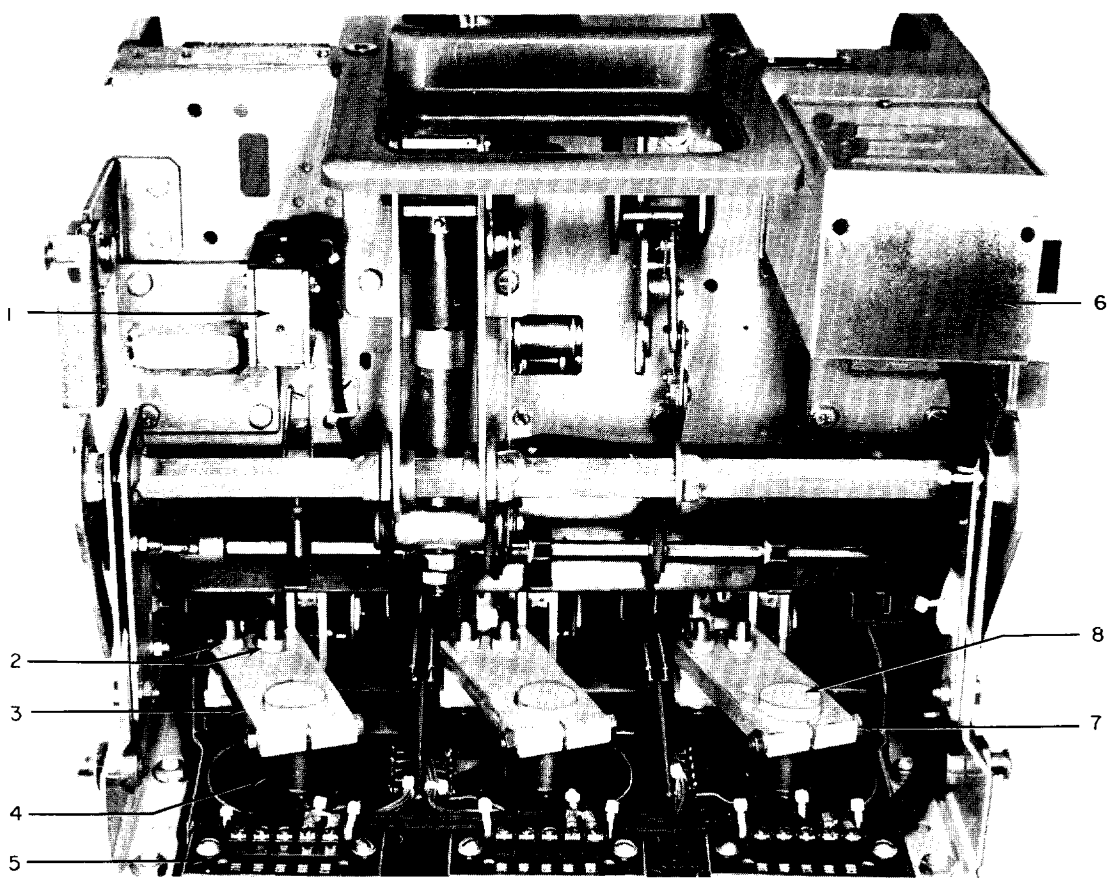
d) When replacing the stud connector, tighten the Allen head screws to 250 ± 10 in-lbs. Tighten the clamping bolt as follows:

AKR 30/30H/30L — 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 0.109 inch diameter rod. Adjust gap to 0.109 inch ± 0.031 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 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 brea ker harness be cut at some convenient point and the new actuator leads solder-spliced together.

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 for point B and BLACK for 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.*

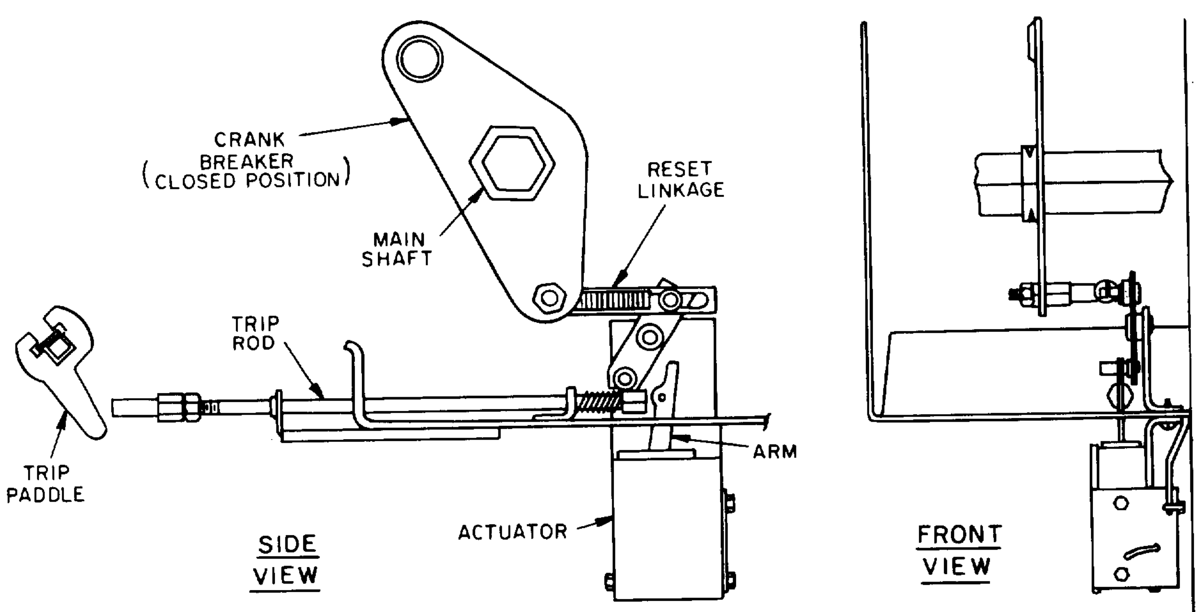
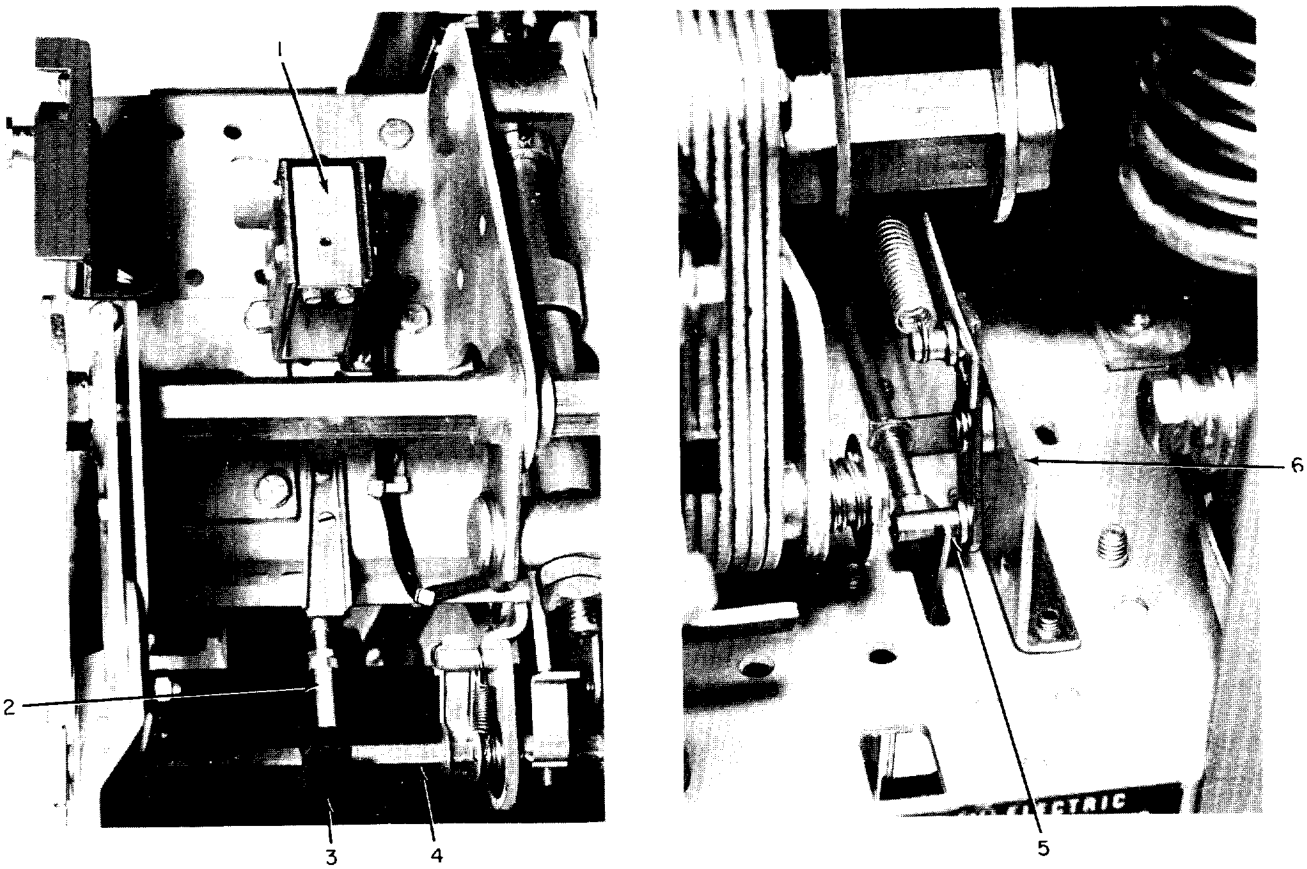


FIG. 64 — FLUX SHIFT TRIP DEVICE AND OPERATING LINKAGES



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

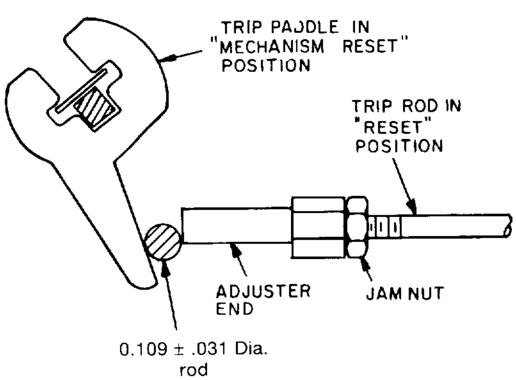


FIG. 66 — TRIP ROD ADJUSTMENT

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

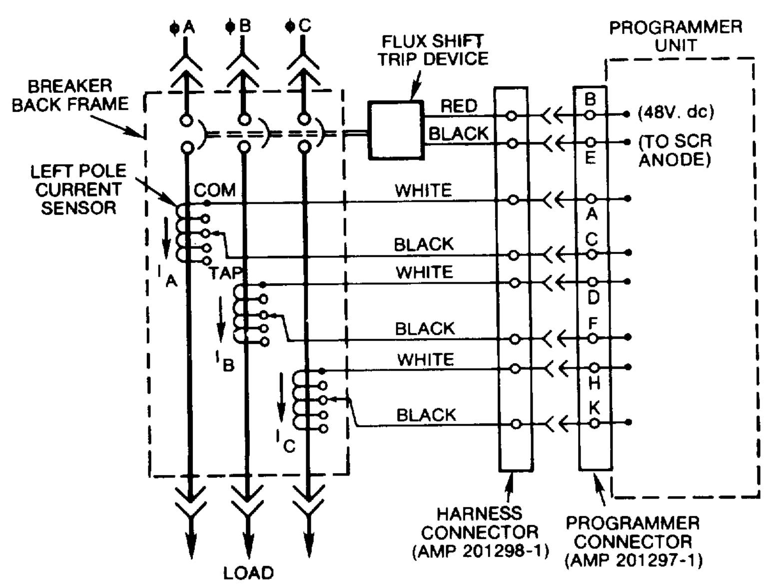


FIG. 68 — CABLING DIAGRAM — SST WITHOUT GROUND FAULT

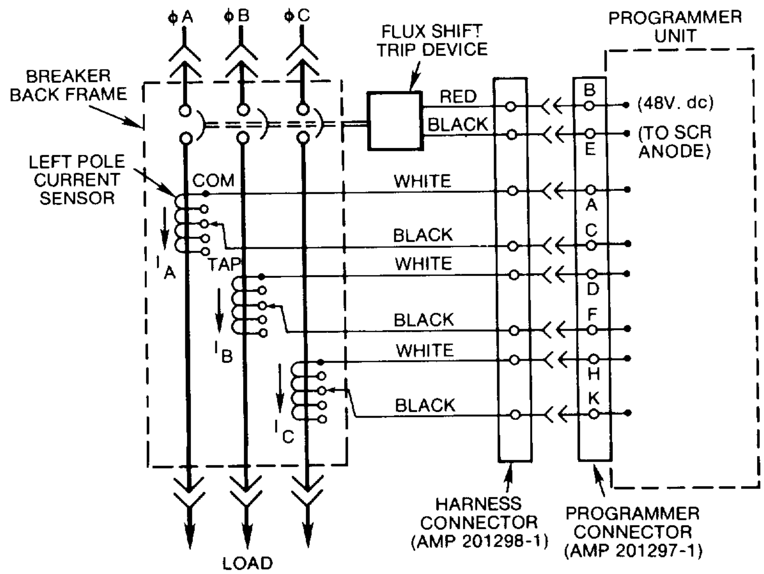


FIG. 69 — CABLING DIAGRAM — SST WITH GROUND FAULT ON 3-WIRE LOAD

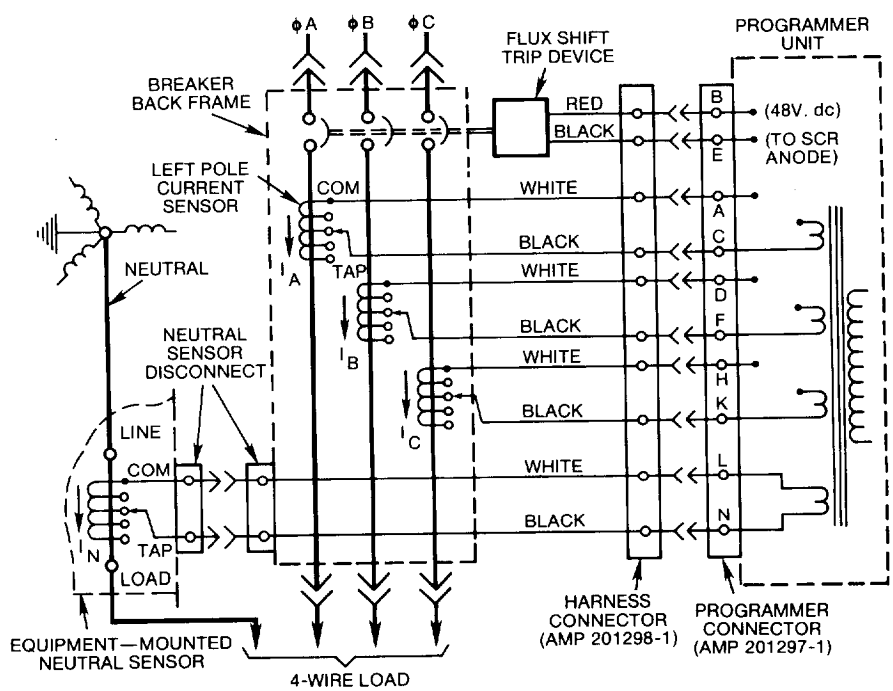


FIG. 70 — CABLING DIAGRAM — SST WITH GROUND FAULT ON 4-WIRE LOAD

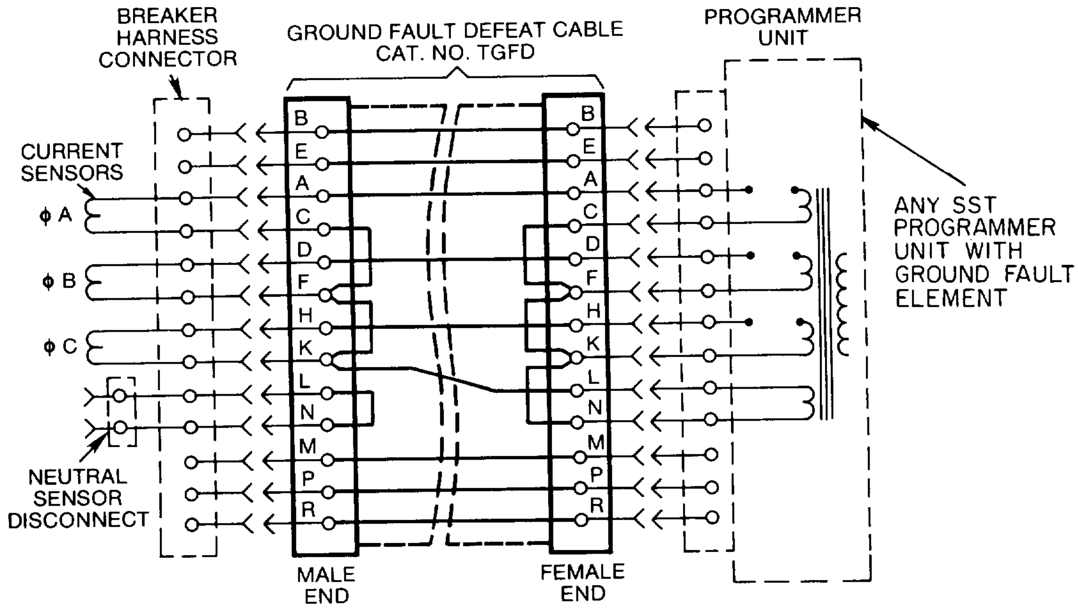


FIG. 71 — CABLING DIAGRAM WITH GROUND FAULT DEFEAT CABLE INSERTED BETWEEN BREAKER HARNESS AND SST PROGRAMMER UNIT — FOR USE DURING SINGLE-PHASE, HIGH CURRENT — LOW VOLTAGE TESTING

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

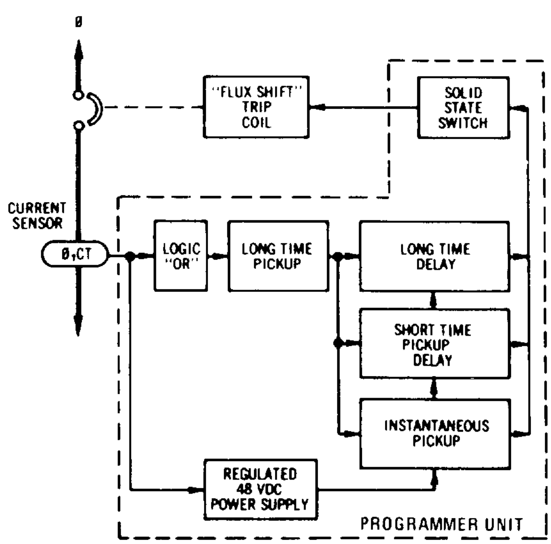


FIG. 73 — ECS BLOCK DIAGRAM

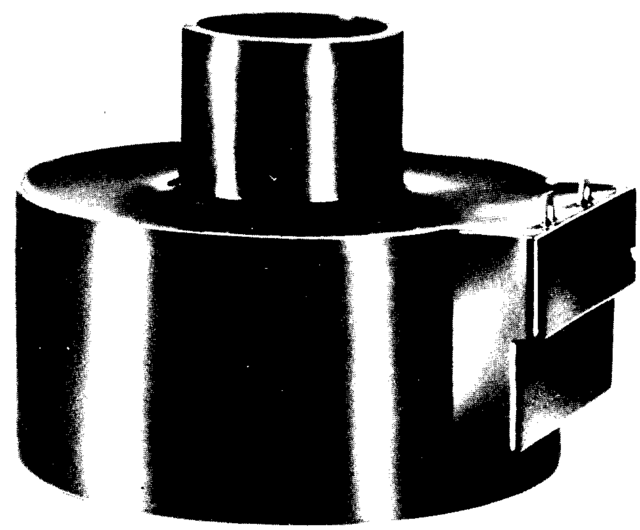


FIG 74 — ECS CURRENT SENSOR

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 — 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)
AKR-30	800	100, 150, 225, 300, 400, 600, 800	.6, .7, .8, .9, 1.0, 1.1 (X)	Maximum 22 Intermed. 10 Minimum 4	3, 4, 5, 6, 8, 10 (L) —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)
AKR-50	1600	300, 400, 600, 800, 1200, 1600					
AKRT-50	2000	800, 1200, 1600, 2000					

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

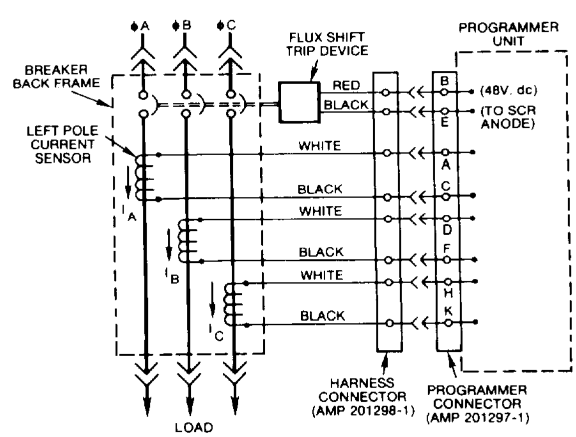


FIG. 75. CABLING DIAGRAM FOR ECS TRIP DEVICE

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.

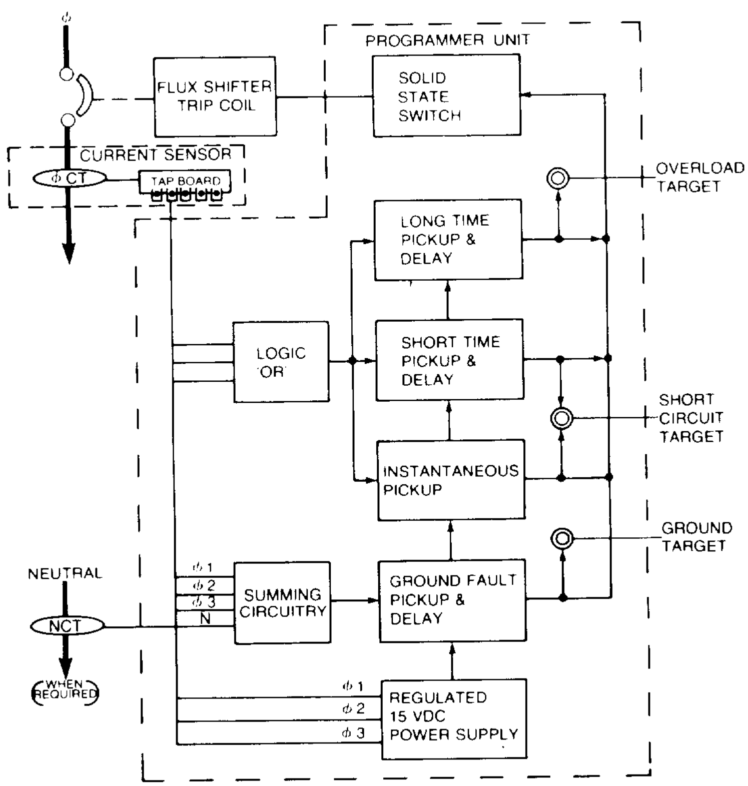


FIG. 76
MICROVERSATRIP BLOCK DIAGRAM

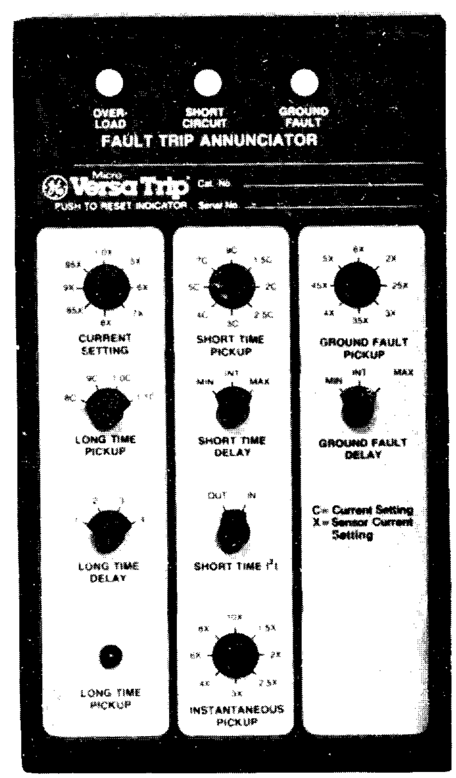


FIG. 77
MICROVERSATRIP PROGRAMMER

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.

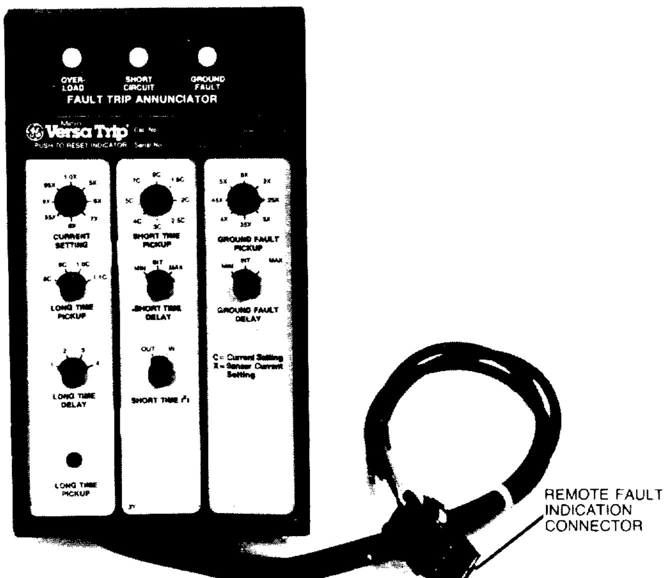


FIG. 78 MICROVERSATRIP W/REMOTE FAULT INDICATION HARNESS

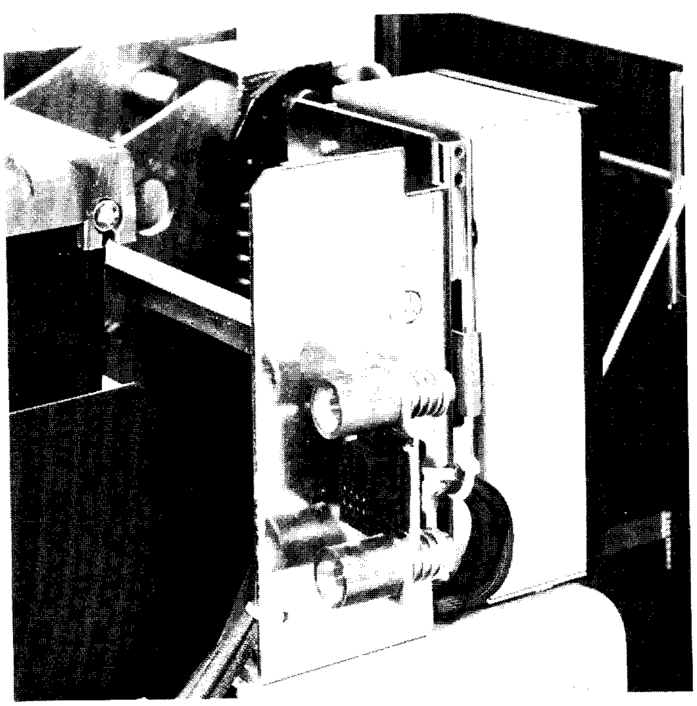


FIG. 79 PROGRAMMER SECONDARY CONNECTOR

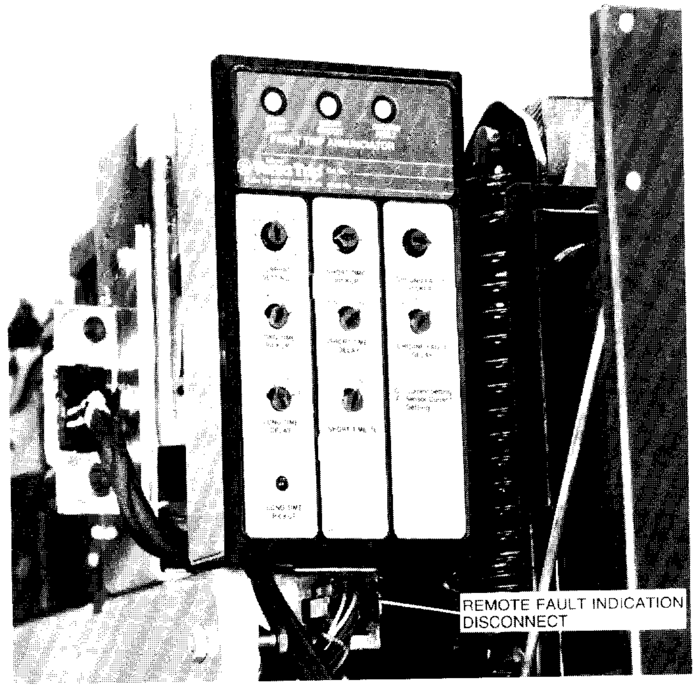


FIG. 80 REMOTE FAULT INDICATOR DISCONNECT

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.

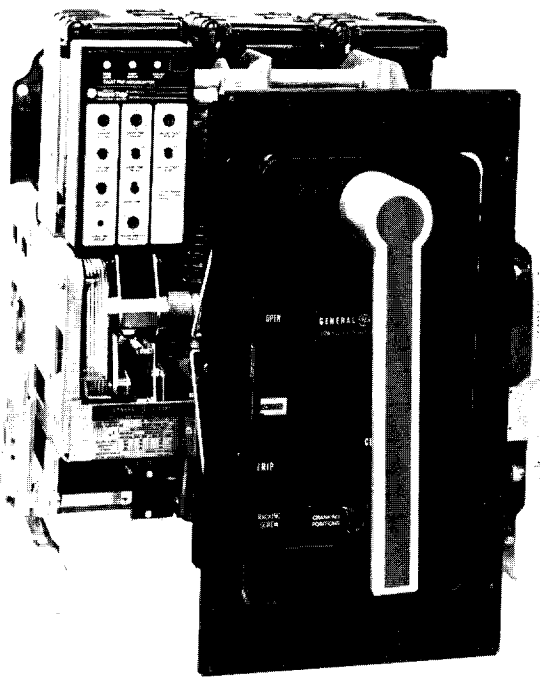


FIG. 81 — AKR-6D-30

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.

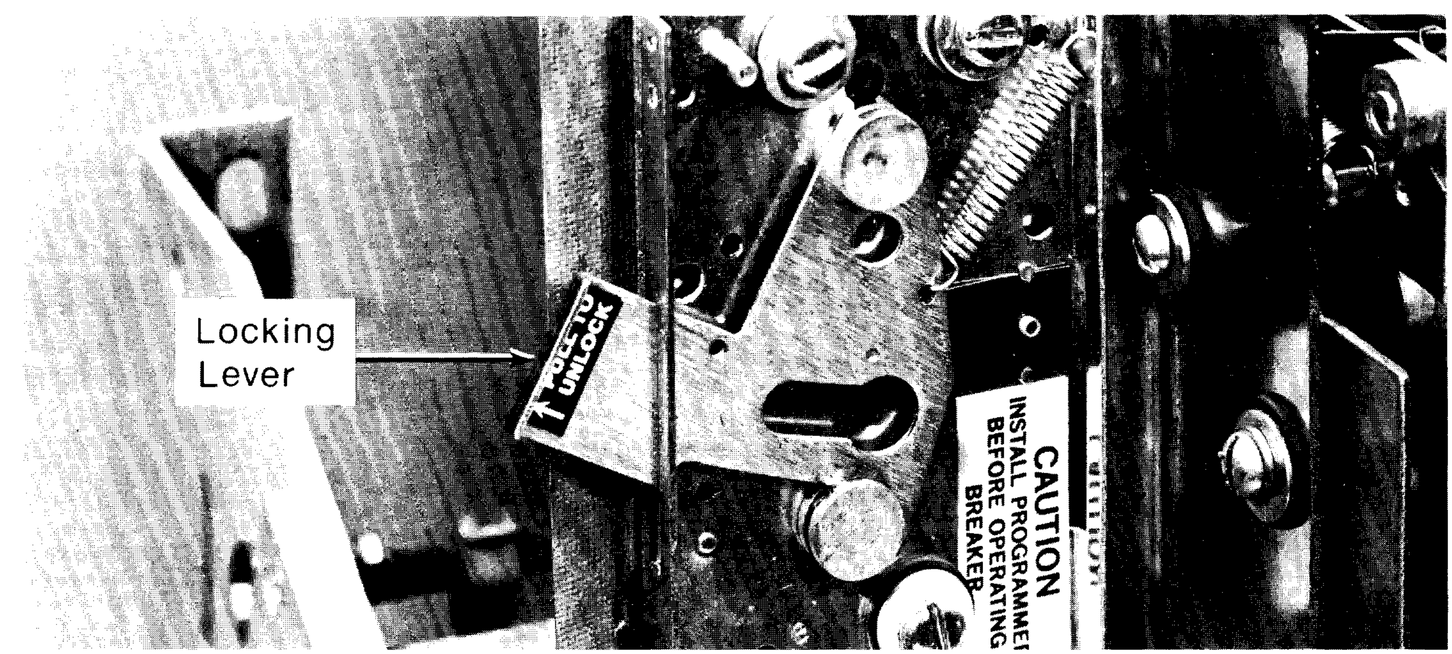


FIG. 82 — MICROVERSATRIP® RMS-9 AND POWER LEADER MOUNTING BRACKET

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.)

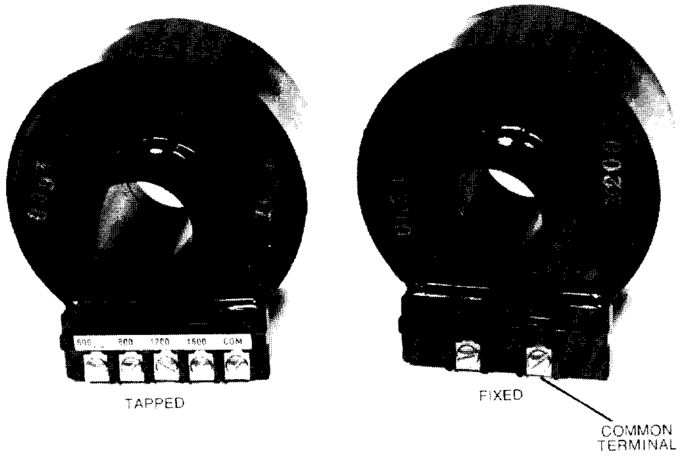


FIG. 83 — MICROVERSATRIP™ PHASE SENSORS

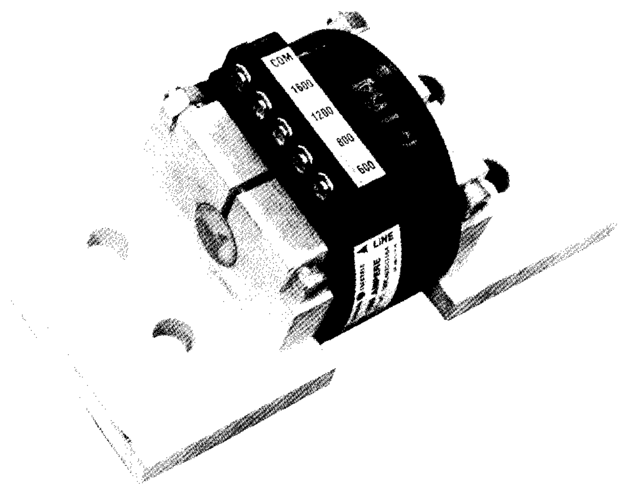


FIG. 85 — TYPICAL NEUTRAL SENSOR

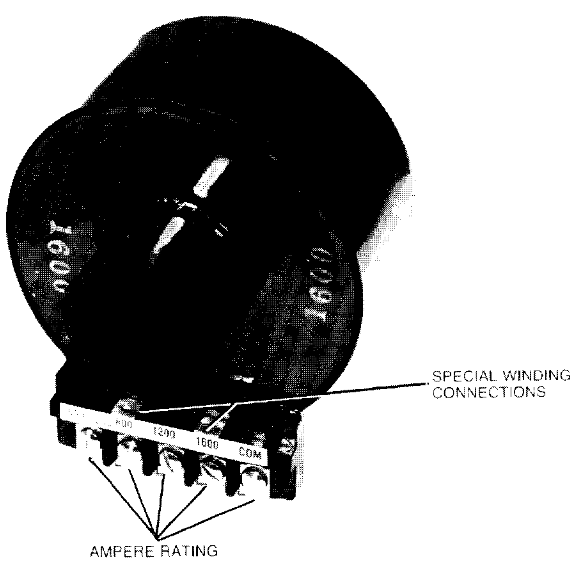
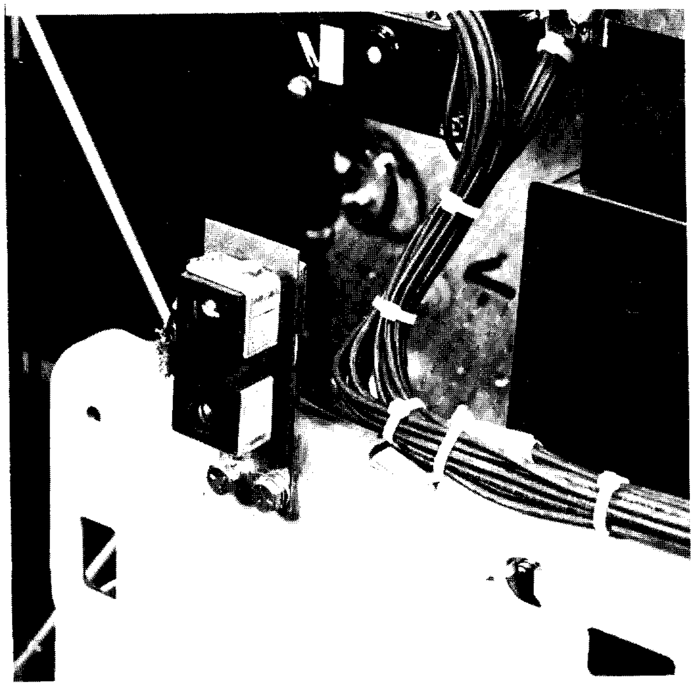
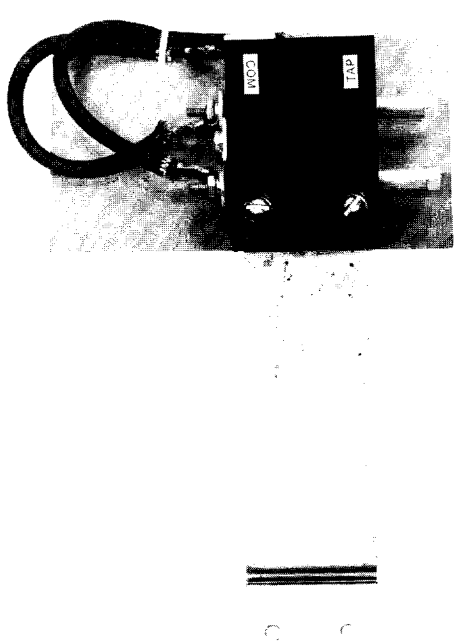


FIG. 84 — 'H'-OPTION PHASE SENSOR



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 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 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
AKR 30L 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.

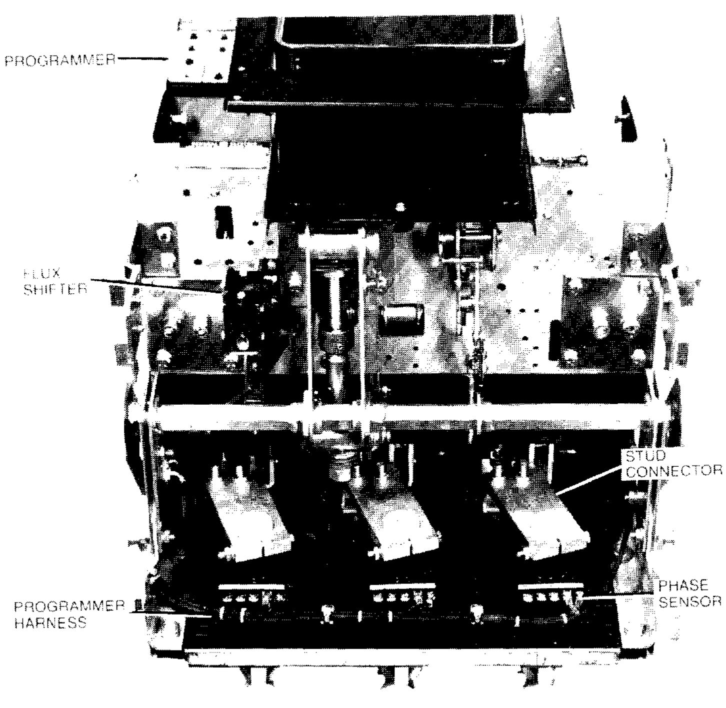


FIG. 87A — MICROVERSATRIP® COMPONENT WITH TAPPED SENSORS

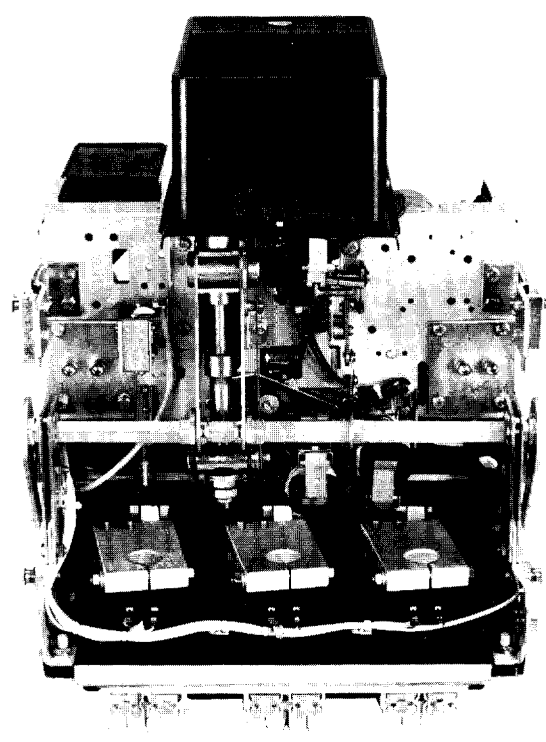


FIG. 87B — RMS-9, EPIC MICROVERSATRIP® AND MVT-PLUS OR MVT-PM COMPONENTS WITH FIXED SENSORS

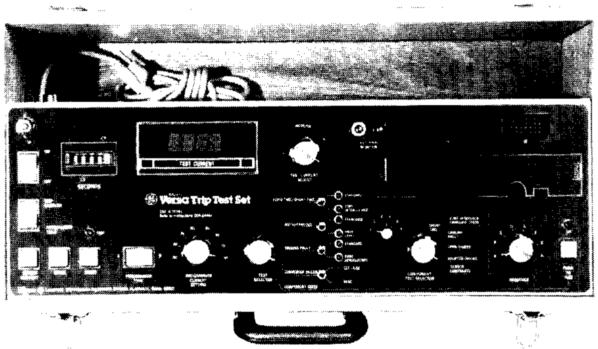


FIG. 88 TEST SET, CAT. NO. TVTS1

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

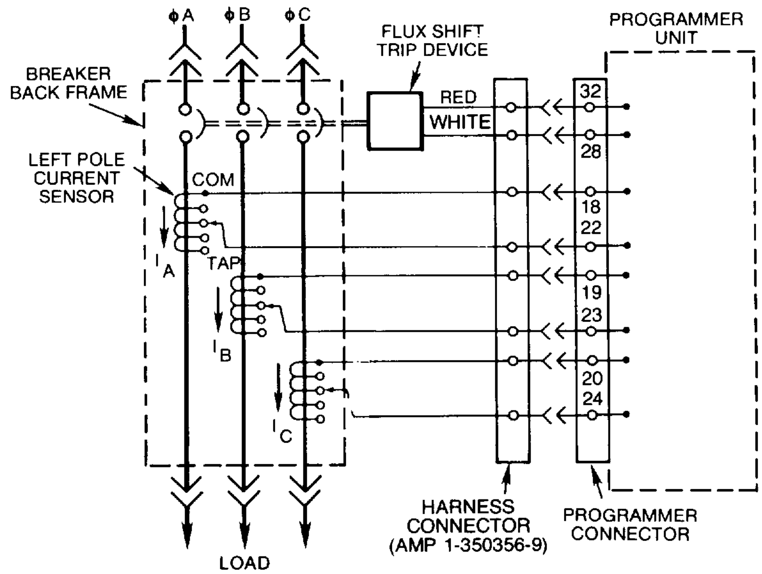


FIG. 89. CABLING DIAGRAM—MICROVERSATRIP™ WITHOUT GROUND FAULT

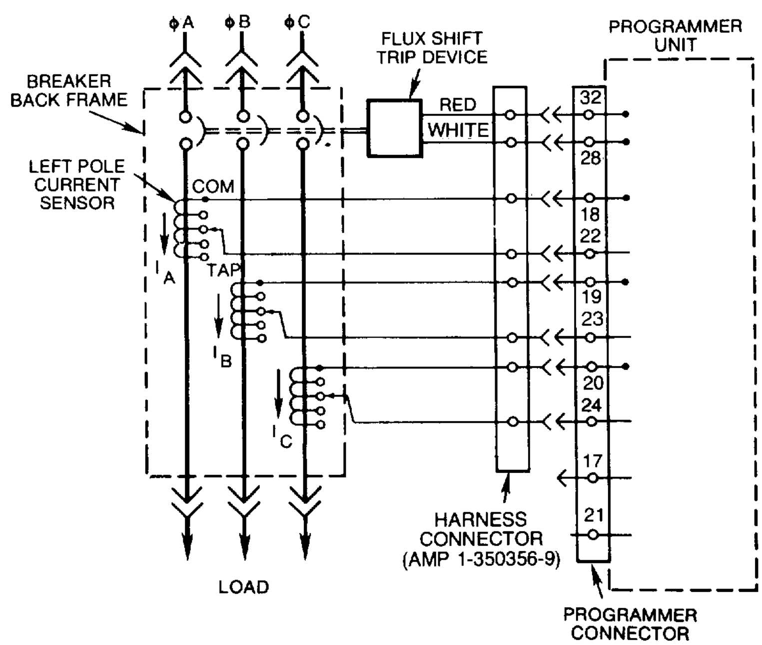


FIG. 90. CABLING DIAGRAM—MICROVERSATRIP™ WITH GROUND FAULT ON 3-WIRE LOAD

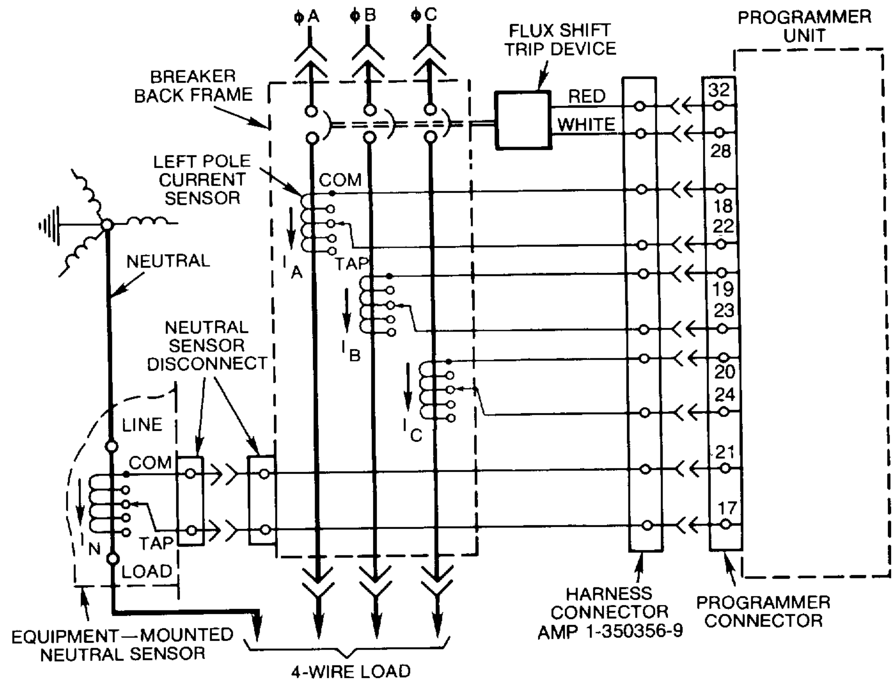


FIG. 91. CABLING DIAGRAM—MICROVERSATRIP™ WITH GROUND FAULT ON 4-WIRE LOAD

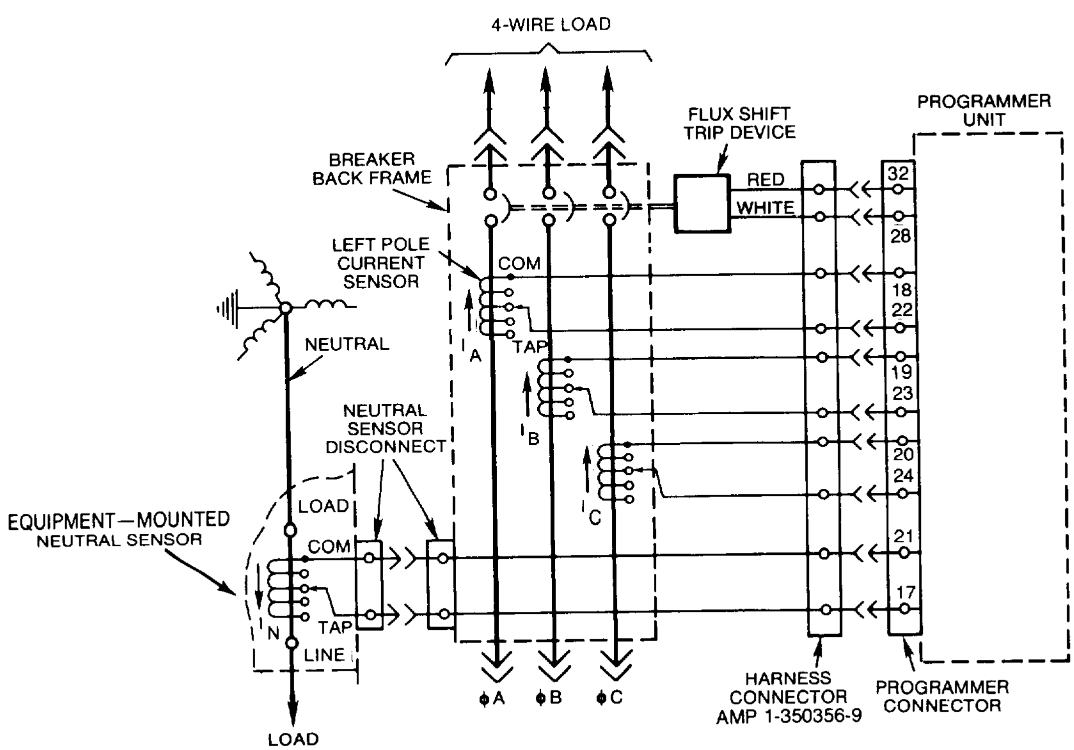


FIG. 92. CABLING DIAGRAM—MICROVERSATRIP WITH GROUND FAULT ON 4-WIRE LOAD—BREAKER REVERSE FEED

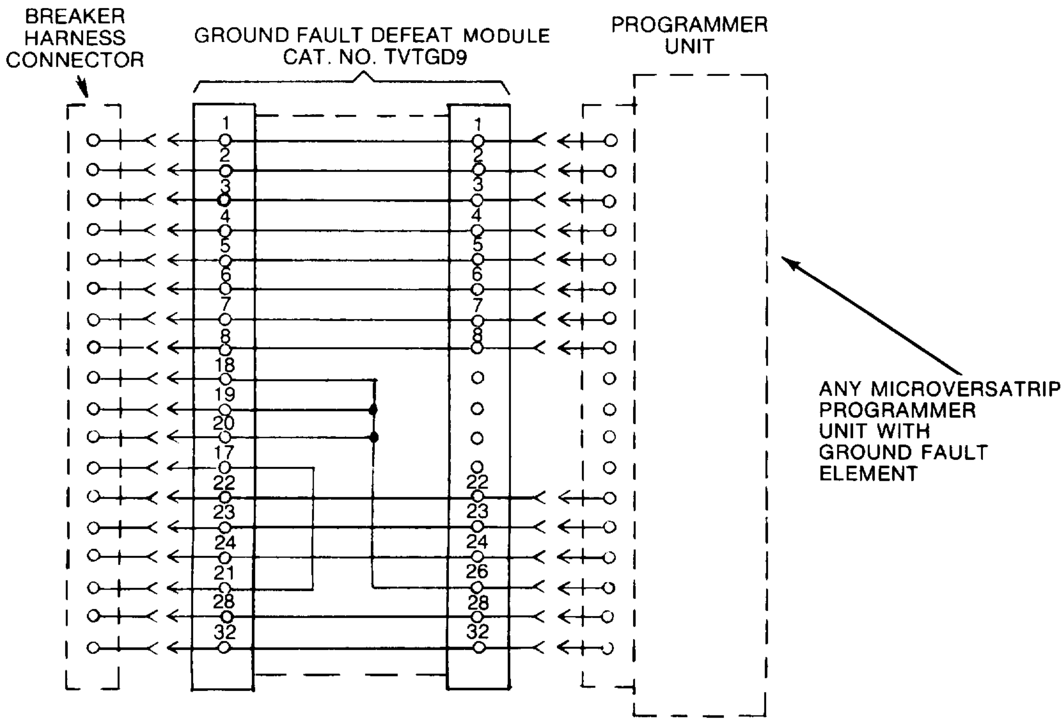


FIG. 93. CABLING DIAGRAM WITH GROUND FAULT DEFEAT MODULE INSERTED BETWEEN BREAKER HARNESS AND MICROVERSATRIP PROGRAMMER UNIT—FOR USE DURING SINGLE-PHASE, HIGH CURRENT—LOW VOLTAGE TESTING.

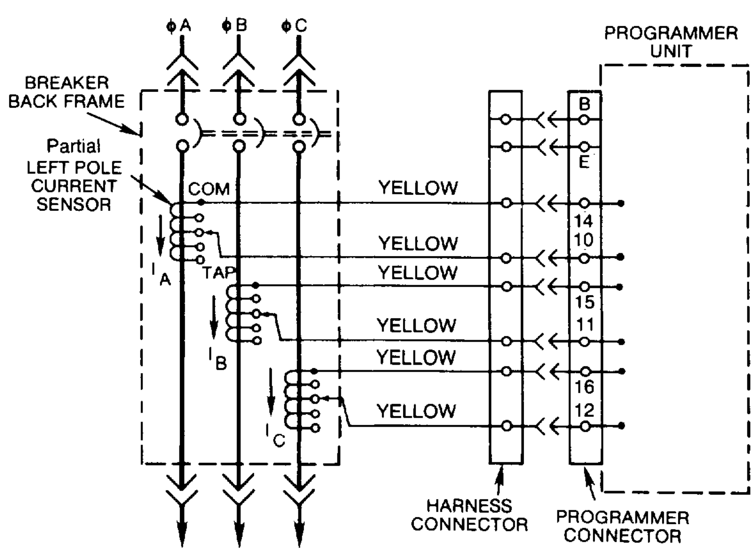


FIG. 94. PARTIAL CABLING DIAGRAM: 'H'-OPTION WINDING CONNECTIONS

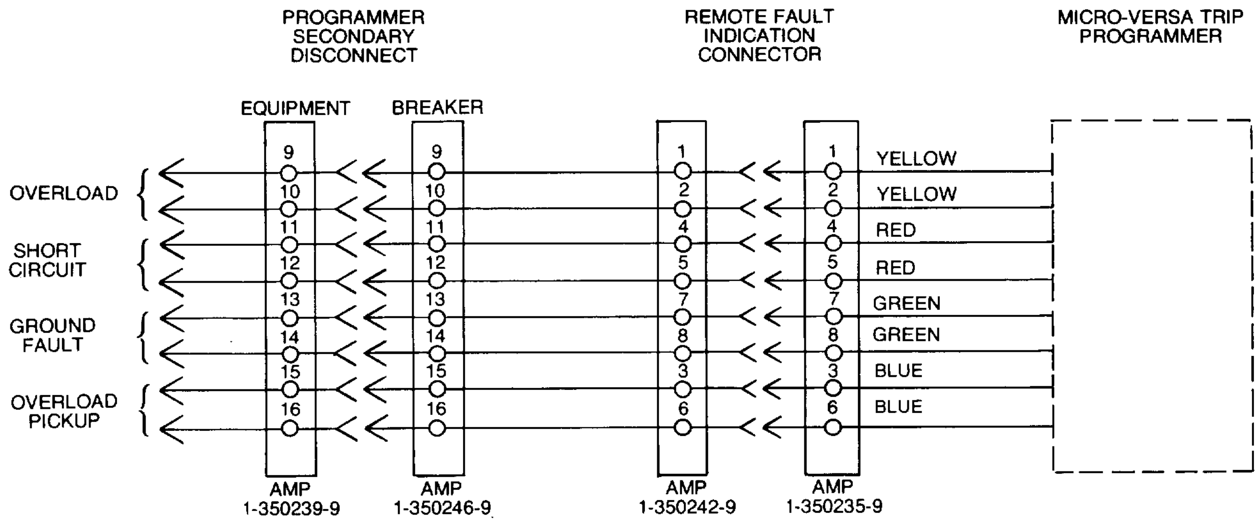


FIG. 95. CABLING DIAGRAM—REMOTE FAULT INDICATION

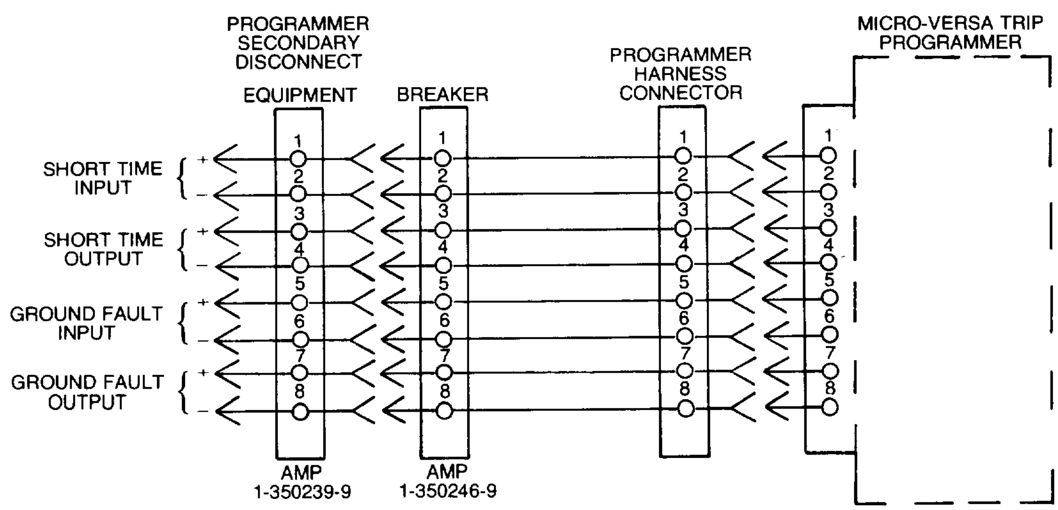


FIG. 96. CABLING DIAGRAM—ZONE SELECTIVE INTERLOCK

SECTION 13—RMS-9 & Epic MicroVersaTrip®

The RMS-9/Epic MicroVersaTrip® is a solid-state, direct-acting, self-powered trip device system. The RMS-9 system consists of the RMS-9 programmer, current sensors, and a flux shifter trip device. Fig. 97 shows a block diagram of the system.

13.1 PROGRAMMER UNIT

Fig. 98 shows a typical RMS-9/Epic MicroVersaTrip® programmer unit. Like the MicroVersaTrip®, the RMS-9 Epic MicroVersaTrip® provides the comparison basis for overcurrent detection and delivers the energy necessary to trip the breaker. It contains a programmable micro-electronic 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 15 for trip functions available and Table 16 for trip function characteristics. A detailed description of each trip function is given in publication GEK97367.

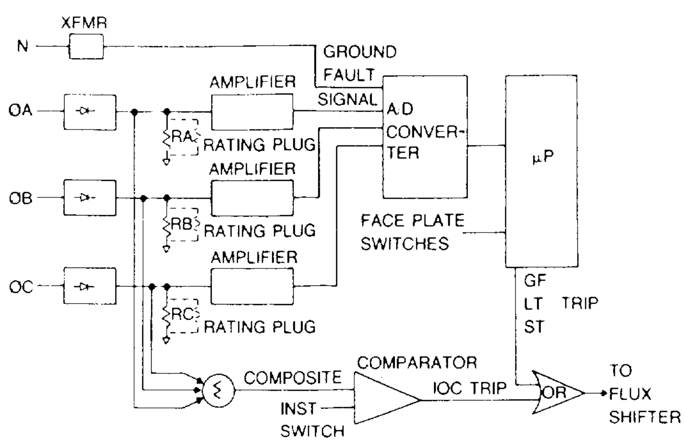


FIG. 97 — RMS-9 BLOCK DIAGRAM

13.1.1 FAULT TRIP INDICATORS

The optional fault trip indicators are similar to the MicroVersaTrip® 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.

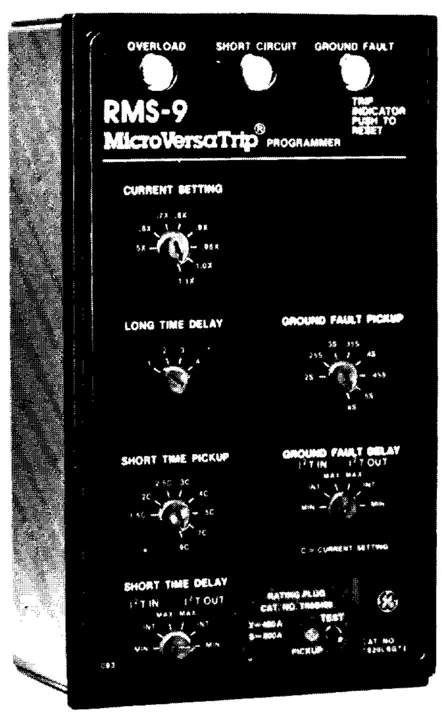


FIG. 98 — RMS-9 & EPIC MICROVERSATRIP® PROGRAMMER

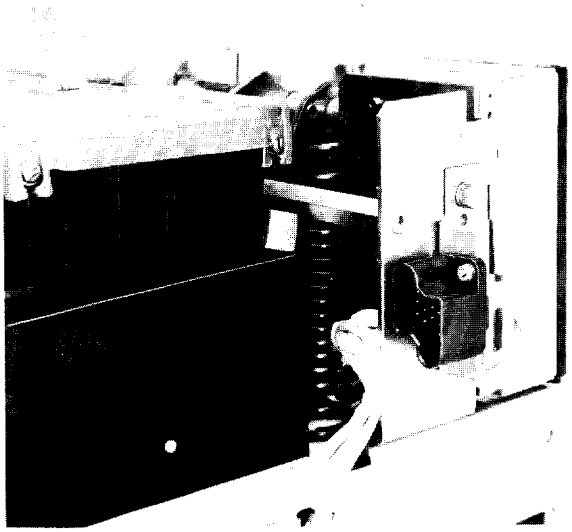


FIG. 99 — PROGRAMMER SECONDARY CONNECTOR EPIC MICROVERSATRIP®

13.1.2 RMS-9 & EPIC MICROVERSATRIP® INSTALLATION

The programmer mounts to the upper left of the breaker as shown in Fig. 100. It mounts to the bracket assembly shown in Fig. 82. Referring to Fig. 82, the guide pins mate with the hole 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.

Installation is as follows:

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

b. The locking lever is released, securing the programmer.

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

To remove the programmer:

a. Pull out locking lever, which will release the programmer pin. Remove the programmer.

13.2 CURRENT SENSORS

The current sensors supply the power and signal input necessary to operate the trip system. Like the MicroVersaTrip®, the RMS-9 and Epic MicroVersaTrip® uses a phase and neutral sensor. Fig. 101 shows the phase sensors. See Section 13.5 for cabling diagrams.

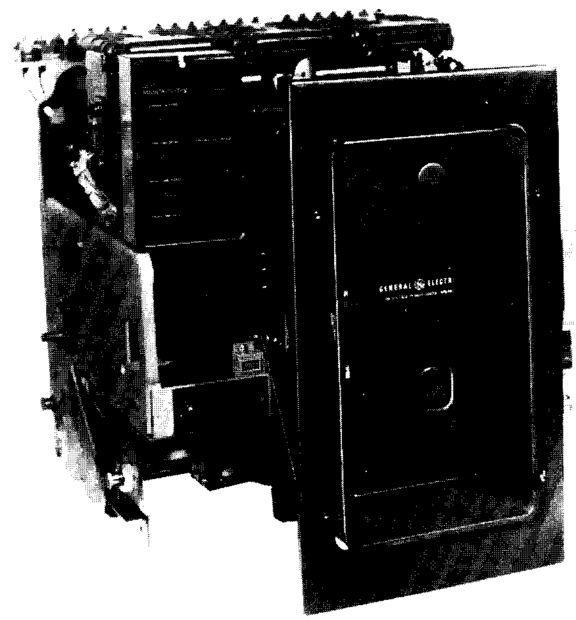


FIG. 100 — AKR-7D-30

The fixed phase sensors have a polarity associated with their windings. Their COMMON terminal is the right hand terminal as shown in Fig. 101. A white wire with a terminal will be connected to this COMMON terminal. All phase sensors must be correctly wired for the programmer summing circuit to function properly.

The phase sensors are available with an additional winding. This winding is brought out to separate flag terminals. These phase sensors are used when the hi-level instantaneous RMS-9 option ('H'-option) is required. Fig. 102 shows an 'H'-option phase sensor. When the 'H'-option phase sensor is installed, there are four leads connected to it. There is no polarity associated with the special winding connection. Fig. 102 shows the connections for the additional 'H'-option windings.

SECTION 13—RMS-9 & Epic MicroVersaTrip®

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 Switch ①					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 only ②											X				
	—local and remote												X			
	• Zone Selective Interlock															
	—Ground Fault ③													X		X
	—Short Time ①														X	X

1 Short-Time Delay is required
2 Standard when Ground Fault specified
3 Ground Fault required

TABLE 12 — RMS-9 AND EPIC MICROVERSATRIP® CHARACTERISTICS

Frame Size	Max. Amp Rating	Sensor Rating (Amps) (S)	Current Setting (Mult. of Rating Plug Amps) (X)	Long-Time: Pick up (Mult. of Current Setting) (C)	Long-Time: Delay ① (Sec.)	Short-Time: Pick up (Mult. of Current Setting) (C)	Short-Time: Delay (Sec.)	Adjustable Instantaneous Pick Up w/o ST (Mult. of Rating Plug Amps) (X)	Adjustable Instantaneous Pick Up with ST (Mult. of Rating Plug Amps) (X)	High Range Instantaneous (Mult. of Frame Short-time ③ Rating) (H)	Triple Selective Trip Fixed High Range Instantaneous ④ ⑤	Ground Fault: Pickup (Mult. of Sensor Amp Rating) (S)	Ground Fault: Delay w/ I^2T (Sec.)	Ground Fault: Delay ⑥ w/o I^2T (Sec.)
AKR-30 AKR-30H	800	150, 400, 800	.5, .6, .7, .8, .9, .95, 1.0, 1.1	Fixed at 1.0 of Current Setting	2.4, 4.9, 9.8, 20	1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.0, 9.0	I^2T in: ① .40 I^2T out: ② .10, .21, .35	1.5, 2, 3, 5, 7, 9, 10	1.5, 2, 3, 5, 7, 9, 10, 13 15	.4, .6, .8, 1.0	NA	.2, .25, .3, .35, .4, .45, .5, .6	.44 at 200% of pick up at lower limit of band	.10, .21, .35
AKR-50	1600	800, 1600	.5, .6, .7, .8, .9, .95, 1.0, 1.1	Fixed at 1.0 of Current Setting	2.4, 4.9, 9.8, 20			1.5, 2, 3, 5, 7, 9, 10	1.5, 2, 3, 5, 7, 9, 10, 13 15	.4, .6, .8, 1.0	NA	.2, .25, .3, .35, .4, .45, .5, .6		.10, .21, .35
AKRT-50	2000	2000	.5, .6, .7, .8, .9, .95, 1.0, 1.1	Fixed at 1.0 of Current Setting	2.4, 4.9, 9.8, 20			1.5, 2, 3, 5, 7, 9, 10	1.5, 2, 3, 5, 7, 9, 10, 13 15	.4, .6, .8, 1.0	NA	.2, .25, .3, .35, .4, .45, .5, .6		.10, .21, .35

① Time delay shown at 600% of currents setting at lower limit of band.

② Time delay shown at lower limit of each band. All pick up tolerances are ±10%.

X = Rating plug amps
S = Sensor amp rating
C = Current setting

⑤ Triple selective trip is standard when long-time/short-time only is required.

⑥ Time delay shown at lower limit of each band. Ground fault pick up not to exceed 1200 amps.

X = Rating plug amps
S = Sensor amp rating
C = Current setting
H = Short-time rating

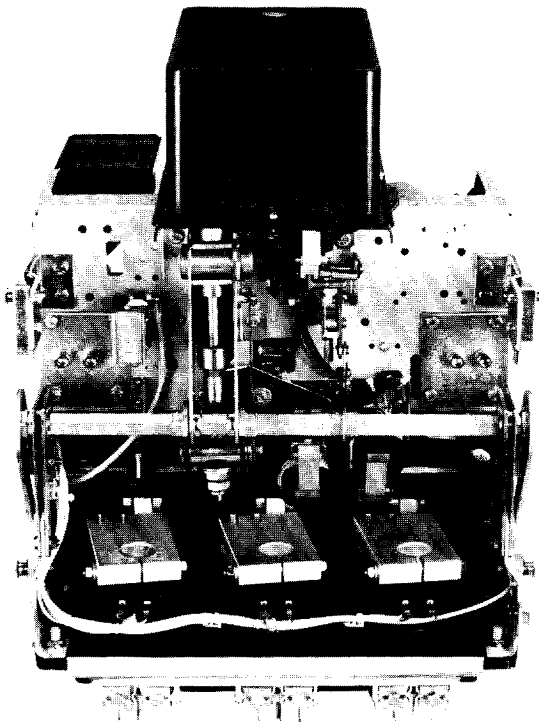


FIG. 101 — RMS-9 PHASE SENSORS

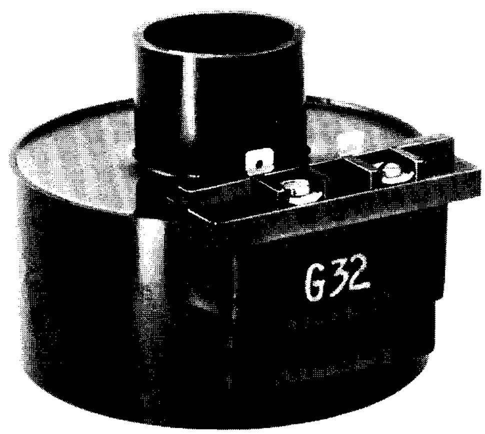


FIG. 102 — 'H'-OPTION PHASE SENSOR

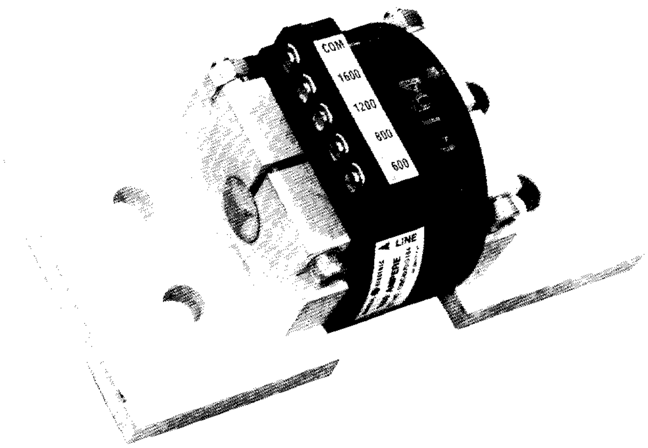


FIG. 103 — TYPICAL NEUTRAL SENSOR

Fig. 103 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. 107.

The neutral sensor is an electrical duplicate of the phase sensor. Therefore, when phase sensors are charged the neutral sensor must be correspondingly changed.

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 RMS-9 system.

13.2.1 REPLACEMENT OF CURRENT SENSORS

Referring to Fig. 87B, replacement of RMS-9 & Epic MicroVersaTrip current sensors is accomplished by the same procedure as the MicroVersaTrip® current sensors.

13.3 FLUX SHIFTER TRIP DEVICE

The only difference between the RMS-9/Epic MicroVersaTrip® and SST flux shifter trip devices is the solenoid winding. Refer to Section 10.3 for details.

When replacing a RMS-9/Epic MicroVersaTrip® flux shifter, AMP extraction tool Cat. No. 455822-2 is required to remove the socket leads from the AMP connector.

13.4 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 maintenance along its trip shaft.

c) Inadvertent shunt trip activations.

WARNING: *Do not 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 RMS-9 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 RMS-9 system using portable Test Set Type. The applicable test procedures are detailed in instruction Book GEK-97367.

The time-current characteristics for the RMS-9 & Epic MicroVersaTrip® Device are given in curves GES-6229 and GES-6228.

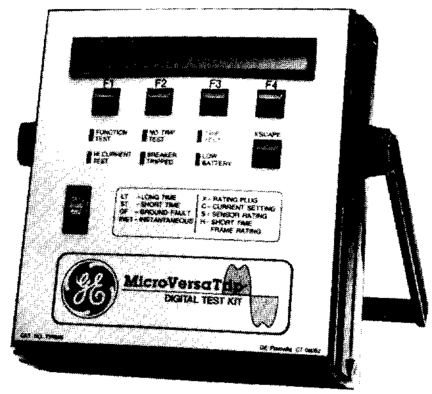


FIG. 104 — TEST SET, CAT. NO. TVRMS

13.4.1 RESISTANCE VALUES

For use in troubleshooting the RMS-9 current sensors, the resistance of the fixed windings is given in Table 15.

TABLE 15 — FIXED SENSOR RESISTANCE VALUES

Ampere Rating	Resistance in Ohms Between Terminals
150	10-12
400	27-32
800	58-68
1600	129-151
2000	207-243

The coil resistance of the RMS-9 & Epic MicroVersaTrip® device is approximately 7 ohms.

13.4.2 FALSE TRIPPING — BREAKERS EQUIPPED WITH GROUND FAULT

When nuisance tripping occurs on breakers equipped with the Ground Fault tip element, a probable cause is the existence of a false "ground" signal. As indicated by the cabling diagram of Fig. 106, 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) the circuity 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 RMS-9 or Epic MicroVersaTrip components have previously demonstrated satisfactory performance via the 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).

c) Verify that the harness connections to the sensors meet the polarity constraints indicted 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. 107). In particular,

(1) Verify that the neutral sensor has the same rating 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. 108.

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

3) 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-t0-tap resistances should closely agree. See Table 15.

13.5 CABLING DIAGRAMS

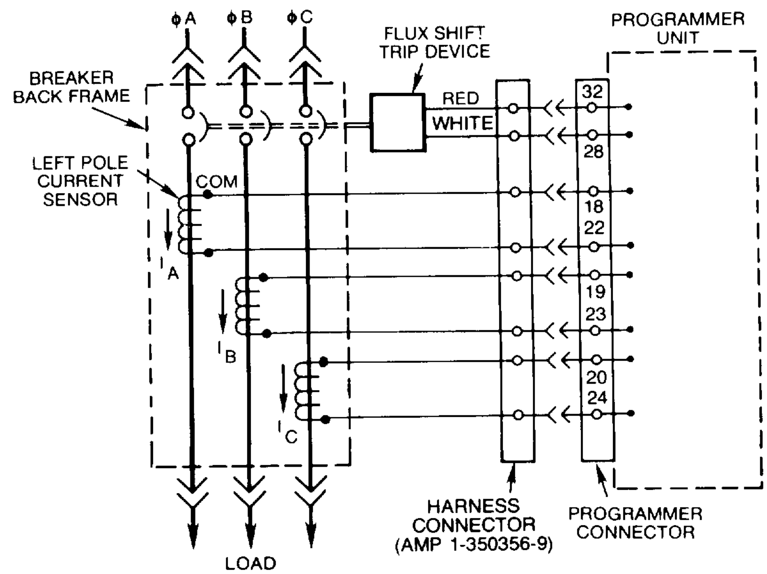


FIG. 105 — CABLING DIAGRAM — RMS-9 & EPIC MICROVERSATRIP® WITHOUT GROUND FAULT

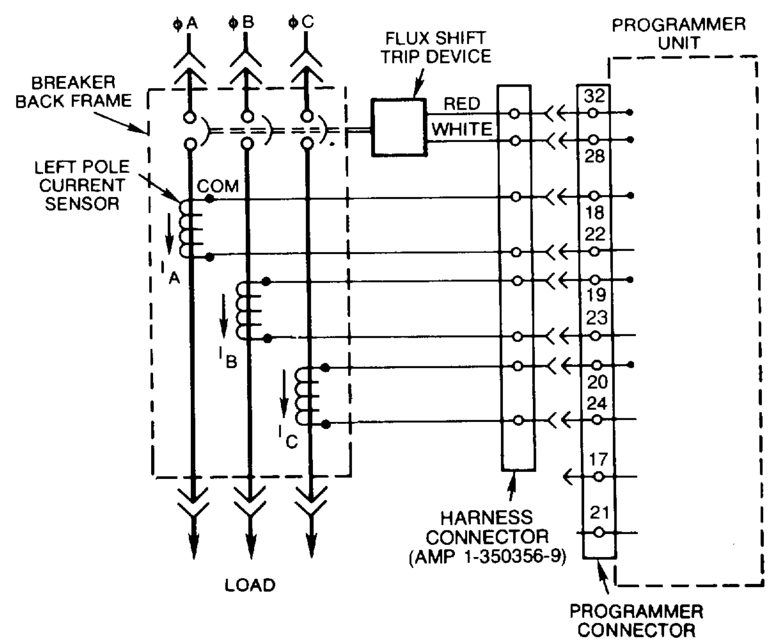


FIG. 106 — CABLING DIAGRAM — RMS-9 & EPIC MICROVERSATRIP® WITH GROUND FAULT ON 3-WIRE LOAD

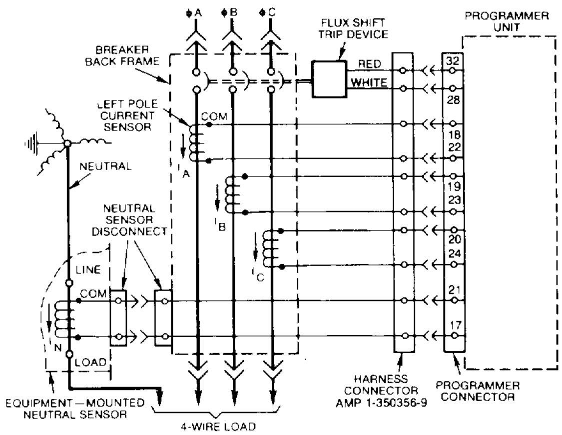


FIG. 107 — CABLING DIAGRAM — RMS-9 & EPIC MICROVERSATRIP® WITH GROUND FAULT ON 4-WIRE LOAD

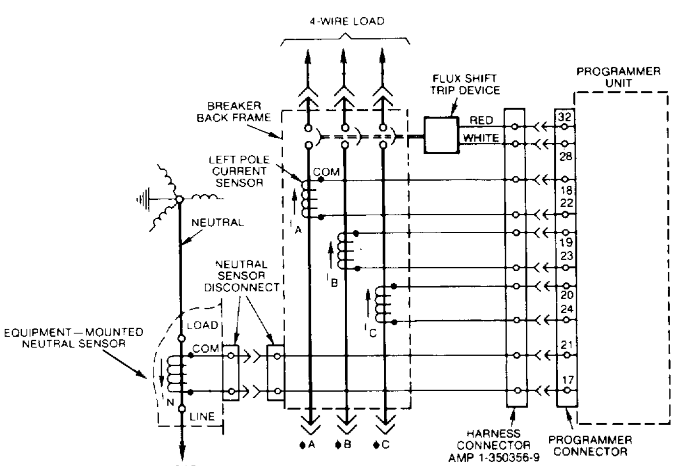


FIG. 108 — CABLING DIAGRAM — RMS-9 & EPIC MICROVERSATRIP® WITH GROUND FAULT ON 4-WIRE LOAD — BREAKER REVERSE FEED

	Socket		
	PIN No.		
Zone Selective Interlock	5	+	Zone Inputs
	6	-	
	7	+	Zone Outputs
	8	-	
Epic MVT	11	-	Homnet
	12	+	
	9	Spare	
	10	VC	
	1	VB	
	4	VA	
	2	24 Ret	
	3	+ 24 VDC	

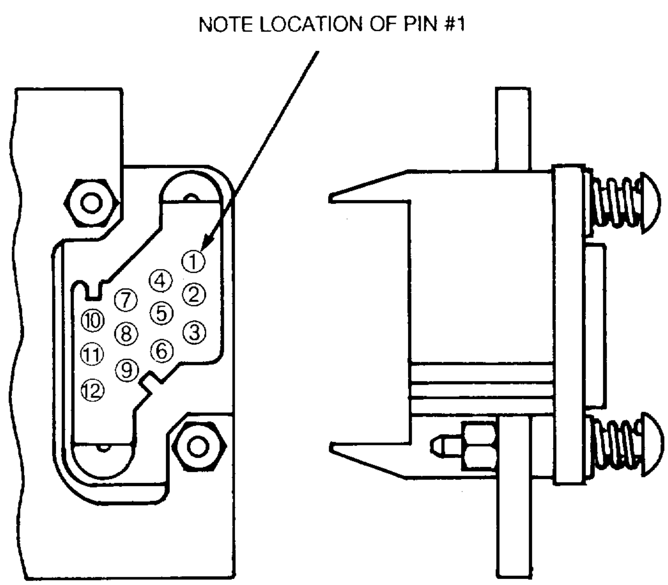


FIG. 109 — PROGRAMMER SECONDARY CONNECTOR PIN LOCATIONS FOR ZONE SELECTIVE INTERLOCK AND EPIC MVT

SECTION 14—MicroVersaTrip® Plus and MicroVersaTrip® PM Trip Units

The MVT-Plus/MVT-PM is a solid-state direct-acting self-powered trip device system. The system consists of the MVT-Plus/MVT-PM programmer, current sensors and a flux shifter trip device. Figure 110 shows location of features on programmer. See user manual GEH-5891A.

14.1 TRIP UNIT

MicroVersaTrip® Plus Trip Unit

MicroVersaTrip® Plus trip units utilize a digital, LCD display with a four-button keypad to provide local set-up and readout of trip settings. A 3-phase ammeter and trip indicators are standard, as is a clear plastic cover with provisions for sealing to allow tamper resistant installation. The trip unit digitally measures the current waveform in each phase to determine the true RMS value of the current, regardless of the waveshape. MicroVersaTrip® Plus trip units provide accurate, predictable overload and short circuit protection for distribution systems that include ac and dc variable speed drives, rectifiers, induction heating, and other loads that cause high harmonic distortion as well as standard circuit. They provide maximum breaker-to-breaker selectivity and custom load protection. Short time and ground fault functions include the flexibility of coordination with or without an I^2t ramp and are also available with high range instantaneous.

MicroVersaTrip® PM Trip Unit

The MicroVersaTrip® PM trip unit adds power management system capability, advanced metering, and protective relays to the basic functions of the MicroVersaTrip® Plus. MicroVersaTrip® PM trip units communicate directly on the GE POWER LEADER™ communications bus.

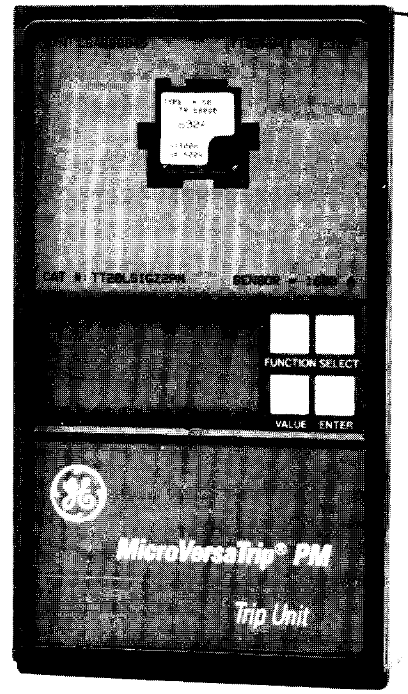


FIG. 110

Power Requirements

A small amount of power is necessary to energize the liquid crystal display (LCD) during setup, for viewing breaker status, and for metering displays. MicroVersaTrip® PM trip units require external 24 Vdc control power for operation. The four sources of such power are the following.

- *Flow of current* – Breaker current sensors provide sufficient power to energize the LCD when at least 20% of the sensor's ampere rating is flowing.
- *24 Vdc control power* – Breakers with MicroVersaTrip® PM trip units are supplied with external 24 Vdc power that, whenever present, energizes the LCD. Some breaker models that are configured for MicroVeraTrip Plus trip units may be optionally equipped to accept an external 24 Vdc supply.
- *MicroVersaTrip Test Kit* – The MicroVersaTrip® Test Kit, Cat No. TVRMS, contains a 24 Vdc power supply. The LCD is energized whenever the test kit jack is plugged into the test receptacle on the rating plug.
- *MicroVersaTrip battery pack* – The portable MicroVersaTrip® battery pack contains a 24 Vdc power source and a jack. The LCD is energized when the jack is plugged into the rating plug test receptacle.

14.2 TESTING

Testing of MicroVersaTrip® Plus and MicroVersaTrip® PM trip units may be performed with the trip unit installed in the circuit breaker, the rating plug installed in the trip unit, and the breaker carrying current. The test set catalog number is TVRMS. The test set plugs into the test socket of the rating plug.

Test set TVRMS may also be used for MicroVersaTrip® RMS-9 and Epic MicroVersaTrip® trip units. Refer to the Maintenance and Troubleshooting section for additional details.

14.3 PRODUCT STRUCTURE

MicroVersaTrip® Plus and MicroVersaTrip® PM trip units are removable. Figures 111 and 112 contain front and rear views of a MicroVersaTrip PM trip unit.

Figure 112 shows the 36-pin plug that connects either trip unit to the circuit breaker and equipment circuity. This plug is called the trip unit disconnect.

CAUTION: Removal of a trip unit from its breaker must be performed with the breaker in the OPEN or TRIPPED position. Draw-out breakers should be racked out first.

CAUTION: Do not attempt to operate the breaker without its assigned trip unit. Installation of an incorrect trip unit may result in unsafe operation of the breaker.

CAUTION: Removal of the rating plug while the breaker is carrying current reduces the breaker's current-carrying capacity to approximately 25% of the current sensor rating. This may result in undesired tripping.

NOTE: Trip units as received may have settings that are undesirable for the specific application. Ensure that settings are appropriately adjusted before energizing.

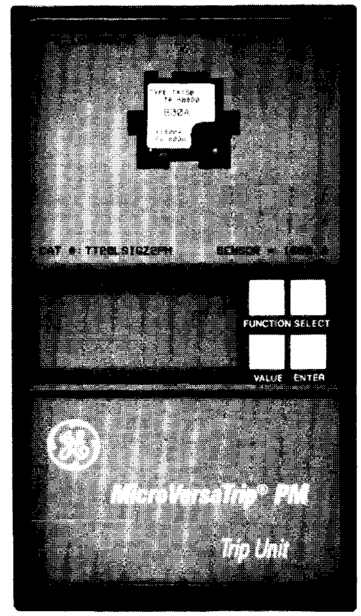


FIG. 111 — FRONT VIEW OF MICROVERSATRIP® PM TRIP UNIT

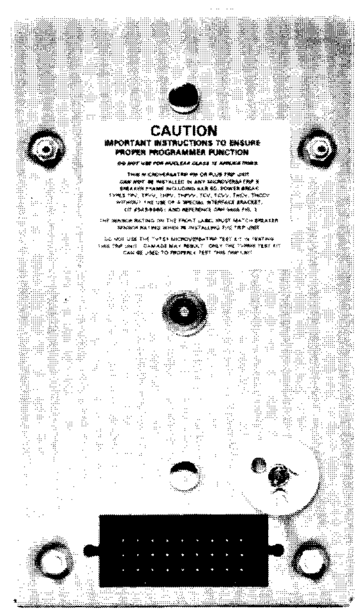


FIG. 112 — REAR VIEW OF MICROVERSATRIP® PM TRIP UNIT

14.4 TRIP UNIT REMOVAL AND REPLACEMENT

The programmer mounts to the upper left of the breaker as shown in Fig. 115. It mounts to the bracket assembly shown in Fig. 82. Guide pins on the bracket 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. When a trip unit is replaced, the locking arm snaps back into place to indicate proper alignment.

WARNING: Always de-energize Type AKR circuit breakers before attempting to remove or replace the trip unit. Because of the exposed location of the trip unit, failure to observe this warning may result in equipment damage or personal injury, including death.

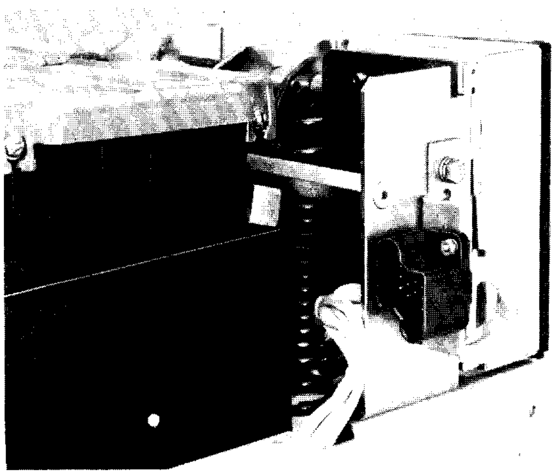


FIG. 113 PROGRAMMER SECONDARY CONNECTOR

	Socket		
	Class No.		
Zone Selective Interlock	5	+	Zone Inputs
	6	-	
	7	+	Zone Outputs
	8	-	
MVT-PM	11	-	Homnet
	12	+	
	9	Spare	
	10	VC	
	1	VB	
	4	VA	
	2	24 Ret	
	3	+ 24 VDC	

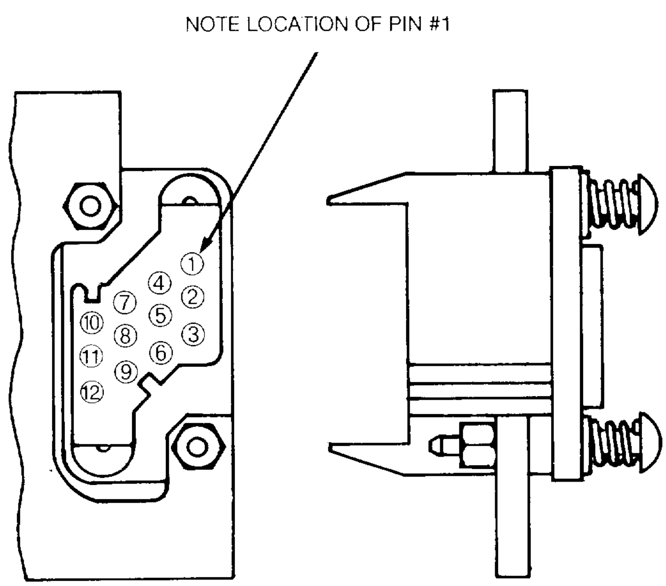


FIG. 114 PROGRAMMER SECONDARY CONNECTOR PIN LOCATIONS FOR ZONE SELECTIVE INTERLOCK AND MVT-PM

SECTION 14—MicroVersaTrip® Plus and MicroVersaTrip® PM Trip Units

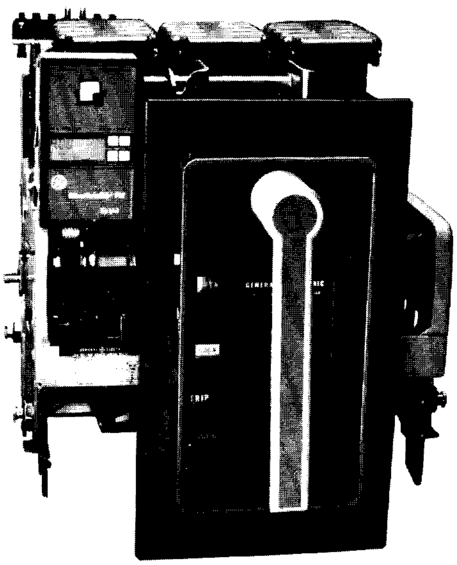


FIG. 115

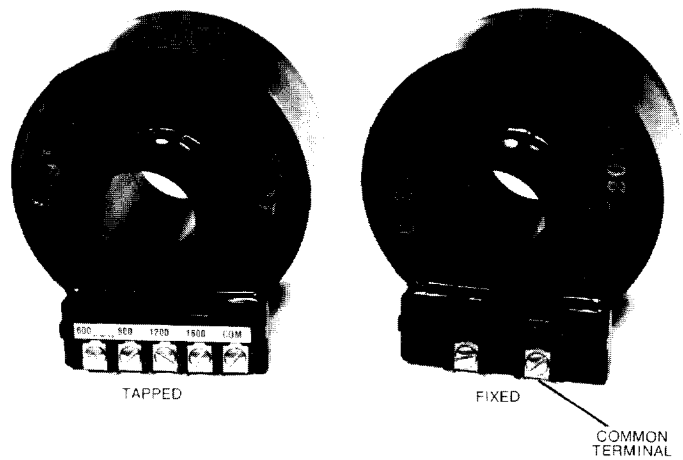


FIG. 116

14.5 PHASE CURRENT SENSORS

The current sensors supply the power and signal input necessary to operate the trip system Fig. 116 shows the fixed phase sensors available. The sensors have a polarity associated with their windings. The common terminal of the sensor is the right hand terminal. A white wire with a push-on terminal will be connected to this common terminal. All phase sensors must be correctly wired for the programmer summing circuitry to function properly.

The fixed phase sensors are available with an additional winding. This winding is brought out to separate flag terminals. These phase sensors are used when the hi-level instantaneous ('H'-option) is required. Fig. 117 shows an 'H'-option phase sensor. When the 'H'-option phase sensor is installed, there are four leads connected to it. There is no polarity associated with the 'H'-option windings.

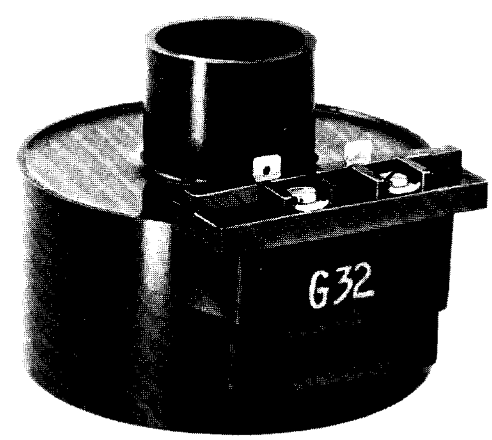


FIG. 117 'H'-OPTION PHASE SENSOR

14.6 NEUTRAL CURRENT SENSORS

CAUTION: Neutral current sensors are required for three-phase, four-wire systems. When the trip unit is connected to a three-phase, three-wire system, the neutral sensor terminals are left open. Do not short any neural current sensor terminals in a three-phase, three-wire system, as this could result in damage to or malfunction of the electrical system.

Fig. 118 shows the neutral sensor. The neural 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.

The neutral sensor is an electrical duplicate of the phase sensor. Therefore, when phase sensors are changed, the neutral sensor must be correspondingly be changed.

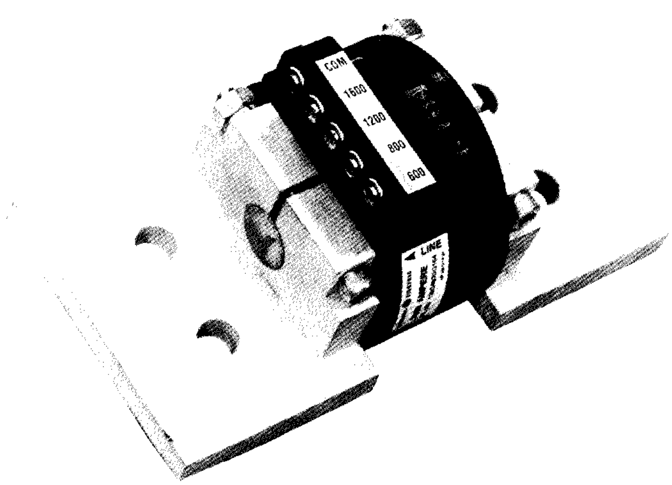


FIG. 118 TYPICAL NEUTRAL SENSOR

14.7 RATING PLUG REMOVAL AND REPLACEMENT

CAUTION: Removal of the rating plug while the breaker is carrying current reduces the breaker's current-carrying capacity to approximately 25% of the current sensor rating.

Interchangeable rating plugs are removed with a Rating Plug Extractor, Catalog No. TRTOOL. (Suitable equivalents are commercially available as "integrated circuit (DIP) extractors.") Grasp the rating plug tabs with the extractor and pull the plug out. Be sure to grab the tabs and not the front cover of the rating plug, or the plug may be damaged.

Rejection features are provided on all rating plugs to prevent application mismatches. Never force a rating plug into place. Refer to Table 16 to find the appropriate rating plugs for each sensor rating and breaker frame.

If a replacement rating plug has a different rating than the plug that was removed, follow the appropriate setup procedure GEH-5891A to enter the new rating.

Do not attempt to use a rating plug from a Spectra RMS breaker or a MicroVersaTrip® Plus or MicroVersaTrip® PM Trip Unit.

TABLE 16

Cat. No.	Sensor Rating, Amps	Plug Rating	Breaker Frames
TR4B150	400	150	AKR30, AKR30H, AKR30L
TR4B200		200	
TR4B225		225	
TR4B250		250	
TR4B300		300	
TR4B400		400	
TR8B300	800	300	AKR30, AKR30H, AKR50S, AKR50H
TR8B400		400	
TR8B450		450	
TR8B500		500	
TR8B600		600	
TR8B700		700	
TR8B800		800	
TR16B600	1600	600	AKR50, AKR50H
TR16B800		800	
TR16B1000		1000	
TR16B1100		1100	
TR16B1200		1200	
TR16B1600		1600	
TR20B750	2000	750	AKRT50H
TR20B800		800	
TR20B1000		1000	
TR20B1200		1200	
TR20B1500		1500	
TR20B1600		1600	
TR20B2000		2000	

14.8 TRIP UNIT FUNCTIONS

MicroVersaTrip® Plus and MicroVersaTrip® PM trip units have specific standard and optional functions. All trip units share a series of interchangeable rating plugs. The standard functions for both types of trip unit are as follows:

- Protection
  - Long-time protection
  - Instantaneous protection
- Status
  - Trip target
- Metering display
  - Phase current (selectable among phases)

The optional functions available on both types of trip unit are as follows:

- Adjustable protection
  - Switchable instantaneous and ground-fault protection
  - High-range (fixed) instantaneous overcurrent protection
  - Short-time protection, with or without I^2T
  - Ground-fault protection, with or without I^2T
  - Zone-selective interlock, with ground fault only or with both ground fault and short time

Additional optional functions available only with PM style trip units are as follows. PM style trip units require the presence of external control power.

- Configurations
  - Communication and metering
  - Communication and protective relaying
  - Communication, metering, and protective relaying
- Metering and protective-relaying functions
  - Voltage
  - Energy (kWh/MWh)
  - Real power (kW/MW)
  - Total power (kVA/MVA)
  - Frequency (Hz)
  - Protective relays (undervoltage, overvoltage, voltage unbalance, current unbalance, and power reversal)

14.9 TROUBLE-SHOOTING GUIDE

The following guide is provided for trouble-shooting and isolating common problems. It does not cover every possible condition. Contact the Customer Support at 800-843-3742 if the problem is not resolved by these procedures.

Symptom	Possible Cause	Corrective Action
1. The trip unit display is blank.	Line current is below 20% of S (MicroVersaTrip Plus).	At least 20% of the current sensor rating, S, must be flowing through the breaker to activate the display. If not, power the trip unit with the Test Kit or external battery pack.
	External 24 Vdc is absent (MicroVersTrip® PM).	Check that the control power supply is present and operational.
2. The trip unit display flashes.	Can occur on Plus style trip units when load current fluctuates near 20% of S.	Power the trip unit with the Test Kit or external battery pack.
3. The trip unit display flashes ERR.	The built-in self test has detected an error.	Replace the trip unit.
4. The trip indication target will not clear.	Trip unit is not in status mode.	Press FUNCTION until STATUS is displayed. Press SELECT and VALUE together to clear the target.
5. Unit does not communicate with the Monitor, POWER LEADER Distribution Software, or FPU.	Commnet wires are shorted or improperly connected.	Locate and repair the short or the incorrect connection.
	FPU version is lower than 2.0	Update FPU to version 2.0 or higher.
	Trip unit address incorrect.	Check that address assigned to trip unit agrees with address at host.
6. Current readings are incorrect.	Rating plug value was defined incorrectly.	Read the X value from the rating plug name plate and enter this with the rating plug current set point procedure. Do not enter the sensor rating, S.
7. Voltage readings are incorrect.	Potential transformer (PT) primary voltage was defined incorrectly.	Read the PT ordinary rating from the PT name plate and enter this value with the PT primary voltage procedure.
	PT connection was defined incorrectly.	With the PT connection procedure, enter VL-N for a wye-connected PT primary or VL-L for a delta-connected PT.
8. kW legend is flashing.	Total power metering.	Indicates that the total power is metered in kVA.
9. Overload target is flashing by itself.	Test Kit-initiated trip indication.	Clear target as indicated above (Symptom 4).

SECTION 15—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. 119. An optional trip device for these frames is the type EC-1, see Fig. 120.

Trip characteristics are for the EC devices are given in Table 17.

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

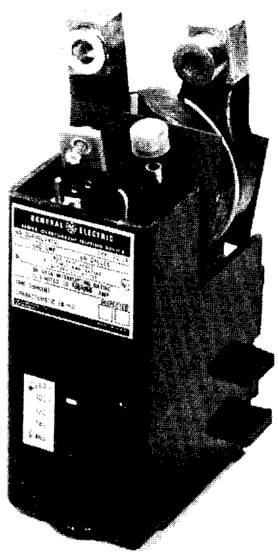


FIG. 119 — EC-2A TRIP DEVICE

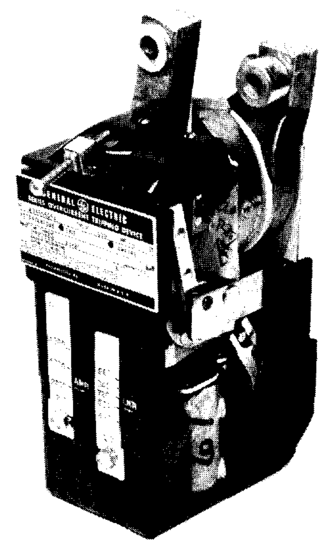


FIG. 120 — EC-1 TRIP DEVICE

TABLE 17 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.

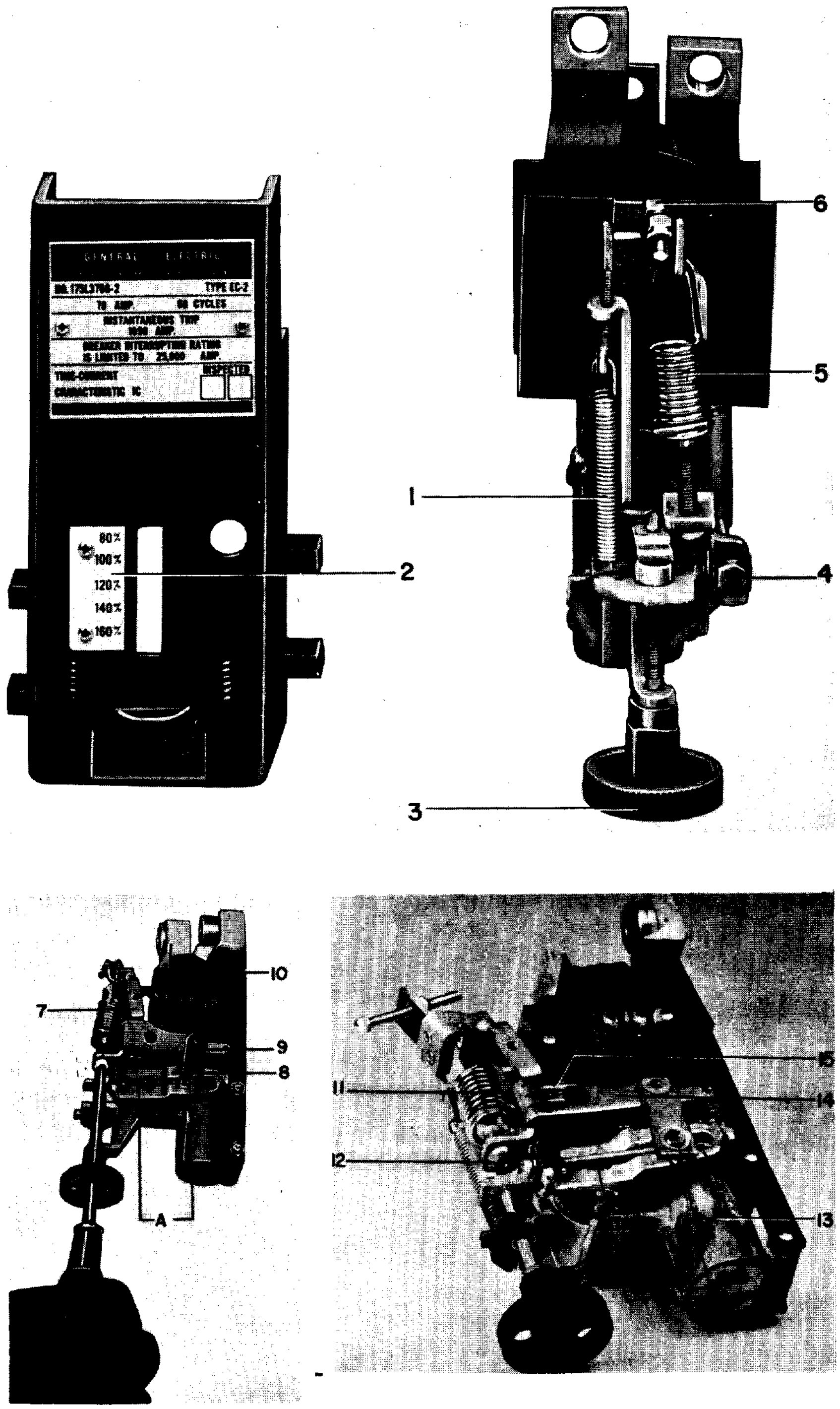


FIG. 121 OVERCURRENT TRIPPING DEVICE — EC-2A

SECTION 15—EC Trip Device (Cont.)

15.1 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. 121 for the discussions given below.

15.1.1 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. 122. 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.121, 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.

15.1.2 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.

15.1.3 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.

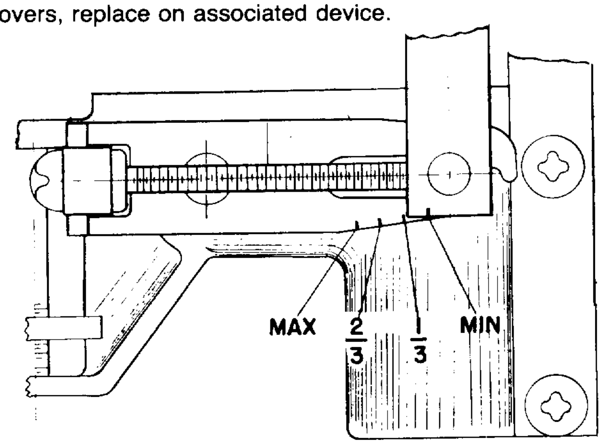


FIG. 122 — TIME-ADJUSTMENT INDEXING

SECTION 15—EC Trip Device (Cont.)

15.2 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.

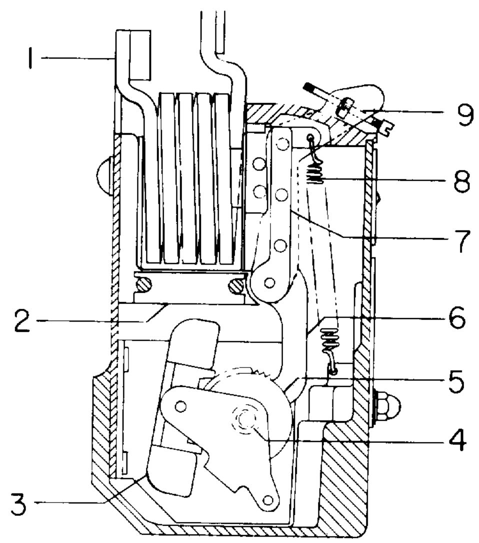
Refer to Fig. 123 for the discussions below.

15.2.1 SHORT TIME-DELAY TRIPPING

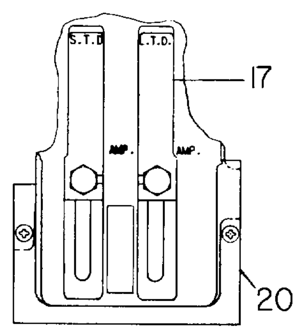
The armature (7) is restrained by calibrating spring (8). After the magnetic force produced by an overcurrent condition overcomes this restraining force, the armature movement is further retarded by an escapement mechanism which produces an inverse time delay characteristic. The mechanism is shown on Fig. 123

15.2.2 LONG TIME-DELAY TRIPPING

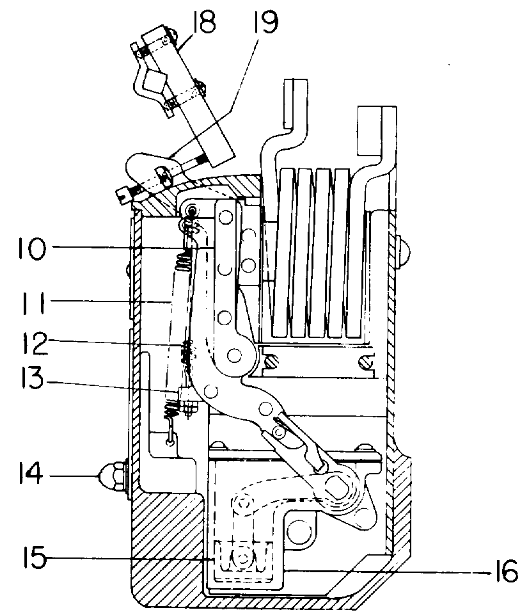
The armature (10) is restrained by the calibration spring (11). After the magnetic force produced by an overcurrent condition overcomes this restraining force, the armature movement is further retarded by the flow of silicone oil in a dashpot, which produces an inverse time delay characteristic. The mechanism is shown on Fig. 123



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. 123 — SERIES OVERCURRENT TRIPPING DEVICE EDC-1

15.2.3 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.

15.2.4 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 124. 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.

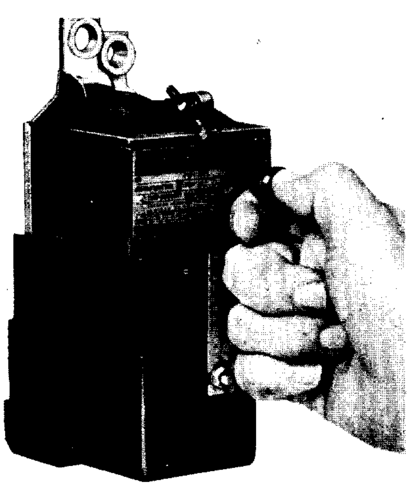


FIG. 124 CHECKING TRAVEL DISTANCE OF SERIES OVERCURRENT TRIPPING DEVICE.

15.3 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 124 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 124, 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 123 can best be manipulated by an extended 1/4 inch hex socket wrench.

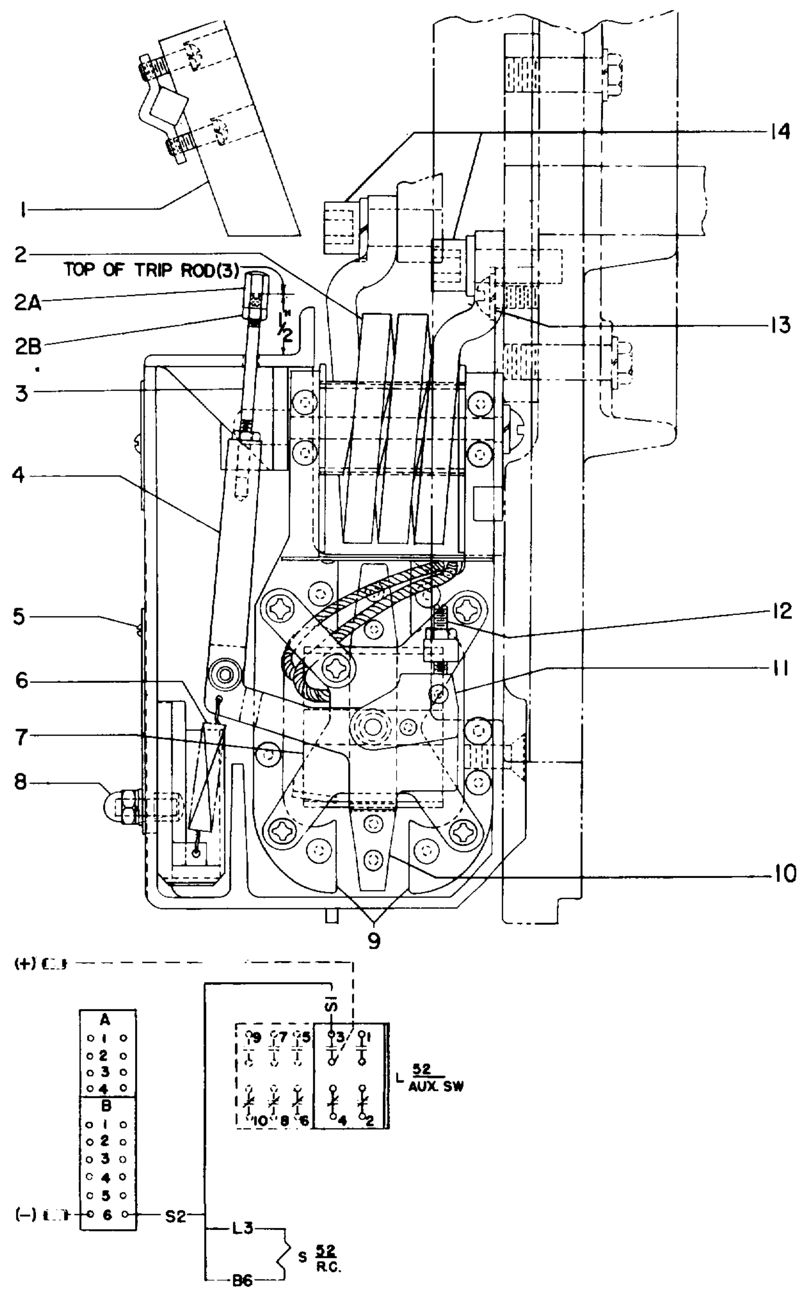
15.4 REVERSE CURRENT TRIPPING DEVICE

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. 125) 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. 125 ED-1 REVERSE CURRENT TRIPPING DEVICE

SECTION 15—EC Trip Device (Cont.)

15.4.1 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.

15.4.2 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 15.6. For wiring, see Fig. 125.

15.5 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%.

15.6 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 126 and 127, 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.

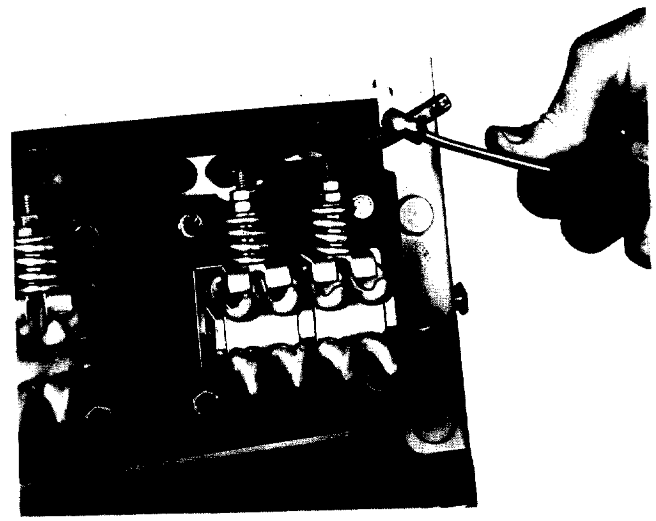


FIG. 126 DISCONNECTING EC COIL

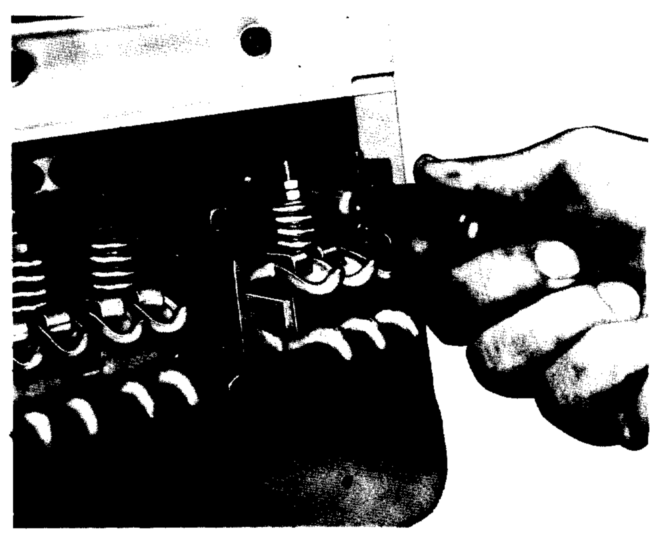


FIG. 127 DISCONNECTING EC FRAME

SECTION 16—Electrical Characteristics

TABLE 18—Charging and Closing Operating Currents

Nominal Control Voltage	Frequency Hz	Voltage Range	MOTOR Current (Amps)		ANTI-PUMP RELAY "W"			CONTROL RELAY "X"			CLOSING SOLENOID			FUSE SELECTION
			Inrush	Sustained	Min (volts) Pick-up	Rated-Amps Inrush Open	Rated-Amps Sealed Closed	Min (volts) Pick-up	Rated Amps Inrush Open	Rated Amps Sealed Closed	Min (volts) Pick-up	Rated Amps Inrush Open	Rated Amps Sealed Closed	
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	1.4		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 19-Bell Alarm Contact Rating

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

Table 20-Auxiliary Switch Contact Sequence

CB Main Contacts	Auxiliary Switch Position "a" Contact	"b" Contact
Open or Tripped	Open	Closed
Closed	Closed	Open

Table 21-Auxiliary Switch Contact Rating

Control Voltage		Auxiliary Switch Interrupting Ratings (Amperes)① Non-Inductive	Inductive
Dc	48 125 250	25 11 2	— 6.3 1.8
Ac	115 240 480	75 50 25	50 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 22 Charging Times

Nominal Voltage	Time (sec.) ①
48VDC	1.5
125VDC 250VDC	1.0
120VAC 208VAC 240VAC	1.5 0.09 1.3

① Closing spring charging times are typical values. The maximum permitted is 5 seconds.

TABLE 23 SHUNT TRIP AND UNDERVOLTAGE DEVICE OPERATING CURRENTS

Nominal Control Voltage	Frequency Hz	SHUNT TRIP				UNDER VOLTAGE		
		Operating Voltage range		Current (Amps) Inrush Open	Current (Amps) Sealed Closed	Operating Voltage range	Current (Amps) Inrush Open	Current (Amps) Sealed Closed
24	DC	14	30	8.3	8.3	SEE TABLE 25	.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	Pickup is 85% or less of nominal voltage. Dropout is 30% to 60% of nominal voltage	.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 24 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 25 INSTANTANEOUS UNDERVOLTAGE DEVICE SETTINGS

COIL RATING	MAXIMUM PICKUP VOLTAGE	DROP OUT RANGE
24 VDC	20	7-14
48 VDC	41	14-29
125 VDC	106	38-75
155 VDC	132	47-93
250 VDC	213	75-150
120 VDC	102	36-72
208 VDC	177	62-125
240 VDC	204	72-144
380 VDC	323	114-228
480 VDC	408	144-288
575 VDC	489	173-345

TABLE 26 TIME-DELAY UNDERVOLTAGE DEVICE SETTINGS

<table>
<tr><th rowspan="2">DELAY UNIT VOLTAGE</th><th rowspan="2">PICK UP RANGE UVR ONLY VDC</th><th colspan="2">UVR INSTALLED MECHANISM RESET</th><th rowspan="2">DROP OUT RANGE</th></tr>
<tr><th>NO PICK UP</th><th>PICK UP</th></tr>
<tr><td>125 VDC</td><td>77 - 85</td><td>50</td><td>90 - 95</td><td rowspan="2">MINIMUM POSSIBLE</td></tr>
<tr><td>250 VDC
208/240 VAC</td><td>125 - 140</td><td>90</td><td>160 - 165</td></tr>
</table>

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 GE Company.

GE Electrical Distribution & Control

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41 Woodford Ave., Plainville, CT 06062

GEK-64459D 0596 PSA