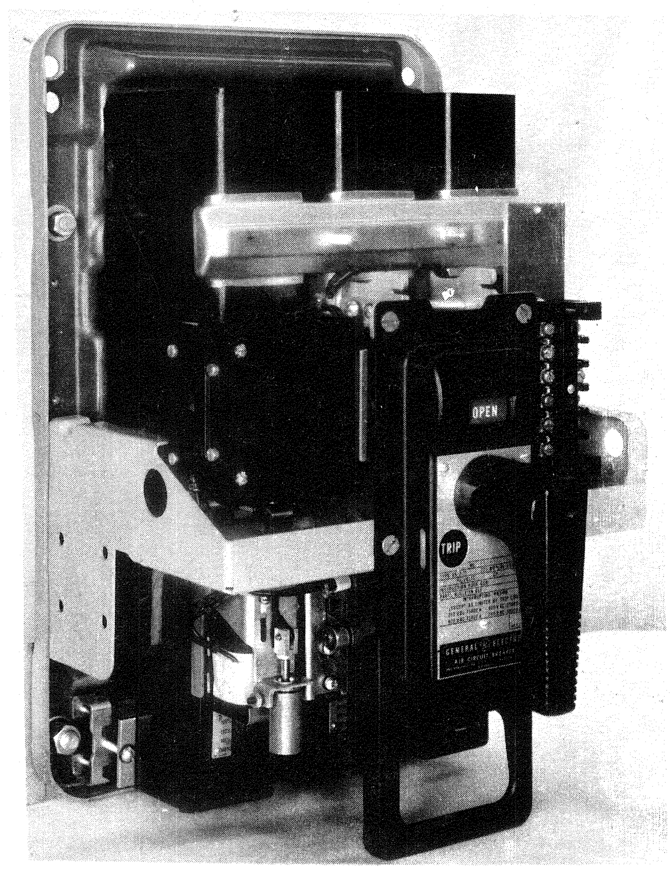
MAINTENANCE INSTRUCTIONS

GEI-50299A
SUPERSEDES GEI-50299

POWER CIRCUIT BREAKERS



Types
AK-2-15
AK-2-25

LOW VOLTAGE SWITCHGEAR DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

CONTENTS

POWER CIRCUIT BREAKERS
TYPES AK-2-15 AND AK-2-25

INTRODUCTION

The instructions contained herein provide information for performing maintenance procedures and for replacing AK-2-15/25 breaker components and accessories. For information regarding the receiving, handling, storage and installation of these breakers, refer to GEH-2021A, furnished with all AK breakers.

OPERATION

ELECTRICAL OPERATION
FIG. 1

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

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

Electrically operated breakers may also be closed by means of the maintenance handle which is furnished with the breaker. This is a separate tool and is simply a lever which permits an operator to push upwards on the closing solenoid armature. Two small hooks on one end of maintenance handle are engaged in slots (9A) Fig. 5, located in the lower portion of the front escutcheon (8A) Fig. 5. Rotation of the long end of the handle downwards forces the shorter end of the handle upwards against the bottom of the solenoid armature, and closes the breaker.

Fig. 1 (695C160-1) (695C159-1)

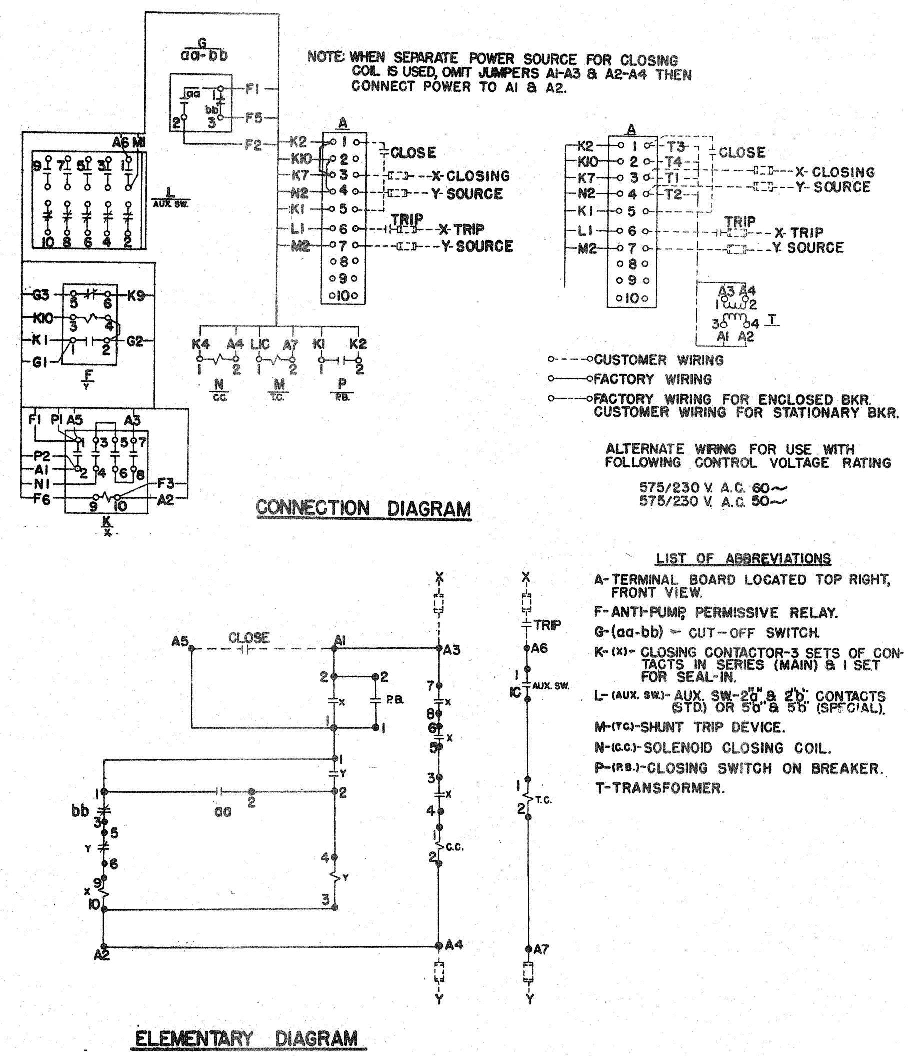


Fig. 1 Typical Wiring Diagram

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

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

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

The undervoltage device coil is normally continually energized. When the control voltage is low or non-existant, as when the breaker has been pulled out for inspection or maintenance, the breaker is rendered trip-free by the undervoltage device. If it is desired to close the breaker, the device armature must be tied down or blocked closed against the magnet.

MANUAL OPERATION

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

The breaker may be tripped manually by pushing the manual trip button. This action pushes a rod against a trip paddle of the trip shaft, rotating it, and causing the mechanism trip latch to be displaced. This allows the mechanism linkage to collapse through the action of the mechanism operating springs.

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

ELECTRICAL AND MANUAL OPERATION

This operating mechanism provides both manual and electrical closing. The operating mechanism is similar to the mechanism of the standard electrical breaker with the addition of the manual handle, cam and mechanism connecting link. The solenoid connecting link and manual cam connecting link are both connected to the closing spring pin at the top of the mechanism, thus compressing the springs when force is provided by either means of breaker closing.

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

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

MAINTENANCE

INSPECTION

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

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

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

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

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

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

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

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

SEPARATION OF FRONT AND BACK FRAMES FIG. 3

Many maintenance operations will either require or be greatly facilitated by separating the front frame and mechanism of the breaker from the back frame or base, which consists of the current carrying parts of the breaker and their supporting structure. The procedure for this operation is as follows:

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

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

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

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

LUBRICATION

In general, the circuit breaker requires very little lubrication. Bearing points and sliding surfaces should be lubricated very lightly at the regular inspection periods with a thin film of extreme temperature, high pressure, light grease, similar to G. E. Spec. No. D50H15 or RPM No. 5. Hardened grease and dirt should be removed from latch and bearing surfaces by the use of a safe cleaning solvent such as kerosene. Latch surfaces should be left clean and dry and not be lubricated. ALL EXCESS LUBRICANT SHOULD BE REMOVED WITH A CLEAN CLOTH IN ORDER TO AVOID ANY ACCUMULATION OF DIRT OR DUST.

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

TROUBLE SHOOTING

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

TROUBLE SHOOTING

TROUBLE	CAUSE	REMEDY
Overheating	Contacts not aligned.	Adjust contacts.
	Contacts dirty, greasy or coated with dark film.	Clean contacts.
	Contacts badly burned or pitted.	Replace contacts.
	Current carrying surfaces dirty.	Clean surfaces of current carrying parts.
	Corrosive atmosphere.	Relocate or provide adequate enclosure.
	Insufficient bus or cable capacity.	Increase capacity of bus or cable.
	Bolts and nuts at terminal connections not tight.	Tighten, but do not exceed elastic limit of bolts or fittings.
	Current in excess of breaker rating.	Check breaker application or modify circuit by decreasing load.
	Excessive ambient temperature.	Provide adequate ventilation.
Failure to Trip	Travel of tripping device does not provide positive release of tripping latch.	Re-adjust or replace tripping device and check mechanism latch adjustment.
	Worn or damaged trip unit parts.	Replace trip unit.
	Bind in overcurrent trip device.	Replace overcurrent trip device.
False Tripping	Overcurrent trip device pick up too low.	Check application of overcurrent trip device.
	Overcurrent trip device time setting too short.	Check application of overcurrent trip device.
	Bind in overcurrrent trip device.	Replace overcurrent trip device.
Failure to Close and Latch	Binding in attachments preventing resetting of latch.	Re-align and adjust attachments.
	Latch out of adjustment.	Adjust latch.
	Latch return spring too weak or broken.	Replace spring.
	Hardened or gummy lubricant.	Clean bearing and latch surfaces.
	Closing solenoid burned out.	Replace solenoid coil.
	Solenoid control device not functioning properly.	Re-adjust or replace device.

BASIC BREAKER COMPONENTS

DISCONNECTS

PRIMARY DISCONNECTS

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

SECONDARY DISCONNECT, FIG. 2

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

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

REPLACEMENT OF MOVABLE SECONDARY DISCONNECTS

1. Unfasten disconnect body from breaker back frame.

2. Open tabs which hold wires on inner side.

3. Pull contact tip loose from hollow tube.

4. Remove contact tip by cutting wire at its base.

5. Push wire through hollow tube of new disconnect assembly.

6. Strip insulation off end of wire to about 1/4 of an inch from end.

7. Place new contact tip on end of wire and crimp.

8. Pull wire through hollow tube until contact tip fits snugly against end of hollow tube.

9. Crimp tab on other side of assembly to hold wire in place.

10. Any hollow tubes which are not used should be pushed into the disconnect body and held in that position by placing fibre spacers over inner ends of tubes and spreading tabs.

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

ARC QUENCHER

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

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

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

REPLACEMENT

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

BREAKER CONTACT STRUCTURE

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

The upper stud branches into two pivot surfaces on its inner end on the forward or front side of the breaker base. Each of these convex pivot surfaces mates with the concave pivot surface on the rear side of the stationary contacts. Each of the stationary contacts pivot in a horizontal plane approximately at their mid-points. The end of the contact opposite to the contact tip end is formed into the shape of a small hook. A tension spring engages this hook and provides the necessary contact pressure at the pivot and also at the point of contact with the movable contact arm. When the breaker contacts open, a projection on the contact tip end of the stationary contact bears against a stop pin restricting the movement of the stationary contact. This arrangement results in a continual high force existing between the mating pivot surfaces and eliminates the necessity of fast-wearing flexible shunts around the pivot point.

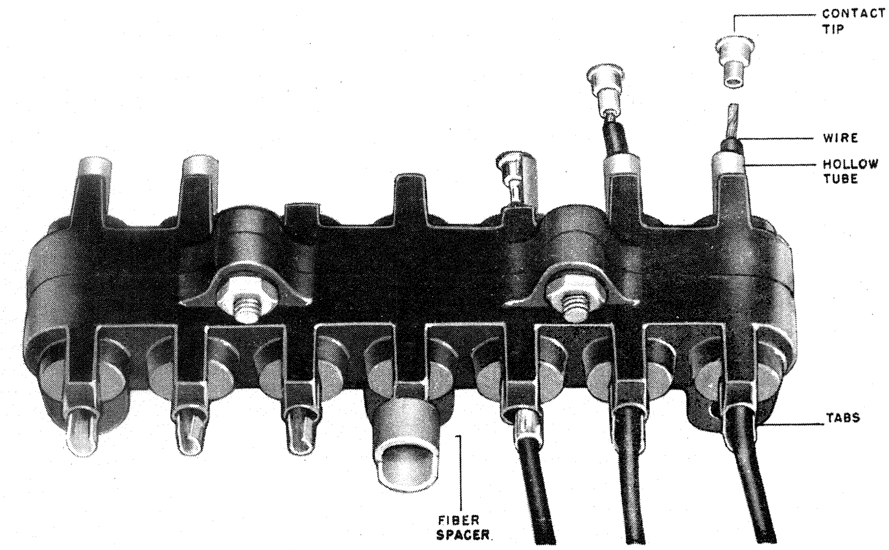


Fig. 2 Movable Secondary Disconnects

Fig. 2 (8017973)

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

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

CONTACT ADJUSTMENTS

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

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

The means of adjusting contact wipe is provided by an eccentric pin which passes through the center of the movable contact assembly. Each end of this pin has a free, projecting, hexagon shaped section which is easily accessible to a small, open end, 1/4 inch wrench. Two cantilever springs, which bear on each end against a portion of the hexagon section of the pin, lock the adjusting pin in place and provide index stops for the process of adjustment. The right hand hexagon shaped end of the pin is numbered from 1 to 6, which provides a reference for making wipe adjustments.

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

1. With the breaker in the open position and using the numbers on the right

end of each adjusting pin as a reference, set each pin in the same position. In many cases, the number 3 is a good beginning point. The proper view of the number on the adjusting pin is obtained by viewing the breaker from the front and the adjusting pin from approximately a 15 degree angle with respect to the movable contacts. Note that the numbers on the pin are not in numerical sequence as the pin is rotated.

2. By measurement, establish the position of the front surfaces of the stationary contacts with reference to the steel arc runners above and behind the contacts.

3. Close the breaker, and establish the amount of wipe by again measuring as in step two, and comparing the measurements with those taken with the breaker open.

4. If any set of contacts lead or lag the others, open the breaker and advance or retard the adjusting pin to the next higher or lower number. Moving the adjusting pin to a higher number will increase the contact wipe and moving to a lower number will decrease the contact wipe.

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

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

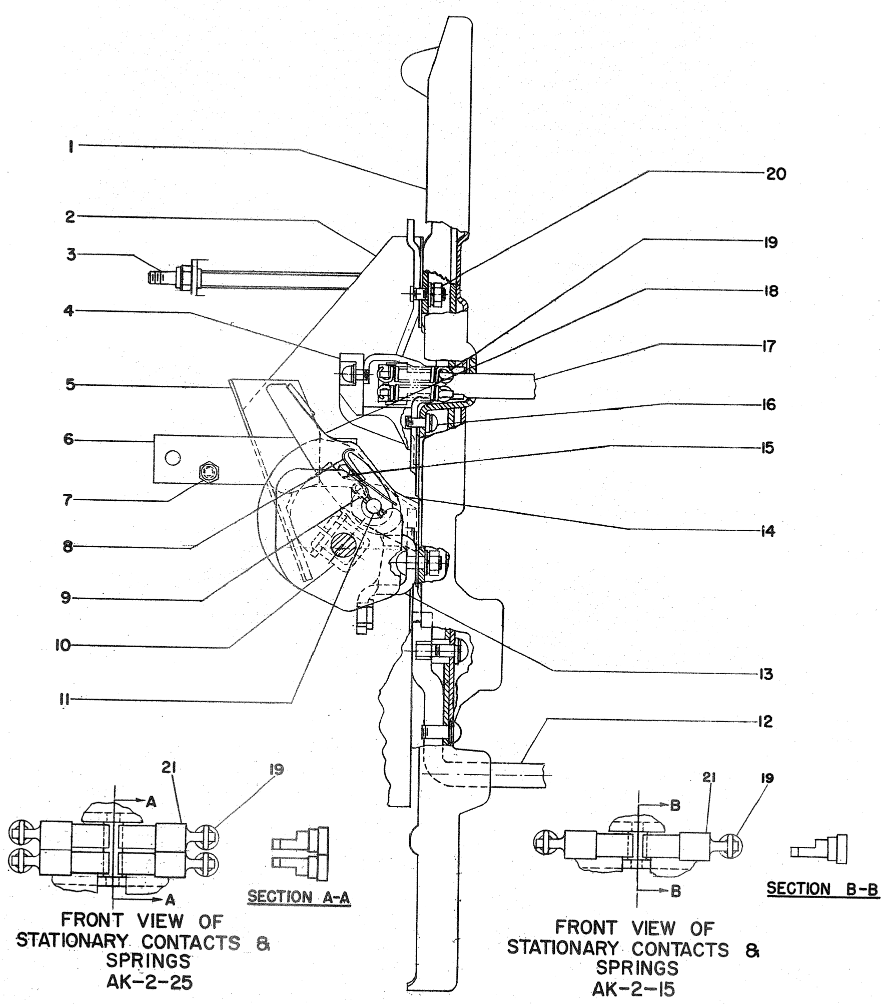
CONTACT REPLACEMENT FIG. 3

The normal situation that will exist in the matter of contact replacement will call for replacement of all the movable and stationary contacts at the same time. This will be the case where long use of the breaker in service has resulted in extensive wear or erosion of the silver alloy contact tips. A commonly used "rule of thumb" is that contact replacement is indicated if less than one-half of the original thickness (1/8 of an inch) of the contact tip material remains.

When the movable breaker contacts are to be replaced, remove the front frame from the back frame as described under "Separation of Front and Back Frames" of these instructions. The stationary contacts can be replaced with the breaker intact. The procedures for replacing both stationary and movable contacts is described as follows:

STATIONARY CONTACTS (21)

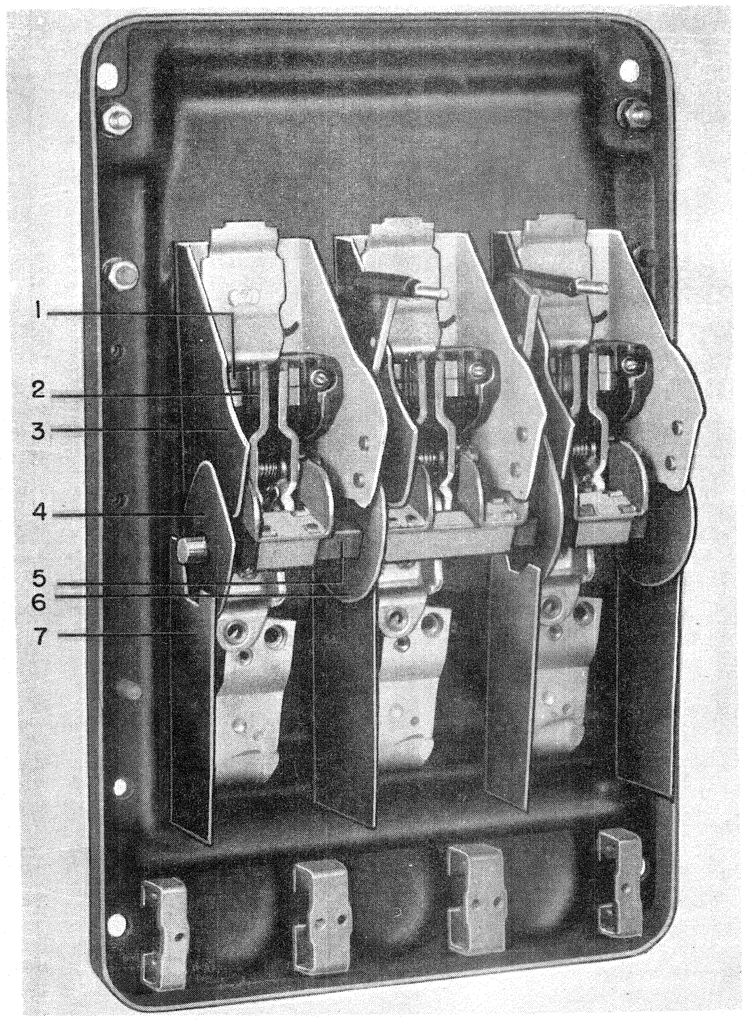
Without separating the breaker front and back frames, force the contacts away from the contact assembly center stop pin and toward their own pivot point with a screwdriver until the contacts stop surface is free of the center stop pin. The contact can then be removed with the fingers by disengaging the contact from its



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

Fig. 3 Contact Assembly

Fig. 3 (549D409-1)



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

Fig. 4 AK-2-25 Back Frame - Location of Crossbar and Pole Shields

Fig. 4 (8026294)

spring. Remove each stationary contact in this manner.

MOVABLE CONTACTS (18)

1. Separate the front frame from the back frame of the breaker. (See section dealing with subject).

2. Remove insulation (5) by lifting and pinching sides together so that the enlarged portion of the slotted hole in each side of the insulation clears the head of the rivet which holds it in place.

3. Release the pivot pin spring clip retainer (9). On the outer poles this retainer is similar to a safety pin and is released by opening its ends as with a safety pin. The center pole is equipped with a clothes pin type retainer which can simply be pulled off the pivot pin (11).

4. The pivot pin (11) of the outer poles is tapped on its outer end. The thread size is #8-32. A #8-32 screw may be used to engage the threads and drift out the pin. If no screw is available, the pin may be pushed out from its inner end.

5. After the pivot pins have been removed from the outer poles, the outer movable contact assemblies may be pulled free of the crossbar assembly (10). A small amount of force will be required to do this as springs (8) and (14) will offer some resisting force.

6. The crossbar assembly (10) may now be removed from the center pole contact assembly. Again, the retaining forces of springs (8) and (14) must be overcome. The pivot pin (11) of the center pole is shorter than its counterpart in the outer poles and does not engage the bracket on the crossbar assembly.

7. If spring clip retainer (9) has not already been removed, it may now be pulled off and the center pole pivot pin (11) drifted out, freeing the contact assembly.

REASSEMBLY

Reassembly is accomplished by reversing the procedure of disassembly. Important factors to remember in performing the reassembly are as follows:

1. The stationary contacts must be arranged in the pole units as shown in sections A-A and B-B of Fig. 3. Note the position of the back projection of each contact. If the contacts are not arranged as shown, the back of the contacts will bear against the stud supports, causing possible damage to the contacts or failure of the breaker to latch in, when the breaker is closed.

2. In replacing the stationary contacts, first place the hook on the end of the contact in the hole of the contact spring (19), then push sidewise until the back projection on the opposite end of the contact can be slipped behind the stop pin in the center of the contact assembly.

3. The adjustment of contact wipe will be facilitated by following the procedure outlined under "Contact Adjustments" of these instructions.

4. When reassembling the crossbar assembly, the crossbar shields should be located with respect to the asbestos pole shields as shown in Fig. 4. If the crossbar shields are not located as shown, breakage may occur when the breaker is operated.

CONTACT SPRINGS (19)

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

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

MECHANISM

The AK-2 breaker mechanism is a spring actuated, over-center toggle type of mechanism. As the closing force is applied, either by movement of the operating handle or the closing solenoid armature, energy is stored in the operating springs. After the springs have gone over center, movement of the output crank of the mechanism is still blocked for a time by a cam arrangement. As the springs are further extended, the blocking cam moves away from the output crank, and the springs are allowed to discharge part of their stored energy, closing the breaker contacts.

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

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

ADJUSTMENT

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

If the breaker mechanism does not function properly, it is best to first perform the available remedial measures listed in the "Trouble Shooting" chart of these instructions. One of the remedies listed is that of proper mechanism latch engagement, the amount of engagement between the latch (7) and latch roller (5), Fig. 6. This is the only adjustment that is required on the breaker mechanism, and proper latch engagement is obtained in the following manner:

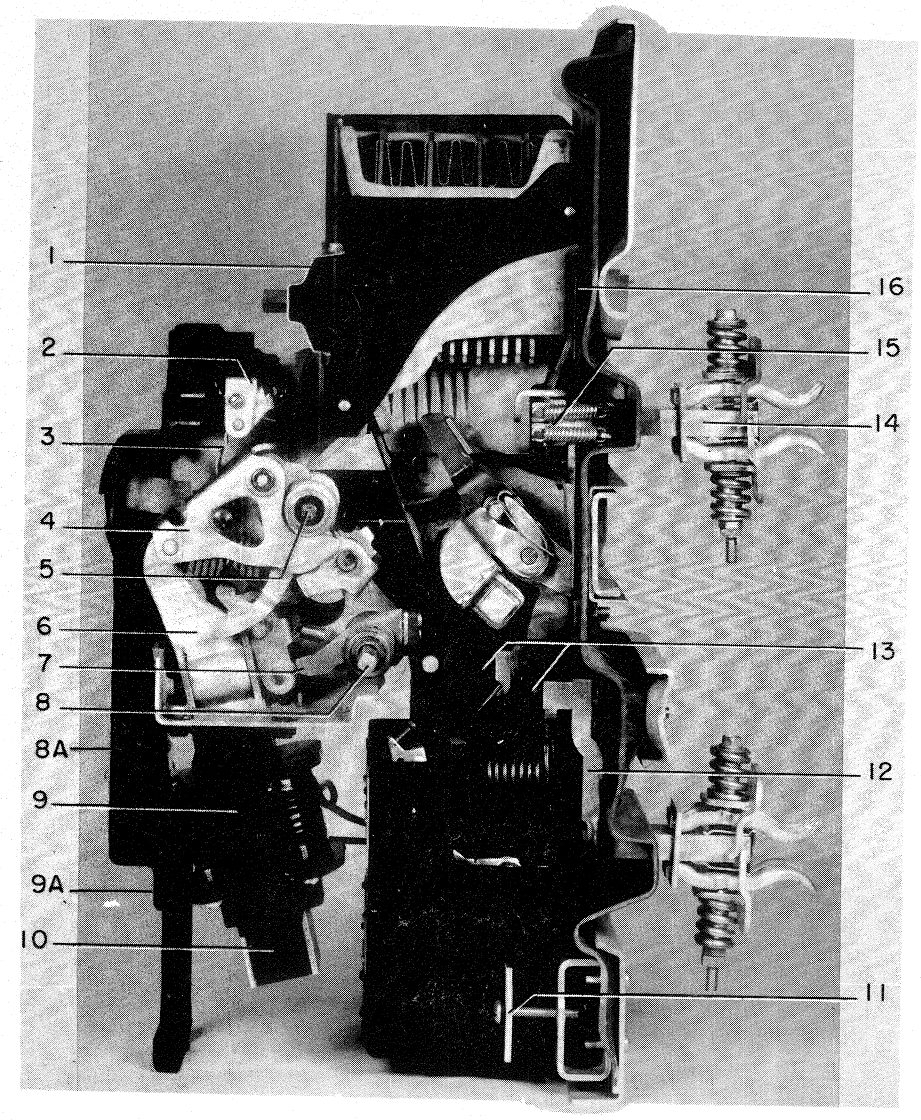
(NOTE - Before making latch adjustments, check to make sure that the buffer paddle which stops against the end of the latch adjustment screw is rigidly fastened to the trip shaft. Hold the trip shaft (8), Fig. 5, steady and attempt to move the buffer paddle. If any relative movement between the two is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

Latch Adjustment - Manual Breakers

1. Locate the latch adjustment screw on the lower, outer side of the right-hand mechanism side frame. This screw is threaded through a nylon insert locknut which, in turn, is welded to a projecting bracket on the side frame.

2. Rotate the closing handle 90 degrees counterclockwise, setting the closing mechanism in the reset position. Turn the adjusting screw into the locknut until the closing mechanism trips open, the closing handle returning to its normal vertical position. NOTE: KEEP HANDS CLEAR OF THE CLOSING HANDLE WHEN MAKING THIS ADJUSTMENT.

3. Withdraw the adjusting screw from the locknut 1/4 turn at a time, attempting to close the breaker after each 1/4



1. Arc Quencher Retainer
2. Cut off Switch
3. Cut off Switch Actuator
4. Spring Carrier
5. Shoulder Pin
6. Connecting Link
7. Trip Latch Roller
8. Trip Shaft

8A. Front Escutcheon

9. Closing Solenoid

9A. Location of Slots For Maintenace Handle

10. Closing Solenoid Armature
11. Cover Retainer of Overload Device
12. Lower Stud
13. Socket Head Screws
14. Upper Stud
15. Stationary Contacts and Springs
16. Arc Runner

Fig. 5 Cut Away Model of Electrically Operated AK-2 Breaker

Fig. 5 (8024457)

turn, and observing whether the contacts move toward closing before tripping occurs. If the contacts move before tripping occurs, you have established the position of the adjusting screw where the latch and latch roller begin to engage. In some cases, it may be necessary to turn the adjusting screw less than 1/4 turn in order to establish the position where the contacts begin to move before tripping occurs. When this position is established, note the position of the slot in the head of the adjusting screw.

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

Latch Adjustment - Electrical Breakers

1. Locate the latch adjustment screw on the lower, outer side of the right mechanism side frame. This screw is threaded through a nylon insert locknut which, in turn, is welded to a projecting bracket on the side frame.

2. With the breaker in the open position turn the adjusting screw into the locknut one complete turn at a time, closing the breaker after each complete turn of the adjusting screw, until the breaker will not close. Use the maintenance closing handle whenever closing or attempting to close the breaker during this entire operation.

3. Withdraw the adjusting screw from the locknut 1/4 turn at a time, attempting to close the breaker after each 1/4 turn, and observing whether the contacts move toward closing before tripping occurs. If the contacts move toward closing before tripping occurs, you have established the position of the adjusting screw where the latch and latch roller begin to engage. In some cases, it may be necessary to turn the adjusting screw less than 1/4 turn to establish the position where the contacts move before tripping occurs. When this position is established, note the position of the slot in the head of the adjusting screw.

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

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

REPLACEMENT

1. If the breaker is electrically operated, remove the front escutcheon by taking four screws from flange. If the breaker is a drawout type, two small round head screws must also be removed from the bottom edge of the escutcheon. (For removal of front escutcheon from manually operated breakers, see procedure described below.)

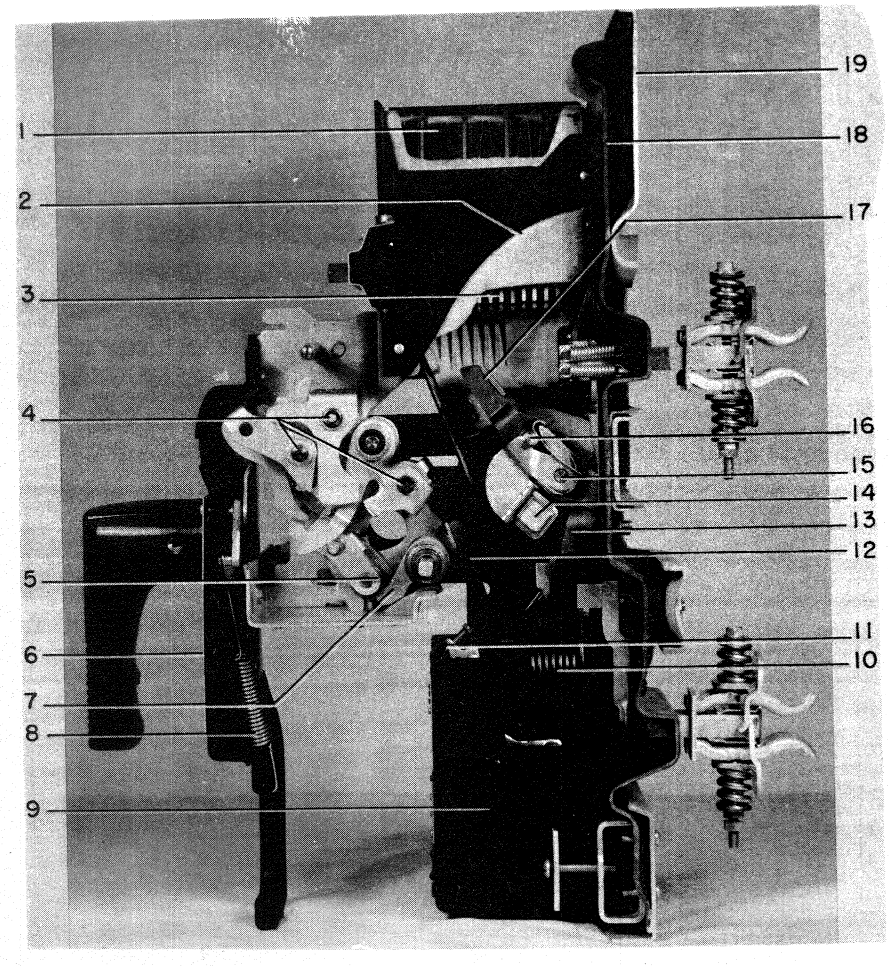


Fig. 6 (8024516)

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

Fig. 6 Cut Away Model of Manually Operated AK-2 Breaker

2. Remove arc quenchers (see "Arc Quencher").

3. Disconnect the two insulated connecting links between the mechanism and the contacts as in step 2 of the procedure for "Separation of Front and Back Frames".

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

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

6. If the breaker is manually operated, and has no auxiliary switch, it is now free to be lifted clear of the breaker. If it has an auxiliary switch, this may be disconnected from the mechanism as described under "Auxiliary Switch - Replacement, elsewhere in these instructions.

7. If the breaker is electrically operated, it will be necessary to disconnect the mechanism from the solenoid armature. In order to do this, raise the mechanism as far as the travel of the armature will permit and remove the screw which binds together the two extensions of the armature. After this is removed, the armature extensions must be spread apart to release them from the link connecting with the mechanism. This can be done by threading a #10-32 screw at least 1 3/4 inches long into the top hole of the armature extension. This hole is just above the one from which the binding screw has been removed. As the end of the screw butts against the far extension, the two extensions will be spread open, releasing the mechanism link.

8. The replacement mechanism may be installed by reversing the order of procedure for disassembly. After reassembly, check the operation of the breaker and, if necessary, adjust the latch engagement.

REMOVAL OF FRONT ESCUTCHEON OF MANUAL BREAKERS

1. Remove set screw fastening the plastic handle to steel operating shaft and remove the operating handle.

2. Open and remove annealed (soft) retainer and two flat washers from shaft.

3. Remove four screws from flange of escutcheon. If the breaker is a drawout type, two small round head screws must also be removed from the bottom edge of the escutcheon.

4. Push steel operating shaft through escutcheon bushing.

5. Remove handle reset spring (8) Fig. 6, and escutcheon is free of breaker.

6. Handle and escutcheon assembly can be assembled most easily by exactly reversing the procedure for disassembly. In replacing the excutcheon it may be necessary to use pliers to pull the operating shaft fully into the escutcheon in order to have space enough to replace the flat washers and the soft retainer. The latter may be closed on its groove in the shaft by ordinary gas pliers. After replacement, check operation of breaker.

AUXILIARY SWITCH

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

REPLACEMENT

1. Remove auxiliary switch cover.

2. Disconnect leads to switch terminals.

3. Remove two screws which fasten switch to side of mechanism frame.

4. Remove switch by moving towards left.

5. Before mounting replacement switch, turn the crank end of the switch operating shaft in position to engage the hole in the link connecting with the breaker mechanism. Be sure the bearing washer is in place between the mechanism link and the switch operating shaft.

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

ELECTRICAL CONTROL COMPONENTS

These consist of the following:

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

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

CLOSING SOLENOID

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

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

REPLACEMENT

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

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

2. Remove closing switch. (See "Closing switch".)

3. Cut off or disconnect the coil leads.

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

5. Allow lower section of magnet and coil to slide downward until clear of armature.

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

"X" CONTACTOR

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

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

REPLACEMENT

Removal of the complete device is accomplished by removing the cover, disconnecting the leads from the terminals, and removing the nuts from the three mounting studs. If the replacement unit includes the mounting bracket, the relay need not be removed from the old bracket. This can be taken off the breaker simply by removing the two screws which fasten it to the breaker frame. If the breaker is a drawout type, the supporting bracket of the "Y" relay may be temporarily displaced to provide access to the screws.

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

Contacts

1. Remove relay cover.

2. Remove terminal binding screw of stationary contact to be replaced.

3. Lightly pinch with pliers (pointed end) the split section of the contact which enters the hole in the compound body of the device and lift out the stationary contact.

4. With the fingers, pull forward on the spring guide of the movable contact, compressing the contact spring as far as possible.

5. With the spring thus held, grip the end of the contact strip with pointed pliers, turn it through 90 degrees on its long axis, and withdraw it.

6. Replace new contacts by reversing the procedure.

Coil

1. Remove relay cover.

2. Turn the two retaining spring clips on the ends of the device through 90 degrees about their pivots.

3. Pull out the two halves of the body of the device which carry the stationary contacts. When these are clear of the frame, the armature and movable contact assembly will move aside, exposing the coil.

4. Remove the terminal screws of the coil and pull it free of its retaining spring clips.

5. Place new coil on pole piece inside of the spring clips and fasten terminals to leads.

6. Just start the replacement of one of the compound blocks which hold the stationary contacts into its groove in the frame.

7. Position the armature and movable contact assembly to allow the entrance of the second stationary contact block.

8. When these parts are all properly aligned, with the stationary contacts under the movable contacts, push them into their guiding grooves in the frame until they bottom.

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

"Y" RELAY

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

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

REPLACEMENT

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

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

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

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

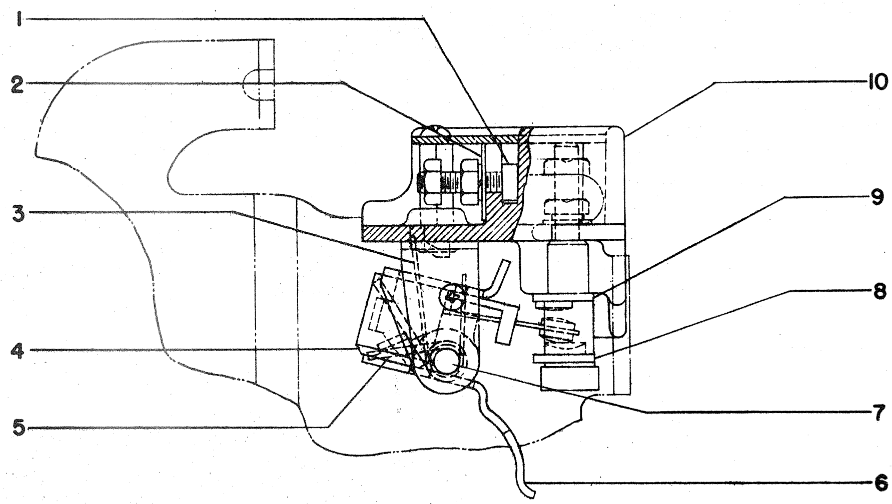
1. Apply closing voltage to terminal board or secondary disconnects.

2. Push button of closing switch and hold closed.

3. Continuing to hold push button in closed position, manually trip the breaker open.

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

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



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

Fig. 7 Cut-Off Switch

CUT-OFF SWITCH, FIG. 7

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

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

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

REPLACEMENT

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

1. Remove the cover on the top of the switch by taking out the two screws which hold it in place.

2. After taking careful note of the connection arrangement, disconnect the leads from the switch terminals.

3. Remove the two screws, one on each side, which fasten the switch to the mechanism side plates. Note that the one on the right hand side also holds a wiring cleat and spacer which serves to hold the wires clear of the link connecting the mechanism and the breaker position indicator.

4. Remove the front escutcheon from the breaker.

5. Slide the cut-off switch out from between the steel side plates by pulling straight forward.

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

CLOSING SWITCH, FIG. 8

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

REPLACEMENT

1. Remove escutcheon (3).

2. Disconnect leads from switch terminals.

3. Deflect the left end of hinge (7) to the left so that the movable contact (5) may be disengaged from the switch assembly.

4. Removal of the two screws (10) from speednuts (9) completes the disassembly of the switch.

5. Reassembly with new parts is a matter of reversing the described procedure. In reassembling, be sure the tab on the left end of hinge (7) is bent to the right far enough to avoid any possibility that movable contact (5) might become free of the assembly.

SHUNT TRIP DEVICE, FIG. 9

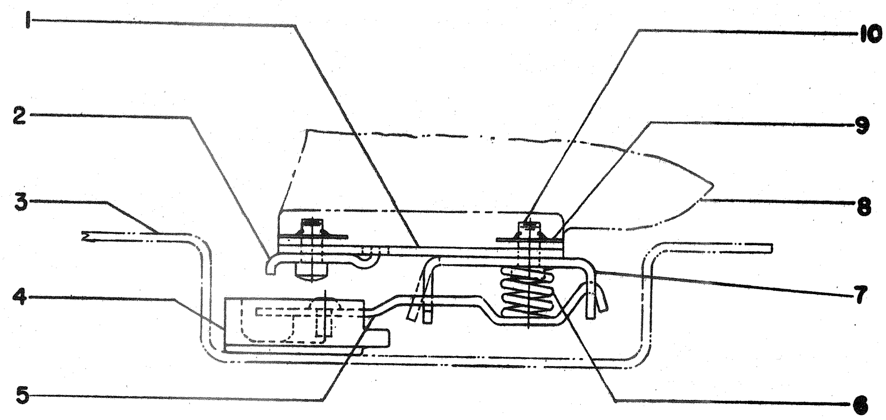
The shunt tripping device is mounted underneath the horizontal cross frame member, just to the left of the front escutcheon. It is composed of a magnet, coil and armature. The armature has an extended arm or striker (11) which bears against the trip paddle (12) on the trip shaft when the coil (8) is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

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

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

REPLACEMENT

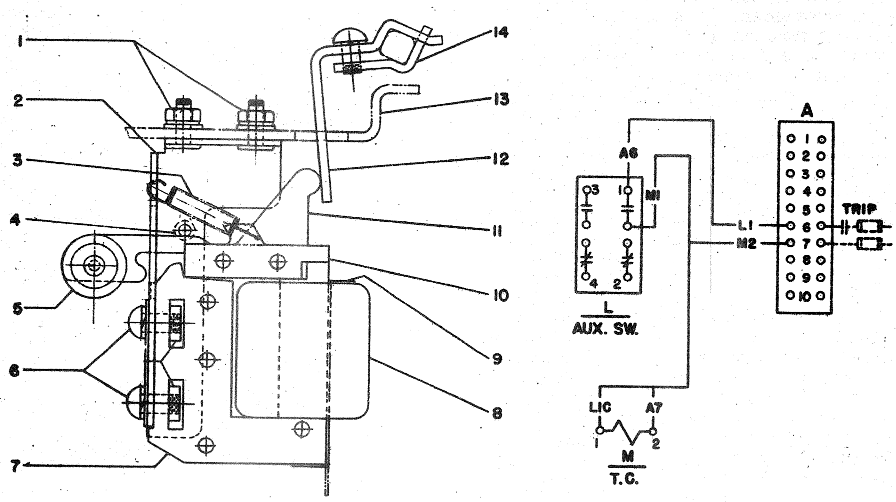
The entire shunt trip device may be dismounted by disconnecting the coil leads and removing nuts (1). However, the only part of the device that might conceivably



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

Fig. 8 Closing Switch (Top View)

Fig. 8 (8058905)



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

Fig. 9 Shunt Trip Device

Fig. 9 (695C161)

need replacement during the life of the breaker is the coil (8). This may be replaced without removing the device from the breaker by proceeding as follows:

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

ADJUSTMENT

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

PROTECTIVE DEVICES

An AK-2-15 or AK-2-25 breaker may be equipped with any combination of the following protective devices:

1. Overcurrent trip
2. Reverse current trip
3. Undervoltage trip
4. Bell alarm and/or lockout attachment.

OVERCURRENT TRIP DEVICE

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

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

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

An AK-2-15/25 breaker may be equipped with either the EC-2 or EC-1 overcurrent trip device. The majority of applications will require the use of the EC-2 device. The EC-1 device is normally used when the short-time delay feature is required, or when the trip device is used to operate a special overcurrent alarm switch.

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

EC-2 OVERCURRENT TRIP DEVICE

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

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

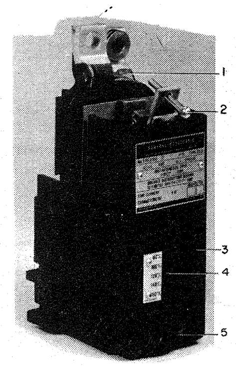
The dual trip has adjustable long-time and instantaneous pick-up settings and adjustable time settings. Both forms of instantaneous trips have adjustable pick-up settings.

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

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

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

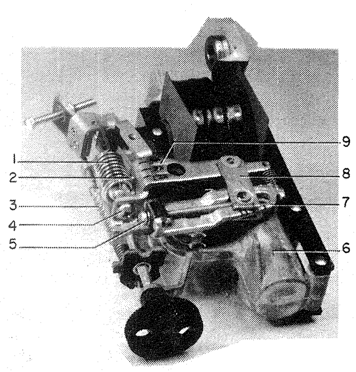
The tripping time may be varied within the limits shown on the characteristic curves by turning the time adjustment screw (5), Fig. 11. Turning in a clockwise direction increases the tripping time; counter-clockwise motion decreases it. The dashpot arm (7), Fig. 11, is indexed at four points, max. - 2/3 - 1/3 - min. from the left, as viewed in Fig. 11. When the index mark on the connecting link (8), Fig. 11, lines up with a mark on the dashpot arm, the approximate tripping time as shown by the characteristic curve is indicated. The 1A and 1B characteristic devices are shipped with this setting at the 2/3 mark and the 1C characteristic at the 1/3 mark. The standard characteristic curves are plotted at the same settings.



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

Fig. 10 (8024842)

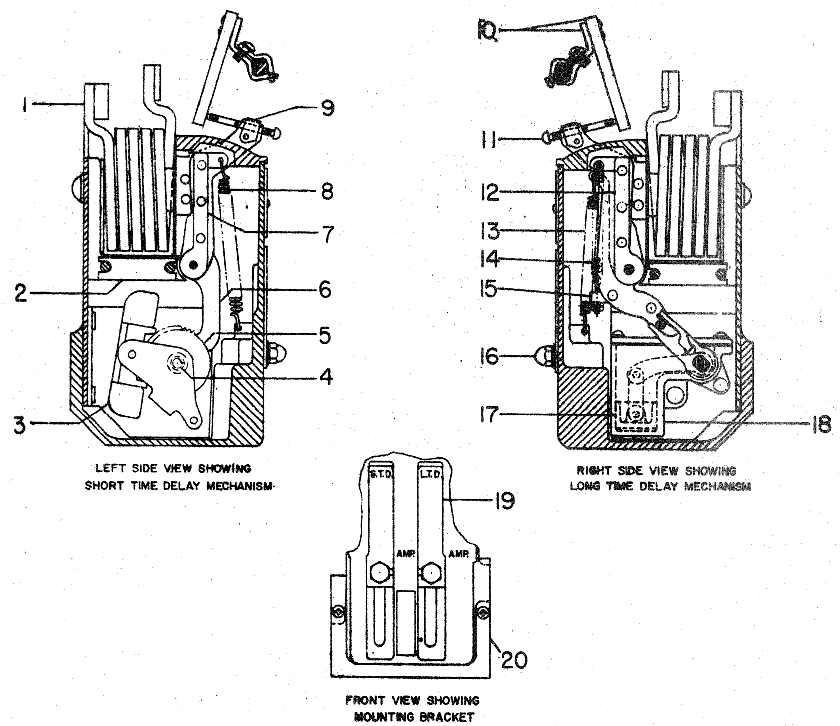
Fig. 10 EC-2 Overcurrent Trip



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

Fig. 11 (8024843)

Fig. 11 EC-2 Overcurrent Trip With Cover Removed



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 Arm
10. Trip Paddle
11. Trip Paddle Adjusting Screw
12. L.T.D. Armature
13. L.T.D. Calibration Spring
14. Instantaneous Trip Spring (High Set)
15. Spring Holder
16. Calibration Clamp Nut
17. Plunger
18. Cylinder (Dashpot)
19. Calibration Plate
20. Clamping Bracket

Fig. 12 (695C189)

Fig. 12 EC-1 Type Overcurrent Trip Device

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. 11, is greatest. The time adjustment screw (5), Fig. 11, may be turned by inserting a Phillips head screwdriver through the hole in the front of the case, but if it is desired to relate the linkage setting to the index marks on the linkage it will be necessary to remove the case. This may be done by removing the two mounting screws, one on each side of the case, which may be taken off without disturbing the trip unit itself.

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

INSTANTANEOUS LOW-SET TRIPPING

The low-set instantaneous pick-up point may be varied by the adjustment knob (5), Fig. 10. The calibration in this case usually ranges from 80% to 250% of the series coil rating, the calibration plate being indexed at values of 80%, 100%, 150%, 200% and 250% of the rating.

INSTANTANEOUS HIGH-SET TRIPPING

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

Three standard calibration marks will appear on the operating arm at (9), Fig. 11, and the value of these calibration marks will be indicated by stampings on the arm as follows:

4X		6X		9X
6.5X	or	9X	or	12X
9X		12X		15X

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

EC-1 OVERCURRENT TRIP DEVICE

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

1. Long time delay, short time delay and instantaneous tripping.

2. Long time and short time delay tripping only.

3. Long time delay and instantaneous tripping.

4. Short time delay and instantaneous tripping.

5. Short time delay tripping only.

6. Instantaneous tripping only.

   (a) Adjustable (Low set)
   or
   Nonadjustable (High set)

SHORT TIME DELAY TRIPPING, FIG. 12

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

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

LONG TIME DELAY TRIPPING, FIG. 12

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

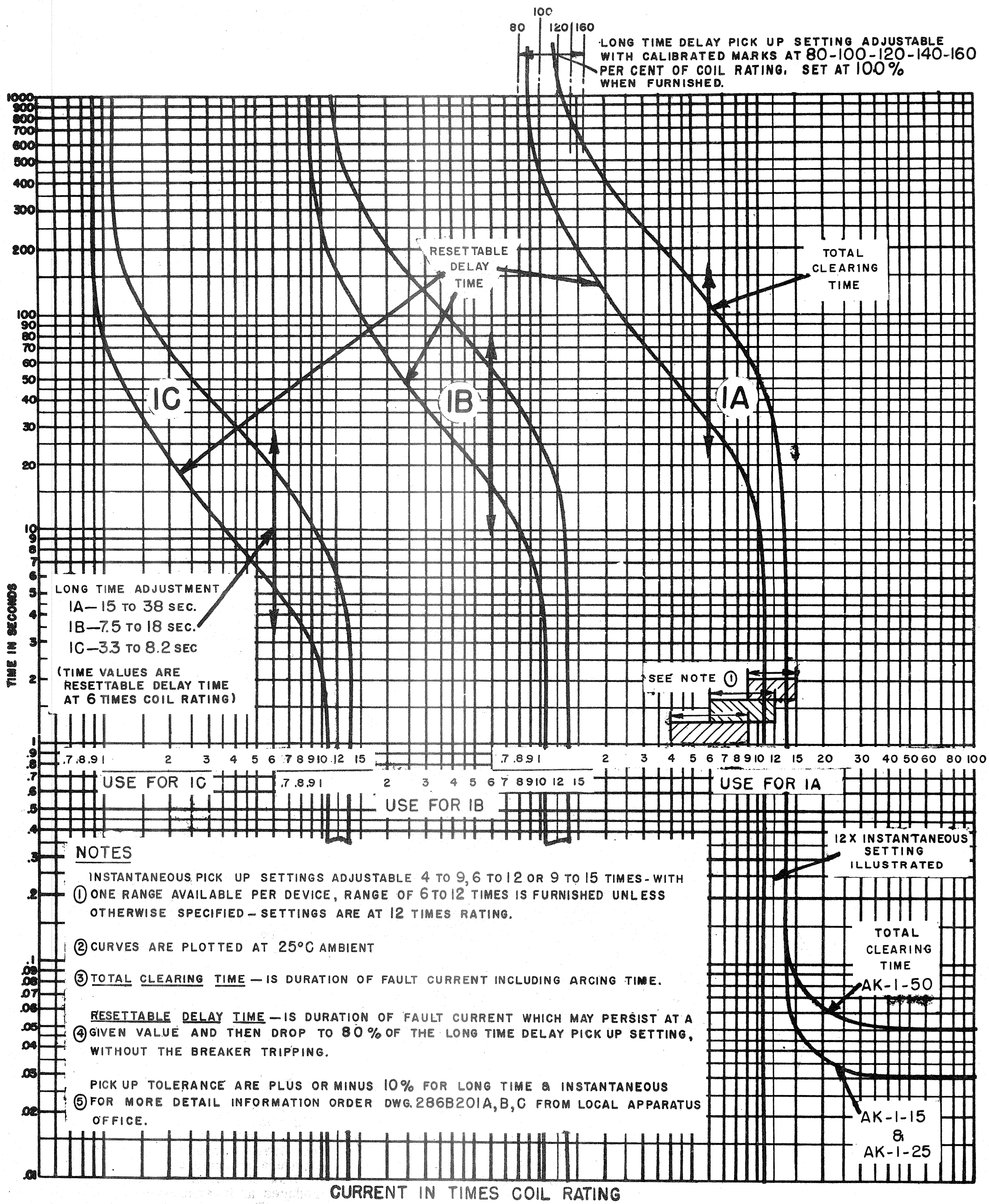


Fig. 13 Time-Current Characteristic of the Type EC-2 Overcurrent Trip Device

Fig. 13 (286B209)

INSTANTANEOUS TRIPPING, FIG. 12

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

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

SELECTIVE TRIPPING

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

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

ADJUSTMENTS, EC-1 AND EC-2

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

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

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

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

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

REPLACEMENT, EC-1 AND EC-2

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

1. Separate the breaker's front and back frames as described in the section under "Maintenance".

2. Remove the steel clamps which fasten the cover of the device to the back of the breaker. NOTE: Pickup settings on the cover of each device are calibrated for the specific device. When replacing covers, replace on associated device.

3. Using a 5/16 inch Allen Head Wrench, remove the 3/8 inch bolts which fasten the coil of the overload device to the breaker copper.

4. Remove the round head screw which fastens the frame of the overload to the breaker base.

5. After reassembling breaker with new overload device, adjust for "positive trip" as described under "Adjustments" of this section.

REVERSE CURRENT TRIP DEVICE

FIGURE 14

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

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

As long as the flow of current through the breaker is in the normal direction, the magnetic flux of the series coil and the magnetic flux of the potential coil produce a torque which tends to rotate the armature counterclockwise. The calibration spring (3) also tends to rotate the armature in the same direction. This torque causes the armature to rest against stop screw (9) attached to a bearing plate on the right side of the device.

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

ADJUSTMENTS

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

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

1. Loosen the locking nut (2A).

2. Manually lift the trip rod and vary the position of the adjusting nut (2), thus establishing the position of the adjusting nut where the breaker is just tripped. (NOTE - Be sure that all parts of the person are kept clear of moving breaker parts when tripping the breaker.

3. With this position of the adjusting nut established, advance the adjusting nut upward one and one half turns.

4. Tighten the locking nut and the minimum 1/32 of an inch overtravel of the trip rod should be obtained.

REPLACEMENT

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

UNDERVOLTAGE TRIP DEVICE

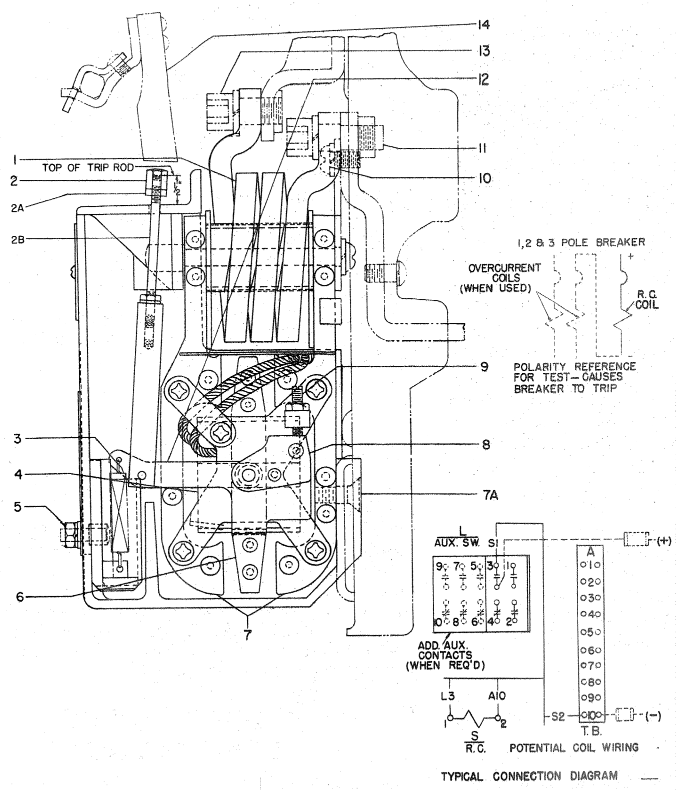
FIGURE 15

The undervoltage device is mounted on the left side of the breaker observed from the front. It hangs from the left end of the horizontal cross member of the front frame. This device has the function of tripping the breaker open if the circuit voltage drops below a predetermined value. Since the coil (16) of the device is normally energized, the flux of the magnetic circuit normally holds armature (3) down against magnet (14). If the voltage drops below a certain percentage value of nominal voltage, the magnetic flux is no longer strong enough to overcome the force of calibration spring (4) which tends to pull the armature away from the magnet. When this occurs, the striker on the armature hits against trip paddle (23), tripping the breaker open.

The undervoltage device may or may not be equipped with a time-delay feature, depending upon requirements. This is provided by an oil dashpot (12) and piston (11). If it does have this feature, when the voltage drops below tripping value, the movement of the armature is delayed by the time it takes to displace the piston a short distance through the oil. The minimum time delay thus afforded is 3 seconds. The depth of the oil in the dashpot should be 1/4 to 3/8 of an inch. The oil level may be checked by unscrewing cylinder (12) from its cap. If additional oil is needed, G. E. silicone oil SF96-40, or its equivalent should be used.

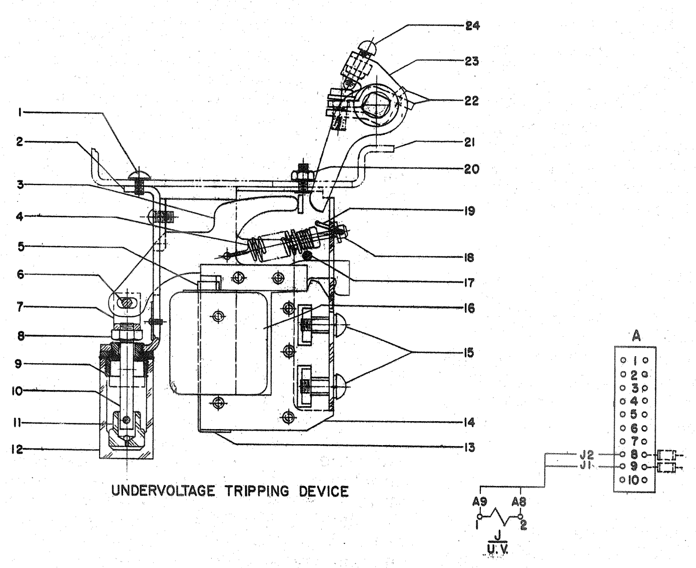
ADJUSTMENTS

Adjustment screw (24) is used to provide an overtravel of from 1/32 to 1/16 of an inch beyond the point of tripping. If the armature is manually held down with the de-energized breaker in the closed position, and then allowed to gradually move to



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

Fig. 14 Reverse Current Tripping Device



1. Mounting Screw
2. Device Frame
3. Armature
4. Spring
5. Shading Ring
6. Pin
7. Clevis
8. Locking Nut
9. Cap
10. Connecting Rod
11. Plunger (Piston)
12. Cylinder (Dashpot)
13. Clamp
14. Magnet
15. Screws
16. Coil
17. Rivet
18. Adjusting Screw
19. Locking Wire
20. Mounting Nut
21. Mechanism Frame
22. Trip Paddle Clamps
23. Trip Paddle
24. Adjusting Screw

Fig. 15 Undervoltage Tripping Device

the point of tripping the breaker, the amount of further armature movement may be noted visually. If this is approximately within the range stated, the positive trip adjustment is satisfactory.

The time delay of the device may be varied somewhat by changing the relative positions of the connecting rod (10) and clevis (7). This is accomplished by first loosening the locking nut (8), then raising or lowering the plunger (11), by turning the connecting rod which is threaded into the clevis. When any time delay of 3 to 10 seconds exists from loss of voltage, the device is considered satisfactorily adjusted.

The value of increasing voltage at which the open armature will pick-up and close, allowing closure of the breaker, is determined by a sliding stop which sets the open gap of the armature. This is a factory adjustment, and should not be set in the field. The pick-up point of voltage is 80% of normal voltage.

Calibration spring (4) establishes the drop out value of voltage, which results in breaker tripping. This setting is made at the factory. Drop-out voltage is set at between 30% and 60% of normal voltage.

REPLACEMENT

The entire device may be dismounted by disconnecting the coil leads and removing screw (1) and nuts (20). Normally, only the coil (16) will ever need replacement. This may be removed from the device by taking out screws (15) which will free both the magnet (14) and the coil. Straightening of the bend in clamp (13) will separate the coil from the magnet. The coil leads, of course, must be disconnected.

BELL ALARM SWITCH AND/ OR LOCKOUT ATTACHMENT

FIGURE 16

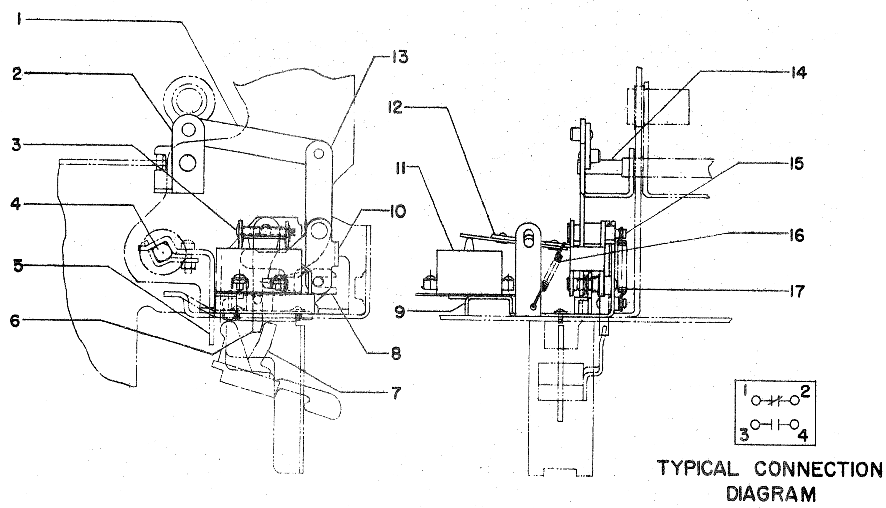
The bell alarm device is mounted on top of the horizontal cross frame member just to the left of the mechanism frame when the breaker is viewed from the front. This device operates a switch with two sets of contacts, one normally open, the other normally closed. The switch may be used to open or close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

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

OPERATION

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

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



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

Fig. 16 Bell Alarm and Lockout Device

Fig. 16 (695C158)

MISCELLANEOUS

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

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

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

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

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

ADDITION OF	COVERED BY
Shunt Trip Device	698C900
Auxiliary Switch	698C901
Undervoltage Device	698C902
Bell Alarm & Lockout Device	698C903
Drawout Mechanism	698C922
Conversion to Elec. Oper.	698C904

MAINTENANCE TOOLS

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

SCREW DRIVERS

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

PLIERS

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

END WRENCHES

Adjustable, 8"
1/4" open end

ALLEN HEAD WRENCHES

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

SOCKET WRENCHES (3/8" DRIVE)

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

MISCELLANEOUS TOOLS

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

RENEWAL PARTS

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

Renewal Parts which are furnished may not be identical to the original parts since from time to time design changes may be made. The parts supplied, however, will be interchangeable with the original parts.

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