IB 6.1.2.7-6B

# Installation/Maintenance Instructions

Low-Voltage
Power Service Protectors

RSP 3000 Contact @ 3/32.

## KSP-1200 thru 4000
Stationary Switchboard Mounted

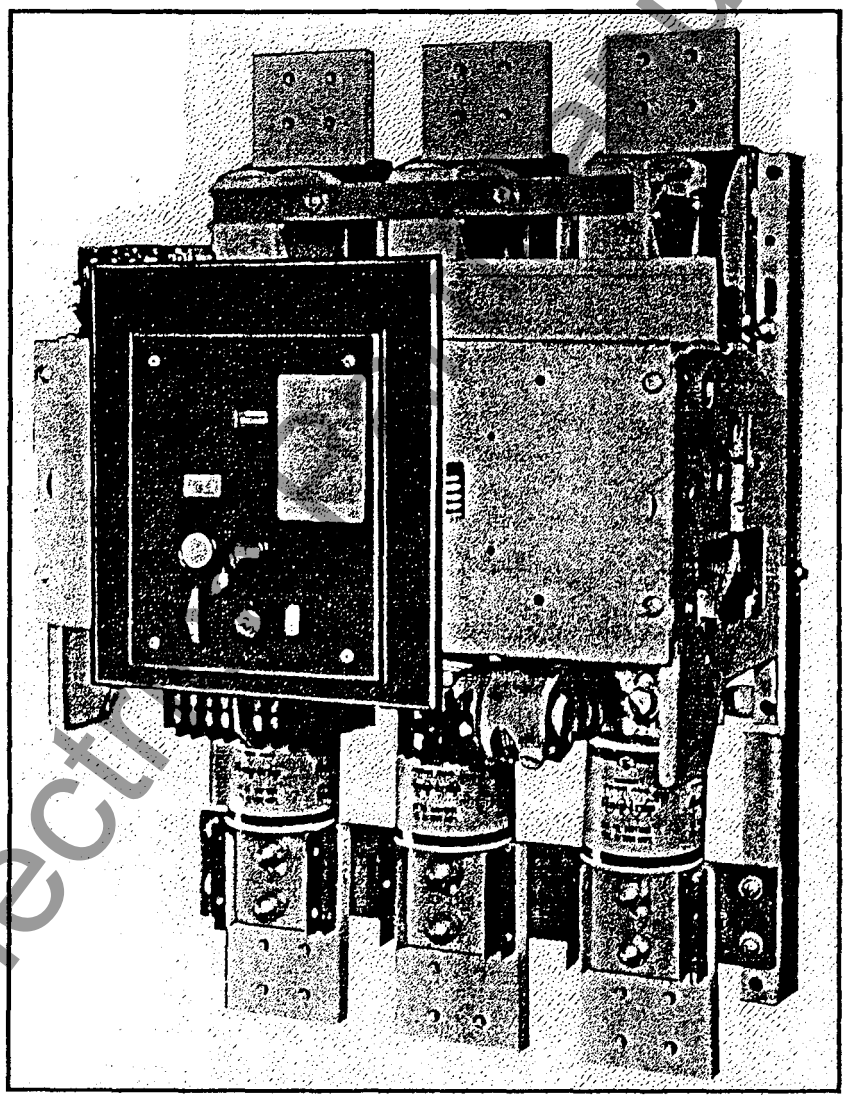

**ABB Power Distribution, Inc.**
**Circuit Breaker Division**

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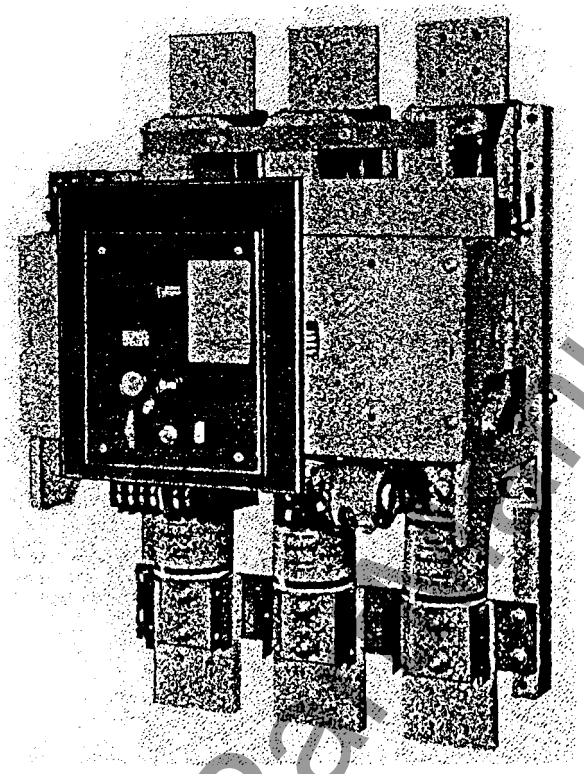

Fig. 1

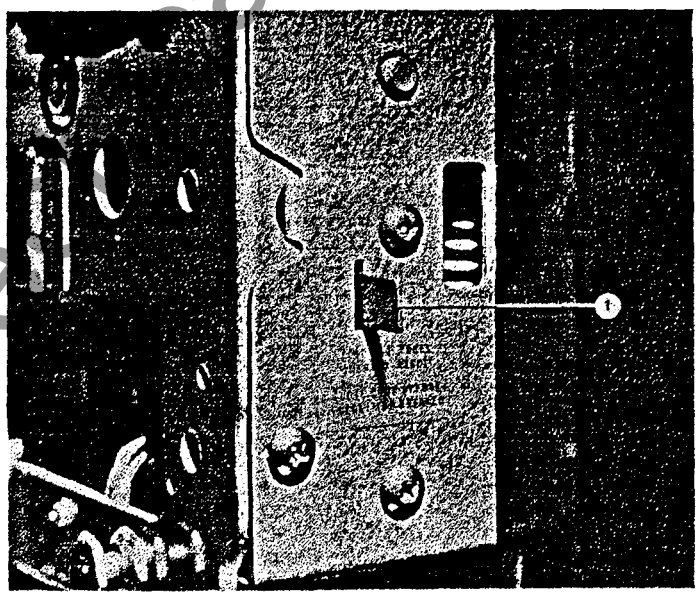

Fig. 2

## INTRODUCTION

The KSP-1200, KSP-1600, KSP-2000, KSP-3000 and KSP-4000 power service protectors are modified basic K-Line® circuit breakers, without direct-acting trip devices, and are supplied for stationary mounting only.

The power service protectors have three added features as follows:

1. Current-limiting fuses, Class L Type.
2. Open-Fuse-Trip device (when ordered).
3. Mechanism Interlock extension to lock door closed when device is in closed position.

All instructions pertaining to installation, operation and maintenance of basic K-Line circuit breakers also apply to the power service protectors.

Refer to the basic instruction and renewal parts bulletins as listed at the bottom of this page.

## CURRENT-LIMITING FUSES (See Fig. 1 )

The current-limiting fuses normally supplied with the power service protector are the Gould-Shawmut Class L Type, and the continuous current rating is equal to the frame size of the particular power service protector. It should be noted that special blocking is provided on the power service protector such that fuses of a continuous current rating higher than that of the protector cannot be installed.

When a fault occurs to open a fuse or fuses, the power service protector will not open unless it is equipped with an open-fuse-trip device. If not so equipped, other means must be used to determine circuit conditions so that the device may be opened to prevent single - phasing of protected equipment.

When a fuse or more than one fuse has blown, it is recommended that all three fuses be replaced regardless of apparent condition because the time-current characteristic of an unblown fuse could be affected and thus system coordination would be affected.

To replace the fuses, the power service protector should be opened and padlocked in the open position for safety to insure that it cannot be closed during this fuse replacement. Replacing the fuses is a simple mechanical procedure, and the one basic requirement is that the bolts should be retightened to a torque value of 85 ft./lbs.

**NOTE:** When replacing the fuses, do not remove the wires from the Open-Fuse-Trip device. If it is necessary to check individual fuse continuity, the fuses must be removed from the service protector to isolate the fuse from the paralleled coil of the device.

Replacement fuses MUST be the current-limiting type and are recommended to be the Gould-Shawmut Type, Catalog A4BY, Type 55, of the appropriate continuous current rating. Any Underwriters' Laboratories, Inc. listed Class L fuse may be used if necessary, however.

## OPEN-FUSE-TRIP DEVICE

The open-fuse-trip device, supplied on 3-pole service protectors, provides automatic opening of the protector when one or more fuses open.

The device consists of three voltage coils with one coil wired in parallel with each fuse. The coils operate on the voltage produced by the fuse during interruption and cause mechanical tripping of the protector.

When the open-fuse-trip device operates, an indicator ( 1, Fig. 2) will extend through the front of the mechanism mounting plate providing indication that the protector has opened due to fuse operation. This is visible only with the door open. Further, the automatic trip indicator on the escutcheon will also have extended providing visible external indication of automatic opening .

When the open-fuse-trip device indicator is extended, the protector will be held in the trip-free position so that it cannot be reclosed. If the indicator is inadvertently reset and the protector reclosed before the fuses are replaced, the protector will safely open again, but this practice is not recommended.

After the fuses have been replaced and the fault removed, both trip indicators should be pushed in to reset the service-protector mechanism. The power service protector may then be closed and service resumed.

The design of the open-fuse-trip device is such that no maintenance or adjustment is necessary on this device for its normal operating life.



BIASIC INSTRUCTION AND RENEWAL PARTS BULLETINS

| Type | Instructions | Repair Parts |
|---|---|---|
| KSP-1200, KSP-1600, KSP-2000 | IB-6.1.2.7-I | RP-6-1.2.8-I |
| KSP-3000, KSP-4000 | IB 6.1.2.7-2 | RP6.1.2.8-2 |

IB 6.1.2.7-2E

# Installation/Maintenance Instructions

Low-Voltage
Power Circuit Breakers

*Type K-3000, K-4000*
*K-3000S, K-4000S, K-3000M, K-4000M*
*3000 and 4000 Amperes*
*600 Volts*

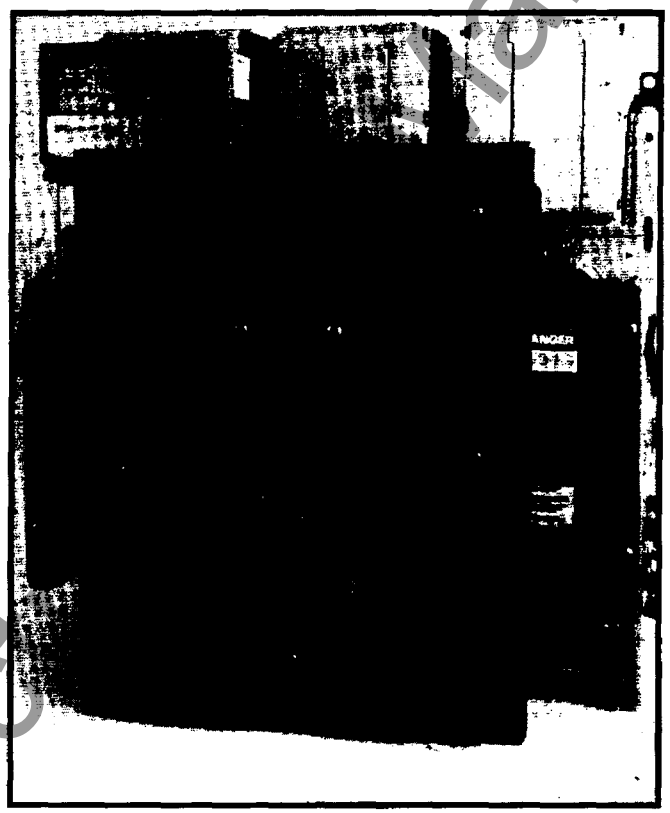



**ABB Power T&D Co. Inc.**
**ABB Power Distribution**
**Distribution Systems Division**

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## INTRODUCTION

These instructions apply to the type K-3000, K-4000, K-3000S, K-4000S, K-3000M, and K-4000M circuit breakers; 3000 and 4000 ampere ac continuous current rating respectively. The type K-3000 and K-4000 are equipped with electromechanical overcurrent trip devices, whereas breakers with "S" and "M" suffixes incorporate the solid state overcurrent trip devices. A K-3000S circuit breaker is shown on the front cover of this bulletin.

The K-3000 and K-4000 circuit breakers can be furnished with two or three poles for dc or ac operation. Breakers with "S" and "M" suffixes are only furnished for three pole ac operation.

All circuit breakers can be furnished as drawout or stationary mounted and are available as manually or electrically operated, and with electrical control devices available in various ac and dc voltage combinations. Many optional features are also available.

An electrically operated, drawout type circuit breaker is shown in Figure 1, with a typical schematic diagram shown in Figure 2.

These instructions should be read thoroughly before handling, installing and/or operating the circuit breaker.

## RECEIVING AND STORAGE

Immediately upon receipt of the circuit breakers, examine the cartons to determine if any damage or loss was sustained during transit. If injury or rough handling is evident, file a damage claim at once with the carrier and promptly notify the nearest Sales Office. The Company is not responsible for damage of goods after delivery to the carrier. However, the Company will lend assistance if notified of claims.

Unpack the circuit breakers as soon as possible after receipt. If unpacking is delayed, difficulty may be experienced in making a claim for damages not evident upon receipt. Use care in unpacking in order to avoid damaging any of the circuit breaker parts. Check the contents of each carton against the packing list before discarding any packing material. If any shortage of material is discovered, promptly notify the nearest Sales Office. Information specifying the purchase order number, carton number and part numbers of the damaged or missing parts should accompany the claim.

Circuit breakers should be installed in their permanent location as soon as possible. (See Basic Handling below). If the breakers are not to be placed in service for some time, it is advisable to provide adequate means of protection. This may be done by keeping the breaker in its original carton, covering with waterproof paper and sealing to prevent infiltration of dirt. Where conditions of high humidity prevail, the use of heaters is recommended.

## BASIC HANDLING INSTRUCTIONS

Once the circuit breaker has been unbolted and removed from its shipping carton, it should be turned to the upright position and placed on a flat surface to avoid damage to breaker parts. For safety, all handling in this position should utilize the lifting yoke (20) shown in Figure 1.

## CIRCUIT BREAKER OPERATION CIRCUIT BREAKER RATING

The K-3000/K-3000S/K-3000M and K-4000/K-4000S/K-4000M circuit breakers are designed to carry a maximum ac continuous current of 3000 amperes and 4000 amperes respectively. Exceeding these ratings may raise the temperature of the breakers beyond their design limit and thus affect the life of the breaker. Thus, any long-time pickup setting exceeding 100% of the frame size is to be used only for coordination, not for carrying increased continuous current.

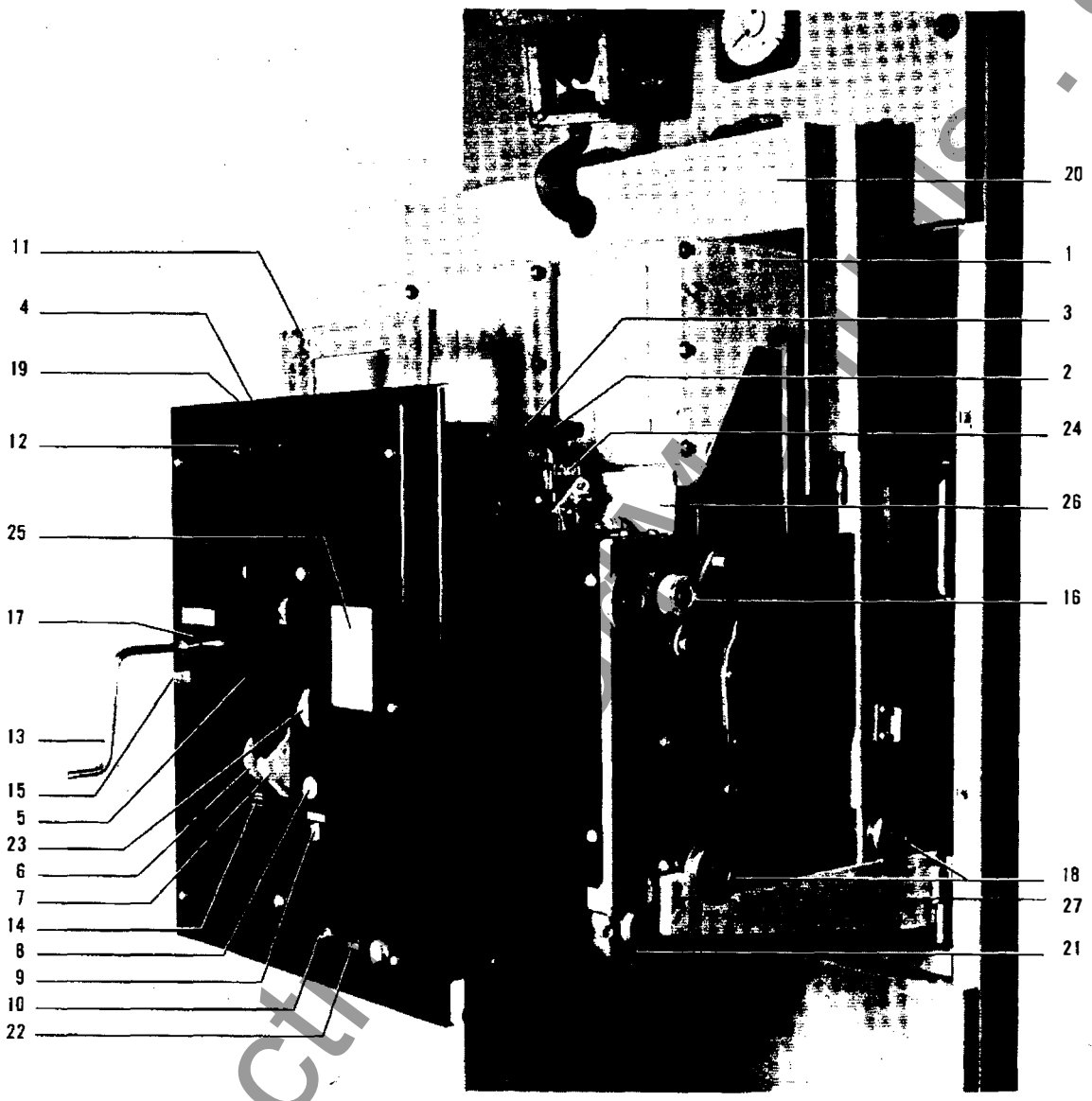
## CLOSING SPRING OPERATION

The two closing springs supply the power that closes the circuit breaker and also charge the two opening springs during the closing operation. The closing springs are charged by a motor in the electrically operated breaker and charged by hand in the manually operated breaker; however, in either type, the springs are charged the same amount and when charged, the spring energy is available to close the breaker, thus referred to as "stored energy". The closing springs are normally charged when the breaker is opened. If charged after closing, (optional) the breaker may be opened and then reclosed without recharging the springs. In drawout breakers, the closing springs are automatically discharged when the breaker is moved from the disconnected to the withdrawn position (shown in Figure 1). This prevents accidental discharge.

## ESCUTCHEON OPERATING FEATURES

Manually and electrically operated circuit breakers are provided with an extendible escutcheon face plate. This escutcheon provides a central area for the controls which are mounted directly on the circuit breaker.

The controls for manually operated circuit breakers, Figure 1, included in the escutcheon face plate are: (25) a nameplate giving the various ratings assigned to the particular




1. Arc Chute
2. Arc Chute Retainer Molding
3. Arc Chute Mounting Screw
* 4. Shutter
* 5. Visual Indicator for Breaker "Closed" or "Opened"
6. Manual Close Lever
7. Manual Charging Lever
8. Manual Trip Button
9. Automatic Trip Indicator
10. Motor Disconnect Switch
11. Spring Retainer Bracket
12. Manual Charge Handle
13. Racking Crank
14. Closing Spring Charge Indicator
15. Drawout Lever
16. Racking Cam Rollers
17. Racking Crank Opening
18. Wheels
* 19. Shutter Lock Screw (Inserted in Shutter)
20. Lifting Yoke
21. Closing Spring Charging Motor
22. Electrical Close Button
23. Locking Hasp
24. Auxiliary Switch
25. Nameplate
26. Plate
27. Hinged Track Extensions

*Not Visible in This View

**Fig. 1 — Typical Electrically Operated, Drawout Type K-3000 Circuit Breaker**

type of circuit breaker, (12) the manual charging handle, (8) the manual trip button, (5) the "OPEN" and "CLOSED" position indicator, (9) the automatic trip indicator with optional facilities for alarm indication and for lockout, (23) a means for padlocking the circuit breaker in the "CONNECTED," "TEST" or "DISCONNECTED" positions, and (14) closing spring charging indicator.
The controls for the electrically operated circuit breakers, Figure 1, are the same as the manually operated circuit breakers except the charging handle (12) is removed and stored for maintenance use, and the presence of (10) motor disconnect switch for the motor electrical circuit and (22) electrical close push button switch .
The manually and electrically operated drawout circuit breaker escutcheon also contains the racking crank opening (17) and interlocking drawout lever (15).
A self-aligning plate, immediately behind the escutcheon face plate, is used to exclude dust from the circuit breaker compartment. On drawout type circuit breakers, the escutcheon face will protrude through the front door of the compartment when the circuit breaker is in the "TEST" and "DISCONNECTED" positions. In these positions, the dustplate still functions to exclude dust.

**Circuit Breaker Nameplate** (Figure 1, Item 25)
The circuit breaker nameplate contains information regarding (1) the manufacturer's name and address, (2) type of circuit breaker design, (3) serial number of circuit breaker, (4) continuous current rating of frame size, (5) short circuit current rating at rated voltages, (6) frequency, (7) short time current.

**Manual Charging Handle** (Figure 1, Item 12)
The manual charging handle is a T-shaped lever used to charge the closing springs by pumping approximately ten times.

**Manual Trip Button** (Figure 1, Item 8)
The manual trip button, when pushed, trips the circuit breaker to "OPEN."

**Circuit Breaker "OPEN" or "CLOSED" Indicator** (Figure 1, Item 5)
This indicator shows the physical position of the circuit breaker contacts.

**Automatic Trip Indicator** (Figure 1, Item 9) ( Not including undervoltage, alarm switch or lockout)
The automatic trip indicator is provided as standard equipment on the K-line® circuit breakers and is used to indicate the operation of the overcurrent trip device.
This device is an indicator only and does not prevent the circuit breaker reclosing.
Upon an overcurrent trip operation, the indicator protrudes from the front plate approximately 1/2 inch.
The automatic trip indicator should be reset after each trip indication by pushing back into its normal latch position. The operator should investigate the cause of tripping before resetting the automatic trip indicator and subsequently reclosing the circuit breaker after an outage which results in an operation of the indicator.

**Automatic Trip Alarm Contacts (Hand Reset)** (Figure 1, Item 9)
An alarm switch for remote electrical indication, which is optional, shows when automatic tripping has occurred. This is accomplished by adding a precision snap switch to the automatic trip indicator assembly. The automatic trip indicator actuates the roller on the alarm switch which in turn causes a normally open contact to close and a normally closed contact to open on overcurrent trip. The alarm contact is manually reset by pushing the trip indicator (9) back into its normal position.

**Automatic Trip Lockout (Hand Reset)** (Figure 1, Item 9)
An additional device (which is also optional) may be added to the automatic trip indicator assembly device which serves to mechanically prevent reclosing the circuit breaker after an automatic trip operation. When the trip indicator is pushed in, the circuit breaker mechanism can then be operated to close the circuit breaker contacts.

**Padlocking Device** (Figure 1, Item 23)
All K-line circuit breakers are equipped with means of padlocking the circuit breaker mechanism in a trip-free position. This is accomplished by the use of a locking plate to maintain the manual trip button in a tripping direction when the locking plate is held forward by one or more padlocks. To obtain the condition for padlocking the circuit breaker in the open position, the manual trip button is pushed inward. Then the padlock plate is pulled out and the padlock inserted into the vertical slot. In this position, the mechanism is maintained trip free and the contact arm cannot be moved to the closed position.
On circuit breakers equipped with drawout mechanism, the padlocking device is associated with the drawout interlocking mechanism so that the circuit breaker cannot be moved from any of its three basic drawout positions of "CONNECTED," "TEST" or "DISCONNECTED" with the padlocking in effect.

**Closing Spring Charge Indicator** (Figure 1, Item 14)
Under normal operating conditions, the closing springs are automatically charged after each tripping operation. However, there are occasions when the springs will be in a discharged state. Therefore, it is desirable that means be available to indicate the charged or uncharged condition of the closing springs. This is accomplished by a visual indicator seen through an aperture in the escutcheon plate, The indicator is marked "CHARGED" and "UNCHARGED."

**Motor Disconnect Switch** (Figure 1, Item 10)
The motor disconnect switch is a double pole, single-throw toggle type switch connected in series with the charging motor circuit and is used to disconnect the motor from the voltage source. This switch is used (1), when it is desirable to prevent automatic recharging of the closing springs just prior to taking the circuit breaker out of service for maintenance and (2), for control wiring dielectric test. The motor must be disconnected for the control wiring dielectric test and subsequently tested at 540 V ac or 760 V dc.

**Electrical Close Push Button** (Figure 1, Item 22)
The electrical close push button is used to electrically close the circuit breaker from the escutcheon. This contact is connected in series with the latch release coil. Energizing the latch release coil allows the charged springs to close the circuit breaker.

**Manual Close Lever** (Figure 1, Item 6)
The manual close lever is provided on all circuit breakers to provide a safe means of closing the breaker without control power. The lever is provided with a ring to which a lanyard should be attached for closing the breaker at a safe distance.

**Racking Mechanism** ( Drawout Breaker)
The racking mechanism is used to move the circuit breaker to any one of its three positions—"CONNECTED," "TEST" or "DISCONNECTED." All of these positions are attainable with the cubicle door closed or opened. The breaker can be closed only when the drawout lever (15, Figure 1) is up. When up, the racking crank (13, Figure 1) cannot be turned. The circuit breaker must be in the "OPEN" position before lever (15, Figure 1) can be pushed down. In order to move the circuit breaker from one position to another, the lever must be pushed down and the crank turned; once turning begins, the lever will stay down until another position is reached and the lever will snap up, preventing additional turning, until the lever is again pushed down.
When the padlocking device is locked, the lever (15) is locked in the up postion preventing movement of the racking mechanism.
Figure 1 shows the breaker in the fully withdrawn position. There are two sets of indicator lines on the left side of the breaker to show breaker position. One set is visible with the switchboard door closed, the other visible when the door is open.

**OPERATION OF DEVICES**
(Note: Description and operating instructions for the MPSC Type Trip System begins on page 18.)
**Electro-Mechanical Overcurrent Trip Devices Type K-3000 and K-4000 Circuit Breakers** (Figures 10 and 11)
(A) Type OD-300 General Purpose Overcurrent Trip Device. The type OD-300 overcurrent trip device, for general purpose applications, provides long-time delay tripping on moderate overcurrents which are above the long-time pickup setting; and instantaneous tripping on fault currents above the instantaneous trip setting. This device must be properly set to provide adequate protection for an electrical system. Three adjustment screws on the bottom of the device provide independent control of the long-time pickup, instantaneous pickup and amount of time delay. The nameplate of this device shows the setting of these adjustments and the range of settings which are available. For information on the time-current characteristics of this device, request a copy of TD-6693.
(B) Type OD-400 Selective Overcurrent Trip Device. The type OD-400 overcurrent trip device, for selective tripping applications, provides long-time delay and short-time delay tripping. Independent adjustment of both pickup and time delay is provided for both types of tripping. The nameplate of this device shows the settings which are available. For information on the time-current characteristics of this device, request a copy of TD-6694.
(C) See Table 1 for complete list of Electro-Mechanical overcurrent trip devices available.

**Power Shield™ Solid State Overcurrent Trip Devices Type K-3000S and K-4000S Circuit Breakers**
(See Figure 12)
This device includes the power supply sensors, overcurrent sensors, Power Shield solid state logic assembly, magnetic latch and the interconnecting wiring. Each phase of the circuit breaker has a power supply sensor and overcurrent sensor. The trip elements that are available are: long-time delay, instantaneous, short-time delay and ground fault. On a 3-phase 4-wire system, an additional remote sensor, mounted in the neutral bus, is required for complete ground fault protection.
The logic assembly is mounted near the front of the circuit breaker and with the cubicle door open the overcurrent control panel is readily accessible. This device must be properly set, as required by individual circuit conditions, to provide adequate protection for an electrical system, The movable plugs on the control panel provide independent control of the long-time, short-time, instantaneous and ground fault pickup and amount of time delay. The overcurrent device, with the exception of ground fault, will trip at the value of the AMPERE TAP setting times the plug setting of the various pickup elements. The ground fault trip value will be the plug setting value times 100, as indicated on the nameplate.
(A) Type SS-3. This trip device is for general purpose application. It provides long-time delay tripping on moderate overcurrents, which are above the long-time pickup settings, and instantareous tripping on fault currents above the instantaneous trip setting. For information on the time-current characteristics of this device, request a copy of TD-

6966 (TD-9001*).
(B) Type SS-4 Selective Overcurrent Trip Device. This trip device, for selective tripping application provides long-time delay and short-time delay tripping. For information on the time-current characteristics of this device, request a copy of TD-6967 (TD-9002*).
(C) Type SS-5 Triple-Selective Overcurrent Trip Device. This device includes the trip elements found in both the SS-3 and SS-4; i.e., long-time delay, short-time delay, and instantaneous tripping. For information on the time-current characteristics of this device, request a copy of TD-6967 (TD-9002*).
(D) The above three solid state overcurrent trip devices are available with ground fault protection and are designated by the types SS-3G, SS-4G and SS-5G. For information on the time current characteristics of this feature, request a copy of TD-6968 (TD-9005*).
(E) See Table 1A for a complete list of standard Solid State overcurrent trip devices.

**Control Relay**
This device is contained in the black insulated molding, 3" X 5" X 6" approximate, located at the lower front of the mechanism and is used on all electrically operated mechanisms. The 52Y coil, and contacts 52Y/1,52Y/2 are connected as shown in the schematic diagram, Figure 2. The purpose of this device is to require that, if the remote or local close contacts are closed, resulting in the charging springs discharging, the close contacts must first be released (opened) before the breaker can be reclosed. This prevents closing the breaker more than one time unless the close contacts are first released.

TABLE 1
STANDARD ELECTRO-MECHANICAL OVERCURRENT TRIP DEVICES

| Overcurrent Device Type | Trip Element | | | Time-Current Characteristic Curve |
|---|---|---|---|---|
| | Long-Time | Short-Time | Instantaneous | |
| OD-300 | X | | X | TD-6693 |
| OD-400 | X | X | | TD-6694 |
| OD-500 | X | X | X | TD-6695 |
| OD-600 | X | | X | TD-6695 |

NOTE: OD-300 long-time delay element has one time delay band only. All other long-time & short-time delay elements have three time delay bands.

TABLE 1A
STANDARD SOLID STATE OVERCURRENT TRIP DEVICES

| Overcurrent Device Type | Trip Element | | | | Time-Current Characteristic Curve | |
|---|---|---|---|---|---|---|
| | Long-Time | Short-Time | Instantaneous | Ground | Device in RED CASE | Device in GRAY CASE* |
| SS-3 | X | | X | | TD-6968 | TD-9001 |
| SS-3G | X | | X | X | TD-6966<br>TD-6968 | TD-9001<br>TD-9005 |
| SS-4 | X | X | | | TD-6967 | TD-9002 |
| SS-4G | X | X | | X | TD-6967<br>TD-6968 | TD-9002<br>TD-9005 |
| SS-5 | X | X | X | | TD-6967 | TD-9002 |
| SS-5G | X | X | X | X | TD-6967<br>TD-6968 | TD-9002<br>TD-9005 |

NOTE: Time-current characteristic curves are not included in this book because separate coordination curves are normally provided with each order. When field calibration is performed, necessary instruction books (refer to page 15) will be provided and will include all pertinent timing information.

**Auxiliary Switches**
The auxiliary switches (24, Figure 1) contain the "a" and "b" contacts (Figure 2) and are furnished in 4 or 8 contact arrangements. They are mechanically interconnected with the main breaker contacts such that, with the breaker closed, the "a" contacts are closed. With the circuit breaker open, the "b" contacts are closed.

**Undervoltage Trip Device**
The electrically reset undervoltage trip device is a single-phase device which automatically trips the circuit breaker when its supply voltage decreases to 30 to 60 percent of the rated voltage. This device may be furnished either for instantaneous trip operation or with adjustable time delay tripping of 0-15 seconds. The undervoltage trip device is an integral unit which may be added to the circuit breaker either at the factory or in the field.
The undervoltage device may be connected so that the automatic trip indicator (Figure 1, Item 9) will protrude from the front plate when the breaker is tripped by the undervoltage device.
See Table 4, page 16, for electrical characteristics.

**INSTALLATION, INITIAL TESTING AND REMOVAL (Drawout & Stationary)**

CAUTION CAUTION CAUTION CAUTION

**FOR SAFETY**: WHEN INSTALLING OR REMOVING STATIONARY BREAKERS, THE SUPPLY FOR PRIMARY AND CONTROL CIRCUITS MUST BE DE-ENERGIZED AT ALL TIMES. TESTING OF STATIONARY BREAKERS MUST BE DONE WITH THE PRIMARY SUPPLY CIRCUIT DE-ENERGIZED.

For initial installation of drawout breakers in the "CONNECTED" position, the supply for the primary circuit should be de-energized. Testing of the drawout breaker must be done in the test position.
**NOTE:** (K-3000 and K-4000 Circuit Breakers) Prior to inserting the circuit breaker into the switchboard and with the breaker in the upright position, exercise the long time armatures (1" wide armatures) several times until resistance to motion has increased, indicating that the oil dashpot is functioning properly. Improper operation can result because the circuit breaker is shipped or stored on its back. This causes the oil in the dashpot to be displaced and an air bubble can be trapped under the piston. The exercise removes the air to permit proper operation.

**INSTALLATION** (Drawout Type)
(See Figure 1)
The circuit breaker must be in the "OPEN" position, the racking crank (13) when inserted in opening (17) is rotated counterclockwise until the racking cam roller (16) is rotated down into a 45° angle, and the motor disconnect switch (10) for electrically operated circuit breakers is in the "OFF" position, **NOTE:** Lever (15) must be pushed down to permit the rotation of crank (13).

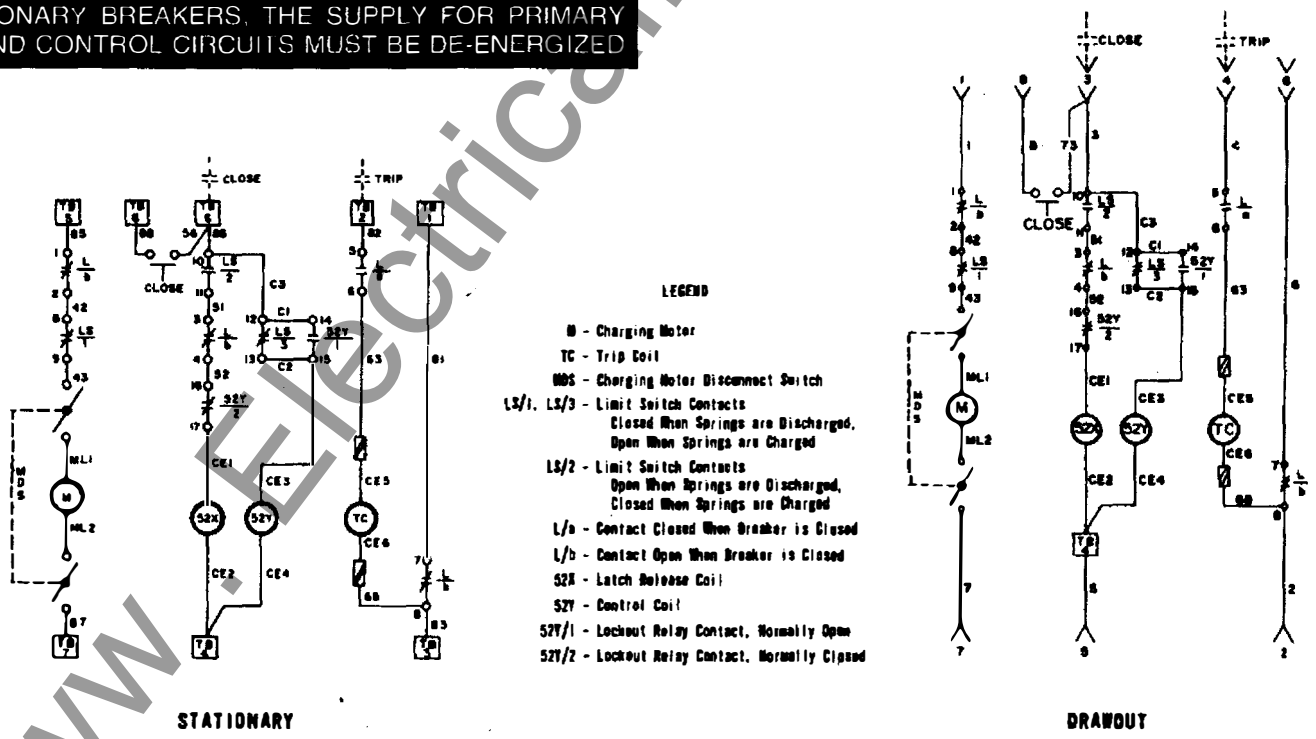



**Fig. 2 — Typical Schematic Diagram of Control Circuit**

Open compartment door and lower the right and left hand tracks to fully extended position.
Use lifting yoke (20, Figure 1), which is inserted in holes in the upper rear frame, and lower circuit breaker wheels (18) onto track extensions. Remove lifting yoke.
Push circuit breaker into compartment until racking cam rollers (16) stop against their guides.

CAUTION CAUTION CAUTION CAUTION

RAISE TRACK EXTENSION INTO COMPARTMENT BEFORE RACKING.

Insert racking crank (13) into opening (17) and depress drawout lever (15). Turn crank clockwise until automatically stopped. Breaker is now in "DISCONNECT" position. An arrow on the left side of plate (26) will also line up with "DISCONNECT" on the cradle.
Again depress drawout lever (15) and turn crank clockwise until automatically stopped. Breaker is now in "TEST" position.

**INSTALLATION** (Stationary Type)
Lifting yoke (20) should be used to move the breaker to the switchboard; however, other handling means will be required to move the breaker into position inside the switchboard .

**CHECKING CIRCUIT BREAKER OPERATION IN "TEST" POSITION (Electrically Operated, Drawout Type)**
(See Figure 1)
a. Manually reset automatic trip indicator (9) if it protrudes approximately 1/2 ". Push in to reset.
b. Turn motor disconnect switch (10) to "ON" position and closing springs will automatically charge.
c. Close circuit breaker by local close button and trip by local trip button.
**NOTE:** All breakers have a manual trip button. The local close button for electrical breakers is standard. The local trip button for electrical breakers is optional.
d. Close and trip circuit breaker by means of remote control switch.
e. Check each auxiliary device for proper operation.

**CHECKING CIRCUIT BREAKER OPERATION IN "TEST" POSITION (Manually Operated, Drawout Type)**
(See Figure 1)
a. Manually reset automatic trip indicator (9) if it protrudes approximately 1/2 ". Push in to reset.
b. Charge and close circuit breaker; See "Manual Closing Operation" below.
c. Trip by manual "TRIP" button (8).
d. Check each auxiliary device for proper operation.

**CHECKING CIRCUIT BREAKER OPERATION IN "CONNECTED" POSITION (Drawout Type)**
After completing check procedures in "TEST" position, continue as follows:
With circuit breaker in "OPEN" position and motor disconnect switch (10) in "OFF" position, insert racking crank (13) in opening (17) and press down drawout lever (15). Rotate the racking crank clockwise until lever (15) moves up and cranking is automatically stopped. Breaker is now in "CONNECTED" position. Excessive cranking force indicates misalignment or interference of parts.

**CHECKING CIRCUIT BREAKER OPERATION** (Stationary Type)
Follow the same procedure as for drawout circuit breaker, except the circuit breaker will be in the "CONNECTED" position. Primary supply circuit must be de-energized.

**MANUAL CLOSING OPERATION**
The following manual closing procedures are recommended: (See Figure 1 )
a. Observe circuit breaker conditions on control escutcheon.
b. If closing springs are discharged, manually charge closing springs by means of the manual charge lever (12) then pull the manual close lever (6) by a lanyard from a safe distance.
c. If springs are charged, pull the manual close lever (6) by means of a lanyard from a safe distance.
d. For partially charged closing springs, should closing not occur upon pulling the manual close lever, continue charging until closing springs are completely charged (heard to snap) and by visual indicator (14), then pull manual close lever (6) by means of a lanyard from a safe distance.

**CIRCUIT BREAKER REMOVAL** (Drawout Type)
(See Figure 1)
a. Trip circuit breaker by any tripping means.
b. Open front compartment door.
c. Engage racking crank (13) in opening (17) and push drawout lever (15) down. Rotate racking crank counterclockwise until racking mechanism automatically stops at "TEST" position. Lower track extensions.
d. Repeat step "C" to rack circuit breaker to "DISCONNECT" position.
e. Depress drawout lever (15) and continue cranking counterclockwise as far as stops will allow. (Do not force beyond stops.)
f. Pull circuit breaker forward to fully extended position. (Should the circuit breaker be charged, closing springs will automatically be discharged at this point.)
g. Remove circuit breaker from tracks with lifting yoke, then raise tracks into compartment and close door.

**MAINTENANCE AND ADJUSTMENTS SAFETY NOTES**

WARNING WARNING WARNING WARNING

DE-ENERGIZE BOTH PRIMARY AND CONTROL CIRCUITS BEFORE MAKING ANY INSPECTIONS. ADJUSTMENTS OR REPLACEMENTS OF PARTS. MAKE CER-

TAIN BREAKER IS OPEN BY OBSERVING INDICATOR (5, FIGURE 1), AND CLOSING SPRINGS ARE NOT CHARGED BY OBSERVING INDICATOR (14, FIGURE 1).

When it is necessary that the charging springs be charged, or the circuit breaker closed, make sure to stay clear of operating parts.
Stationary breakers should be checked for operation with the control circuit energized and the primary power de-energized. Drawout breakers should be withdrawn to "TEST" position for checking the breaker operation. For further inspection, adjustments, cleaning or replacement of parts, the drawout circuit breaker should be withdrawn and moved to a suitable area.
Stationary breakers should likewise be removed, but, if removal is not possible, then the primary and control circuit sources MUST BE DE-ENERGIZED.

**PERIODIC MAINTENANCE INSPECTION**
The safety and successful functioning of the connected apparatus depends upon the proper operation of the circuit breaker. Therefore, it is recommended that a maintenance program be established that will provide for a periodic inspection of the circuit breaker after 250 no load or load current switching operations.
If 250 operations are not completed in the first year of service, the circuit breakers should be inspected regardless. The circuit breaker should also be inspected after a short circuit or severe overload interruption, regardless of time period or number of operations.
Where unusual service conditions exist, as covered by ANSI C37.13, it must be assumed that these conditions were considered at the time of order. These maintenance instructions only cover circuit breakers used under the Standard's normal service conditions.
The inspection should include opening and closing the circuit breaker electrically and manually. The unit should be visually inspected for loose or damaged parts. Arc chutes, contacts and insulation structure should be inspected as described below.

**ARC CHUTES**
If the circuit breaker has a solid state overcurrent trip device, it is necessary to remove the screws fastening the solid state control assembly, so that the control assembly can be moved to permit removal of the arc chute.
a. Remove two arc chute mounting screws (3, Figure 1) and retainer molding (2). Lift arc chute (1) up and draw out.
b. Inspect for breakage to side moldings, center moldings, arc plates and liner plates. Check for presence of foreign particles such as chips of moldings and metal.

**INSULATION STRUCTURE**
Insulated parts should be checked for damage. Dust and dirt should be removed by air or wiped with a clean lintless cloth. Do not use any oil based solvents. Spray solvents vary as to type and must not be used. The moldings at the rear of the breaker must be kept clean to avoid dielectric problems. Wipe dust away and blow out with clean, dry, compressed air. Additional steps must be taken if dust accumulation continues to be a problem.

**CONTACTS**
a. Remove dirt or grease on contacts with a clean, lintless cloth.
b. Discoloration of the main contacts does not necessarily indicate damage. However, this condition may be removed by opening and closing the circuit breaker under no-load conditions.

**CONTACT PITTING**
a. A moderate amount of pitting will not interfere with the operation of the arcing contacts.
Should it be necessary to dress the arcing contacts to remove small burrs, cover the mechanism with a cloth. Follow the contour of the contacts with light wipes of a fine file and do not attempt to eliminate pitting entirely. When finished, remove cloth and wipe off any remaining dirt or filings. Do not use emery cloth or the like for sanding contacts. The material deposits affect continuous current ability adversely.
b. Should the main contacts show more than moderate pitting, check the contact pressure.

**CONTACT PRESSURE CHECK AND ADJUSTMENT**
**Jaw Type Arcing Contacts** (See Figure 3A)
**FOR SAFETY:** Keep clear of breaker parts during this operation .
a. Close the breaker. Lever (15, Figure 1) must be in the up position.
b. For each set of eight contacts on one pole, the smallest gap "A" should be .100-.105 inch. If ad justment is required, loosen lock screw (2). Turn adjustment screw (1) until .100-.105 is obtained on the smallest gap of the eight contacts. Repeat this for the other two poles.
Tighten lock screw (2).
Note that if an adjustment is necessary for "simultaneous" make, the contact pressure will increase on those adjusted poles. Thus, a dimension of more than the ranges listed above indicates more contact pressure, which is acceptable.

**For Earlier Model Circuit Breakers Furnished with Butt Type Arcing Contacts** (See Figure 3)

**FOR SAFETY:** Keep clear of breaker parts during this operation .

a. Close the breaker. Lever (15, Figure 1) must be in the up position.

b. For each set of eight contacts on one pole, the smallest gap "A" should be .090-.095 inch. If adjustment is required, loosen lock screw (2). Turn adjustment screw (1) until .090-.095 is obtained on the smallest gap of the eight contacts. Repeat this for the other two poles.

c. Slow close the breaker (see "Manual Slow Close to Check Contact Pressure" below) until the first arcing contact of the three poles just touches and hold in this position. Adjust the other two poles, screw (1), until the leading arcing contacts of each pole make simultaneously within 1/32 inch.

Tighten lock screw (2).

Note that if an adjustment is necessary for "simultaneous" make, the contact pressure will increase on those adjusted poles. Thus, a dimension of more than the ranges listed above indicates more contact pressure, which is acceptable.

**MANUAL SLOW CLOSE TO CHECK CONTACT PRESSURE** (See Figures 1, 3 and 4)

a. Remove arc chutes ( 1).

b. If the circuit breaker closing springs are discharged as seen by the spring charged indicator (14), engage the manual charge handle (12) with the charging lever (7). Pump charging lever until the circuit breaker closing springs are heard to snap into the charged position.

c. Remove screw (19), shift the shutter (4) to the left and insert the spring retainer bracket (11) so that its tips fit into the closing springs and its flanges fit into the holes in the closing spring guides,

**NOTE:** On drawout breakers, shutter (4) cannot be opened unless breaker drawout mechanism is in the "DISCONNECT", "TEST" or "CONNECTED" position. The drawout lever ( 15) cannot be operated when shutter (4) is open.

d. Use a stick to hold the spring retainer bracket (11) toward the front of the breaker and in place while pulling the manual close lever (6) to discharge the closing springs. (This will partially close contacts.)

e. Insert the manual charge handle (12) into the charging lever socket and pump to slow close the circuit breaker to the required amount.

f. To remove the spring retainer bracket (11), push the manual trip button (8) to trip the circuit breaker. Continue pumping until closing springs are again heard to snap. Then remove spring retainer bracket.

9. The circuit breaker is now charged and ready to be closed.

h. To discharge closing springs, pull the manual close lever (6) and push manual trip button (8).

i. Put arc chutes (1) back on.

**OPERATING MECHANISM**

The circuit breaker mechanism is adjusted at the factory for correct operation and should not be disturbed unless necessary.

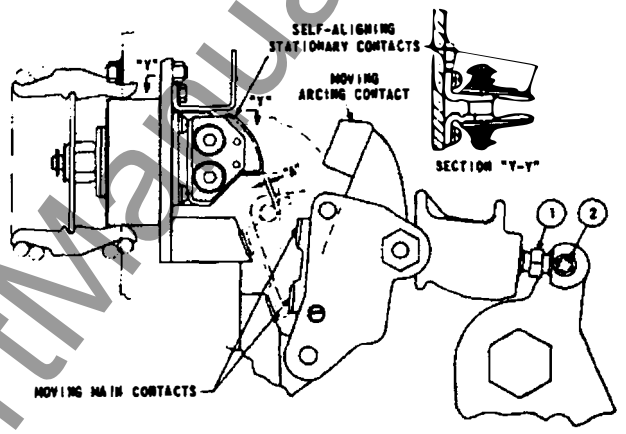



**Fig. 3A — Contact Pressure Check and Adjustment**

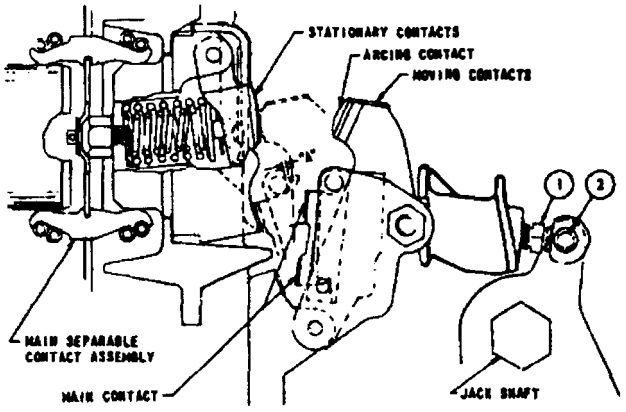



**Fig. 3 — Contact Pressure Check and Adjustment**

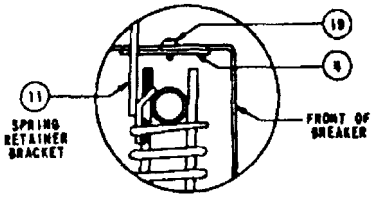



**Fig. 4 — Shutter Detail**

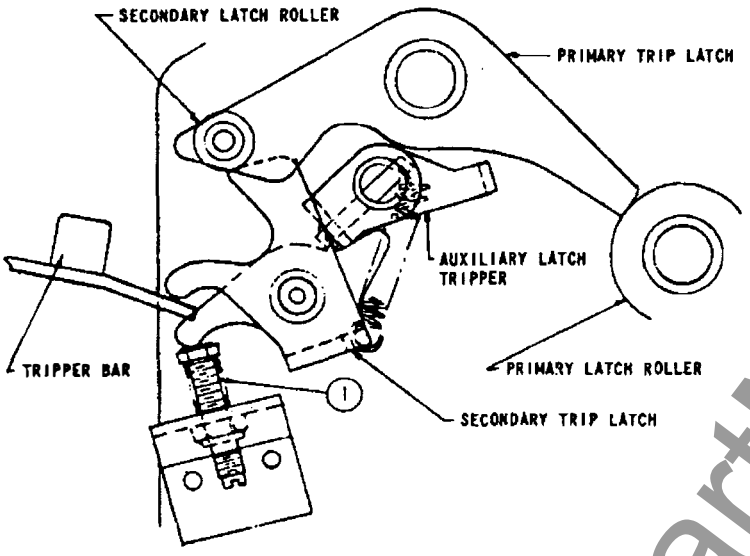



Fig. 5 — Primary Trip Latch Adjustment

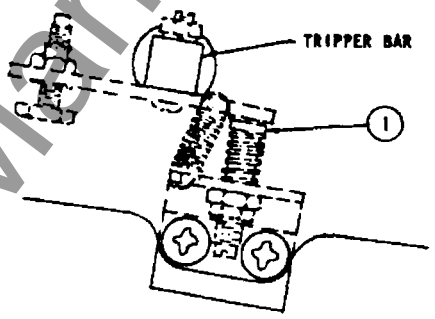



Fig. 6 — Tripper Bar Tripper Adjustment

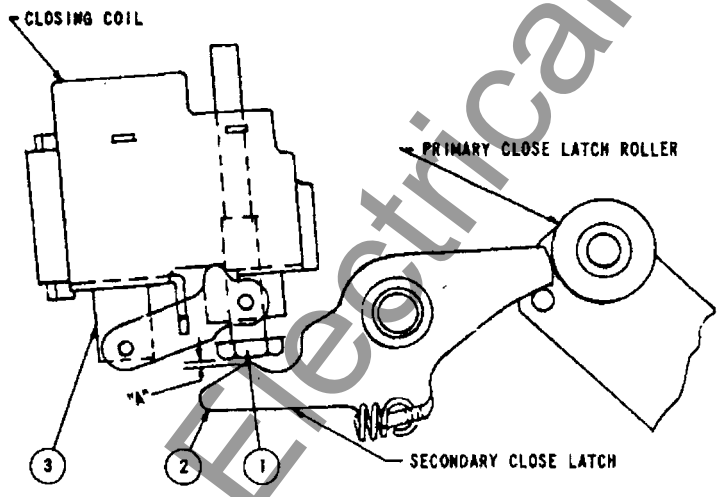



Fig. 7 — Primary Close Latch Adjustment

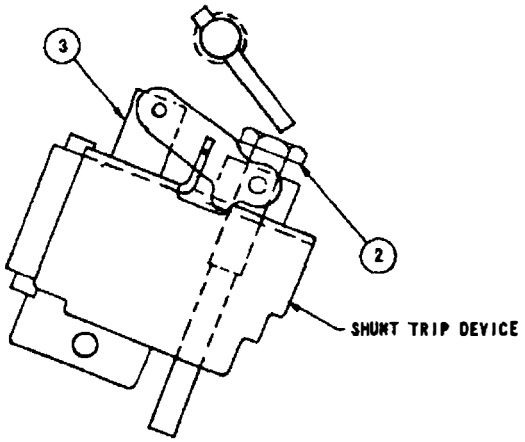



Fig. 8 — Shunt Trip Device Adjustment

**FOR SAFETY:** Keep hands clear of all moving parts. Serious injuries can result if a person comes in contact with breaker parts when the breaker is being opened or closed, or closing springs are being charged or discharged. Use extension tools for manipulating breaker parts .
If field testing indicates breaker malfunction, the following items may be checked.

**Primary Trip Latch**
Figure 5 shows the arrangement necessary for the breaker to be in the closed position. The spring holds the secondary trip latch down against screw (1). The secondary trip latch holds the secondary latch roller up, which in turn holds the opposite end of the primary trip latch down. This prevents the primary latch roller from moving to the left and opening the breaker. If none of the various trip devices are acting on the tripper bar or the auxiliary latch tripper to open the breaker or to prevent the breaker from closing and the breaker still will not close, then the following adjustment should be made.
a. Turn screw (1) down to insure that secondary trip latch will hold the secondary latch roller up.
b. With the breaker closed, turn up on screw (1) until the breaker trips.
c. Turn screw (1) down two turns.

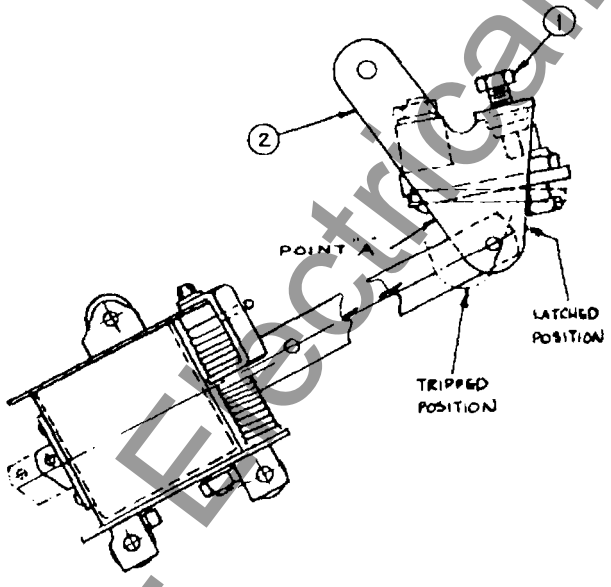



**Fig. 9 — Magnetic Latch Trip Adjustment Type K-3000S and K-4000S Circuit Breakers**

**Tripper Bar Adjustment** (Figure 6)
To insure that tripper bar and tripper is in the correct position with the secondary trip latch, check and adjust as follows:
a. Turn screw (1) down to make certain the tripper will not trip out the breaker.
b. With breaker closed, turn screw (1) up until the breaker trips,
c. Turn screw (1) down 2 3/4 turns.

**Primary Close Latch** (See Figure 7)
a. With the circuit breaker closing springs charged and breaker contacts opened, the closing plunger (3) in de-energized position, there should be a 1/16" air gap between the rod (1) and the secondary latch (2) at point "A". Turn rod (1) for 1/16" dimension.

**Shunt Trip Device** (See Figure 8)
a. Turn trip rod (2) down until circuit breaker does not trip with plunger (3) held down.
b. Close circuit breaker.
c. Push plunger (3) down as far as possible and hold in this position while turning up trip rod ( 2) until circuit breaker just trips.
d. Turn rod (2) up 2 l/2 to 3 turns.

**Magnetic Latch Device (Type K-3000S, K-4000S) Trip Adjustment** (Refer to Figure 9)
1. Turn adjusting screw (1) out as far as possible so that the circuit breaker will not trip when the magnetic latch trips.
2. Remove the terminal block cover on the solid state assembly by removing two lower screws (Fig. 12). Disconnect two wires at terminals 15 and 16.
3. Close the circuit breaker.
4. While lightly pushing at point "A" so that the lever (2) does not move through its full stroke and trip the circuit breaker, momentarily apply the voltage (3 V) from two dry cell batteries, size "D", to the two wires (+ to wire 16, — to wire 15) that were disconnected in operation 2. The magnetic latch should trip.
5. Gradually release the hold on lever (2).
6. While holding the lever (2) in the tripped position, turn in on screw (1) until the circuit breaker just trips, then turn in one additional turn.
7. Replace wires 15 and 16 and the terminal block cover.

## ELECTRO-MECHANICAL OVERCURRENT TRIP DEVICE ADJUSTMENTS

**Short Time Delay Adjustment** (See Figure 11)
(OD Types 400, 500, 900, 1000).
Push the short time lever to rear of breaker and slide the lever to the desired band. Make sure the lever pin drops into the pin hole.

**Long Time Delay Band Adjustment** (Figure 10)
(OD Types 400, 500, 600).
To reset long time delay to a different band, first loosen the locking screw for long-time delay adjustment approximately one turn. Turn the adjusting knob until the pointer lines up with the desired line marked "Minimum Time" "Instantaneous Time" or "Maximum Time". Retighten the locking screw.
**NOTE:** OD-300 has only one long-time delay setting; therefore resetting is not required.

**Pick-Up Setting Adjustments** (Figure 10)
Pick-up settings may be changed by turning the appropriate adjusting screw until the moving indicator lines up with the desired pick-up point line.
**NOTE:** The top line corresponds to the top pick-up point, the second line from the top corresponds to the second pick-up point from the top, etc.

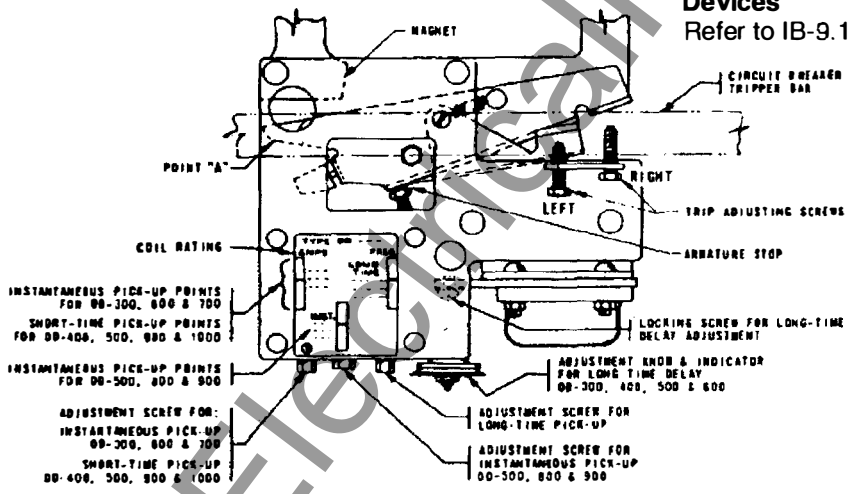



**Fig. 10 — Overload Device Adjustments**

**Armature Trip Travel Adjustment.**

CAUTION CAUTION CAUTION CAUTION

KEEP HANDS CLEAR OF ALL MOVING PARTS. THE CIRCUIT BREAKER WILL TRIP TO THE "OPEN" POSITION WHILE CHECKING OR ADJUSTING THE ARMATURE TRIP TRAVEL.

The overload device trip travel is set at the factory; however, if trip travel readjustment is required due to replacement of overloads or other parts, then readjust as follows:
a. (See Figure 10.) Back out on the two trip adjusting screws until the screws are engaging the nut by approximately two turns.
b. Charge springs and close circuit breaker.
c. Using a one foot long (approximate) stick, push up on long time armature (thick armature) at point "A", and hold it tight against the magnet. Turn in screw marked "Right" until the breaker just trips, Continue to turn the screw in an additional 1 1/2 turns,
d. Charge springs and close circuit breaker. Push up on the thin armature and adjust the screw marked "Left" using the same procedure as "c" above.
e. Readjust the trip travel at the other two poles using the same procedure (steps a through d) .

**Field Testing of Electro-Mechanical Overcurrent Trip Devices**
Refer to IB-9.1.7-5 for complete testing of devices.

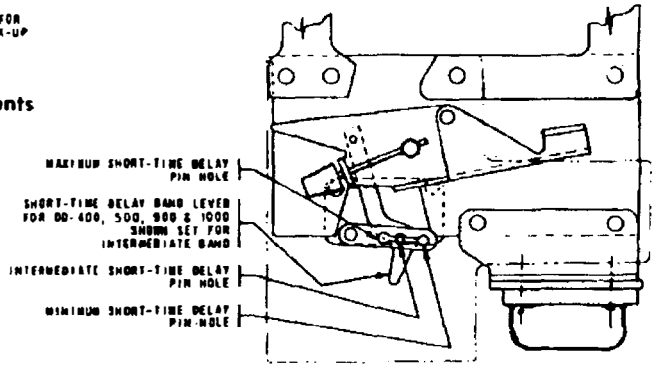



**Fig. 11 — Short-Time Delay Band Adjustments**

**SOLID STATE OVERCURRENT TRIP DEVICE SETTINGS**

(See Figure 12)

No adjustments are necessary in selecting trip settings on this trip device. The selector plugs (solid circle) allow flexibility in settings and may be moved from one plug tap to another, consistent, however, with the pickup and time band settings necessary for proper circuit protection. Make certain that the selector plugs are pushed in completely for proper operation. If a plug is left out or not secure, the affected element will trip at the minimum setting shown, for safety, but coordination will be affected.

**Field Testing of Solid State Overcurrent Trip Devices**

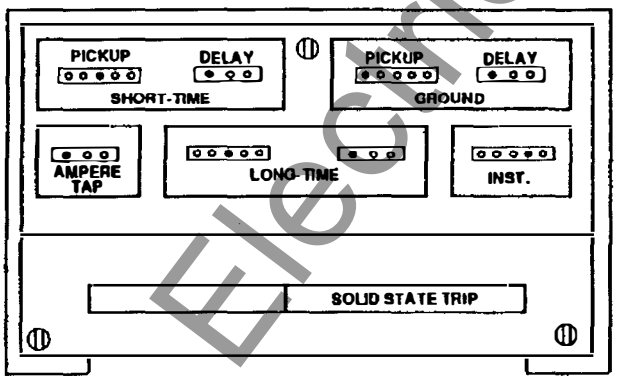
For complete testing of these devices, refer to the following Instruction Bulletins:

IB-9.1.7-21 (Device in RED CASE) IB-9.1.7-22 (Device in GRAY CASE)

**LUBRICATION**

Only two lubricants are approved for use on the K-Line circuit breaker. Lubricated during final assembly, the K-Line circuit breaker should not require additional lubrication during its service life when applied in accordance with ANSI C37.13. If, however, the breaker is applied in unusual situations defined by ANSI C37.13, has lubrication contaminated with dirt and debris, or has parts replaced, relubrication should be performed as follows:

When mechanism cleaning and relubrication is required, do not spray solvents down through the mechanism to remove old lubricants, dust, and debris.




Do not use dichlorodifluoromethane on any part of the circuit breaker. These solvent tend to wash debris into the bearing areas of the breaker, while at the same time removing any existing lubricant. Breaker performance will be compromised when these cleaning techniques are employed.

Proper relubrication requires disassembly, thorough cleaning by wiping, then reassembly using a brush or other means for reapplying the lubricants listed.

1. Apply NO-OX-ID special grade A" grease from Dearborn Chemical Company to all mating surfaces of moving current carrying joints. Do not apply NO-OX-ID grease on any main or arcing contact surfaces. Primary disconnects should be maintained by reapplying NO-OX-ID during maintenance periods. NO-OX-ID is available from Asea Brown Boveri in one pint cans, Number 713222-A00.

2. Apply Anderol 757 synthetic grease manufactured by HULS AMERICA, INC. to mechanism parts, bearings and pins. DO NOT APPLY GREASE TO LATCH OR ROLLER SURFACES. Anderol 757 is available from Asea Brown Boveri in four ounce tubes, part Number 712994-A00.

3. Anderol synthetic lubricant is also available as a spray, Anderol 732. Anderol 732 is useful as a solvent for removing old lubricant, dirt, and debris in the mechanism. It can NOT be used as a substitute for Anderol 757. Please observe the following warnings:

a. DO NOT apply light machine oil, or thin spray lubricants to lubricate any mechanism part.

b. DO NOT attempt to relubricate the spring charging motor gearbox. It is sealed and should not require repacking.

c. DO NOT lubricate magnetic latch device or otherwise clean or spray with any substance.

4. Use only the recommended lubricants. Use of other than approved lubricants can cause breaker misoperation at temperature extremes.

## DIELECTRIC WITHSTAND TESTS ON POWER AND CONTROL CIRCUITS

1. Dielectric withstand tests on circuit breakers shall be made to determine the ability of the insulation to withstand overvoltages.

2. A 60-cps alternating sinusoidal voltage (rms) value equal to the specific voltage shall be used. All voltages used in the dielectric withstand test shall be measured in accordance with ANSI Measurement of Voltage in Dielectric Tests, C68.1.

3. Duration Of Test - The dielectric test voltage shall be applied for a period of 60 seconds. The duration of the test may be one second if a voltage 30% greater than that specified is applied.

4. Condition Of Circuit Breaker To Be Tested - Dielectric tests shall be made on a new, completely assembled circuit breaker and not on individual parts. When a circuit breaker is tested in the field or after storage, the test voltage shall be 75% of the value listed in C37.50-3.5.2. (Value shown below.)

5. Temperature At Which Tests Are To Be Made - Dielectric tests shall be made at any temperature between 10 and 55 C

6. Magnitudes And Point Of Application Of Test Voltage - The dielectric test shall be applied as follows:

a. With circuit breaker in open position, apply 2200 volts (1000 volts plus twice 600 volts on new breakers; 0.75 x 2200 = 1650V on breakers that have been in service):

i. Between live parts, including both line and load terminals, and metal parts that are normally grounded.

ii. Between live terminals and load terminals.

b. With circuit breaker in closed position, apply 2200 volts on new breaker and 1650 volts on breakers that have been in service.

i. Between live parts and metal parts that are normally grounded.

ii. Between terminals of different phases.

c. With circuit breaker in either open or closed positions, apply 1500 volts (1125 volt on breakers taken out of service):

Note: Disconnect solid state trip unit, as a precaution.

i. Between control circuit and metal parts that are normally grounded . If the circuit breaker control circuit includes a motor, the motor MUST be disconnected during the dielectric test on the control circuit.

### TABLE 2

**TEST VOLTAGE TO BE APPLIED FOR ONE MINUTE TO TEST THE ABILITY OF THE INSULATION TO WITHSTAND OVERVOLTAGES**

| | Breaker Open | Breaker Closed | Breaker Open or Closed |
|---|---|---|---|
| Breaker In Service or After Storage | 1650 V ac - - 2300 V dc<br>a. Between terminals and metal parts normally grounded.<br>b. Between line and load terminals. | 1650 V ac - - 2300 V dc<br>a. Between terminals and metal parts normally grounded.<br>b. Between phases. | 1125 V ac - - 1600 V dc<br>a. Between control circuit and metal parts normally grounded.<br>NOTE: Motor must be disconnected from control circuit for this test. |
| After Short Circuit | 1320 V ac - - 1860 V dc<br>a and b as above | 1320 V ac - - 1860 V dc<br>a and b as above | 900 V ac - - 1260 V dc<br>a as above |

d. Apply 1000 volts:

i. Between leads of new motors.

e. SPECIAL NOTES:

i. Apply 60% of the values given in (a) through (d) above on breakers that interrupted a short circuit.

ii. Motors that have been in service may fail dielectric due to a normal accumulation of debris from the commutator. Cleaning the motor will restore dielectric integrity.

iii. Do not perform dielectric testing on the solid state trip system.

## ELECTRICAL CHARACTERISTICS OF CONTROL DEVICES

For closing and tripping currents, voltages and ranges, refer to Table 3 below.

For undervoltage trip devices, standard voltages and operating data, refer to Table 4 below.

Current values are average steady-state values. Momentary inrush currents for all charging motors and AC coils are approximately 6 - 8 times these values.

## RENEWAL PARTS

Asea Brown Boveri recommends only those renewal parts be stocked that will be required to insure proper and timely maintenance of the breaker.

Refer to Renewal Parts Bulletin RP 6.1.2.8-2 for complete ordering information and parts list.

The minimum quantities of assemblies recommended in the Renewal Parts Bulletin are based on ABB's own tests and statistical information on customer operating experience. The replacement of total assemblies is recommended in the field so that the circuit breaker can be returned to service as quickly as possible. The faulty assemblies can be returned to ABB for reconditioning when that is possible.

The ABB service organization and factory personnel can be reached by calling:

Service (215) 669-8887
Factory (803) 665-4144

**TABLE 3**

**ELECTRICAL CHARACTERISTICS OF CONTROL DEVICES**
**CLOSING AND TRIPPING CURRENTS, VOLTAGES AND RANGES**

| Type Breaker | Nominal Control Voltage | Average Closing Motor Current Amperes | Shunt Trip Current Amperes | Closing Relay Current Amperes | | Closing Circuit Voltage Range | Shunt Trip Circuit Voltage Range | Recommended Control Fuse Size |
|---|---|---|---|---|---|---|---|---|
| | | | | Anti-Pump | Release | | | |
| K-3000 K-4000 K-3000S K-4000S | 120 V ac 60 cycles | 10. | 10.0 | .15 | 10.0 | 104 - 127 | 50 - 127 | 10 A |
| | 240 V ac 60 cycle | 5. | 1.84 | .075 | 1.84 | 208 - 254 | 208 - 254 | 10 A |
| | 48 V dc | 25. | 5.0 | .11 | 5.0 | 38 - 58 | 28- 56 | 15 A |
| | 125 V dc | 10. | 2.0 | .06 | 2.0 | 100 - 140 | 70 - 140 | 10 A |
| | 250 V dc | 5. | 1.0 | .03 | 1.0 | 200 - 280 | 140-280 | 10 A |

**TABLE 4**

**UNDERVOLTAGE TRIP DEVICE**
**STANDARD VOLTAGES AND OPERATING DATA**

| Service Voltage | Current at Rated Volts | Maximum Pickup Voltage | Dropout Voltage Range |
|---|---|---|---|
| 120 V ac 60 cycles | 0.5 | 102 | 36 - 72 |
| 240 V ac 60 cycles | 0.2 | 204 | 72 - 144 |
| 480 V ac 60 cycles | 0.1 | 408 | 144 - 288 |
| 48 V dc | 0.3 | 41 | 15 - 29 |
| 125 V dc | 0.2 | 106 | 38 - 75 |
| 250 V dc | 0.1 | 212 | 75 - 150 |

## MPS-C ELECTRONIC TRIP SYSTEM

This electronic, microprocessor-based trip system includes the sensors, the MICRO PowerShield-Communication (MPS-C) electronic trip device, the magnetic latch, and the interconnecting wiring. A current sensor is integrally mounted on each phase of the circuit breaker to supply a value of current flowing in the trip unit which is directly proporational to the current passing through the primary circuit. When the value of current in the primaries exceeds the trip unit setting threshholds for a given time in long time, short time, and/or ground, then tripping occurs by sending a signal to the magnetic latch. Instantaneous tripping occurs, in the same manner, without time delay. On a three phase, four wire, wye systems, provisions are made for input from a separately mounted sensor to obtain a residual connection of all four sensors for sensitivity to ground currents.

### MICRO-PowerShield-Communication Trip Unit

The MPS-C trip unit (Figure 3) is visible on the front of the circuit breaker. It is completely self-powered, taking the tripping energy from the primary current passing through the circuit breaker without the need for any additional power supply. To cope with modern power systems where harmonics in the system can cause cable and busway overheating, the MPS-C long time trip element samples the current in a unique algorithm, then calculates the root mean square (RMS) value of the system current, providing tripping when the RMS current is above the trip threshhold. Overheating in cable and busway is thus avoided with the MPS-C trip system. Short time and instantaneous tripping remains based on peak sensing methods, avoiding unnecessary delay in tripping caused by the RMS calculation.

The MPS-C trip system also includes all the connections and software for performing communication duties when connected to the PRICOM or PRICOM-PLUS communication systems. This is a standard feature for all forms of the MPS-C trip device. Although a breaker may not be connected to a communication system when it is installed, it will not require any modification to be connected to the Network Interface Module (NIM) in the PRICOM system at some future time. This unique feature allows for future expansion without incurring additional up-front expenses. The NIM cable is connected to the nine-pin connector behind the 25-pin connector at the side of the MPS-C trip device. An additional connector is provided for the Voltage Interface Module (VIM) which attaches directly to the bottom side of the MPS-C unit. The VIM connector is accessed by removing a white adhesive label. Do not remove this label unless VIM installation is planned. See bulletin 3.1.3-2A for additional details about the PRICOM communication system.

### Protective Elements

Four basic trip elements within the MPS trip unit perform the protective functions: long time, short time, instantaneous, and ground. MPS-C types with various combinations of these protective elements are shown in Figure 4. Selection of type is dependent upon the protection and coordination requirements for the specific power circuit. Since there are no mechanical devices which may have lost adjustment during shipment, and the MPS-C trip unit is completely tested prior to shipment, no readjustments, other than making the required settings, need be made prior to placement in service. The following trip characteristics are available: long time setting and delay bands; short time setting and delay bands with switchable $I^2t$ characteristic, instantaneous setting, and ground setting and delay bands with switchable $I^2t$ characteristic.

The MPS-C trip unit must be properly set, as required by the individual circuit based on a coordination study performed for the system, in order to provide the necessary protection. The MPS-C trip device is shipped with standard shipping settings; THE SHIPPING SETTINGS DO NOT CORRESPOND TO THE REQUIREMENTS OF SYSTEM IN WHICH THE BREAKER IS INSTALLED. DETERMINE WHAT THE CORRECT SETTINGS ARE FOR THE ELECTRICAL SYSTEM IN WHICH THE BREAKER IS INSTALLED PRIOR TO CLOSING THE CIRCUIT BREAKER INTO THAT SYSTEM. Nuisance tripping or inadequate protection may result from failure to properly adjust the circuit breaker trip device. To set the MPS-C trip device, remove the device clear cover, being sure to capture the mounting hardware for future re-use. A small screwdriver may be used for making the setting and delay adjustments for each of the trip elements provided. Trip elements are provided in accordance with circuit breaker requirements determined prior to circuit breaker order entry to suit the intended application.

The MPS-C trip unit trip elements, with the exception of ground, will cause the circuit breaker to trip at a value equal to the ampere range selector position times the threshold setting of the various protective elements. The ground trip settings are marked on the faceplate in primary amperes.

### Ampere Range Selector

The ampere range selector switch provides two settings:

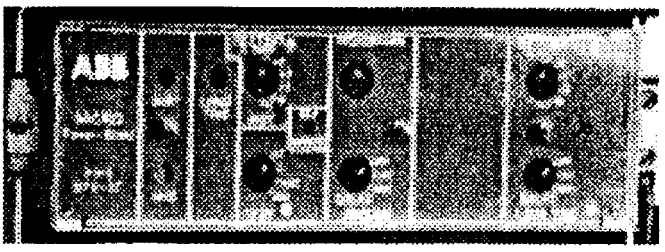


**Figure 14 - Available MICRO PowerShield Trip Units**

| ADJUSTABLE PROTECTIVE TRIP ELEMENTS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TYPE | LONG-TIME | | SHORT-TIME | | INSTANTANEOUS | GROUND | | CHARACTERISTIC CURVES | | |
| | SETTING | DELAY | SETTING | DELAY | SETTING | SETTING | DELAY | OVCT. | FT | GROUND |
| MPS C-3 | X | X | --- | --- | X | --- | --- | TD9650 | --- | --- |
| MPS-C-3G | X | X | X | X | X | X | X | TD9650 | --- | TD9652 |
| MPS-C-4 | X | X | X | X | --- | --- | --- | TD9651 | TD9653 | --- |
| MPS-C-4G | X | X | X | X | --- | X | X | TD9651 | TD9653 | TD9652 |
| MPS-C-5 | X | X | X | X | X | --- | --- | TD9651 | TD9653 | --- |
| MPS-C-5G | X | X | X | X | X | X | X | TD9651 | TD9653 | TD9652 |

fifty percent and one hundred percent of phase sensor rating. In the right position, the setting is at the 100% setting; in the left position, the 50% setting is selected. This feature expands the available trip settings without the use of rating plugs or sensor tap changes made at the sensor. This feature has no influence on the ground settings which remain marked in primary current amperes.

### Targets

Trip operation indicators, or targets, are provided as standard equipment on all types of MPS-C trip units. One trip target is provided for each trip element provided on the MPS-C electronic trip device; a maximum of four can be provided. When the MPS-C determines that a trip is necessary, it will both signal the magnetic latch and display the appropriate trip target with an orange "day-glo" color. Since the target is a mechanical device, it does not require power to retain its indication. This indication is resistant to shock and vibration, and will remain as long as the breaker is open. Targets are automatically reset by the microprocessor within two seconds after breaker closure (as long as at least 6% of sensor current is flowing through the circuit breaker phases). In situations where a circuit breaker is closed into a circuit where a trip condition still exists, the previous target will be reset instantaneously, and the new target displayed when the breaker re-trips. New circuit breakers unpacked from the factory will have one of the targets displayed; this is a result of the factory testing performed on the breaker prior to shipping. This target will reset when the circuit breaker is closed and primary current is flowing.

*Figure 15 - Current Sensors and Circuit Breaker Settings*

| SENSOR RATING | AMPERE RANGE SELECTOR SETTINGS | GROUND PRIMARY AMPERES, SETTING | AVAILABLE ON CIRCUIT BREAKER TYPES! |
|---|---|---|---|
| 3000 | 1500, 3000 | 500, 600, 800, 900, 1000, 1200 | K-3000M, K-4000M |
| 3200 | 1600, 3200 | 500, 600, 800, 900, 1000, 1200 | K-3200M, K-4000M |
| 4000 | 2000, 4000 | 500, 600, 800, 900, 1000, 1200 | K-4000M |

## AVAILABLE SETTINGS

### Ampere Range Selector Switch

Select the range which corresponds to the required trip element settings. With the range selector pushed to your right, the full sensor rating is selected. The left position selects one-half the sensor size. Except for ground, all the other trip settings are multiples of this switch setting.

**WARNING WARNING WARNING WARNING**

WHEN MAKING LONG-TIME, SHORT-TIME, INSTANTANEOUS, AND/OR GROUND SETTINGS, AND ALL DELAY SETTINGS, MAKE SURE THAT THE SELECTION IS IN A DETENTED POSITION. THERE ARE NO SETTINGS BETWEEN THE MARKED SETTINGS. ATTEMPTS TO MAKE SUCH SELECTIONS WILL AUTOMATICALLY SET THAT SWITCH TO THE VERY LOWEST SETTING OF THAT SWITCH.

### Long-Time

The long-time setting may be 0.5, 0.6, 0.7, 0.8, 0.9, or 1.0 times the range selector setting. The tolerance on the

threshold (pick-up) is minus 0%, plus 10% to assure that the breaker will carry its rated maximum continuous current without tripping when set on the 1.0 multiplier. Minimum (MIN), intermediate (INT), and maximum (MAX) delay bands are also provided. Refer to time current curve TD-9650 or TD-9651.

**Short-Time**
The short-time setting may be 2, 3, 4, 6, 8, or 10 times the range selector setting. Tolerance on short time threshhold is plus or minus 15%. Three delay bands are provided; minimum, intermediate, and maximum time delay. A slide switch labeled "IN" and "OUT" selects the $I^2t$ inverse time tripping characteristic. The $I^2t$ characteristic applies when the switch is in the "IN" position. See time current curves TD-9651 for $I^2t$ "OUT", TD-9653 for $I^2t$ "IN".

**Instantaneous**
The instantaneous trip setting may be 3, 4, 5, 7,10, and 12 times the range selector setting. A plus or minus 20% tolerance applies on pick-up. See curve TD-9650 or TD-9651 for trip characteristics.

**Ground**
There are three ranges of ground settings available based on the frame size of the circuit breaker on which the trip device is installed. The settings are shown in the table in figure 5. These settings are marked on the face plate in primary amperes. A plus or minus 15% tolerance applies on pick-up. Three delay bands are provided: minimum, intermediate, and maximum time delay. A slide switch labeled "IN" and "OUT" selects the $I^2t$ inverse time tripping characteristic. The $I^2t$ characteristic applies when the switch is in the "IN" position. See time current curves TD-9652. Additional unique programming in the MPS-C trip unit responds to low level arcing faults by summing the erratic currents associated with arcing, then providing a trip when that sum is above the trip threshold for a preprogrammed period of time.

**Self Monitoring**
Continuous monitoring of the microprocessor function is programmed into the MPS-C. "Watchdog" circuits guard against the possibility of microprocessor disfunction due to "endless loops". A red light emitting diode (LED) mounted on the MPS-C nameplate indicates the condition of the microprocessor. Normal operation is shown by a blink rate of one flash per second when approximately six percent of the sensor current rating is flowing through the primaries. The LED does not blink at current levels below 6%. Servicing is required if the LED remains lit but does not blink, or does not illuminate at all when current levels are above 6%. When the long time trip element "picks up", indication is provided by a fast blink rate of the self monitor LED. When this is observed, the MPS-C long time trip element is in the timing mode and breaker tripping is imminent.

**Selecting Trip Settings**
The settings of current threshold and delay bands must be determined by an analysis of the protection and coordination requirements of the power system. After selecting the proper range of sensor settings with the range selector, the other settings are made using a small screwdriver to select the multiples of range selector amps in the long time, short time and instantaneous trip elements. Selections in primary current amps are selected with the ground selector switch. Delays for long time, short time and/or ground are made in a similar fashion. Slide switches allow selection of the $I^2t$ characteristic on short time and ground.

Here is an example of breaker settings:
Given: 3000 ampere K-3000M with 3000 ampere sensors
Long time setting required: 1800 amperes
Instantaneous setting required: 30,000 amperes
Ground setting required: 500 amperes

1. Set RANGE SELECTOR to "3000"

2. Set LONG-TIME SETTING to 0.6 setting - (0.6 x 3000 = 1800).

3. Set INSTANTANEOUS to "10" setting - (10 x 3000 = 30,000).

4. Set GROUND to 500 setting.

5. Set DELAY on long time, short time and/or ground as required.

**Testing**

A test set designated type 607 and designed specifically for use with the trip system is available. Refer to IB 6.1.1.7-4. Primary current injection is covered below.

A test function switch in the faceplate is provided for testing only with the type 607 test set.

**WARNING WARNING WARNING WARNING**

WHEN USING PRIMARY CURRENT TO TEST THE MICRO Power-Shield TRIP SYSTEMS EQUIPPED WITH THE GROUND TRIP FUNCTION, THIS FUNCTION MUST BE DEFEATED IN ORDER TO TEST THE OTHER TRIP ELEMENTS. A SPECIAL GROUND DEFEAT TEST CABLE (PART 712918-T09) MUST BE USED. THE CABLE IS INSERTED TEMPORARILY IN THE CIRCUIT CONNECTING THE TRIP UNIT AND THE CIRCUIT BREAKER. FAILURE TO USE THE GROUND DEFEAT TEST CABLE CAN RESULT IN DAMAGE TO THE MICRO Power-Shield TRIPPING SYSTEM. CALL THE NEAREST ASEA BROWN BOVERI DISTRICT OFFICE TO ORDER EITHER THE GROUND DEFEAT TEST CABLE (PART 713918-T09) OR THE D.E.S.P. TEST CABLE (PART 713918-T10).

## PROCEDURE FOR FIELD TESTS ON K-LINE CIRCUIT BREAKERS

### Solid State Trip System testing

There are two ways to evaluate the MICRO Power-Shield solid state trip system. A secondary current injection test set, the type 607 tester, has been designated specifically for use with the box. This tester simulates the current from the current sensor and allows evaluation of the solid state box and magnetic latch. Used in conjunction with the TEST FUNCTION selector switch on the box, the type 607 tester can be used to evaluate long-time, short-time, instantaneous, and ground with or without maglatch. The full range of the circuit breaker frame sizes can be evaluated with the 607 tester. To obtain a tester, call the nearest Asea Brown Boveri sales office and ask for part 716607T01. Refer to Bulletin 6.1.1.7-4, which was written for the 606 test set.

The other method of evaluating the MPS solid state trip system is by primary current injection using the primary current injection test set. This method allows evaluation of the sensors, solid state box, magnetic latch and interconnecting harnesses. Below is a procedure for performing this field test.

### Primary Current Testing - MICRO Power-Shield Type MPS-C

**Notes:**

1. Refer to time current curves TD-9650, TD-9651, TD-9652, TD-9653.

2. When checking calibration, set functions not being tested at their highest threshold value.

3. On MPS trip units equipped with ground, the ground trip must be defeated by using a special cable assembly, part number 716326T14. This assembly is installed between the solid state box and the breaker wiring harness. Failure to use this harness will prevent primary current testing of the long-time delay function.

4. The TESTING FUNCTION selector switch on front of the solid state box operates only with the optional Type 607 secondary current injection test set. The position of this switch has no influence during primary current injection tests.

5. The closing springs must be charged and the circuit breaker closed before each test below.

**Instantaneous Threshold Test**

1. Position the other trip elements selectors at their highest threshold value.

2. Position trip system Range Selector in the desired position, either full or one-half breaker sensor rating.

3. Put instantaneous selector switch in the four times (4X) setting.

4. Test for the actual threshold by increasing test set current until the breaker trips.

5. The threshold tolerance is +/-10% on all selector switch settings.

6. Instantaneous times cannot be accurately measured with primary current test sets. Such times can only be measured with oscillographic equipment. Percent error in the timer and meter of primary current test sets can make it appear that the instantaneous does not fall inside its band.

**Long-Time Delay Test**

1. Position the other trip element selectors at their highest threshold value.

2. Position Range Selector in desired position.

3. Put long-time selector in the one times (1 X) setting.

4. Set test set current so that current through the breaker is three times (3X) trip system Range Selector setting. Times should be as follows:

| | | |
|---|---|---|
| | **MIN.** | **8 - 13 SEC.** |
| | **INT.** | **20 - 33 SEC.** |
| | **MAX.** | **61 - 100 SEC.** |

**Short-Time Delay Test**

1. Position the other trip element selectors at their highest threshold value.

2. Position Range Selector in desired position. To prevent stress on the solid state components, however, the lower position is recommended.

3. Put $I^2t$ switch in the OUT position.

4. Put short-time selector in the two times (2X) setting.

5. Set test set current so that current through the breaker is four times (4X) trip system Range Selector Setting. Times should be as follows:

6. Put $I^2t$ switch in the IN position.

7. Set test set current so that current through the breaker is 1.5 times the two times (2X) trip system Range Selector setting. Times should be as follows:

**Ground Trip Delay Test**

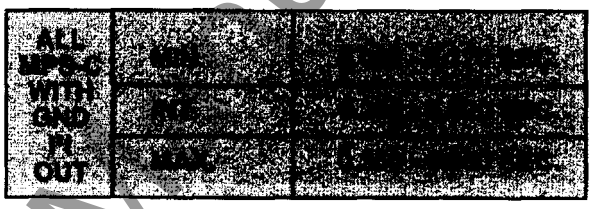
1. Position the other trip element selectors at their highest threshold value.

2. Remove the ground defeat cable assembly. Connect the breaker harness directly to the box.

3. The Range Selector has no influence on the ground settings.

4. Put the ground trip selector in the minimum available ground setting (100A on 200A and 800A sensors, 300A on 1600A through 2500A sensors, and 500A on 3000A through 4200A sensors). Device nameplate has actual current values on ground trip available.

5. Set test set current so that current through breaker is three times (3X) the minimum setting selected in (4) above. Time should be as follows with $I^2t$ out. Times with $I^2t$ "IN" shown on page 23.




6. On breakers with 4-wire ground and 4-wire ground on double-ended substations, the remove neutral sensor can be simulated with the breaker -mounted left pole sensor. On the back of the breaker temporarily reverse wires marked W and N. These wires appear on secondary disconnect points 17 and 18. Connect the circuit breaker so that current flows through the left pole only, and check the ground system as in (5) above. Following the test, return wire W and N to their proper locations.

Note that wire N is on terminal 18 of the secondary disconnect and W is on terminal 17 for 4W ground boxes. On double-ended sub, 4W ground boxes W is on 18 and N is on 1 7.

7. As an alternative to (6) above, a separate neutral sensor can be used to operate the trip system. Optional test cable assembly 713918-T10 provides leads-out which may be connected to a neutral sensor. The type used is at the discretion of the tester. It is recommended that it be of the type planned for final installation. Connect the primary current injection machine to pass current through the neutral sensor.

| | DELAY SETTING | SENSORS | | |
|---|---|---|---|---|
| | | 200-800A | 1600-2500A | 3000-4200A |
| ALL MPS-C WITH GND $I^2t$ IN | MIN. | 0.68-1.3 SEC. | 0.07-0.18 SEC. | 0.05-0.17 SEC. |
| | INT. | 2.1-4.2 SEC. | 0.24-0.47 SEC. | 0.20-0.32 SEC. |
| | MAX. | 5.2-9.5 SEC. | 0.59-1.2 SEC. | 0.35-0.60 SEC. |

**FIELD REPAIR INSTRUCTIONS**

**MICRO Power-Shield Trip Device Removal and Installation**

**WARNING WARNING WARNING WARNING**

NEVER REMOVE AN MPS BOX HARNESS WHEN THE CIRCUIT BREAKER IS CLOSED AND CONDUCTING CURRENT. THE MPS BOX PLUG AND HARNESS PLUG WILL BE DAMAGED BY A HIGH VOLTAGE FLASHOVER. PERSONAL INJURY MAY ALSO RESULT

1. Remove the two nylon screws which retain the trip system harness plug to the device. Retain for re-use.

2 . Remove the four self-tapping screws holding the device shield and remove the shield.

3. Remove the three screws, lockwashers, and nuts that retain the device, then remove the device from the breaker.

4. To reinstall, reverse the above procedure.

**CAUTION CAUTION CAUTION**

Metallic screws must not be used to retain the trip system harness. Should a metallic screw fall into the trip system, serious damage can result. DO NOT OPERA TE THE CIRCUIT BREAKER WITHOUT THE HARNESS SCREWS IN PLACE.

**WARNING WARNING WARNING WARNING**

The trip device red polyester shield must be in place during breaker operation.

**Magnetic Latch Removal**

**WARNING WARNING WARNING WARNING**

THE CIRCUIT BREAKER MUST BE DE-ENERGIZED, RACKED OUT AND REMOVED FROM THE SWITCHGEAR PRIOR TO PERFORMING THIS PRO-CEDURE. (ON STATIONARY BREAKERS IT IS NOT NECESSARY TO REMOVE THE BREAKER R; HOW-EVER. THE MAIN BUS AND CONTROL POWER MUST BE DE-ENERGIZED. THE CLOSING SPRING MUST BE DIS-CHARGED WITH THE MAIN CONTACTS OPEN.

1. Remove the reset spring from its circuit breaker jackshaft mounting.

2. Disconnect the "B" and "F" leads from the breaker harness to the magnetic latch.

3. Remove the two large countersunk screws from the magnetic latch assembly mounting bracket and remove the magnetic latch assembly from the circuit breaker.

4. To reinstall, reverse the removal procedure.

**Maglatch Pretravel Adjustment**

**CAUTION CAUTION CAUTION**

This adjustment must be performed with the circuit breaker closed. Extreme care must be exercised in avoiding moving parts. Drawout circuit breakers must be racked to the disconnect position. It is mandatory on stationary breakers that the main bus be de-energized. Control voltage on stationary breaker must also be de-energized.

1. Perform this adjustment only after maglatch replacement or when automatic trip problems with the maglatch have been observed.

2. Ideal maglatch operation is attained when maglatch armature pretravel of 0.062 to 0.125 inches is achieved. Accepted breaker tripping is the guiding criteria.

3. Pretravel may be evaluated measuring the gap between the magnetic latch plunger and the adjusting screw on the bracket attached to the trip bar of the closed circuit breaker. Care must be taken not to move this bracket as breaker tripping can result.

4. Loosen the $\frac{3}{8}$ inch nut on the adjusting screw, then adjust the screw in the required direction to attain acceptable pretravel using an open-ended $\frac{5}{16}$ inch wrench. It will be necessary to hold the tripper bar secure to keep it from rotating as the adjustment is made.

5. Retighten the $\frac{3}{8}$ inch nut to lock down the adjusting screw.

**Lubrication**

**CAUTION CAUTION CAUTION**

ABB DOES NOT RECOMMEND LUBRICATION OF ANY KIND ON ANY PART OF THE MAGNETIC LATCH ASSEMBLY.

ABB Power T&D Co., Inc.
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Distribution Systems Division
P.O. Box 100524
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ABB

MS 3.1.1.9-2E

# Maintenance and Surveillance

## Low-Voltage Switchgear Equipment

## K-Line® Switchgear

**IB 3.1.1.7-2**

## Type K-225 thru 2000 and K-600S thru 2000S

**IB 6.1.2.7-1**

## Type K-3000, 4000, K-3000S and 4000S

**IB 6.1.2.7-2**

# RECOMMENDED MAINTENANCE & SURVEILLANCE LOW VOLTAGE SWITCHGEAR EQUIPMENT

## EQUIPMENT MAINTENANCE PROGRAM

This Bulletin augments the information and instructions provided in Instruction Bulletin 3.1.1.7-2, 6.1.2.7-2 and 6.1.2.7-1.

Switchgear installations which require exceptional dependability due to serious safety or economic consequences of operating problems should be given comprehensive maintenance and surveillance attention. This program recommendation has been developed specifically for use in Nuclear Power Generating Stations but it is applicable to any installation where exceptional reliability is desired and a preventive maintenance program is to be implemented.

Some maintenance activities are considered essential, therefore ACTIVITIES WHICH ARE MOST IMPORTANT TO ASSURE AVOIDANCE OF PREDICTABLE PROBLEMS ARE UNDERLINED.

## FREQUENCY OF MAINTENANCE

Suggested time frames in the program are not absolute, they represent the best generalized advice of the manufacturer for equipment installed in a clean, uncontaminated environment such as may be found in a power generating station. If equipment is in an area where corrosive or conductive contaminents are present, or if large amounts of airborne contaminants will be experienced, the shortest interval of the range shown in the equipment maintenance program should be used. Further, in highly contaminated areas, as described, circuit breaker servicing should be accomplished at a maximum of two year intervals.

If it becomes apparent after several maintenance cycles that certain activities are not needed as frequently as suggested, or that increased frequency would be prudent, the program should be adjusted to meet the specific needs of the installation.

## RECORDS

Records are a key factor in a preventive maintenance program and can provide vital data for evaluating equipment condition, when necessary, if the recording system is consistent, thorough and available when needed. As a minimum the records should contain the data and, for circuit breakers, the number of operations at last maintenance in addition to results of testing. If observations of equipment condition are recorded, a realistic basis for adjusting maintenance frequency will be available.

## SPARE PARTS

A major factor in overall availability is down-time-per-failure or mean-time-to-repair and, although, switchgear and associated components enjoy favorable reliability expectations, random failure of a component can cause down-time or reduced capability if inadequate attention is given to the spare parts inventory. A spare parts recommendation for the switchgear equipment can be provided to assist in selection of appropriate parts. Storage of spares should be in a clean, dry area. Part access and identification should permit prompt availability, when needed.

## 1. GENERAL

CAUTION: BE SURE THAT ALL ELECTRICAL SUPPLIES ARE OFF BEFORE PERFORMING ANY MAINTENANCE INSIDE EQUIPMENT.

a. The following lubricants are recommended:

| LUBRICANTS | |
|---|---|
| Mechanisms (anti-friction) | ANDEROL 757 Tenneco Chem. Inc. |
| Electrical Contact Compound | NO-OX-ID "A Special" Sanchem Chem. Co. |

Use of other lubricants risks incompatibility with original materials or unproven performance.

b. In tightening bolted conductor connections, use of a torque wrench is recommended. The following torque levels will assure good connections:

| DRY THREAD TORQUE | |
|---|---|
| BOLT DIA. | TORQUE |
| 3/8" | 15-25 ft. lb. |
| 1/2" | 30-45 ft. lb. |
| 5/8" | 50-75 ft. lb. |

c. A clean and dry environment should be a continuing goal of the maintenance program for all electrical equipment.

d. Operating and maintenance personnel should be alert for unusual sounds (sizzling or crackling) and smells (ozone or burning) when in the vicinity of electrical equipment.

2. RECEIPT AND STORAGE

Environmental conditions during transit and storage can have a substantial effect on equipment reliability. Extended periods of storage with original shipping covers in place must be avoided.

a. Upon receipt, equipment should be put into a ventilated storage area protected from the weather. Temperature should be maintained between 40°F and 120°F, humidity should be maintained at 50% relative* or below and/or boxes should be removed.

*If relative humidity above 50% is anticipated, localized heat sources should be provided to maintain equipment temperature above the dew point. One means of accomplishing this is to energize internal equipment space heaters and store circuit breakers within the equipment enclosures.

b. Under all conditions of transport and storage, equipment should be protected from direct impingement of water, flooding and heavy contamination, such as construction dust/dirt.

3. AT INSTALLATION (Repetition of some factory activity is suggested due to uncertainties of shipping, handling, etc.)

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE.

a. Equipment mounting should be on level rails embedded flush with the finished floor per installation dwgs.

b. Removal of all shipping supports and installation of all bus conductors (main ground) across shipping splits should be verified.

c. Check all bolted bus connections for proper torque.

d. Check circuit breaker connection wipe by applying NO-OX-ID compound to stationary connection stubs and racking breaker into connected position, then out. Contact lines in compound verify contact.

e. Exercise each circuit breaker (close and trip twice.)

f. Inspect primary conductor insulation system, remove contamination accumulated in storage and installation.

g. Check primary cable connections for tight hardware and proper stress relief. Check all primary connections to other electrical equipment.

h. Check control wire connections - See 6c.

i. Check trip/racking interlock to verify not racking with breaker closed and no closing unless breaker is latched in position.

j. Millivolt drop measurements on each circuit breaker provide useful preoperation checks and valuable comparative data for future use.

k. Set and check calibration of trip units per I.B.** On solid state trip units, verify that color coded sensor leads agree with the wiring diagram (WD) identified on the circuit breaker nameplate.

4. TWELVE TO EIGHTEEN MONTH INTERVALS

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE

a. Identify and service circuit breakers which are due. See CIRCUIT BREAKER SERVICING section, page 5 of this Bulletin.

** Electro-Mechanical Trip - I.B. 6.1.2.7-1
Solid State Trip - I.B. 6.1.2.7-4

b. Exercise all circuit breakers which are not due for service.

c. Inspect primary interface connections with other equipment for signs of excessive heat (Cable and bus connections, usually in the rear of the equipment.) Discoloration or embrittlement of adjacent insulating materials and conductor corrosion or discoloration may indicate a hot joint. See HOT JOINT MAINTENANCE & JOINT COVERS, below.

d. Inspect primary cables for chafing at conduits or supports.

e. Exercise the racking mechanism.

5. ONE TO THREE YEAR INTERVALS (Nuclear - Alternate refueling shutdowns.)

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE.

a. Clean contamination from all primary insulation with vacuum, distilled water or a solvent approved by NIOSH or local authority, as necessary. Inspect for discoloration or other evidence of excessive heat. If found, preceed per HOT JOINT MAINTENANCE, below.

b. Inspect control wiring bundles for discoloration due to heat, chafing or other damage to insulation.

c. Clean stationary breaker connection stubs in the enclosure with a solvent approved by NIOSH or local authority. Inspect for evidence of contact galling, excessive heat, arcing or corrosion. If found, proceed per HOT JOINT MAINTENANCE below. Reapply NO-OX-ID compound prior to reconnecting circuit breaker.

NOTE: Protective relays should typically be checked for accuracy of calibration at two to five year intervals, see manufacturers instructions for details.

6. TEN YEAR MAXIMUM INTERVAL

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE.

CIRCUIT BREAKER REFURBISHMENT

a. Disassemble, inspect, clean, relubricate, readjust and recalibrate breaker mechanisms which have not been fully refurbished in ten years.

b. All primary conductor connection bolts should be torqued to recommended values. (An alternative to retorquing may be use of infrared heat sensor (thermographic) techniques. These procedures are specialized, however, and require plans to overcome loading and safety difficulties.)

c. Tighten all secondary control wire connections while checking for loose lug crimps and broken wire strands.

HOT JOINT MAINTENANCE - For primary joints which show evidence of excessive heat: (1) Open joint and inspect connection surfaces. (2) If surfaces appear reasonably smooth, with only minor pitting or corrosion, clean and dress contact surfaces minimizing removal of plating. (3) If surfaces are heavily pitted or corroded, or if there has been any melting of conductor material, the affected parts must be replaced. (4) Replace contact finger springs if breaker disconnects have been exposed to excessive heat. (5) Contact surfaces should be protected with NO-OX-ID before reassembly. (6) Use recommended torque values in tightening bolted connections. (7) Before and after millivolt drop testing can provide some confidence that the problem has been corrected.

## CIRCUIT BREAKER SERVICING

Circuit breakers require inspection and servicing periodically to assure operability. Servicing should be accomplished based on number of operations since last serviced, with an elapsed time limit. The appropriate frequency of servicing depends on the duty of the circuit breakers. As experience warrants, the recommended frequency of servicing shown below should be adjusted on specific breakers to account for more/ less severe duty than initially expected, based on the breaker condition when serviced.

Recommended service frequency is shown for three general categories of duty:

LOAD CURRENT SWITCHING, UP TO RATED CONTINUOUS CURRENT ENVIRONMENT NORMAL, MINIMAL CONTAMINATION.

Service breaker every five (5) years or upon accumulating the number of operations shown below since last serviced, whichever comes first.

K-600/800 _____ 1750 Ops.
K-1600 _____ 500 Ops.
K-3000/4000 _____ 250 Ops.

MOTOR START, CAPACITOR & REACTOR SWITCHING OR ANY DUTY IN A CONTAMINATED ENVIRONMENT.

Service breaker every two (2) years or upon accumulating the number of operations shown below since last serviced, whichever comes first.

K-600/800 _____ 1000 Ops.
K-1600 _____ 300 Ops.

FAULT INTERRUPTION

Service a breaker which has interrupted short circuit current as soon as possible.

This service program qualifies a circuit breaker for the total number of operations shown below before replacement or factory refurbishment is required. The limit is suggested to provide margin.

A.C. CIRCUIT BREAKERS

K-600/800 - Total Operations - 12,500
Suggested Limit - 11,250
K-1600 - Total Operations - 4,000
Suggested Limit - 3,600
K-3000/4000 - Total Operations - 1,500
Suggested Limit - 1,350

D.C. CIRCUIT BREAKERS

K-600/800 - Total Operations - 11,450
Suggested Limit - 10,305
K-1600 - Total Operations - 3,700
Suggested Limit - 3,330
K-3000/4000 - Total Operations - 1,350
Suggested Limit - 1,215

The following should be accomplished at each service interval:

CLEAN, INSPECT & LUBRICATE PRIMARY DISCONNECTS.

CONTACT & INSULATION CLEANING.

ARC CHUTE INSPECTION

OPERATION CHECK

CONTACT PRESSURE CHECK*

Instructions follow which clarify the above.

In addition, the hardware (bolts, nuts, screws and pin retainers) should be checked with a thorough inspection to be sure that they are in place and secure.

There are other activities which may be required as shown:

CONTACT PRESSURE ADJUSTMENT*

Required if contact pressure check indicates a problem.

MECHANISM ADJUSTMENT & LUBRICATION*

Required if breaker misoperation occurs (such as not latching closed or high control voltage required for operation).

TRIP DEVICE CALIBRATION CHECK.**

Recommended at alternate service intervals to verify coordination, as needed.

LUBRICATION

The K-Line circuit breakers are lubricated during factory assembly as follows:

All mating surfaces of moving current-carrying joints have been lubricated with NO-OX-ID Special Grade "A" grease.

All other mechanism parts, bearings, pins, etc. have been lubricated with ANDEROL 757.

The circuit breaker mechanism does not ordinarily require lubrication in the usual moderate service environment expected. However, if operating difficulties are experienced, if grease becomes contaminated or if parts are replaced, relubrication with ANDEROL grease may be required. Extensive disassembly is required to properly relubricate the mechanism. Contact the nearest ABB Power Distribution Inc. district office for field assistance or factory refurbishment.

Primary disconnect fingers should be cleaned with a solvent approved by NIOSH or local authority, inspected for corrosion or evidence of arcing and relubricated with NO-OX-ID grease at each servicing.

NOTES:

Do not use No-OX-ID grease on main or arcing contact parting surfaces.

Do not use light oil to lubricate mechanism parts.

The spring charging motor is sealed, lubrication is not recommended.

*Consult the Circuit Breaker Instruction Bulletin for guidance in making the contact pressure check and adjustments, and mechanism adjustments. K-225 to K-2000 - I.B. 6.1.2.7-1, K-3000 & K-4000 - I.B. 6.1.2.7-2.

**Consult the following Instruction Bulletins for details of trip device testing:

Electro-Mechanical Trip - I.B. 6.1.2.7-1
Solid State Trip - I.B. 6.1.2.7-4

## CONTACT AND INSULATION CLEANING

Any dirt, soot or grease should be removed from the circuit breaker contacts and surface of entire current carrying structure, as well as all insulation surfaces, with a cloth saturated with an approved solvent. Cleaning of the insulation is important because contamination can accumulate and, with moisture, can place the circuit breaker in jeopardy, dielectrically.

A degree of burning and pitting on the circuit breaker arcing contacts is to be expected from normal operation; on highly inductive or capacitive circuits and after major interruptions, some pitting may occur on the main contacts. When necessary to dress the contacts, follow the contour of the contacts with a fine file. Do not attempt to eliminate pitting entirely. After this maintenance, the contact pressure should be made, if indicated.

NOTE: Replacement of contact need only be considered when after repeated dressing of contacts, less than 50% of the original contact material thickness is left, the tips of the stationary arcing contacts have been eroded away, or any contact has been broken, cracked or burned through.

CAUTION: FOR SAFETY, KEEP CLEAR OF ALL MOVING PARTS.

## ARC CHUTE INSPECTION

Removal:

1. If circuit breaker has a solid state overcurrent trip device, it is necessary to remove two 1/4" diameter screws fastening the solid state control assembly. Move the assembly access to the arc chute retaining screws.
2. Loosen the retaining screw and remove the screw and arc chute retainer.
3. Pull the arc chute forward slightly then lift to remove.

Inspection:

1. Discoloration or slight eroding is not harmful
2. Arc runners or cooling plates that are seriously burned or eroded and moldings that are cracked or broken require replacement of the arc chute.

Replacement:

1. Properly position the arc chute in the upper molding.
2. Position retainer and insert and tighten screw.

## OPERATION CHECK

During servicing it is desirable to verify breaker operability. On electrically operated breakers this should be done at minimum expected control voltage level (typically 80% of nominal).

## CONTACT PRESSURE CHECK

See circuit breaker Instruction Bulletin for detailed checking procedures.

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