BBC
BROWN BOVERI

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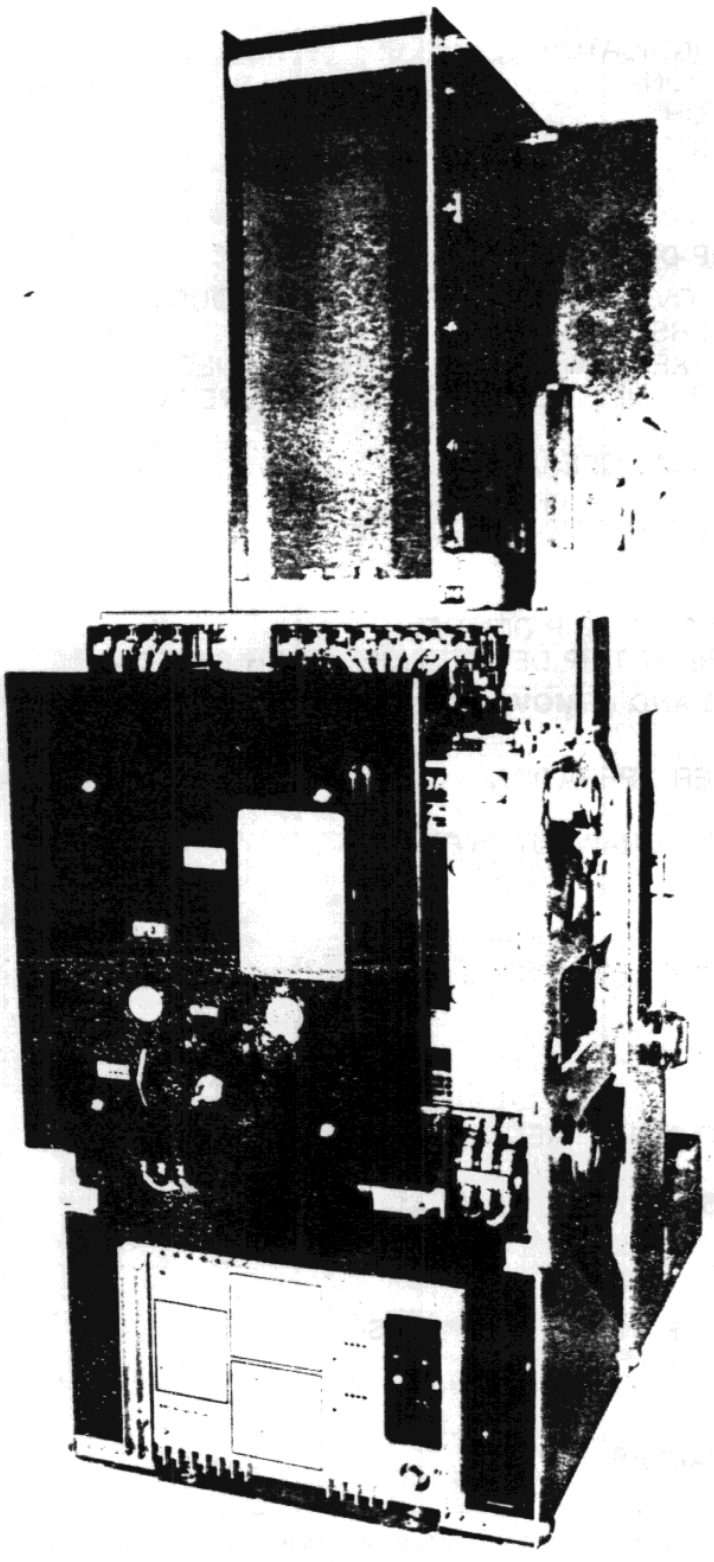
Installation/Maintenance Instructions

I-T-E DC Low Voltage Power Circuit Breakers

Type FBK-H High Speed, Model 01B

1600 through 10,000 Amperes
800 Volts



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INTRODUCTION

These instructions apply to the high speed versions of BBC's direct current circuit breakers with continuous currents of 1600 through 10,000 amperes; the type FBK-H-1600 through FBK-H-10,000. They may be applied on systems with any voltage up to the nominal voltage, 800 V.D.C., or on systems with an E'∞ of 1000 V.D.C. These high-speed circuit breakers will limit the magnitude and duration of fault currents to values significantly less than the circuit's available peak current. The circuit breakers are available as one or two pole breakers with high-speed trip in forward and/or reverse direction. Also available is a negative disconnect withdrawal unit. The mechanisms are electrically operated and mechanically latched with provision for manual close, trip and maintenance slow closing.

A drawout type FBK-H 4000, single pole, is shown in Figure 1, with a typical schematic diagram shown in Figure 12.

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 breakage or rough handling is evident, file a damage claim at once with the carrier and promptly notify the nearest BBC District Office representative. BBC Brown Boveri is not responsible for damage of goods after delivery to the carrier. However, we will lend assistance if notified of claims.

Unpack 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 circuit breaker parts. Check the contents of each carton against the packing list before discarding any packing material. If any discrepancy is discovered, promptly notify the company representative. Information specifying the purchase order number, carton number and part numbers of damaged or missing parts should accompany the claim.

Circuit breakers should be installed in their permanent locations as soon as possible. (See Basic Handling section.) If possible, a drawout circuit breaker should be stored and locked in the "DISCONNECTED" position in its compartment with the door closed. Both the primary and control separable contacts are disconnected in this position. If the breaker cannot be installed in its compartment, it should be kept in a clean and dry location or covered and sealed to prevent infiltration of dirt. Where conditions of high humidity prevail, the use of heaters is recommended, regardless of the method of storage selected.

BASIC HANDLING INSTRUCTIONS

Once the circuit breaker has been removed from its shipping crate, it should be kept in the upright position and placed on a flat surface to avoid damage to breaker parts. For safety, all handling in this position should utilize a lifting yoke (Figure 1, Item 20): CAUTION CAUTION Do not push against or lift the circuit breaker by its arc chute.

CIRCUIT BREAKER OPERATION

Circuit Breaker Rating

The continuous current rating is the maximum current that can be carried without exceeding rated temperature rise. There is no overload rating.

Exceeding the current rating may raise the temperature of the breaker beyond its design limit and, thus, affect the life of the circuit breaker.

Basic Circuit Breaker Operating Scheme

(Refer to the specific schematic diagrams, electrical operating sequences and any other operational information furnished with the order. See also, Fig. 12.)

With the circuit breaker open, the closing springs discharged, the control power source energized, and the motor disconnect switch (MDS) closed, operation occurs as follows:

1. Immediately upon application of control power, the spring charging motor is energized, which in turn charges the closing springs. When the closing springs are charged, limit switch contacts "LS/1" and "LS/3" are opened, and limit switch contact "LS/2" is closed.

2. Operation of the remote close control switch or local electrical close pushbutton (when supplied) energizes the close latch release coil (X) through the circuit breaker auxiliary switch "L/b" contact, the normally closed lockout relay contact "Y/2", the 76 HS1 contact and the limit switch contact "LS/2". The close latch release coil (X) releases the latch and the springs then discharge to close the circuit breaker.

3. When the springs discharge, limit switch contacts "LS/1" and "LS/3" close and limit switch contact "LS/2" opens.

4. When the circuit breaker closes, all auxiliary switch "b" contacts open and all auxiliary switch "a" contacts close.

5. When the limit switch contacts "LS/3" close, the lockout relay coil (Y) is energized and opens lockout contact "Y/2" which de-energizes the close latch release coil (X). Lockout contact "Y1" closes which seals in the lockout relay coil (Y) as long as the "close" contact is maintained. The purpose of the lockout coil (Y) is to prevent pumping of the closing mechanism when closing against a faulted circuit.

6. The circuit breaker can be tripped by operation of the remote trip control switch which energizes the circuit breaker trip coil (TC) through the auxiliary switch "L/a" contact.

7. The closing springs recharge after the circuit breaker closes.

Closing Spring Operation

The two closing springs supply the power that closes the circuit breaker contacts and also charge the opening springs during the closing operation. The closing springs are charged by a motor, storing energy for the next close operation. For safety, the closing springs are automaticlly discharged when drawout circuit breakers are racked from the disconnected to the withdrawn position.

ESCUTCHEON FEATURES

Summary of Features

All FBK circuit breakers are provided with an escutcheon which extends through its enclosure door. All indicators and

controls necessary to open, close, or rack the circuit breaker are grouped on this escutcheon.

The controls and indicators (Figure 1) included on the escutcheon face plate are: (19) nameplate giving the rating assigned to the particulr circuit breaker, (13) manual trip button, (12) electrical close push button switch, (10) motor disconnect switch, (14) "OPEN" and "CLOSED" position indicator, (11) means for padlocking the circuit breaker in the "CONNECTED", "TEST", or "DISCONNECTED" position and (16) closing spring charge indicator. Maintenance handle (22) is inserted for manual spring charging and maintenance slow closing. An operation counter (30) is furnished on all FBK breakers.

All drawout circuit breakers have the racking shutter (15) that must be raised to allow inserting of the racking crank (21).

A self-aligning dust plate (18) 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 dust plate adjusts its position to still function as a dust shield.

Circuit Breaker Nameplate (Figure 1, Item 19)

The circuit breaker nameplate contains information regarding (1) the manufacturer's name and address, (2) type of circuit breaker, (3) serial number, (4) continuous current rating, (5) short circuit current rating at rated voltages and (6) momentary current rating.

Circuit Breaker "Open" or "Closed" Indicator (Figure 1, Item 14)

This indicator shows the physical position of the circuit breaker contacts.

Manual Trip Button (Figure 1, Item 13)

This button, when pushed, mechanically trips the circuit breaker to "OPEN".

Padlocking Device (Figure 1, Item 11)

All FBK circuit breakers have provisions for padlocking the mechanism in the trip-free position. When the padlocking hasp is pulled out, it can be secured with up to three padlocks.

To use the Padlocking Device, first push the manual trip button to trip the circuit breaker (if it is closed) and to unlatch the padlock hasp. Pull out the padlock hasp and affix the padlock(s) through it. In this position, the mechanism is held trip-free; the main contacts cannot be closed even though the closing springs can be charged and discharged.

On circuit breakers equipped with drawout mechanism, the Padlocking Device will also lock the circuit breaker in any of its three basic drawout positions of "CONNECTED", "TEST", or "DISCONNECTED".

Closing Spring Charge Indicator (Figure 1, Item 16)

The closing springs on a FBK circuit breaker are automatically charged as soon as control power is applied and immediately after each closing operation when the Motor Disconnect Switch is on. The Closing Spring Charge Indicator shows the status of the closing springs by showing "SPRINGS CHARGED" or "SPRINGS DISCHARGED" through an escutcheon window.

Auto-Trip Indicator (Optional) (Figure 1, Item 17)

This white pushbutton, engraved "RESET", is located on the lower right corner of the escutcheon when furnished. In its normal position, it is almost flush with the circuit breaker escutcheon. The following conditions cause it to pop out:

a. Operation of the direct acting overcurrent trip device, either high speed or semi-high speed. (Optional)
b. Operation of the direct acting undervoltage trip device.

Depress the button before reclosing the circuit breaker.

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 cut-off switch is used:

a. When it is desirable to prevent automatic recharging of the closing springs just prior to taking the circuit breaker out of service.
b. To prevent automatic recharging when racking in the circuit breaker.
c. For control wiring dielectric tests. The motor must be disconnected for the control wiring dielectric test and tested at voltages recommended by the latest revision of ANSI C37.14. Note in that document, the lower dielectric test voltage allowance for breakers that have been in service.

Electrical Close Push Button (Figure 1, Item 12)

The electrical close push button is used to electrically close the breaker from the escutcheon. This contact is connected in series with the latch release coil (X). Energizing the latch release coil allows the charged springs to close the circuit breaker.

Operation Counter (Figure 1, Item 30)

The operation counter is used to count each opening of the circuit breaker contacts. The counter is nonresetable and gives only progressive adding indication. It is frequently used as a reference to schedule maintenance intervals.

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. The racking shutter (15, Fig. 1), which must be lifted to gain access to the racking mechanism, is interlocked with the circuit breaker so that the circuit breaker contacts must be open before the shutter can be lifted to rack the circuit breaker to another position. The circuit breaker cannot be closed when the shutter is open. The circuit breaker may be padlocked open by means of the locking hasp. This automatically locks the racking mechanism.

There are two sets of arrows and indicating lines to show the circuit breaker position within the compartment. One set, located on the dust cover, is utilized with the compartment door closed and one set, located on the cradle, its utilized with the door open.

1. Arc Chute
2. Auxiliary Switch
3. Secondary Separable Contacts
4. Racking Arm Assembly
5. Overcurrent Trip Device (Semi-High Speed)
6. Positioning Wheels
7. Closing Spring Charging Motor
8. Escutcheon Assembly
9. Arc Chute Return Connections
10. Motor Disconnect Switch
11. Locking Hasp
12. Electrical Close Push Button
13. Manual Trip Button
14. "OPEN" or "CLOSED" Indicator
15. Racking Shutter
16. Closing Spring Charge Indicator
17. Auto Trip Indicator
18. Self-Aligning Dust Plate
19. Nameplate
20. Lifting Yoke
21. Racking Crank
22. Removable Maintenance Handle
23. Track (Not Shown)
24. Latch (Not Shown)
25. Arc Chute Retaining Bolts
26. High-Speed Trip Calibration Selector Plug
27. Position Indicator
28. Cradle (Not Shown)
29. High-Speed Trip Control Assembly (76HS)
30. Operation Counter
31. High-Speed Trip Test Button
32. Arc Chute Shelf
33. Electrical Trip Button (Optional)

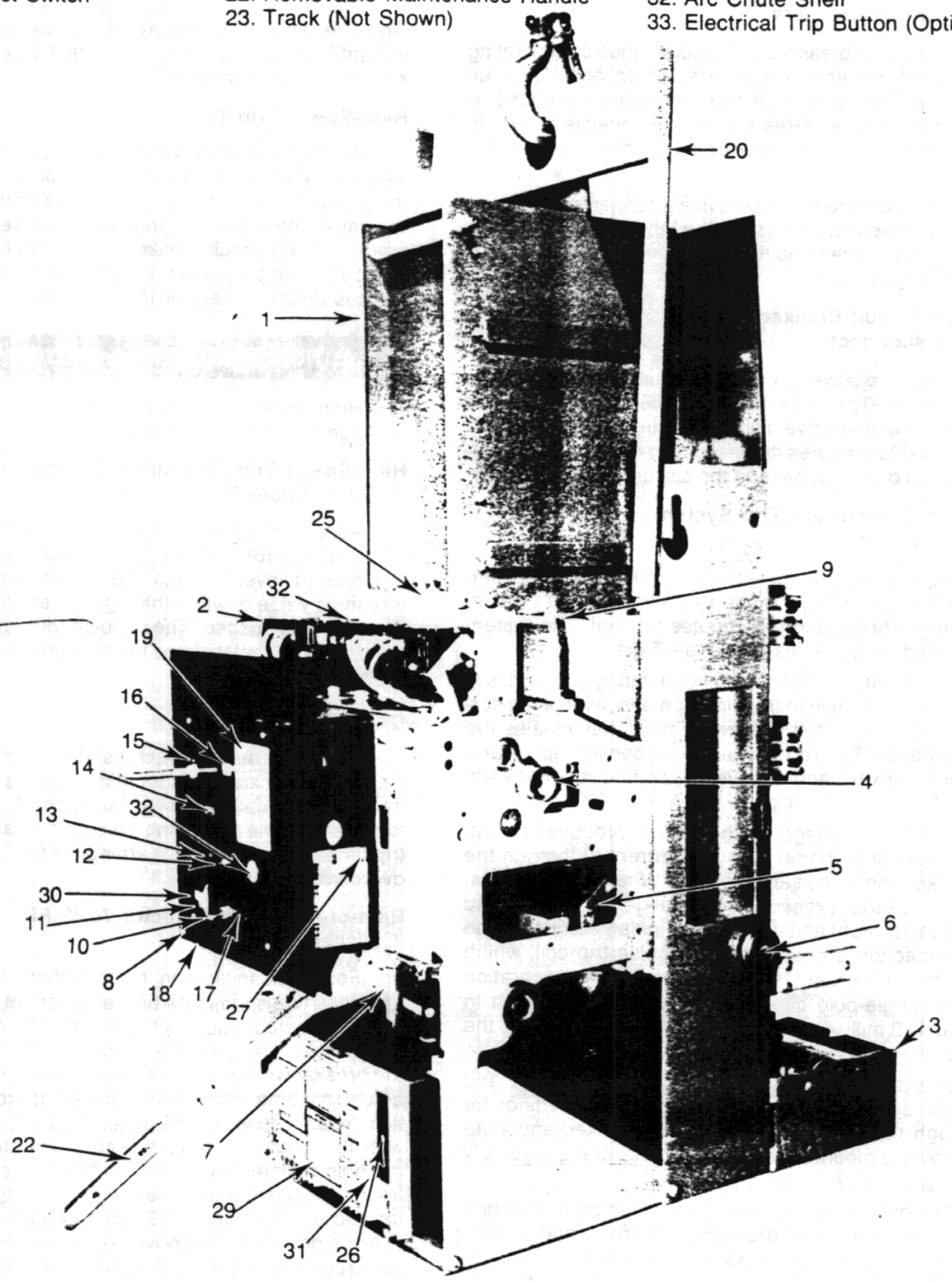


Fig. 1 — FBK-H Drawout D-C Circuit Breaker — Major Components

OPERATION OF AUTOMATIC TRIP DEVICES

Single-Pole Circuit Breakers Rated Over 6,000 Amperes Continuous

Circuit breakers with these ratings consist of two (2) main contact assemblies electrically connected in parallel with both sets of contacts operated by a common jackshaft and one operating mechanism. The electro-mechanical trip devices and high speed trip devices are calibrated for the current that passes through one main contact assembly and is equal to one-half the current passing through the circuit breaker.

Two-Pole Circuit Breakers

Two-pole circuit breakers with a continuous current rating less than 8000 amperes are assembled on one (1) circuit breaker frame. Two-pole circuit breakers with continuous current ratings of 8000 amperes and above consists of two (2) circuit breaker frames with the breakers being electrically interlocked.

The normal overcurrent trip device arrangement is to provide the high speed function(s) on the left hand pole and the direct acting overcurrent trip function (when ordered) also on the left hand pole.

Single-Pole Circuit Breakers with Negative Disconnect

Single-pole/negative disconnect circuit breakers rated up to and including 6000 amperes are on one (1) circuit breaker frame. Single-pole/negative disconnect circuit breakers rated in excess of 6000 amperes consist of two (2) frames, the circuit breaker on one (1) frame and the disconnect on the other.

High-Speed Overcurrent Trip System
(Electrical Operation)

The high-speed overcurrent trip system is a multi-component system consisting of sensor(s), a high-speed trip control assembly (76HS), and the impulse trip coil. The system is represented by block diagram (see Figure 11).

The sensor(s), supplied in several ratings, provides a signal in direct response to the direction and level of the current (I) through the circuit breaker. This signal initiates the tripping operation. By proper selection of sensor ratings and connections, forward and/or reverse tripping functions are provided at selected settings.

The Hall device, integral in the sensor, produces an output voltage signal proportional to the current (I) through the circuit breaker and in the same polarity. When a fault occurs, this output voltage exceeds the level-detector threshold voltage value; (pickup) and the detector initiates a firing pulse from the capacitor to energize the impulse trip coil, which opens the circuit breaker. This high-speed tripping operation causes the single-pole circuit breaker contacts to part in approximately 3 milliseconds after the fault level reaches the selected pickup value.

Pickup settings are provided that are 1.0, 2.0, 3.0 and 4.0 times the selected sensor rating (twice these settings for 8000 through 10,000 amp. FBK-H circuit breaker) and a tap block with plug is mounted on the front panel of the assembly for selecting the pickup setting required.

Monitoring: The high-speed control assembly is designed to monitor the trip system, providing automatic interlocking in the event control power is low or unavailable. When this happens, the 76HS1 contact opens the close latch release coil circuit (Fig. 2). If the circuit breaker is open, it cannot be closed electrically. Another contact, 76HS3 rated 15 VA, non-inductive, 1 ampere maximum, opens when 76HS1 opens. This contact is available for customer use.

As an option, the high-speed trip system will trip the circuit breaker on loss of control power. If this option is not selected, a remote indication can be obtained by wiring the 76HS3 contact in parallel with a "b" auxiliary contact switch. A closed circuit indicates a good power supply or an open breaker. An open circuit indicates a closed circuit breaker with no high-speed trip capability.

After a high-speed tripping operation, contacts in the high-speed control assembly will prevent circuit breaker closing until the trip capacitor is fully recharged. Refer to Table 4 for capacitor charging time.

High-Speed Trip Test

Another feature provided is a test push button which provides a means of simulating a sensor output signal above the pickup level. Pressing this button with the breaker closed will cause the breaker to trip open. This test should only be made with the circuit breaker in the test position when automatic reclosing equipment is provided, unless such equipment is disconnected for the test period.

CAUTION CAUTION CAUTION CAUTION

High speed trip tests done in rapid succession can damage the impulse trip coil.

High-Speed Trip (Mechanical Operation)
(Refer to Figure 7)

As described in the electrical operation, above, the impulse trip coil (6) is energized by capacitive discharge when the current level through the circuit breaker reaches its threshold value or when the high-speed trip test pushbutton (31, Fig. 1) is pushed. The impulse trip armature (3) acts on the tripper (4) that initiates the movement of the mechanism to the open position.

OTHER TRIP DEVICES

Other trip devices such as shunt trip, undervoltage or electro-mechanical overcurrent trip devices act directly on the latch bar (10) causing roller (8), latch (7) and the jackshaft to move as a unit in opening the circuit breaker. The operating trip times of these devices are not as fast as the high-speed overcurrent trip system.

Rate-of-Rise Fault Detector 76HS-RR
(Optional)

For transit application, the rate-of-rise fault detector (R-R) functions to discriminate between normal train starting currents and actual track fault currents. The circuit is based on a true rate-of-rise principle. Upon detection of the track fault, the breaker will trip within a preset time limit. This device has adjustable time delay. This adjustment provides fault detection "reach" based on the parameters of the system. Inherent with this device is a push button operated test circuit for periodic maintenance checks. The test circuit simulates a track fault signal which checks the integrity of the R-R detector and trip system. NOTE: Where automatic reclosing circuitry is provided, the above test should only be made when the breaker is in the TEST position or if the reclosing circuit is disconnected during the test.

Control Device (Fig. 9)

This device is mounted below and to the left of the mechanism. The control device contains three electrical components, the limit switch (LS), the lockout relay (Y), and the latch release relay (X). The schematic diagram of the control circuit (Fig. 2) illustrates the function of this device. In addition to its electrical functions, the base of the device provides a terminal block for the circuit breaker wiring. A close latch release plunger is available for manual close and spring discharge operation.

The lockout relay (Y) in the control device is energized with the latch release relay (X) and serves as an anti-pump device. Without this device, a maintained close signal would then allow the FBK circuit breaker to close, recharge its springs, discharge, recharge and so on until the close signal is released. The lockout relay requires that the close signal be removed before the close coil can be re-energized. Because some control systems require maintained close signals, the lockout relay is designed for continuous operation.

Auxiliary Switches (Figure 1, Item 2)

The auxiliary switches, available for customer use, are mounted on the upper right-hand side of the circuit breaker and are wired to its secondary disconnects. Two types of contacts are provided: "a" contacts which are closed when the circuit breaker main contacts are closed, and "b" contacts which are open when the circuit breaker mains are closed. Driven by the same mechanical operator as the main contacts, the auxiliary contacts are available in four and eight pole forms. Two "a" contacts and two "b" contacts are supplied on four pole forms with four "a" and four "b" on eight pole forms. These switches can be field converted to meet various control needs.

Direct Acting Undervoltage Trip Device
(Optional)

The electrically reset undervoltage trip device automatically trips the circuit breaker when its control voltage decreases to 30 to 60 percent of the rated voltage. This device may be furnished for either instantaneous or adjustable time delay (0-15 seconds) tripping.

See Table 3 for electrical characteristics.

Direct-Acting Overcurrent Trip Devices (Fig. 10)
(Optional) (Semi-High Speed) (Bi-directional)

A. Type ODFBK-8 Overcurrent Trip Device. This device provides semi-high speed instantaneous tripping normally adjustable from .8X to 2.5X the circuit breaker continuous current rating. A screw on the bottom of the device provides adjustment for the instantaneous pickup. The instantaneous setting is indicated on the device nameplate.

B. Type ODFBK-3 Dual Overcurrent Trip Device. This trip device, for general purpose applications, provides long-time delay tripping on moderate overcurrents which are above the long-time pickup settings; and instantaneous (semi-high speed) tripping on fault currents above the instantaneous trip setting. Three adjustment screws on the bottom of the device provide independent control of the long-time delay.* The setting of these adjustments and the range of settings when are available are indicated on the device nameplate. The long-time pickup is adjustable from 0.5X to 1.0X the circuit breaker continuous current rating. The instantaneous pickup is adjustable from 1.0X to 4.0X the circuit breaker continuous current rating. The time-current characteristics of this device are shown on Dwg. TD-6991 (copies available upon request).

*The long-time delay adjusting screw is factory set and is not to be disturbed.

INSTALLATION, INITIAL TESTING AND REMOVAL

(Drawout & Stationary)

CAUTION CAUTION CAUTION CAUTION

When installing or removing stationary breakers, the supply for primary and control circuits must be de-energized at all times. Testing of stationary circuit breakers should 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 should be done in the "TEST" position.

NOTE: If the circuit breaker has an overcurrent device with long-time delay (OD FBK-3), then, prior to inserting the circuit breaker into the switchboard and with the breaker in the upright position, exercise the long-time armature (1" wide armature) several times until resistance to motion has increased, indicating that the oil dashpot is functioning properly. Improper operation can result if 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 described above removes the air to permit proper operation.

Installation (Stationary Type) (Refer to Fig. 1)

Lifting yoke (20, Fig. 1) can be used to move the breaker to the installation location.

Installation (Drawout Type) (Refer to Fig. 1)

To insert the circuit breaker into its compartment, proceed as described below:

1. The circuit breaker must be in the "OPEN" position, the racking crank turned in the counterclockwise direction fully against its stop, and the motor disconnect switch (10) in the "OFF" position.

2. Open the compartment door and pull out the right-hand and left-hand tracks (23) to the fully extended and latched position.

3. Using a lifting yoke (20), lower the circuit breaker so that the positioning wheels (6) (two on each side of circuit breaker) rest in the cut-out sections of each track (23).

4. Remove the lifting yoke and push the circuit breaker toward the compartment. The circuit breaker will slide in the cut-out sections of the tracks until the positioning wheels reach the end of the cut-outs. While holding the two latches (24, one on each side of the circuit breaker) down, push the circuit breaker toward the compartment until the racking cams (4) stop against their guides on the cradle (28). Release hold on latches.

5. Lift shutter (15) covering the racking opening, insert racking crank, and turn crank clockwise, pass through the "DISCONNECTED" position, until the position indicator on the cradle (left side) shows "TEST" position. Remove racking crank. The shutter should close if the breaker is in the

proper position. In the "TEST" position, the primary disconnects are not engaged in the cradle, but the control power disconnects are engaged.

Checking Circuit Breaker Operation in "TEST" Position (Drawout Type) Control Power On (Refer to Fig. 1)

1. Turn motor disconnect switch (10) to "ON" position and closing springs will automatically charge.

2. Close circuit breaker by local close button and trip by local trip button.

NOTE: All breakers have a manual trip button. A local electrical trip button is optional.

3. Close and trip circuit breaker by means of remote control switch (when used), if the control scheme allows this with the breaker in the "TEST" position.

4. Check each auxiliary device for proper operation.

5. Close the circuit breaker and check that the shutter (15) cannot be lifted to allow insertion of the racking crank. This demonstrates that the circuit breaker could not be racked while closed in the test position.

6. With the circuit breaker closed, push the high-speed test push button (31). The circuit breaker should trip, indicating that simulated sensor output signal will trip the circuit breaker. Note that a delay is required before the circuit breaker can be reclosed. The delay time is shown in Table 4.

7. If the circuit breaker is equipped with the loss of control power trip option, close the circuit breaker. Then de-energize the control circuit and note that the circuit breaker opens.

Checking Circuit Breaker Operation in "CONNECTED" Position (Drawout Type) Control Power On (Refer to Fig. 1)

Primary supply circuit must be DE-ENERGIZED with the circuit breaker in the "OPEN" position and the motor disconnect switch (10) in the "OFF" position, insert the racking crank and turn clockwise until the position indicator on the cradle shows "CONNECTED" position. Test the circuit breaker as it was tested in the "TEST" position above.

Check Circuit Breaker Operation (Stationary Type)

Follow the same procedure as for the drawout circuit breaker, except the circuit breaker will be in the "CONNECTED" position. (PRIMARY SUPPLY CIRCUIT MUST BE DE-ENERGIZED.)

Emergency Operation (Refer to Fig. 3)

Circuit breakers may be charged manually by a removable maintenance handle (4) for emergency operation.

The removable maintenance handle (4) is first positioned in two slots in the pawl carrier (2). The handle is then raised and lowered in a pumping motion until the pawl carrier (2) no longer rotates the ratchet wheel (1). The breaker closing springs are now fully charged and ready for a closing operation.

NOTE: The motor crank arm (3) may occasionally stop in such a position as to prevent charging the springs with the handle. Should this happen, the motor crank arm must be rotated manually by using a screwdriver or similar tool to rotate the crank arm a quarter turn so that the springs may be charged with the handle as described above.

Circuit Breaker Removal (Drawout Type) (Refer to Fig. 1)

To move the circuit breaker to the "TEST" position or to remove it from the compartment, proceed as follows:

1. With the compartment door closed, trip the circuit breaker by means of the remote control switch (when used) or manual "TRIP" button (13) on the escutcheon.

2. Lift racking shutter (15), insert racking crank and turn counterclockwise until position indicator (27) on the right-hand side of the escutcheon shows "TEST" position.

3. Continue turning the racking crank counterclockwise until the position indicator (27) on the right-hand side of the escutcheon shows "DISCONNECTED" position. Remove the racking crank.

4. Open compartment door. Place motor disconnect switch (10) in the "OFF" position.

5. Insert racking crank and turn counterclockwise as far as the stops will allow. Check that the automatic spring discharge device will discharge the closing springs near the end of the racking operation.

6. Pull circuit breaker forward on tracks (23) to the fully extended and latched position.

7. With a positive pull, release positioning wheels from cut-out sections of the tracks.

8. Remove circuit breaker from tracks by means of lifting yoke and crane.

9. Release latch (24) on each track, push tracks into the compartment, and close compartment door.

MAINTENANCE

CAUTION CAUTION CAUTION CAUTION

De-energize both primary and control circuits before making any inspections, adjustments, or replacements of parts. Make certain that the circuit breaker is open and that the closing springs are discharged by observing their indicators on the front escutcheon (14 and 16, Figure 1).

When it is necessary that the charging springs be charged, or the circuit breaker be closed, make sure to stay clear of operating parts.

Beware of impulse coil wiring from high speed box. A voltage potential of 2500 volts exist on these wires for those breakers that do not have loss of control power trip. De-energize control power and use high speed trip push button to discharge capacitor.

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 a given number of operations as follows:

FBK-1600 through 6000 - 1 pole	500 Operations
FBK-8000, 10000, and all 2 pole	250 Operations

The above inspection periods apply to either no-load or load current switching operations. If the listed number of operations are not completed in the first year of service, the circuit breakers should be inspected, regardless.

When a circuit breaker is known to have interrupted close-in, high current faults or highly inductive track faults, it should be inspected after the series of faults regardless of any time period or number of operations.

If, after initial inspection period, there is no indication of any problem, actual operating experience can then determine the inspection cycle.

Where unusual service conditions exist, as covered by ANSI C37.14, it must be assumed that these conditions were considered at the time of order; that the equipment supplied was designed for the special applications; and that an appropriate supplemental maintenance program has been developed. These maintenance instructions only cover circuit breakers used under the standard usual service conditions decribed in ANSI C37.14.

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. All accessible bolts, nuts and screws should be checked to insure that they are tight.

Arc Chute (Refer to Figure 2)

Removal

1. Remove the two nuts and washers which secure the return connections (9, Fig. 1) to the arc chute.

2. Pull the return connections off the studs projecting from each side of the arc chute and position them back away from these studs. Replace the washers and nuts to prevent loss and hold the studs in place.

3. Remove the two bolts and washers that secure the front of the arc chute to the frame of the circuit breaker.

4. Using a ¼-inch Allen wrench on a long extension, loosen the two Allen screws at the bottom rear of the arc chute. Do not remove these screws; leave them in place loosened so that they are removed when the arc chute is lifted from the circuit breaker.

5. Lifting STRAIGHT UP, remove the arc chute (with its rear screws in place) from the circuit breaker. The arc chute is much heavier than it looks; some assistance may be necessary to remove it.

Examination

Examine the arc chute for damage. Discoloration or slight eroding of the arc plates, runners or liners is normal and does not signify damage.

The cooling plates of the arc chute feature a special light blue epoxy paint. Take care to avoid chipping or scratching this paint; chips in the paint can compromise the performance of the arc chute. If chips are noted, a repair kit is available from BBC Brown Boveri, Circuit Breaker Division.

The sides of the arc chutes have insulating strips which cover the staked ends of the cooling plates. (See Fig. 2.) These four strips must be securely in place to maintain arc chute integrity.

If a crust has formed on the liner plates at the base of the arc chute, lightly remove it with a carborundum stone or scraper. Remove all dirt by blowing out the arc chute with DRY compressed air. DO NOT USE SOLVENTS OF ANY KIND TO CLEAN ANY PART OF THE ARC CHUTE.

If any of the following conditions exist, the arc chute should be replaced:

1. Arc runners or cooling plates that are badly burned or liner plates with large cracks.

2. A hole ¼" in diameter or larger burnt in the rear steel arc plate.

3. Broken or cracked polyester side plates.

Installation

The arc chute is installed by reversing the removal sequence. Make sure to tighten the hardware at each end of the return connection.

Contacts

Remove dirt and/or grease on contacts with a clean, lintless cloth. DO NOT USE SOLVENTS OF ANY KIND TO CLEAN THE CONTACTS. SOME SOLVENTS CAN DAMAGE THE CIRCUIT BREAKER INSULATION STRUCTURES. Pitting or discoloration of the contacts is normal and is only detrimental when it interferes with proper contact adjustment. Oxidation of contact surfaces can be removed by several no-load operations every two weeks.

Small burrs on the arcing contact can be removed with non-metallic abrasive pads (like Scotch-Brite, a 3M Company product). Larger burrs can be removed by filing along the contour of the contacts.

CAUTION: Before cleaning the contacts, cover the puffer nozzle. Do not allow debris removed from the contacts to fall into the breaker mechanism. Use DRY compressed air to blow out stray debris after cleaning the contacts.

Contacts should be replaced if any of the following conditions exist.

1. Less than 50% of the original contact material thickness is left.

2. The tips of the arcing contacts are eroded away.

3. Any contact is broken or cracked.

When the contacts are filed or replaced, the contact pressure must be checked and adjusted if necessary.

Insulation Structure

Insulated parts, such as the push rod and the lead support structure, should be checked for cracks or other damage. Dust and dirt can be removed by DRY compressed air or wiped clean with a lintless cloth. DO NOT USE SOLVENTS OF ANY KIND AS THEY MAY DAMAGE THE SURFACE FINISH OF THE INSULATION STRUCTURE.

Puffer

The puffer helps push the arc up into the arc chute with a blast of air. Its performance can easily be checked during the maintenance interval. Charge and close the circuit

breaker with the arc chute removed. Keeping clear of moving parts, place a hand above the arcing contact and open the circuit breaker. A moderate blast of air should be felt. If the puffer has low or no puffing action, do not put the circuit breaker in service. Check the puffer nozzle for blockage, the puffer tube for cracks or breaks, and the puffer piston seals and adjustment. Replace any of these parts if found defective. See below for puffer adjustments.

WARNING WARNING WARNING WARNING

KEEP CLEAR OF ALL MOVING PARTS WHEN MAKING ADJUSTMENTS.

ADJUSTMENTS

NOTE: The operating mechanism must be operated slowly, as described in section SLOW CLOSE PROCEDURE, when performing any adjustment requiring contact movement.

In order to charge the closing springs and to close and open the circuit breaker, the racking mechanism must be turned to a position such that the racking shutter (15, Fig. 1) closes when the racking crank (21, Fig. 1) is removed.

Only one basic adjustment is normally required and that is contact adjustment. This should be checked to the dimensional values required as described in paragraph "Contacts". Other adjustments are required only when operational check indicates a need.

Slow Close Procedure

NOTE: The charging cranks must be reset (see steps 8, 9 and 10 below) after the last slow close operation, or future electrical operation will be impossible.

Refer to Figure 4 unless otherwise noted.

1. The closing springs must be charged; check spring charge indicator (16, Fig. 1).

2. Insert a screwdriver or rod through the hole in the escutcheon box (4) (right-hand side when facing the front of the circuit breaker) and depress the close block lever pin (5) at "A".

3. Push up on the close latch release rod (5, Fig. 9) to manually close the circuit breaker. The close block lever pin (5, Fig. 4) will now remain in the down position. Remove screwdriver or rod.

4. Insert the maintenance handle in the ratchet carrier and operate the handle to slowly close the contacts. (See Fig. 3 and "Emergency Operation".)

To repeat the slow-close operation, continue with the following steps:

5. Insert the maintenance handle and continue the charging operation until the indicator (16, Fig. 1) shows "SPRINGS CHARGED".

6. Push manual "TRIP" button (13, Fig. 1) to open the contacts.

7. Repeat steps 2, 3, and 4 above for the slow-close operation.

To reset the charging cranks for normal electrical operation, proceed as follows:

8. Repeat steps 5 and 6 above.

9. Push up on close latch release rod (5, Fig. 9) manually close the circuit breaker.

10. Push the manual "TRIP" button (13, Fig. 1) to open the contacts.

The circuit breaker is now ready for normal service operation with the charging cranks reset and the closing springs discharged.

Contacts
(Refer to Figure 5)

1. The hex portion of the adjusting stud (1) should be centered within 1/16 inch, between the yoke (2) and the insulator (3).

2. Turning the adjusting stud (1) counterclockwise when viewed from the insulated push rod (3) will increase the contact pressure and dimension "X".

3. If stationary arcing contact is removed for any reason, be sure to reinstall the contact with its keeper plate.

4. The initial contact adjustment, 5.62 (+.03, −.00), is to be made with the circuit breaker in the open position.

With the breaker closed, check that the "X" dimension is .025" minimum. If under .025, increase dimension "X" by increasing contact pressure. After fast closing the breaker, recheck the "X" dimension.

High-Speed Trip

Impulse Trip Coil Armature Pretravel Adjustment
(Refer to Figure 7)

For reliable operation of the high-speed trip system, the impulse trip coil armature requires pretravel before the circuit breaker tripper (5) is engaged. Follow the following procedure to set pretravel:

1. Manually close the circuit breaker (defeat or energize the undervoltage device, if so equipped).

2. Check the gap between the impulse trip coil armature (3) and the trip lever (4) with a 0.030 to 0.040 shim.

3. If necessary, adjust the gap with an Allen-type wrench in the adjusting screw (7).

4. Check the adjustment by tripping the breaker with the high-speed trip system.

Tripper Bar Load (Refer to Figure 6)

The tripper bar load is measured by use of a spring scale (4) positioned as shown. With the circuit breaker in the "CLOSED" position, the push required to trip the circuit breaker must be between 40 and 60 ounces for a one pole unit and 48 to 80 ounces for a two pole unit.

Shunt Trip Device (Refer to Figure 8)

After tripper bar is set per the above, proceed with the following:

1. Charge springs (electrically or manually).

2. Turn trip rod (1, Fig. 8) up until a .105 gauge fits between head of trip rod (1) and trip extension (5).

3. Remove gauge and close breaker.

4. Try .105" gauge; it should still fit. If it doesn't, turn up trip rod until gauge can be inserted.

5. Try .156" gauge - it should not fit.

6. Push up slowly with screwdriver or small rod at position "A" to make sure the breaker trips mechanically.

Control Device (Refer to Figure 9)

The control device is adjusted before leaving the factory. No attempt should be made to adjust the internal relays and contacts of this device in the field. If replacement of the control device is required, the close latch release rod (5) overtravel may require adjustment as described below.

Close Latch Release Rod

1. Back off on the close latch release rod (5) and check that the circuit breaker will not close by attempting to close it electrically or manually pushing up on the close latch release rod (5) to the full extent of its travel.

2. Charge the closing springs. Push up on the close latch release rod (5) to the full extent of its travel. While holding this rod up, turn it in until the closing springs are released, closing the breaker. Turn the close latch release rod (5) up an additional 1½ turns.

OD-Overcurrent Device Adjustments
(Refer to Figure 10)

Pick-up Setting Adjustments

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 printed pick-up value, the second line from the top corresponds to the second printed pick-up value from the top, etc.

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:

1. Back out on the two trip adjusting screws (2 & 3) until the screws are engaging the nut by approximately two turns.

2. Charge springs and close circuit breaker.

3. Using a 1-foot long (approx.) rod, push up on long time armature (thick armature) at point "A", and hold it tight against the magnet. Turn in screw (3) until the breaker just trips. Continue to turn the screw in an additional 1½ turns.

4. Charge springs and close the circuit breaker. Push up on the thin armature and adjust screw (2) using the same procedure as "3" above.

High-Speed Trip Pickup Setting

The pickup current for high-speed trip operation is set in multiples of the sensor rating by locating the selector plug (Figure 13) in the desired tap block slot. If the selector plug is accidentally left out, the trip setting automatically reverts to the minimum setting.

LUBRICATION

Only two lubricants are approved for use in the FBK circuit breaker. Lubricated during final assembly, the FBK circuit breaker should not require additional lubrication during its service life when applied in accordance with ANSI C37.14. If, however, the breaker is applied in unusual situations defined by ANSI C37.14, has lubricant contaminated with dirt and debris, or has parts replaced, relubrication should be performed as follows:

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 SURFACE. Primary disconnects should be maintained by reapplying NO-OX-ID during maintenance periods. is available from Brown Boveri in one pint cans, number 713222-A.

2. Apply Anderol 757 synthetic grease manufactured by Tenneco Chemical, Inc., Intermediate Division to mechanism parts, bearings and pins. DO NOT APPLY GREASE TO LATCH OR ROLLER SURFACES. Anderol 757 is available from Brown Boveri in four-ounce tubes, part number 712994-A. This synthetic lubricant is also available in a spray with tube-type applicator as Anderol 732, part number 712994-B.

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

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

5. NEVER LUBRICATE THE OD-TYPE ELECTROMECHANICAL OVERCURRENT TRIP DEVICE. NEVER LUBRICATE IMPULSE TRIP COIL.

DIELECTRIC TEST

If the insulation has become contaminated, or routine tests are required, the test voltages to be applied for one minute to test the ability of the insulation to withstand overvoltages are as shown in Table 1.

CAUTION CAUTION CAUTION CAUTION

Disconnect the charging motor by means of the motor disconnect switch (10, Fig. 1) to avoid motor damage.

Before any dielectric tests are made on the control circuit, the plug connections at the rear of the circuit breaker connecting the circuit breaker and high speed trip assembly should be disconnected. No dielectric tests should be made on the high speed trip assembly parts.

It is not recommended that the motor be dielectric tested, but if desired, then test at 600V ac. Motors that have been in service for a long period of time may fail dielectric due to normal accumulation of debris from the brushes and commutator. Cleaning the motor will restore dielectric integrity.

ELECTRICAL CHARACTERISTICS OF CONTROL DEVICES

For closing and tripping currents, voltages and ranges, refer to Table 2.

For undervoltage trip devices, standard voltages and operating data, refer to Table 3.

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

BBC 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-4.2.1.8 for complete ordering information and parts list.

The minimum quantities of assemblies recommended in the Renewal Parts Bulletin are based on BBC'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 then be returned to BBC for reconditioning when that is possible.

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

Service 215-699-8887
Factory 1-800-258-1435

REFERENCES

Additional reference material available.

IB 4.2.1.7-2 — Instructions for High-Speed Trip Control Assembly

IB 4.2.1.7-3 — Instruction Supplement for High-Speed Trip Control Assembly with Optional Monitoring Accessories

TD-6691 — OD-FBK-3 Time Current Characteristic Curves

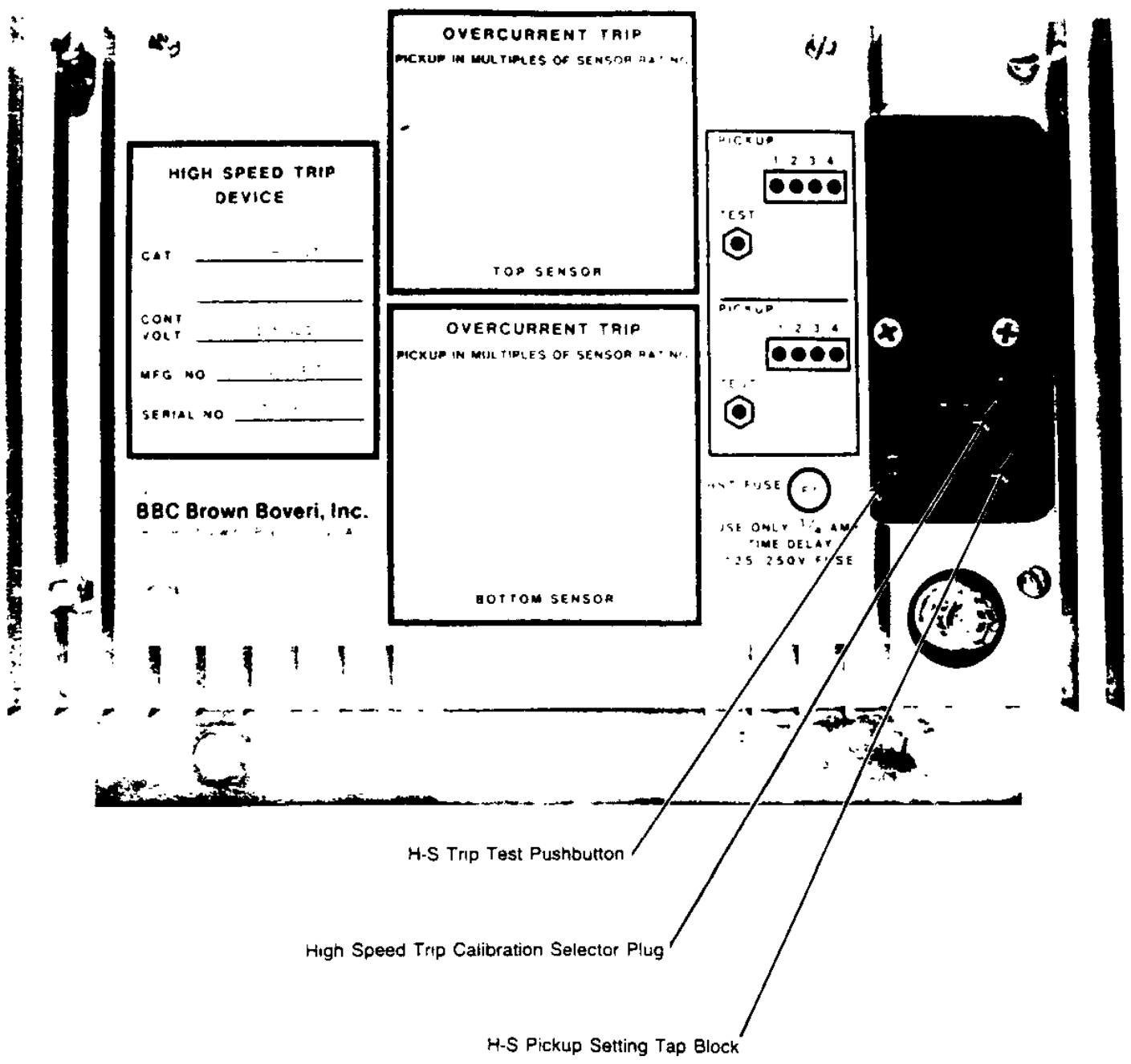
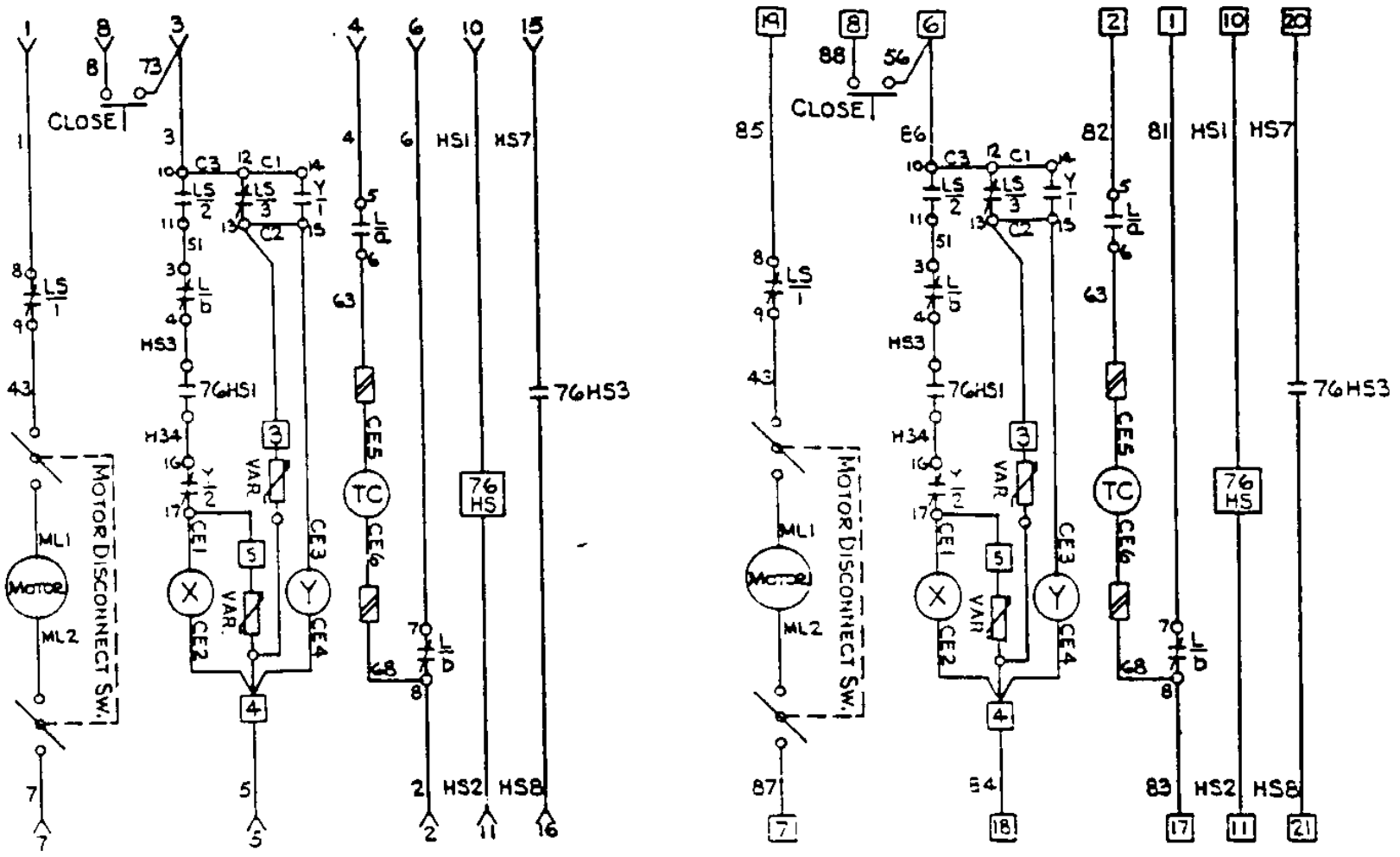


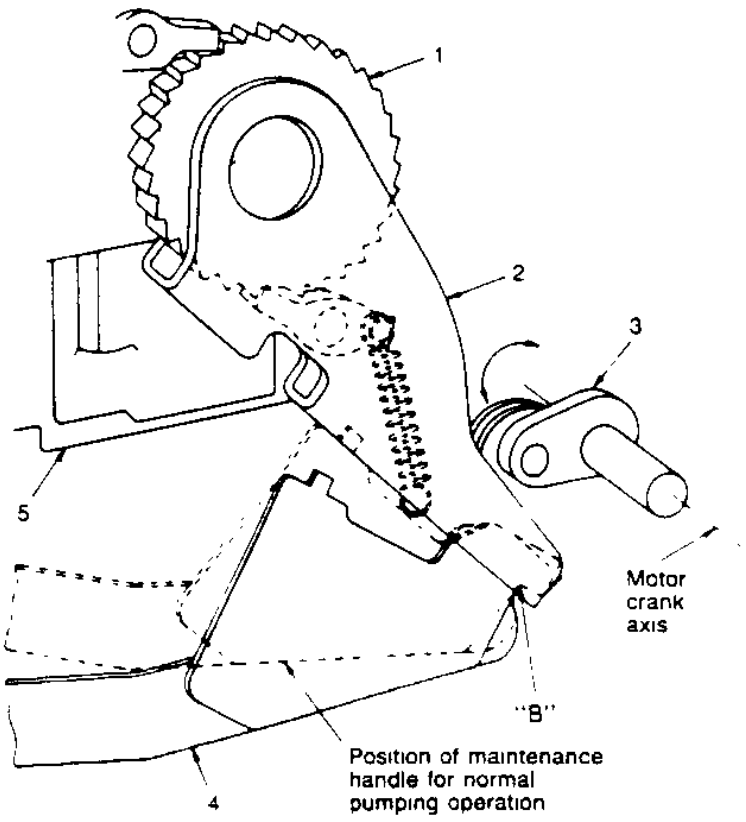
Fig. 1A — High-Speed Trip Control Assembly



LEGEND

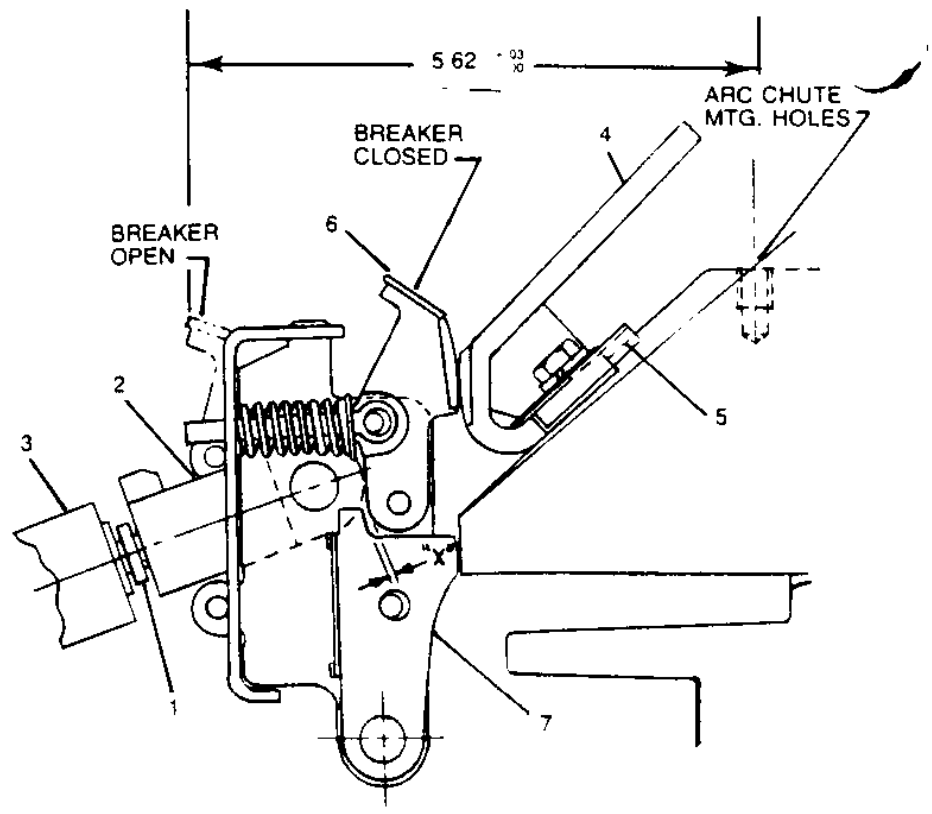
Symbol	Description
a	AUXILIARY SWITCH CONTACT OPEN WHEN BREAKER IS OPEN
b	AUXILIARY SWITCH CONTACT CLOSED WHEN BREAKER IS OPEN
bp	BYPASS SWITCH CONTACTS CLOSED WHEN DRAWOUT BREAKER IS WITHDRAWN
CE	COIL LEAD.
L	AUXILIARY SWITCH MOUNTED ON LEFT HAND SIDE
LS/2	LIMIT SWITCH CONTACT OPEN WHEN SPRINGS ARE DISCHARGED. CLOSED WHEN SPRINGS ARE CHARGED
LS/1 & LS/3	LIMIT SWITCH CONTACT CLOSED WHEN SPRINGS ARE DISCHARGED. OPEN WHEN SPRINGS ARE CHARGED
ML	MOTOR LEAD.
PB	LOCAL PUSH BUTTON RECOMMENDED OPERATION IN TEST POSITION ONLY
r	ALARM CONTACT CLOSES ON OVERCURRENT TRIP. MANUALLY RESET
s	ALARM CONTACT OPENS ON OVERCURRENT TRIP. MANUALLY RESET
R	AUXILIARY SWITCH MOUNTED ON RIGHT HAND SIDE
TB	TERMINAL BLOCK POINT
TC	SHUNT TRIP COIL.
UV	UNDERVOLTAGE DEVICE (TRIP OR LOCK OPEN)
UV/b	UNDERVOLTAGE CONTACT CLOSED WHEN UV COIL IS DE-ENERGIZED. OPEN WHEN UV COIL IS ENERGIZED
X	CLOSING LATCH RELEASE COIL
Y	CONTROL RELAY LOCKOUT COIL
Y/1	NORMALLY OPEN CONTROL RELAY CONTACT
Y 2	NORMALLY CLOSED CONTROL RELAY CONTACT
	MOVABLE SECONDARY DISCONNECT CONTACT
	KNIFE BLADE WIRE DISCONNECTS
LC	LATCH CHECK SWITCH; CLOSED WHEN PRIMARY TRIP LATCH IS RESET
76HS	HIGH SPEED TRIP OVERCURRENT RELAY DEVICE WITH TRIP CAPACITOR
76HS-1 & 76HS3	76HS PERMISSIVE CONTACTS, CLOSED WHEN CONTROL POWER IS AVAILABLE AND TRIP CAPACITOR IS CHARGED
	DISCONNECT PLUG PIN AND RECEPTACLE
MDS	MOTOR DISCONNECT SWITCH
CD	CONTROL DEVICE
	VARISTOR

Fig. 2 — Typical Control Circuit Schematic Diagrams



1. Ratchet Wheel
2. Pawl Carrier
3. Motor Crank Arm
4. Removable Maintenance Handle
5. Control Device

Fig. 3 — Method of Applying Maintenance Handle for Charging Closing Springs

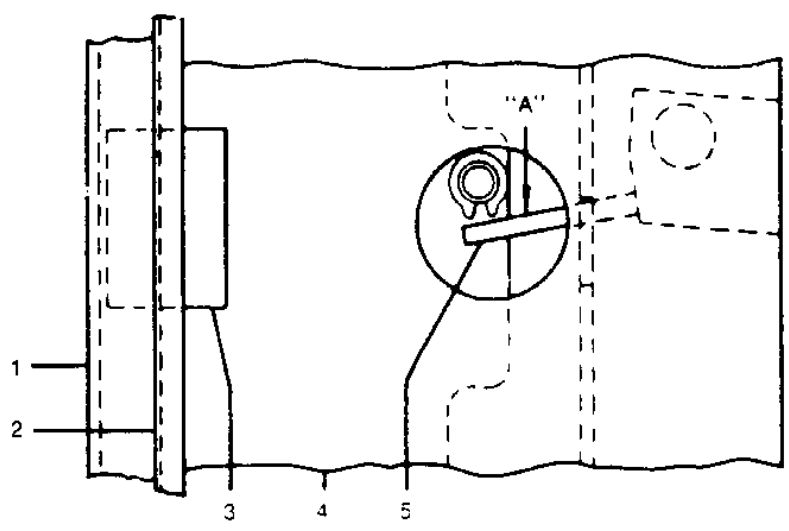


1. Adjusting Stud
2. Contact Yoke
3. Insulated Pushrod
4. Stationary Arcing Contact
5. Arcing Contact Keeper Plate
6. Moving Arcing Contact
7. Main Contact

Fig. 5 — Contacts

Pic open dimension 5.62
X = .25 Approx

IF X = .025
open dimension 5.925

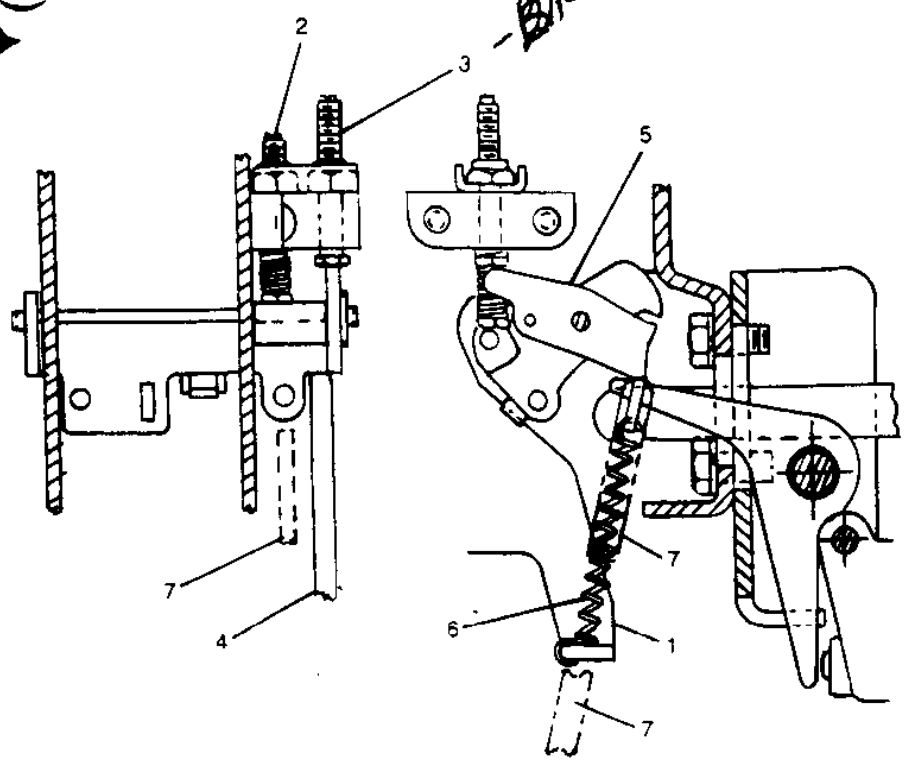


1. Escutcheon
2. Dust Plate
3. Spring, Dust Plate
4. Box, Escutcheon (Right-Hand Side)
5. Pin, Close Block Lever

Fig. 4 — Partial View of Escutcheon Assembly (Right-Hand Side) Showing Slow Close Lever for Electrically Operated Circuit Breakers

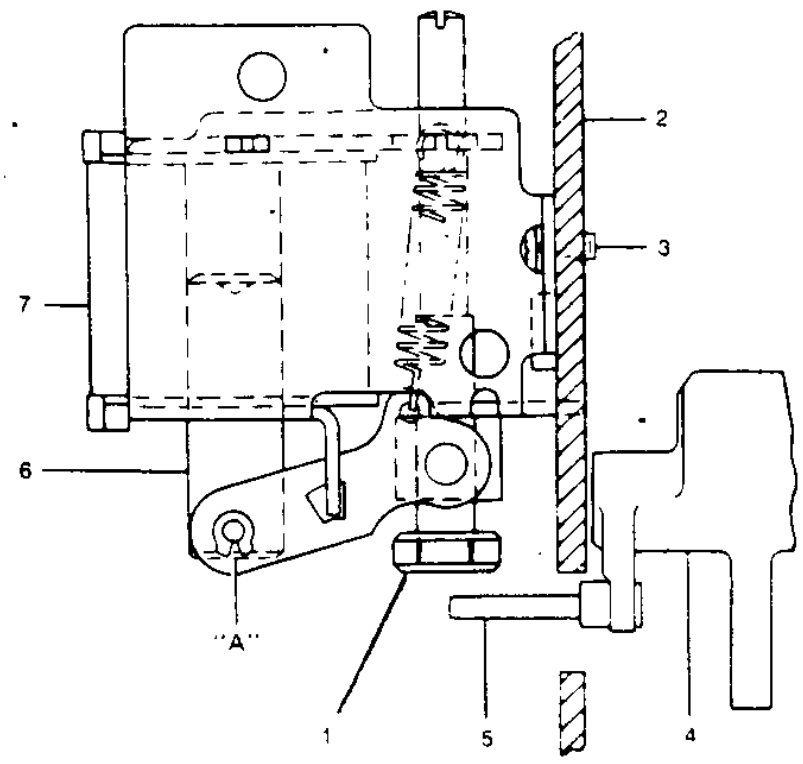
Back 2 Turns

Back 2½ Turns



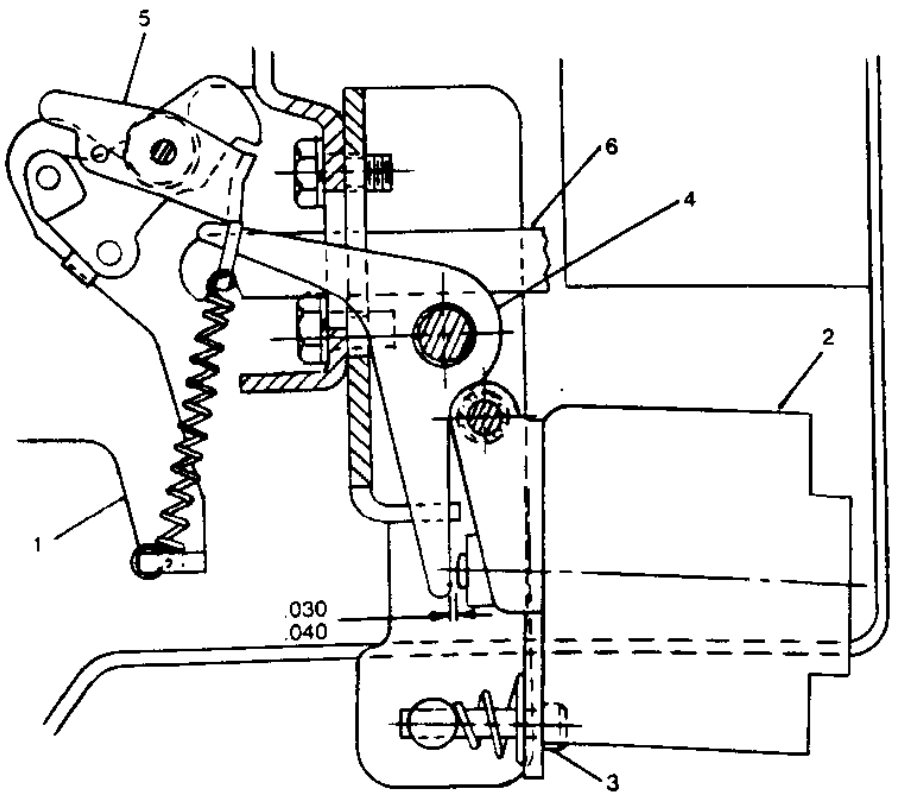
1. Mechanism Frame
2. Latch Engagement Adjusting Screw
3. Tripper Bar Latch Engagement Adjusting Screw
4. Trip Lever
5. Tripper
6. Tripper Return Spring
7. Spring Scale (Push Type)

Fig. 6 — Trip Latch



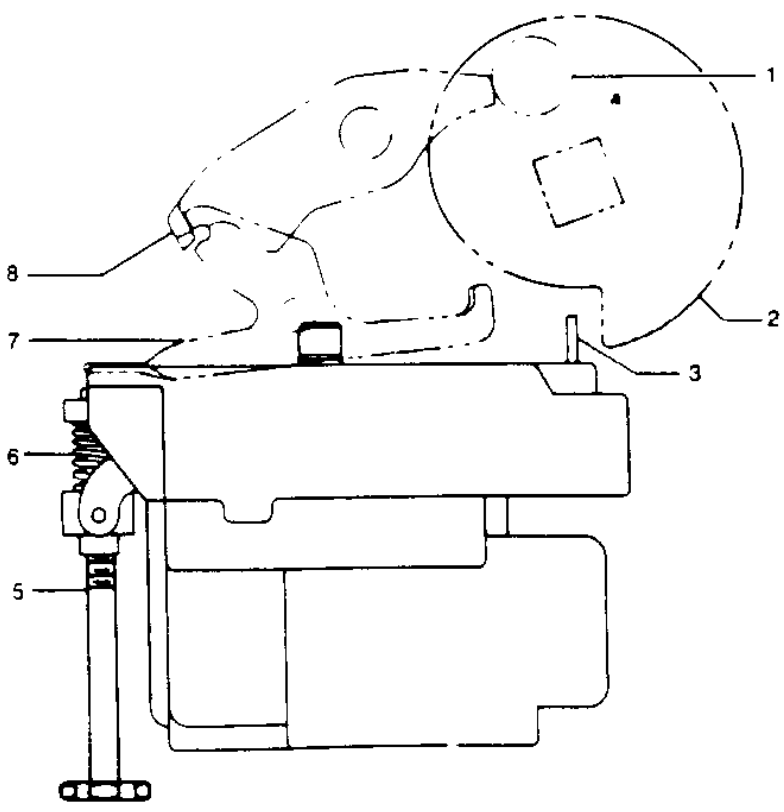
1. Trip Rod
2. Mechanism Housing (Left-Hand Side)
3. Mounting Screw
4. Latch Bar
5. Trip Extension
6. Armature
7. Coil

Fig. 8 — Shunt Trip Device Adjustment



1. Mechanism Frame
2. Impulse Trip Device
3. Impulse Trip Device Adjusting Screw
4. Trip Lever
5. Tripper
6. Trip Lever from OD Device

Fig. 7 — Impulse Coil



1. Roller, Close Latch
2. Charging Cam
3. Acutator, Limit Switch
5. Close Latch Release Rod
6. Spring, Close Latch Release Rod
7. Secondary Close Latch
8. Primary Close Latch

Fig. 9 — Control Device Adjustment

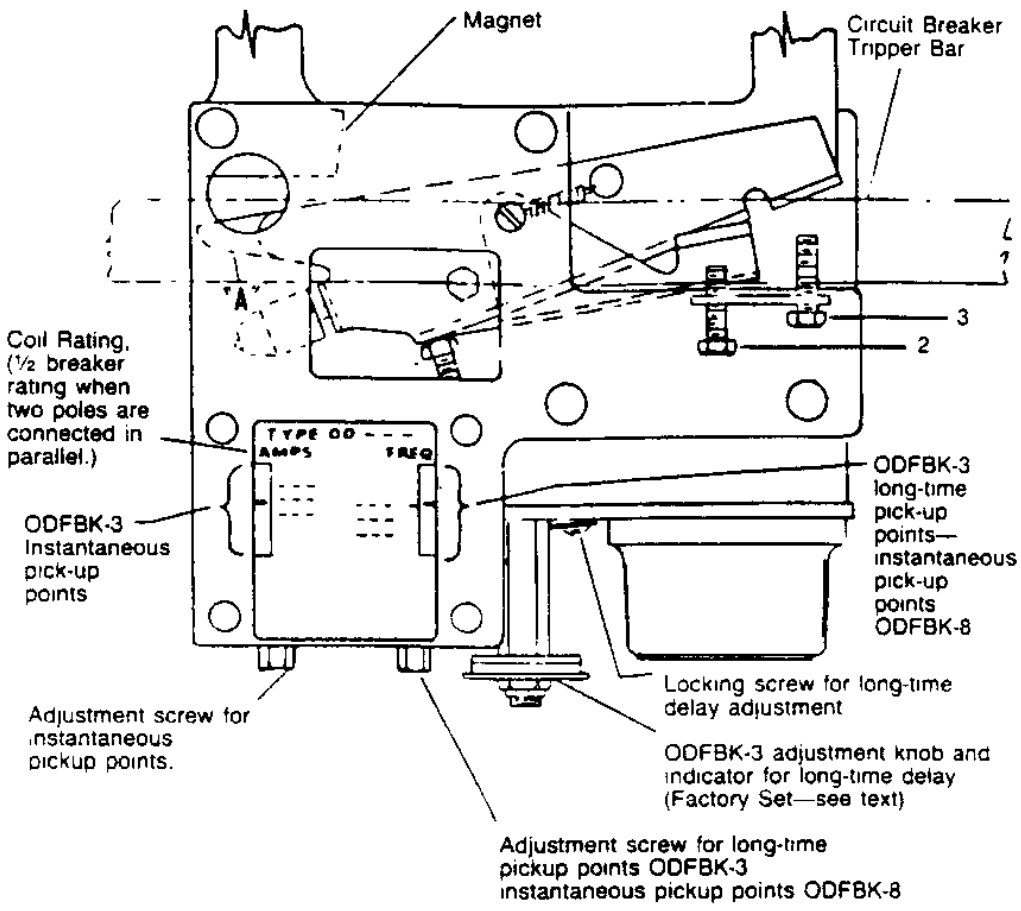


Fig. 10 — Direct-Acting Overcurrent Trip Device

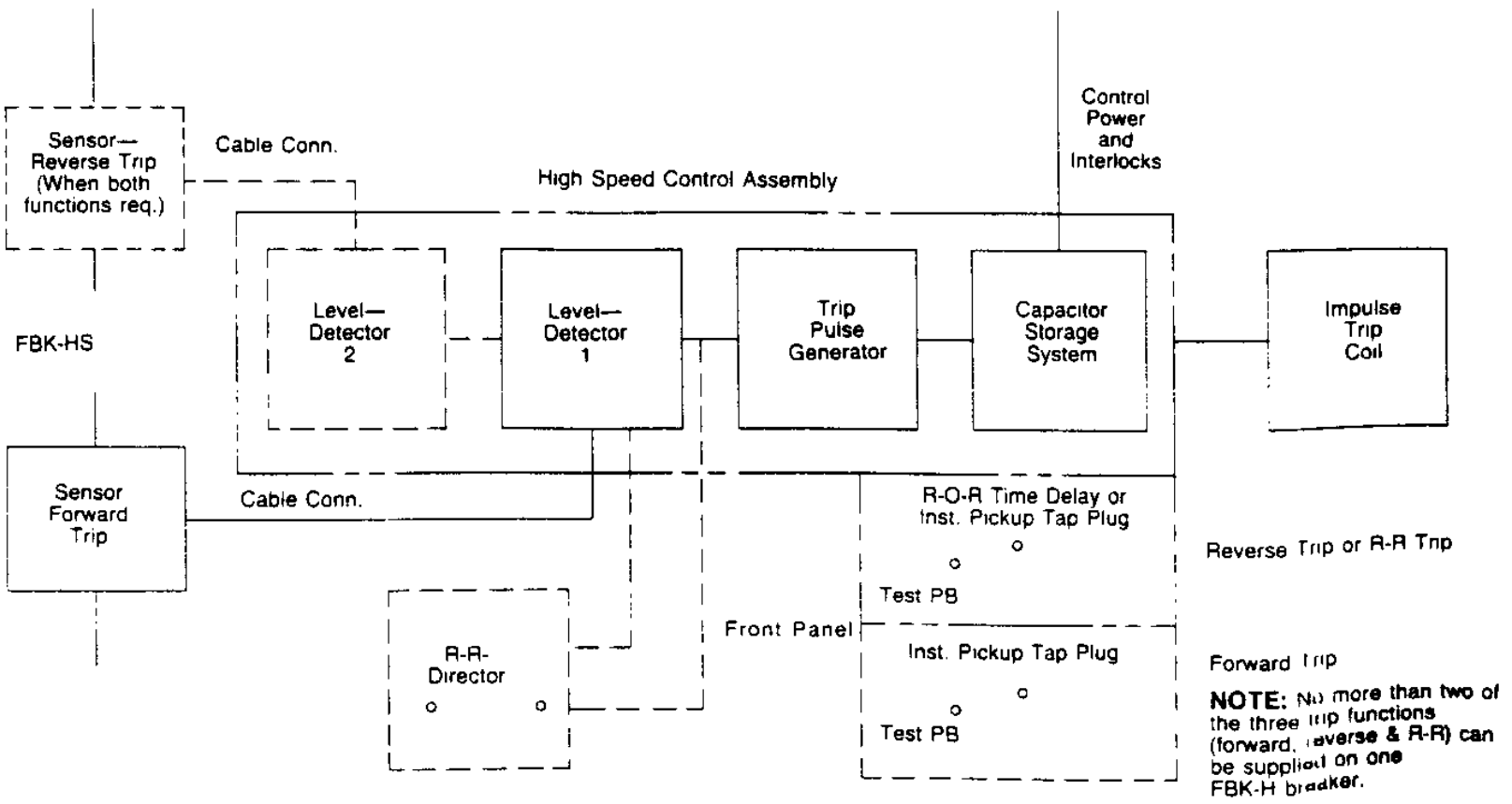


Fig. 11 — High Speed Trip Control Assembly Block Diagram

TABLE 1
TEST VOLTAGES 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	3150V. A.C. a. Between line and load terminals and metal parts normally grounded b Between line and load terminals	3150V A.C. a. Between terminals and metal parts normally grounded. b. Between phases.	1125V A.C a Between control circuit and metal parts normally grounded NOTE Motor & high-speed trip assy must be disconnected from control circuit for this test
After Short Circuit	2520V A C a and b as above	2520V A C a. and b as above	900V A.C a. as above and note

TABLE 2
ELECTRICAL CHARACTERISTICS OF CONTROL DEVICES CLOSING AND TRIPPING CURRENTS, VOLTAGES AND RANGES

Nominal Control Voltage	Average Closing Motor Current Amperes	Shunt Trip Current Amperes	CONTROL DEVICE Current Amperes (Y) Anti-Pump	(X) Release	Closing Circuit Voltage Range	Shunt Trip Circuit Voltage Range	FBK-H High Speed Trip Device Voltage Range	FBK-Mech Recommended Control Fuse Size*
120 ac 60 cycle	10.	6.5	.4	1.5	104-127	104-127	104-127	10 A
125V dc	10	1.3	.06	7	106-140	70-140	70-140	10 A
250V dc	5.	.65	03	.3	210-280	140-280	140-280	10 A

*High Speed and Rate-of-Rise Control Fuse

High Speed Trip Device Control Fuse. Time Delay

125VDC	250VDC
¾A., 250V , 3AG	½A., 250V , 3AG

TABLE 3
UNDERVOLTAGE TRIP DEVICE STANDARD VOLTAGE AND OPERATING DATA

Service Voltage	Current At Rated Volts	Maximum Pickup Voltage	Dropout Voltage Range
120V ac 60 cycle	0.4	92	36-72
125V dc	0 2	100	38-75
250V dc	0.1	200	75-150

TABLE 4
MINIMUM RECLOSE TIME-SECONDS (TRIP CAPACITOR CHARGING TIME)

Service Voltage	Frame Size	
	1600-6000A	8000-10,000A
120V 60HZ (NOM)	4	4
104V 60HZ (MIN)	7	7
125V DC (NOM)	4	4
106V DC (MIN)	7	7
250V DC (NOM)	12	12
210V DC (MIN)	20	20

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