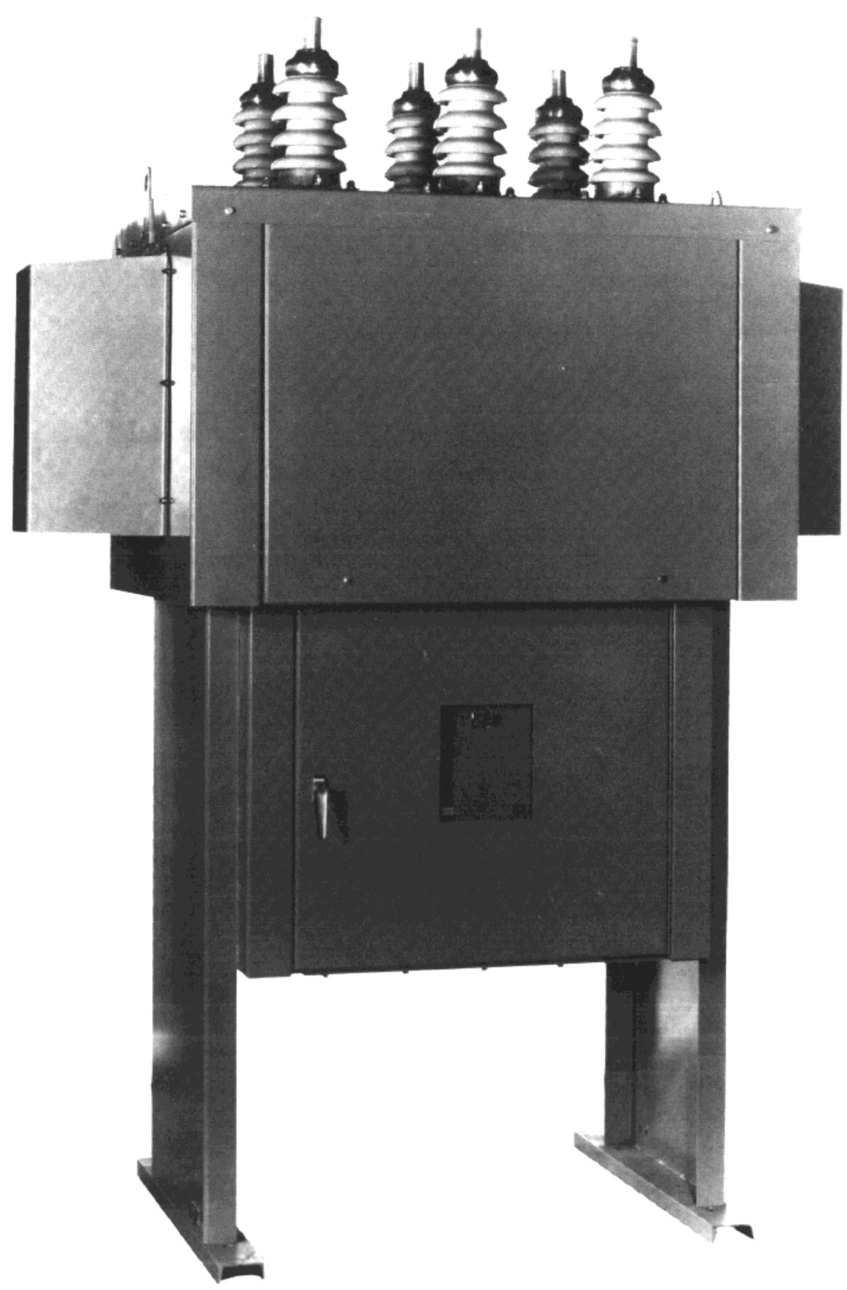
October, 1986

Manual 6065-1
Supersedes Manual 6080-2, Dated 9/1983
And Manual 6065-1, Dated 12/1985

Installation & Maintenance Manual

VACARC®
Vacuum Circuit Breaker
Type FVB

• Installation • Operation • Maintenance



SQUARE D COMPANY

CONTENTS

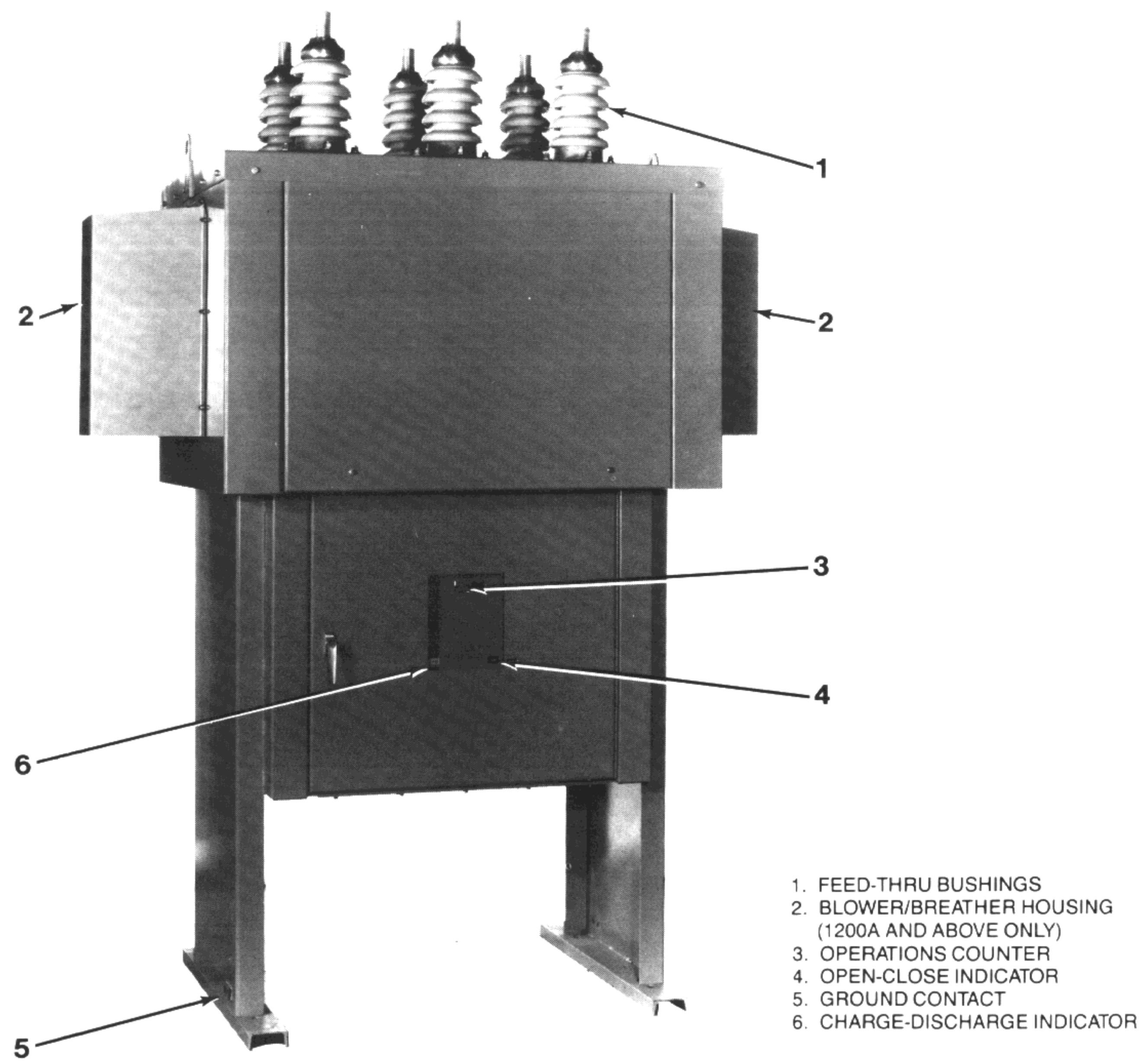


Figure 1

1. INTRODUCTION

This manual provides installation, operation, and maintenance instructions for all models of the FVB series of free standing vacuum circuit breakers. Available in all standard ratings and meeting or exceeding all applicable industry standards, the FVB series provides three-cycle interruption, long switching life, and ease of operation and maintenance.

1.1 Receiving

Upon receipt by the customer, the entire breaker should be inspected for damage that may have been incurred in transit. All items should be checked against the packing list provided. The transportation company and the manufacturer should be notified of damages or shortages.

1.2 Handling

Use care when uncrating and handling the breaker. When using a fork lift or hoist, lift the breaker by the strong points of the frame to prevent damage. Two lifting eyes have been welded to the top of the breaker housing for lifting by crane.

1.3 Storage

If the breaker must be stored before it is put into operation, keeping it in a place that is clean, dry and free of corrosive elements and mechanical abuse is absolutely necessary.

Breakers that must be stored for prolonged periods should be inspected regularly for rusting and overall condition. Greasing should be performed when necessary. Space heaters should be kept energized.

2. INITIAL BREAKER PREPARATION

The following describes the steps that are necessary to prepare the breaker for operation:

a) Examine the entire breaker.

b) Use a clean, dry cloth to remove dirt and moisture that may have collected on the outside of the vacuum interrupters (Figure 2, 1) and on all insulating parts.

c) Cycle the breaker manually several times and check for proper operation. This is accomplished by using the manual charging handle (supplied with the breaker) to move the manual charging arm (Figure 4, 7) up and down until the drive springs (located behind the return springs) (Figure 3, 7) are fully charged. The drive springs are fully charged when the charge-discharge indicator (Figure 3, 1) reads "charged" and the manual charging arm can no longer be raised. The breaker can be closed by lifting the close lever (Figure 3, 2), then opened by lifting the open lever (Figure 3, 3). (NOTE: The breaker is shipped in the open position with all springs discharged.)

d) Electrically operate the breaker several times and check for proper operation.

e) To assure that damage has not occurred during shipment, perform a hi-pot test across the open contacts of each vacuum interrupter. Then, with the breaker in the closed position, perform a phase to ground and phase to phase hi-pot test for each pole.

Gradually raise the voltage to the proper level. The hi-pot test voltage should be 38KV rms or DC for a 15.5KV class breaker or 45KV rms or DC for a 25.8KV class breaker. The breaker should sustain this potential for 1 minute.

Do not attempt to compare the condition of one vacuum interrupter with another nor to correlate the condition of any interrupter to low values of leakage current. There is no significant correlation.

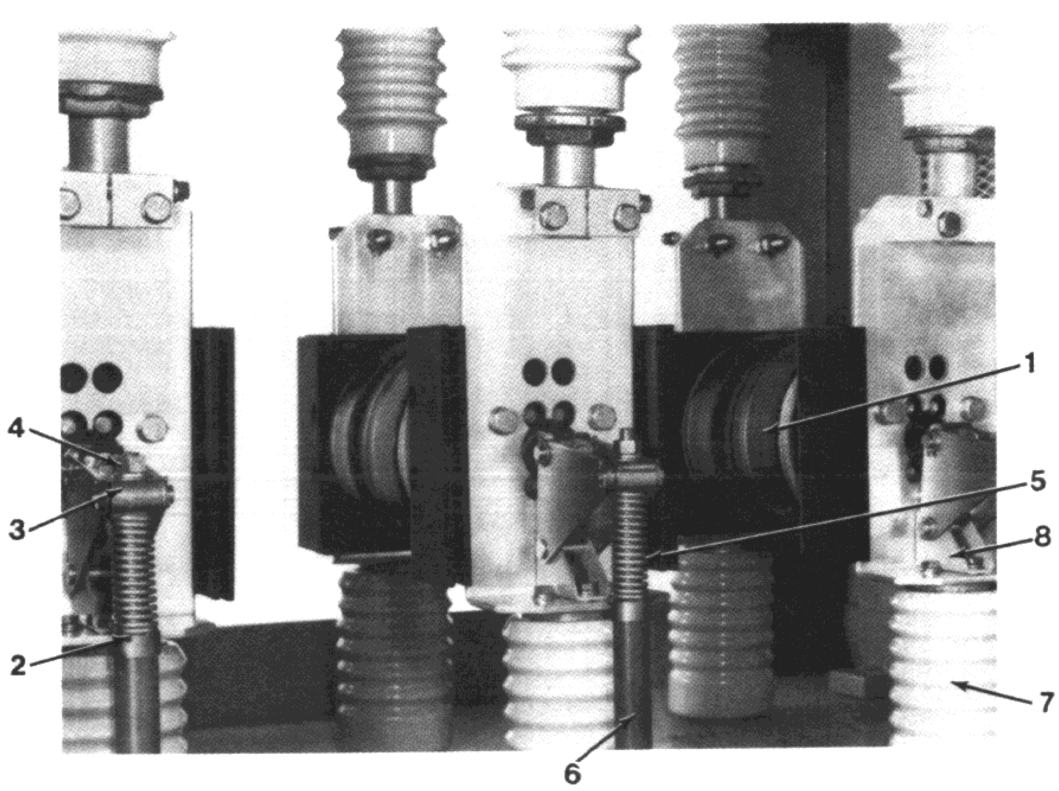
Observe the following instructions when performing the hi-pot test:

1. Do not exceed the above voltages.

2. Do not test interrupters with open gaps less than $^3/_8$".

3. All persons should stay at least 1 meter (39 inches) away from the vacuum interrupter under test.

4. Perform tests only when all insulating parts are installed. Preferably the operator should be positioned so that one of the metal sides of the housing is between the operator and the interrupter under test.



1. VACUUM INTERRUPTER
2. BOTTOM SPRING RETAINER
3. SPRING PIVOT
4. SPRING RETAINER WASHER
5. BIAS SPRING
6. DRIVE CONNECTING LINK
7. STANDOFF INSULATOR
8. PIVOT BASE

Figure 2

5. Discharge to ground the feed-thru bushing conductors (Figure 7, 1) and vacuum interrupter mid-band ring before handling. These areas can retain a static charge after a hipot test.

f) Adjust the thermostat, if supplied, to the appropriate setting.

g) The breaker is now ready for normal operation.

3. FVB VACUUM CIRCUIT BREAKER DESCRIPTION

3.1 Vacuum Interruption

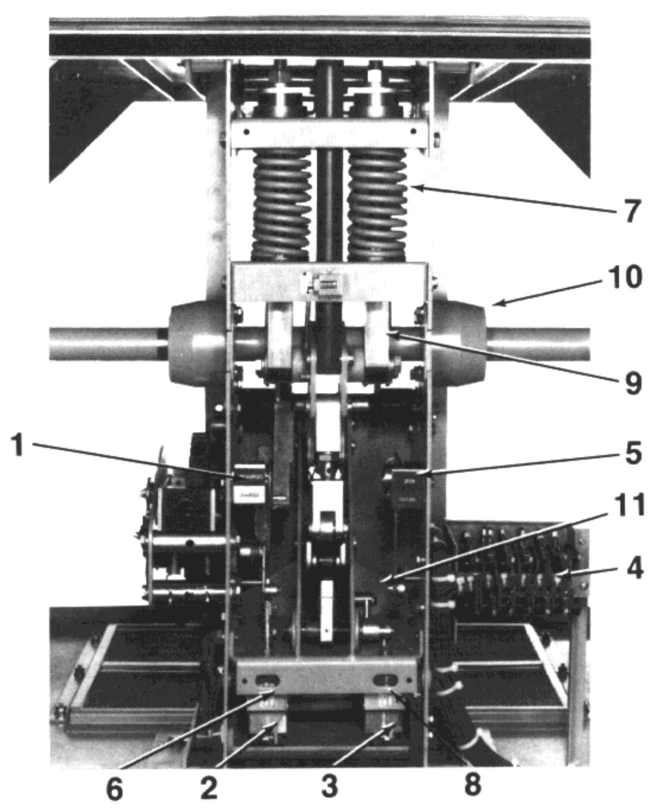
Interruption in the FVB series of vacuum circuit breakers is performed by the vacuum interrupters (Figure 2, 1) mounted horizontally within the high voltage compartment. Consisting of a pair of butt contacts, one movable and one fixed, hermetically sealed in a high vacuum, these interrupters require only a short contact gap for circuit interruption. The resulting high operating speed allows the entire interruption sequence to be consistently performed in three cycles or less.

3.2 Feed-Thru Bushings

The primary connections to the circuit breaker are made through the six feed-thru bushings (Figure 1, 1) mounted vertically at the top of the breaker housing. Take care to insure the feed-thru bushings do not receive rough treatment.

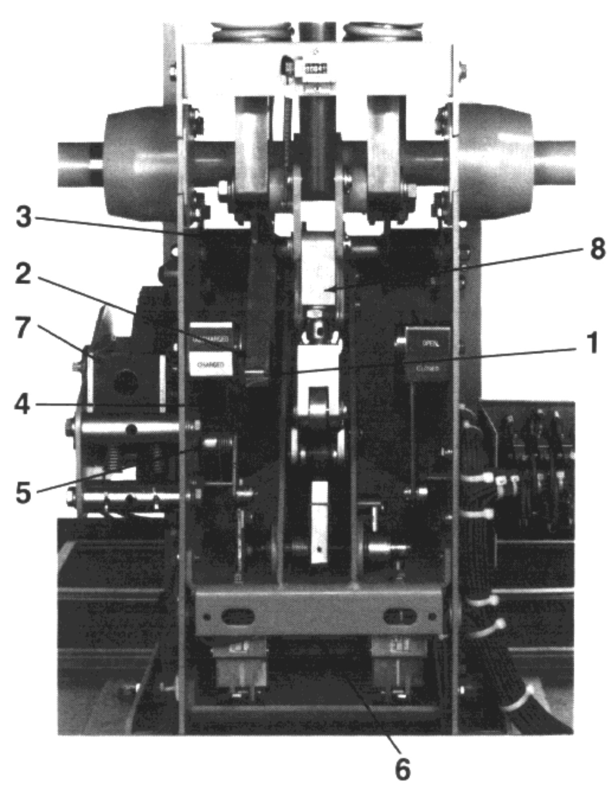
3.3 Operating Mechanism

The FVB operating mechanism is of the stored energy type, employing charged springs to perform breaker opening and closing functions. The operating mechanism contains all necessary controls and interlocks. It is mounted at the front of the breaker in the low voltage compartment so it can be easily accessed for inspection and servicing. Opening, closing, and spring charging can be performed electrically or manually.



1. CHARGE-DISCHARGE INDICATOR
2. CLOSE LEVER
3. OPEN LEVER
4. AUXILIARY SWITCH
5. OPEN-CLOSE INDICATOR
6. CLOSING SOLENOID
7. RETURN SPRING
8. OPENING SOLENOID
9. RETURN SPRING CONNECTING BLOCK
10. MAIN SHAFT BEARING
11. LATCH CHECK SWITCH

Figure 3



1. LIFTING ROLLER
2. LIFT ARM
3. DRIVE SHAFT
4. TRIP CLOSING ROLLER
5. TRIP CLOSING CAM
6. CHARGING MOTOR
7. MANUAL CHARGING ARM
8. DRIVE LINKAGE

Figure 4

3.4 Control Circuitry

A typical schematic diagram for the control circuitry of the FVB circuit breaker is presented in Figure 6. A copy of the exact schematic diagram(s) and wiring diagram(s) for the circuit breaker is provided in the manual holder located on the rear mechanism compartment door.

3.4.1 Auxiliary Switch

The auxiliary switch (Figure 3, 4) is a multi-stage switch used to operate those circuits which are dependent upon the position of the breaker contacts. The schematic diagram (Figure 6) indicates how each of the auxiliary switch stages are interconnected with the breaker circuitry. The function of each stage is discussed below.

1) The two sets of a-type contacts (52/a1 and 52/a3), connected in series with the trip solenoid (52/TC), disable the trip solenoid when the breaker is in the open position.

2) The two sets of b-type contacts (52/b2 and 52/b4), connected in series with the closing solenoid (52/CC), disable the closing solenoid when the breaker contacts are in the closed position.

3) For user convenience in indicating the position (opened or closed) of the breaker contacts, a pair of a-type contacts (52/a5) and a pair of b-type contacts (52/b6) are provided.

4) Three pair of b-type contacts (52/b8, 52/b10, and 52/b12) and three pair of a-type contacts (52/a7, 52/a9, and 52/a11) are provided, as shown in Figure 6, for optional use.

3.4.2 Charging Motor Limit Switch

The charging motor limit switch (52/LS) (Figure 6) energizes the motor relay (52MR) when a drive spring charging operation is required and de-energizes the motor relay when the drive springs, located behind the return springs (Fig. 3, 7), reach the fully charged position. As shown in the schematic diagram of Figure 6, the charging motor limit switch is connected in the normally closed position (shown with springs discharged). When the drive springs are not in the fully charged position, the charging motor limit switch cam (Figure 5, 2) actuates the charging motor limit switch, energizing the motor relay which, as described in 3.4.3, energizes the spring charging motor (52/M). Once the drive springs are fully charged the cam allows the switch to assume the open position, de-energizing the motor relay.

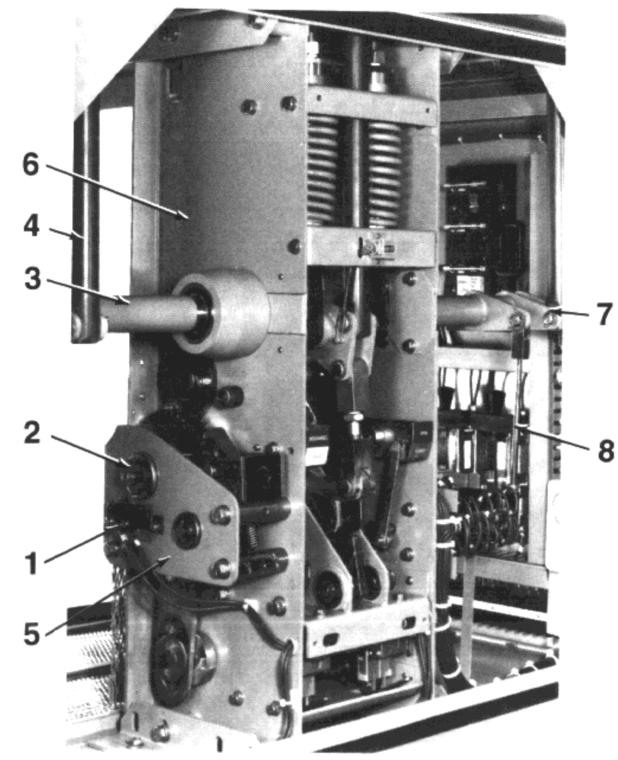
3.4.3 Motor Relay

When energized by the closing of the spring charging motor limit switch (52/LS), the motor relay (52MR) energizes the spring charging motor (52/M) through a pair of normally open contacts and disables the closing solenoid (52/CC) through a pair of normally closed contacts. If the CS/C control switch is closed, the motor relay will also energize the anti-pump relay (52Y) through a pair of normally open contacts.

3.4.4 Anti-Pump Relay

The anti-pump relay (52Y) insures that should the closing control switch (CS/C), which energizes the closing solenoid (52/CC), be continuously maintained in the closed position, the drive springs will not be continuously charged and discharged. The anti-pump relay (Figure 6) performs this function by allowing the closing solenoid to be energized only if the control switch (CS/C) is closed after the drive springs have reached the fully charged position and the motor relay (52MR) has been de-energized.

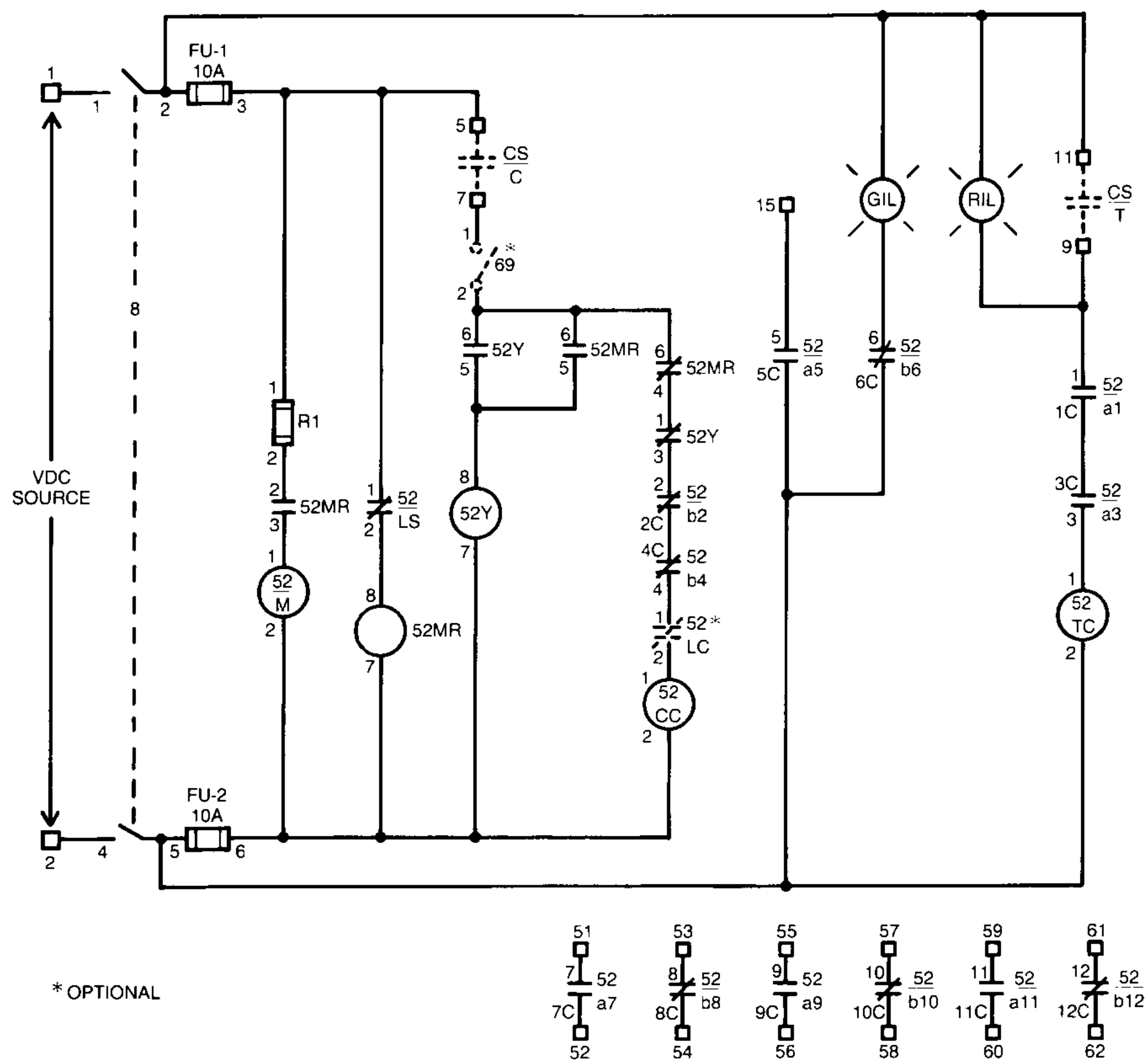
As discussed in section 3.4.3, the anti-pump relay will be energized if the closing control switch is closed and the motor relay (Figure 6) is energized. If the closing control switch is held closed continuously, the anti-pump relay will be latched in the energized position by a set of its own normally open contacts after the motor relay is de-energized. When the anti-pump relay is energized, a set of its normally closed contacts in series with the closing solenoid insure that the closing solenoid cannot be energized by the control switch. The closing solenoid cannot be energized unless the closing control switch is first opened (de-energizing the anti-pump relay), then closed again.



1. CHARGING MOTOR LIMIT SWITCH
2. CHARGING MOTOR LIMIT SWITCH CAM
3. MAIN SHAFT
4. DRIVE CONNECTING LINK
5. GEAR MOUNTING PLATE
6. SIDE PLATE
7. MAIN SHAFT CLEVIS PIN
8. AUXILIARY SWITCH LINKAGE

Figure 5

TYPICAL SCHEMATIC DIAGRAM OF FVB BREAKER



LEGEND

8	Control Power Switch	52/M	Spring Charging Motor
CS	Control Switch	52/CC	Closing Coil
52/LS	Motor Limit Switch	52/TC	Trip Coil
52/a or 52b	Auxiliary Switch	☐	Terminal Block
FU	Fuse	RIL	Red Indicating Light
52MR	Motor Relay	GIL	Green Indicating Light
52Y	Anti-Pump Relay	R1	120V/500W Resistor (250 VDC/240 VAC Only)

Figure 6

3.4.5 Control Power Switch (8)

When opened, the control power switch (8) (Figure 6) disconnects the control power from the entire control circuitry. As shown in Figure 6, two poles of this knife switch have been left free for optional use.

3.4.6 Latch Check Switch (Optional)

When specified a latch check switch (52/LC) can be supplied. (Normally a latch check switch is specified only when the breaker is to be used for instantaneous reclosing.) The contacts of the latch check switch are connected in series with the closing solenoid (52/CC). The latch check switch is actuated by the trip opening cam (Figure 6, 10) only when the cam is in its normal position as shown in Figure 6. Thus, the closing circuit cannot be energized until the trip opening cam has fully returned to its normal position.

3.5 Heater Circuitry

In normal configurations, two strip heaters (H-1 and H-2, Figure 8) are mounted at the lower rear of the operating mechanism. Their function is to prevent moisture condensation within the circuit breaker housing.

3.5.1 Heater Power Switch (8H)

When opened, the heater power switch (8H) (Figure 8) completely disconnects the control power from the heater circuitry. Both poles of this switch are fused.

3.5.2 Thermostat

When the temperature within the circuit breaker housing falls below the thermostat (23) setting, the normally open contacts within the thermostat (Figure 8) connected between terminals 1 and 2 apply power to the strip heaters H-1 and H-2.

3.6 Blower Circuitry

The mode of operation of the blower circuitry is determined by the position of the selector switch (SS). With the selector switch in the "Off" position, the control power is disconnected from the blower circuitry, making the blowers inoperable. Blower operation with the selector switch in the "Test" and "Auto" position is discussed below.

3.6.1 Blower Operation - Automatic Mode

In the FVB circuit breaker the added cooling capacity provided by the operation of the blowers is required only for current levels above 2000 amperes. The automatic mode of operation has therefore been designed to automatically initiate blower operation only at primary current levels greater than 2000 amperes and to discontinue blower operation below these levels. The discussion in the following sections assumes the selector switch (SS) has been placed in the "Auto" position.

3.6.1.1 Blower Current Transformer (BCT)

The primary winding of the blower current transformer (BCT) (Figure 8) is provided by the X1 lead of one of the bushing current transformers (Figure 7, 4).

The number of turns made as the primary input of the blower current transformer have been so determined as to cause the output of the blower C.T. to energize the blower control (BC) when the current level in the primary circuit is above 2000 amperes.

1. FEED-THRU BUSHING
2. BUSHING CLAMP BOLTS
3. C.T. MOUNTING PLATE
4. BUSHING CURRENT TRANSFORMER

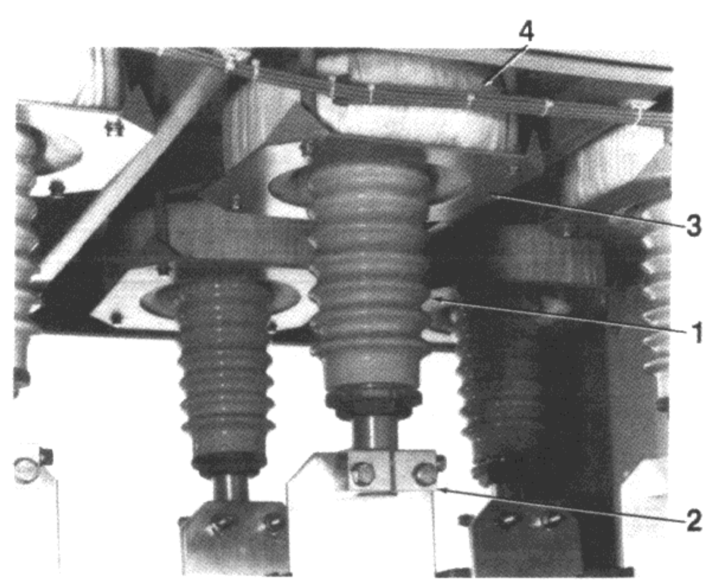
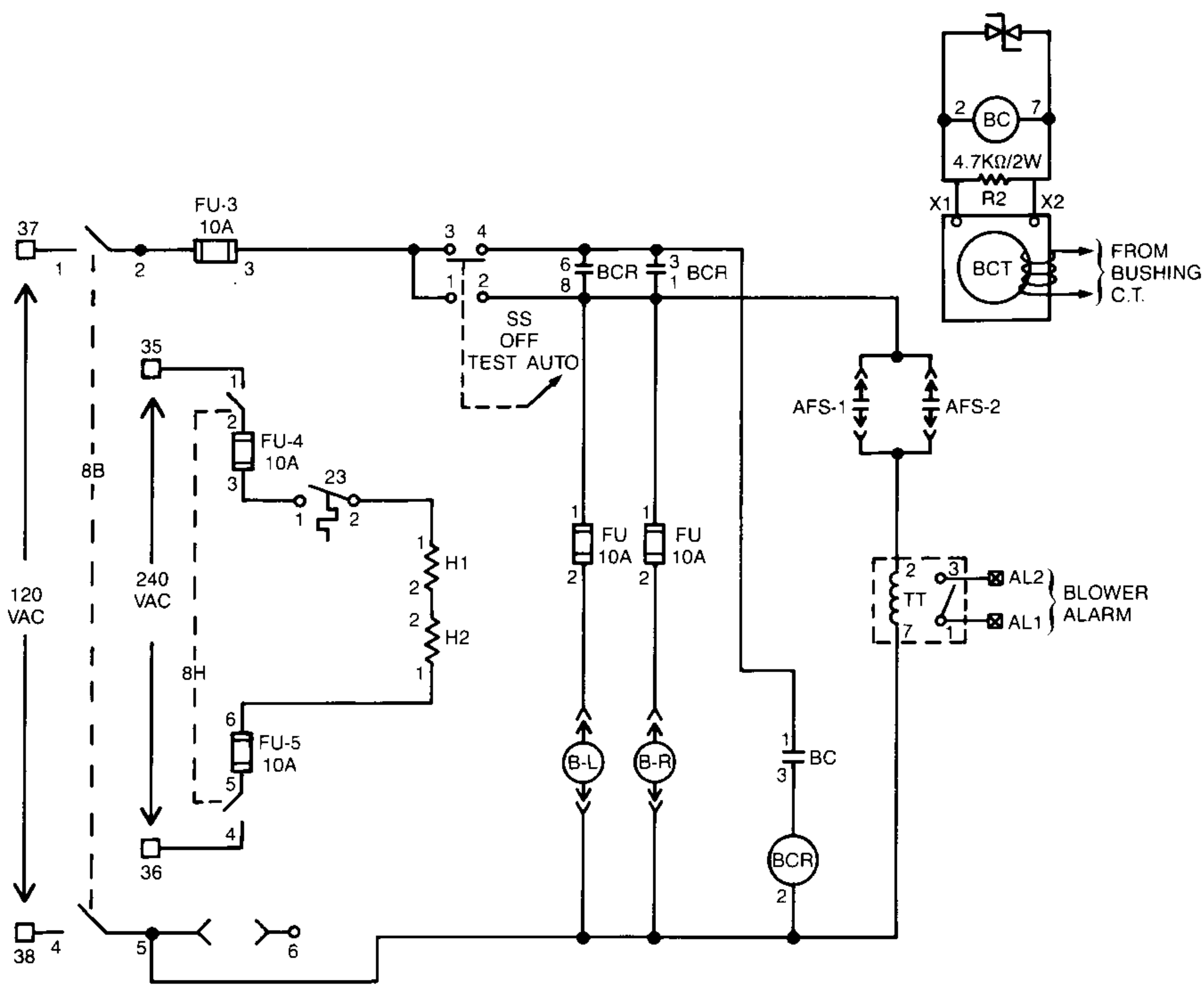


Figure 7

TYPICAL STRIP HEATER/BLOWER SCHEMATIC DIAGRAM



LEGEND

8B	Blower Power Switch
8H	Heater Power Switch
SS	Selector Switch
H	Heater (250W, 240V, 1A)
FU	Fuse
23	Thermostat
BCR	Blower Control Relay
BC	Blower Control
TT	Blower Alarm Relay (10 Sec. Nominal Delay)
BCT	Blower Current Transformer
AFS	Air Flow Switch
B-L	Blower Left
B-R	Blower Right

NOTE: Blower circuitry is applicable only to breakers rated above 2000 amperes continuous current.

Figure 8

3.6.1.2 Blower Control (BC)

The function of the blower control (Figure 8) is to sense precisely the output of the blower current transformer (BCT), and at an output voltage representing a primary current level above 2000 amperes, to energize the blower control relay (BCR) by closing a pair of normally open contacts in series with the blower control relay (Figure 8).

3.6.1.3 Blower Control Relay (BCR)

When energized by the closing of the normally open contacts of the blower control (BC), the blower control relay (Figure 8) applies control power to the blowers and the blower alarm circuit (See section 3.6.3) through the closing of two sets of parallel connected, normally open contacts. Additionally, one set of normally closed contacts is employed to disable the heater circuit whenever the blowers are energized.

3.6.2 Blower Operation - Test Mode

Placing the selector switch (SS) in the "Test" position, overrides the automatic control circuitry described in the preceeding sections, and directly connects the control power to the blowers and alarm circuitry (See section 3.6.3). The blowers and alarm circuitry will remain energized for as long as the selector switch (Figure 8) remains in the "Test" position.

3.6.3 Blower Alarm Circuitry

The blower alarm circuitry (Figure 8) consists of two air flow switches (AFS-1 and AFS-2) — one located in the air flow path of each blower — and a delay-on device (TT).

3.6.3.1 Blower Alarm Delay (TT)

When initially energized, the blowers require a few seconds to develop enough air flow to actuate their respective air flow switches. To eliminate the possibility of a false alarm during this initialization period a time delay device (TT) is employed to disable the blower alarm circuitry momentarily until the blowers have been provided enough time to build up their air flow. The blower alarm delay (TT) (Fig. 8) provides a nominal delay-on period of 10 seconds.

3.6.3.2 Air Flow Switches (AFS-1 and AFS-2)

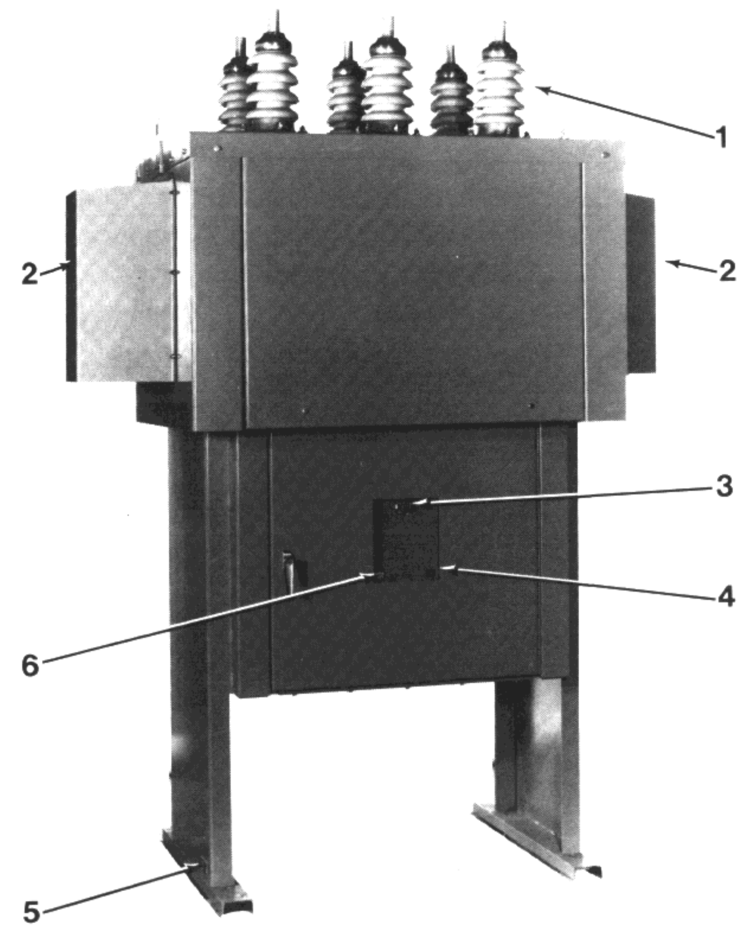
Each air flow switch contains a set of form C contacts. As shown in Figure 8, the normally closed segment of these contacts is employed in the blower alarm circuitry.

Once the blower alarm circuitry has been energized and the blower alarm delay (TT) has completed its delay-on period, the normally open contacts of the delay device will close, connecting pin 1 to pin 3.

User supplied power from input line AL2 on the blower alarm terminal block (Figure 8) will then be connected to output AL1 of the blower alarm terminal block.

3.7 Indicators

Two indicators are provided on the operating mechanism. The open-close indicator (Figure 9, 4) designates the position (opened or closed) of the vacuum interrupter contacts. The charge-discharge indicator (Figure 9, 6) displays the state (charged or discharged) of the drive springs, located behind the return springs (Figure 11, 7).



1. FEED-THRU BUSHINGS
2. BLOWER/BREATHER HOUSING (1200A AND ABOVE ONLY)
3. OPERATIONS COUNTER
4. OPEN-CLOSE INDICATOR
5. GROUND CONTACT
6. CHARGE-DISCHARGE INDICATOR

Figure 9

3.8 Manual Charging

The drive springs, located behind the return springs (Fig. 11, 7), can be manually charged by using the manual charging handle (supplied with the breaker) to move the charging arm (Figure 10, 7) up and down until the drive springs are fully charged. The drive springs are fully charged when the charge discharge indicator (Figure 9, 6) reads charged and the manual charging arm can no longer be raised.

3.9 External Open Button

Located at the front of the circuit breaker and protruding from the bottom of the low voltage compartment, the external open button allows the circuit breaker to be manually tripped open without requiring entry through the low voltage compartment door.

3.10 Protective Control Device (Optional)

If requested by the customer, circuit breakers can be equipped with an optional protective control device (69). This device is simply a toggle switch connected in series with the closing circuit. Whenever a manual opening operation is performed, either via the external open button (See section 3.9) or the open lever (Fig. 11, 3), this toggle switch is automatically opened and thus disables the closing circuit. TO AGAIN ENABLE THE PERFORMANCE OF AN ELECTRICAL CLOSING OPERATION THIS TOGGLE SWITCH MUST BE HAND RESET. This can be done very easily via the appropriately labeled access hole located at the lower center of the front mechanism cover.

3.11 Slow Closing Feature

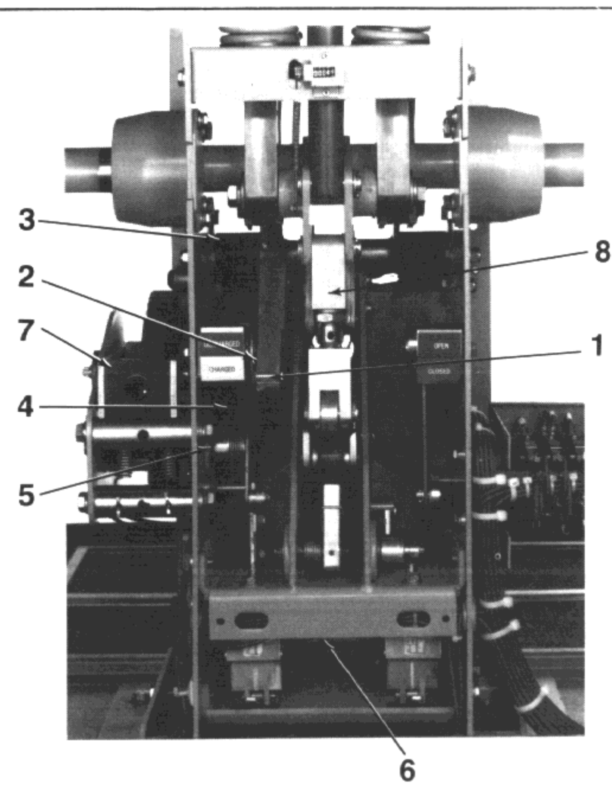
For some maintenance functions it may be desirable to manually slow close the circuit breaker. For such purposes, the FVB operating mechanism provides a built-in slow closing feature.

Manual slow closing is accomplished as follows:

a) With the breaker in the open position and the drive springs charged, insert the drive spring blocking pins (supplied with the breaker) into the hole at the upper end of each drive spring center shaft. Insertion is performed through oblong holes provided at the upper rear of the operating mechanism.

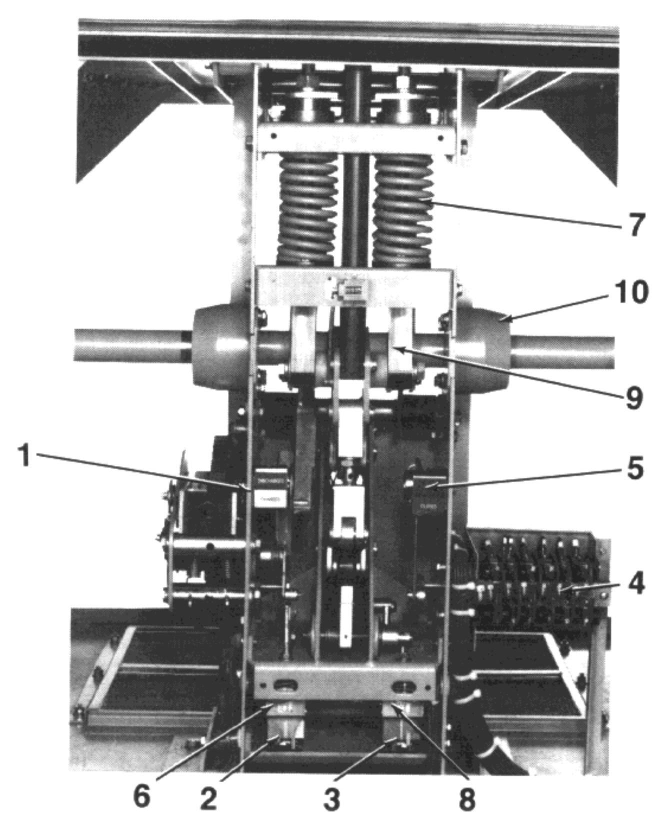
b) Discharge the drive springs.

c) Using the manual charging handle, slowly charge the drive springs as described in section 3.8. The circuit breaker will begin to slow close.



1. LIFTING ROLLER
2. LIFT ARM
3. DRIVE SHAFT
4. TRIP CLOSING ROLLER
5. TRIP CLOSING CAM
6. CHARGING MOTOR
7. MANUAL CHARGING ARM
8. DRIVE LINKAGE

Figure 10



1. CHARGE-DISCHARGE INDICATOR
2. CLOSE LEVER
3. OPEN LEVER
4. AUXILIARY SWITCH
5. OPEN-CLOSE INDICATOR
6. CLOSING SOLENOID
7. RETURN SPRING
8. OPENING SOLENOID
9. RETURN SPRING CONNECTING BLOCK
10. MAIN SHAFT BEARING

Figure 11

4. FVB OPERATING MECHANISM DESCRIPTION OF OPERATION

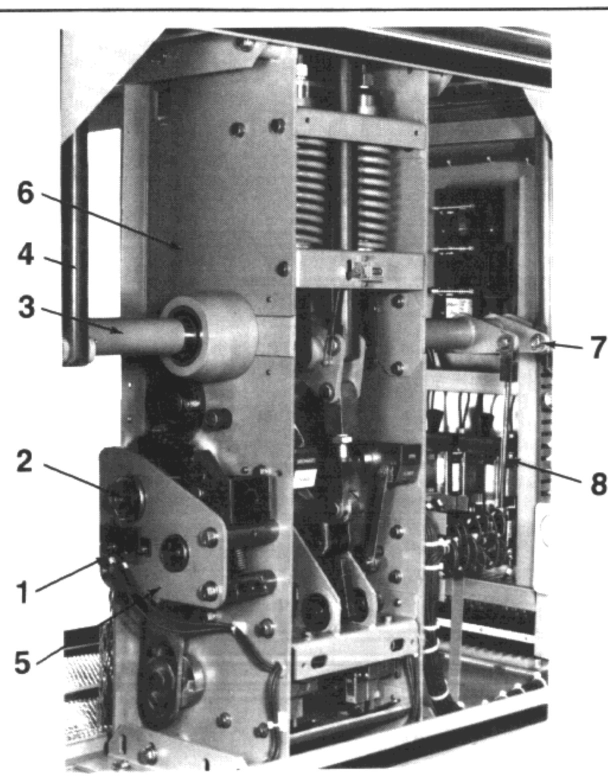
The following is a description of the operation of the FVB operating mechanism. This manual will refer to the operating mechanism as the front of the breaker. The terms left and right will be used as if facing the operating mechanism. The terms clockwise and counterclockwise will be used as if facing the left side of the breaker.

4.1 Spring Charging

Assume that the interrupter contacts are in the open position and that the drive springs, located behind the return springs (Figure 11, 7), and the return springs are discharged. When power is applied to the breaker control circuitry (Figure 6), the charging motor (Figure 10, 6) is energized. The motor eccentric (Figure 13, 1), mounted on the charging motor shaft, drives the ratchet arm assembly (Figure 13, 2) backward and forward. With each forward stroke of the ratchet arm, the spring loaded drive pawl (Fig. 13, 3), mounted on the ratchet arm, engages a tooth on the gear (Fig. 13, 4) and advances the gear a few degrees counterclockwise. The holding pawl (Figure 13, 5) holds the gear in position while the drive pawl makes its reverse stroke to engage another tooth. The gear is free to rotate on the gear shaft (Figure 13,6). As the gear is advanced, the drive block (Figure 13, 8), mounted on the outside face of the gear, engages the ear on the drive hub (Figure 13, 7) and rotates the drive hub. A roll pin connects the drive hub to the gear shaft and drive lever assembly. The gear shaft and drive lever assembly thus rotates with the drive hub.

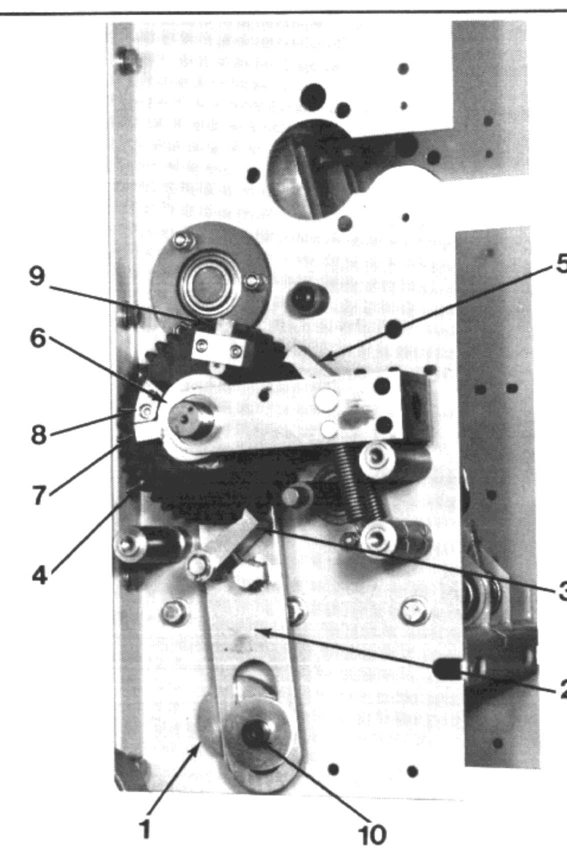
As the drive lever rotates, the lifting roller (Figure 10, 1) on the drive lever contacts the lift arm (Figure 10, 2) on the drive shaft (Figure 10, 3) and pushes the lift arm up rotating the drive shaft counterclockwise. The counterclockwise drive shaft rotation compresses the drive springs until the spring load against the drive lever passes top dead center and attempts to discharge. At this point, the drive lever rotates a few degrees until the trip closing roller (Fig. 10, 4) on the drive lever engages the trip closing cam (Fig. 10, 5). The drive lever can rotate no further and the drive springs are held in this charged position until a closing operation is initiated.

When the drive springs reach the fully charged position, the charging motor limit switch cam (Figure 12, 2) allows the charging motor limit switch (Figure 12, 1) to open, de-energizing the charging motor. Simultaneously, the pawl lift slide (Figure 13, 9) is pushed forward by the cam lobe on the drive hub so that the drive pawl rides on the pawl lift slide and does not engage the gear. This arrangement allows the charging motor and ratchet assemly to coast smoothly to a stop.



1. CHARGING MOTOR LIMIT SWITCH
2. CHARGING MOTOR LIMIT SWITCH CAM
3. MAIN SHAFT
4. DRIVE CONNECTING LINK
5. GEAR MOUNTING PLATE
6. SIDE PLATE
7. MAIN SHAFT CLEVIS PIN
8. AUXILIARY SWITCH LINKAGE

Figure 12



1. MOTOR ECCENTRIC
2. RATCHET ARM ASSEMBLY
3. DRIVE PAWL
4. GEAR
5. HOLDING PAWL
6. GEAR SHAFT
7. DRIVE HUB
8. DRIVE BLOCK
9. PAWL LIFT SLIDE
10. SHOULDER BOLT

Figure 13

4.2 Closing Operation

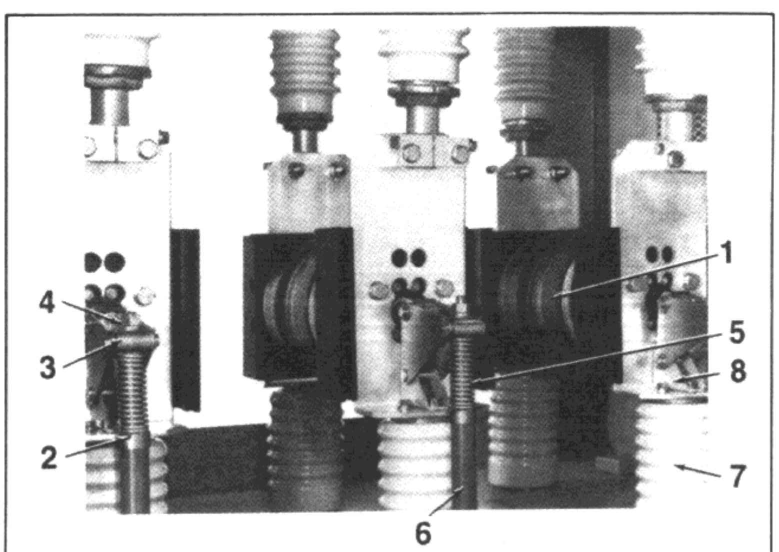
Once the drive springs, located behind the return springs (Figure 11, 7), have been charged, the breaker can be closed by lifting the close lever (Figure 11, 2) or energizing the closing solenoid (Figure 11, 6). Either method disengages the trip closing cam (Figure 10, 5) from the trip closing roller (Figure 10, 4) and allows the drive springs to discharge. The discharging drive springs rotate the drive shaft (Figure 10, 3) clockwise. The clockwise rotation of the drive shaft gives the drive spring bearing (Figure 15, 3) a downward motion. The drive spring bearing engages the toggle cam (Figure 15, 1) rotating the front of the toggle cam up and the rear of the toggle cam down under the catch (Figure 15, 2). The front of the toggle cam is connected to the main shaft (Figure 12, 3) by the drive linkage (Figure 15, 5). The upward motion of the front of the toggle cam thus rotates the main shaft counterclockwise and compresses the return springs (Figure 11, 7).

The drive connecting links (Figure 12, 4) transform the rotary motion of the main shaft into a linear motion which closes the vacuum interrupter contacts. The trip opening cam (Figure 15, 10) forces the entire toggle assembly (Figure 15) to remain latched in this position.

When the drive springs discharge, rotating the drive shaft in a counterclockwise direction, the descending lift arm rotates the drive lever such that the drive lever completes approximately 360 degrees of rotation to its initial position where it can once again perform a drive spring charging operation. The gear shaft and drive hub rotate with the drive lever. The drive hub rotates out of contact with the drive block. Since the gear (Figure 13,4) rotates freely on the gear shaft, the gear remains stationary. The rotation of the drive hub is such that the pawl lift slide (Figure 13, 9) follows the cammed surface of the drive until the pawl lift slide moves back below the gear teeth permitting the drive pawl (Figure 13, 3) to engage the gear. The charging motor limit switch cam (Figure 12, 2) rotates with the gear shaft and closes the charging motor limit switch (Figure 12, 1) energizing the charging motor (Figure 10, 6) which once again charges the drive springs.

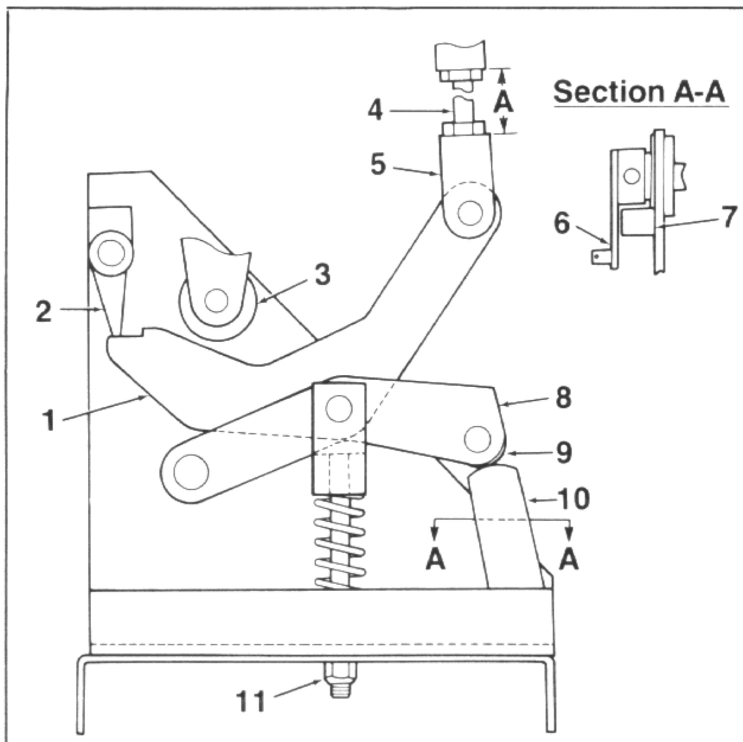
4.3 Opening Operation

With the return springs (Figure 11, 7) charged, the operating mechanism is now ready to perform an opening operation. If the open lever (Figure 11, 3) is lifted or if the opening solenoid (Figure 11, 8) is energized, the trip opening cam (Figure 15, 10) will be rotated clockwise out from under the toggle bearing (Figure 15, 9). The force of the charged return springs pushing down on the rear of the toggle cam (Figure 15, 1) will cause the toggle sub-assembly (Figure 15, 8) to rotate clockwise. When the rear of the toggle cam clears the catch (Figure 15, 2) the return springs will completely discharge, rotating the main shaft (Figure 12, 3) and the toggle cam clockwise. The clockwise rotation of the main shaft is transformed to a linear motion by the drive connecting links (Figure 12, 4). The drive connecting links are connected to the vacuum interrupters (Figure 14, 1) and their motion opens the vacuum interrupter contacts.



1. VACUUM INTERRUPTER
2. BOTTOM SPRING RETAINER
3. SPRING PIVOT
4. SPRING RETAINER WASHER
5. BIAS SPRING
6. DRIVE CONNECTING LINK
7. STANDOFF INSULATOR
8. PIVOT BASE

Figure 14



1. TOGGLE CAM
2. CATCH
3. DRIVE SPRING BEARING
4. DRIVE LINKAGE SHAFT
5. DRIVE LINKAGE
6. TRIP OPEN ARM
7. TRIP OPEN ECCENTRIC
8. TOGGLE SUB-ASSEMBLY
9. TOGGLE BEARING
10. TRIP OPENING CAM
11. TOGGLE SUB-ASSEMBLY RETAINER NUT

Figure 15

5. ADJUSTMENTS

During periodic inspections and when a breaker component is repaired or replaced, the following adjustments should be checked. To perform these adjustments, remove the front mechanism cover. THERE SHOULD BE NO NEED TO ADJUST A NEWLY MANUFACTURED BREAKER.

WARNING: WHENEVER AN ADJUSTMENT IS TO BE CHECKED OR PERFORMED WITH THE DRIVE SPRINGS IN THE CHARGED POSITION, IT IS ABSOLUTELY NECESSARY TO BLOCK THE DRIVE SPRINGS BY PLACING THE BLOCKING PINS IN THE HOLES AT THE UPPER END OF THE DRIVE SPRING CENTER SHAFTS. TWO SPRING BLOCKING PINS ARE PROVIDED WITH EACH CIRCUIT BREAKER AND ARE LOCATED IN THE LOW VOLTAGE COMPARTMENT.

5.1 Trip Open Eccentric

The trip open eccentric (Figure 15, 7) allows adjustment of the trip sensitivity of the breaker. This adjustment is factory set to provide a breaker that consistently meets minimum trip voltage requirements without being overly sensitive. Over adjustment of this setting can cause nuisance tripping.

5.2 Toggle Bearing Clearance

With the breaker in the open position and drive springs charged, the clearance between the toggle bearing (Figure 15, 9) and the trip open cam (Figure 15,10) should be 1/32″ + 1/32″ − 0″. If adjustment is necessary, the toggle sub-assembly retainer nut (Figure 15, 11) should be adjusted clockwise to decrease clearance or counterclockwise to increase clearance. BLOCK THE RETURN SPRINGS BEFORE PERFORMING THIS ADJUSTMENT.

5.3 Charging Motor Limit Switch

Actuated by the charging motor limit switch cam (Figure 12, 2), the charging motor limit switch (Figure 12, 1) serves to energize the charging motor (Figure 10, 6), during a drive spring charging operation and deenergize the charging motor when the drive springs reach the fully charged position. The charging motor limit switch is properly adjusted if its contacts are open when the drive springs are in the fully charged position and closed when the drive springs are discharged.

The position of the charging motor limit switch contacts can be determined by using a continuity tester. If adjustment is necessary, loosen the two screws which hold the charging motor limit switch and move the switch up or down as required. Tighten the two screws to hold the charging motor limit switch in place.

5.4 Adjustments Affecting the Vacuum Interrupter Assembly

THE FOLLOWING ADJUSTMENTS NEED TO BE MADE ONLY WHEN A VACUUM INTERRUPTER IS REPLACED. These adjustments are listed in the order in which they should be performed.

5.4.1 Drive Linkage*

The correct drive linkage adjustment is determined by measuring distance "A" (Figure 15).

For those breakers which employ a drive linkage assembly with only one (1) jam nut on the drive linkage shaft (Figure 15, 4) the correct setting for distance "A" is 1 5/32″ ± 1/16″.

For those breakers which employ a drive linkage assembly with two (2) jam nuts on the drive linkage shaft (Figure 15, 4) the correct setting for distance "A" is 1 5/8″ ± 1/16″.

5.4.2 Pivot Base

The pivot base (Figure 16, 5) is properly adjusted if distance "F" (Figure 16) is 1 1/8″ ± 1/16″ for circuit breakers rated 1200 amperes and above or 2 3/16″ ± 1/16″ for circuit breakers rated 800 amperes and below.

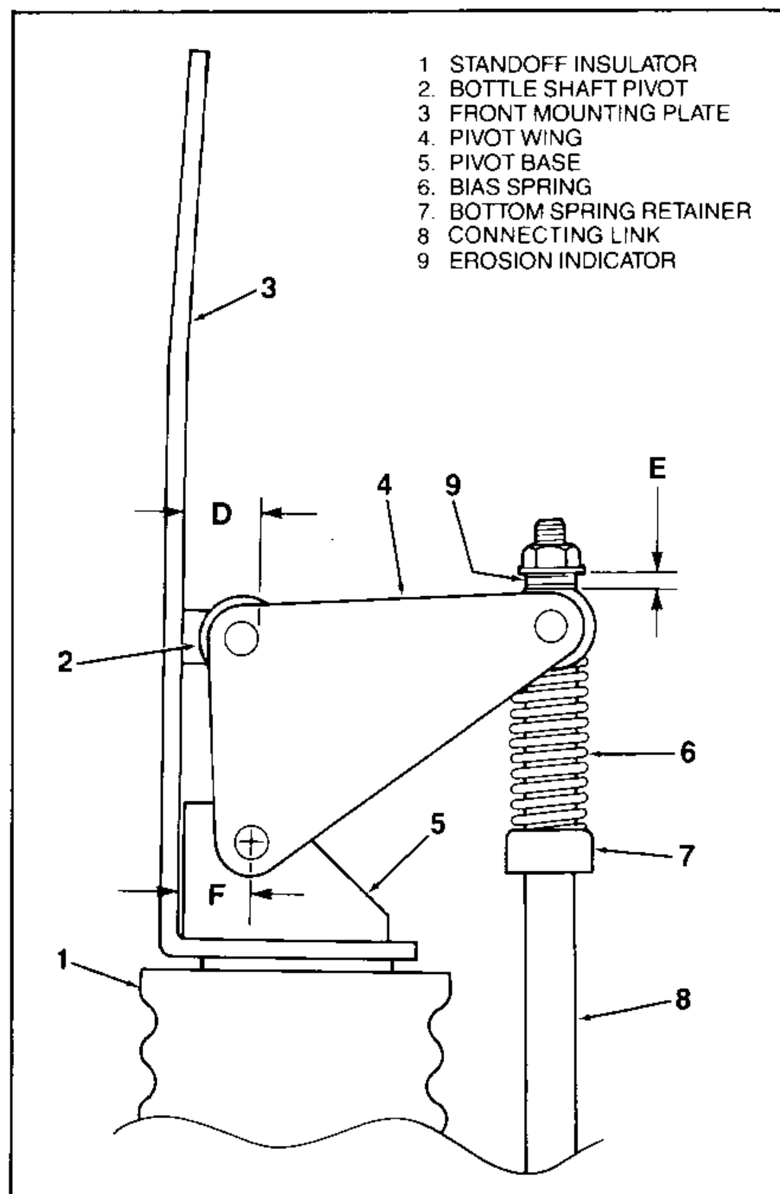


Figure 16

*Note: Breakers manufactured after December 1986 may not employ adjustable drive linkage.

5.4.3 Spring Overtravel

When the breaker is in the closed position, the spring overtravel (Distance "E". Figure 16) for a new vacuum interrupter assembly should be .300" ± .030". Adjustment is performed as follows:

When the breaker is in the fully closed position, check the spring overtravel. If adjustment is necessary, loosen the set screw at the bottom spring retainer (Figure 16, 7) and the nut at the top of the drive connecting link (Figure 14, 6) and turn the retainer clockwise (viewed from above) to shorten the gap or counterclockwise to lengthen the gap. This adjustment is factory set and should only be performed when installing a new vacuum interrupter as any change in dimension "E" provides an indication of contact erosion (See Section 6.1a).

5.4.4 Primary Contact Gap

	Primary Contact Gap	Interrupting Rating
14.4KV Class	.375 ± .050	Thru 12KA
	.560 ± .060	Above 12KA thru 20KA
	.750 ± .050	Above 20KA
23.0KV Class	.560 ± .060	Thru 16KA
	.750 ± .050	Above 16KA

To determine the primary contact gap, measure distance "D" (Figure 16) with the breaker in the open position, then with the breaker in the closed position. The difference between these two measurements is the primary contact gap.

To adjust the primary contact gap, use the return spring stops (Figure 17, 7). Turn the stops clockwise (viewed from above) to decrease the primary contact gap and counterclockwise to increase the primary contact gap. It should be noted that both stops must be adjusted simultaneously and equally. The return spring stops can be turned easily if the locking nut is loosened and the breaker is in the closed position. EXERCISE CAUTION SINCE THE RETURN SPRINGS ARE IN THE CHARGED POSITION. After performing the adjustment, tighten the locking nuts against the stops. Open and close the breaker, then remeasure the primary contact gap. Repeat the procedure until the correct primary contact gap is obtained. (To facilitate this adjustment after return spring replacement has been performed, the initial setting of distance "C" (Figure 17) should be approximately $10^1/_8$" with the breaker in the open position.)

5.4.5 Return Spring Pre-load Setting

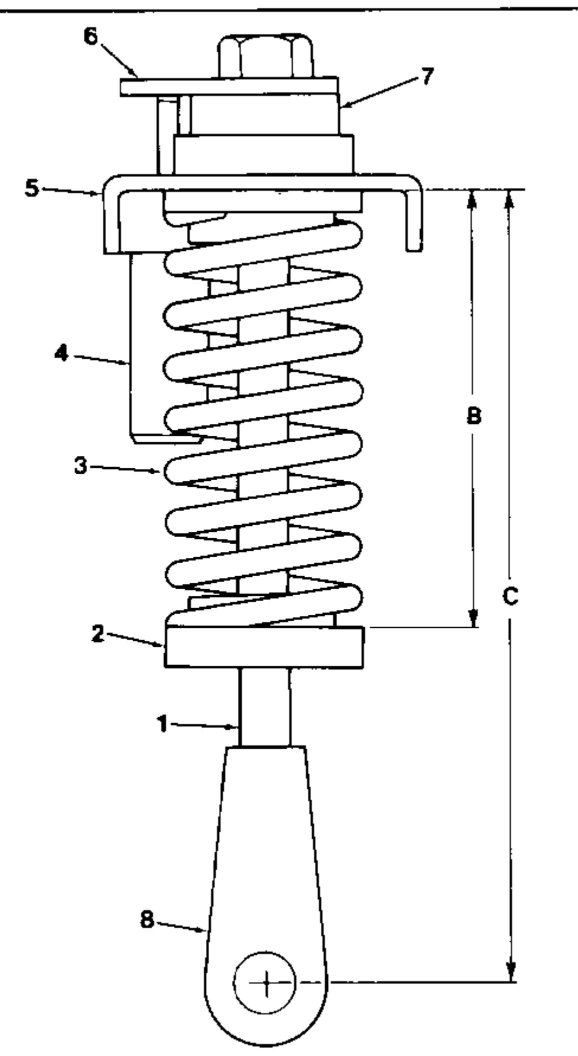
The return spring pre-load setting is determined by distance "B" shown in Figure 17. This adjustment is factory set to provide the correct contact velocities and should not be changed. If disassembly is ever required, note this setting and readjust to the same distance upon reassembly. To adjust distance "B", turn the adjustable retainer (Figure 17, 2) clockwise (viewed from above) to increase distance "B" and counterclockwise to decrease distance "B".

5.4.6 Shock Absorber

All shock absorber adjustments and settings have been made at the factory. No adjustments should be necessary. If, however, they are required, consult the factory.

5.4.7 Contact Compression

Once the above adjustments have been performed, cycle the breaker open and closed 25 times to compress the contacts of the new vacuum interrupter(s) which has been installed. After cycling the breaker remeasure adjustments 5.4.3, 5.4.4 and 5.4.5. Perform these adjustments again if required.



1. RETURN SPRING SHAFT
2. RETURN SPRING ADJUSTABLE RETAINER
3. RETURN SPRING
4. SHOCK ABSORBER
5. RETURN SPRING MOUNTING BOX
6. SHOCK ABSORBER PAD
7. RETURN SPRING STOP
8. RETURN SPRING CONNECTING BLOCK

Figure 17

6. MAINTENANCE

FOR SAFETY, ALWAYS DISCHARGE OR BLOCK THE RETURN SPRINGS (FIGURE 11, 7) AND THE DRIVE SPRINGS, LOCATED BEHIND THE RETURN SPRINGS, BEFORE PERFORMING ANY MAINTENANCE OR REPAIR WORK.

Because of the wide variations in operating uses and environments, each operating company should develop a maintenance schedule, based on operating experience, which will provide assurance of proper breaker condition. Until such a schedule is determined, it is recommended that breakers be inspected after one (1) year or every 2000 operations, whichever occurs first. It is also recommended that breakers be inspected after severe fault operation and notation of any contact erosion be recorded (See 6.1 a).

6.1 Vacuum Interrupters

To assure reliable interruption, perform the following two checks:

a) Contact Erosion: Any contact erosion will result in a reduction of the spring overtravel (See section 5.4.2). Contact erosion can therefore be determined by closing the breaker and measuring the spring overtravel. The difference between this measurement and the original spring overtravel measurement at the time the interrupter was put into service represents contact erosion. When the contacts have eroded 1/8", which is represented by a 3/16" reduction in spring overtravel, vacuum interrupter must be replaced.

FOR EXAMPLE: The factory spring overtravel adjustment is .300" ± .030" (See section 5.4.3); a reduction in this measurement of .188" (3/16") will result in a measurement of .112" (Slightly less than 1/8"). Therefore, a spring overtravel measurement of .112" or less indicates the end of contact life and the need to replace the vacuum interrupter.

NOTE: TO FACILITATE THIS MEASUREMENT, SOME BREAKERS ARE EQUIPPED WITH A GREEN INDICATOR BAND ON THE EROSION INDICATOR (FIGURE 16, 9). WHEN THIS GREEN INDICATOR BAND IS NO LONGER VISIBLE AND ONLY THE RED SECTION IS SHOWING, THE END OF CONTACT LIFE HAS BEEN REACHED AND THE VACUUM INTERRUPTER MUST BE REPLACED.

b) Hipot Tests: Hipot test each interrupter in accordance with the instructions provided in "e" of Section 2.

6.2 Insulating Surfaces

Using a clean, dry cloth, remove all dirt and moisture from the outside of the vacuum interrupters (Figure 14, 1) and from all insulating parts.

6.3 Mechanism

The entire breaker and operating mechanism should be inspected for loose hardware and worn or broken parts. All wiring should be checked for loose connections and damaged insulation. Inspect all bearings and contact surfaces for damage or excessive wear. Examine the shock absorber for evidence of leakage.

6.4 Lubrication

It should be noted that all bearings used in the FVB series of vacuum circuit breakers are sealed and do not require lubrication.

The lubrication chart below provides the location of all lubrication points, the type of lubrication required and the two methods of lubrication. Method 1 is the periodic lubrication required after 2000 operations or one (1) year, whichever occurs first. Method 2 is the lubrication procedure to be used whenever the breaker is overhauled or disassembled. Severe operating conditions may warrant different lubrication intervals and procedures. Variations should be based on the experience of the operating company.

It is recommended that the breaker be manually operated several times after lubrication and observed for proper operation.

IMPORTANT: NEVER APPLY GREASE TO THE MACHINED SURFACE OF THE TRIP CLOSING CAM (FIGURE 10, 5) OR THE TRIP OPENING CAM (FIGURE 15, 10) OR THEIR RESPECTIVE CAM FOLLOWERS.

LUBRICATION CHART

LUBRICATION POINT	METHOD I Lubrication at Maintenance Period	METHOD II Lubrication at Overhaul
Gear teeth.	Wipe clean, and apply lubricant.*	Disassemble, wipe clean, and apply lubricant.*
Contact surfaces on lift arm (Figure 10, 2), toggle cam (Figure 15, 1), return spring connecting blocks (Figure 17, 8) catch (Figure 15, 2), etc.	Wipe clean and apply lubricant.	Disassemble, wipe clean, and apply lubricant.
Gear shaft (Figure 13, 6) and drive shaft (Figure 10, 3).	No lubrication required.	Disassemble, wipe clean, and apply lubricant to contact surfaces.
Ratchet arm (Figure 13, 2).	No lubrication required.	Disassemble, wipe clean, and apply lubricant to bronze bushing and all contact surfaces.
Contact and pivot points of all linkages.	Wipe clean and apply lubricant.	Disassemble, wipe clean, and apply lubricant.
Drive spring assembly.	No lubrication required.	Do not disassemble. Wipe clean and apply lubricant to center shaft.
Motor eccentric (Figure 13, 1) and eccentric roller.	Wipe clean and apply lubricant to slot in ratchet arm.	Disassemble, wipe clean, and apply lubricant.
All shafts, sleeves, spacers and bushings.	No lubrication required.	Disassemble, wipe clean,

**It is recommended that a high grade, heavy duty lubricant such as Texaco Multifac EP2 or Lubriplate #630-2 be used. If a dry lubricant is desired, Sprayon #708 teflon or the equivalent is recommended.*

6.5 Opening/Closing Velocity

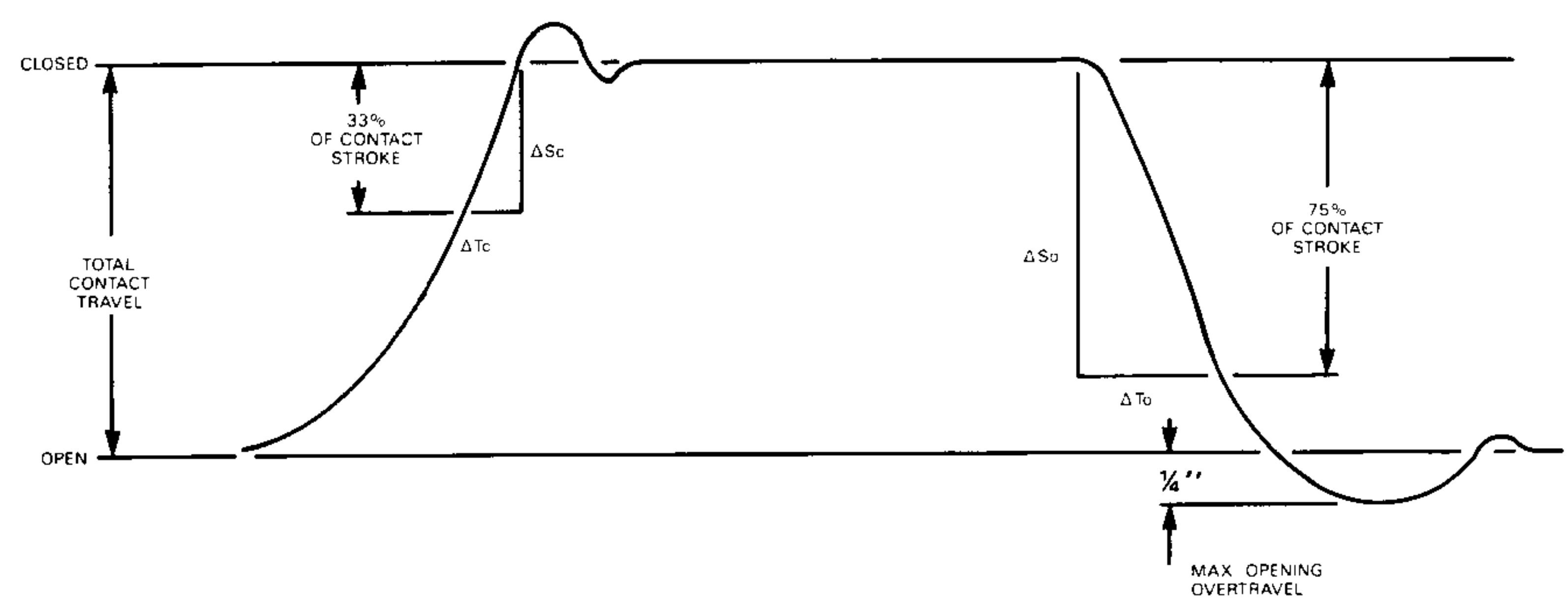
Carefully determine the opening and closing velocities of the vacuum interrupter contacts. These velocities should be:

Opening/Closing Speeds in Feet Per Second

	600A & 800A	1200A	2000A & 3000A
Opening	3.00 - 4.50	3.50 - 5.50	3.00 - 5.50
Closing	2.20 - 3.40	2.20 - 3.40	2.00 - 3.40

It is important to note that for a vacuum interrupter the closing velocity is that average velocity determined by dividing 33% of the contact stroke by the time required to close the final 33% of the stroke. The opening velocity is that average velocity determined by dividing 75% of the contact stroke by the time required to open the contacts to 75% of the stroke. (Refer to the contact travel curve below.)

Contact Travel Curve



$$\text{CLOSING VELOCITY} = \overline{V_c} = \frac{\Delta S_c}{\Delta T_c}$$

$$\text{OPENING VELOCITY} = \overline{V_o} = \frac{\Delta S_o}{\Delta T_o}$$

6.6 FVB Overhaul

After every 10,000 operations it is recommended that the breaker be given a thorough overhaul and that all components which have been excessively worn be replaced. Overhaul may require disassembly of the operating mechanism. For breaker lubrication, follow Method II in the lubrication chart. Check all bearings and replace if necessary. Check for proper adjustments and adjust if required.

6.7 Air Filters

The air filter(s), located on the floor of the mechanism compartment, should be thoroughly cleaned or replaced at least once a year. Severe operating conditions may warrant more frequent air filter maintenance.

Additionally, some circuit breakers employ air filters and/or screens in each breather housing (Figure 9, 2). These should be maintained in the same manner described in the preceding paragraph.

7. RENEWAL PARTS

7.1 Recommended Renewal Parts

Sufficient renewal parts should be maintained in stock to insure prompt replacement of worn, broken or damaged parts. A list of factory recommended renewal parts is provided in the table below.

Because of the wide variation in operating uses and environments, the Recommended Renewal Parts Table is presented only as a minimum requirement. Each operating company should develop its own renewal parts stock, based on operating experience, which will provide assurance of proper breaker condition.

7.2 Ordering Instructions

When ordering renewal parts:

a) Always specify the complete rating plate information.

b) Specify part number, description of part, figure number (if provided) and the catalog number from which this information is taken.

c) For electrical components, specify operating voltage.

d) Standard hardware components are not listed and should be purchased locally.

RECOMMENDED RENEWAL PARTS*
CIRCUIT BREAKER

DESCRIPTION	QTY/BKR	MIN. STK RECOMMENDED	FIGURE NUMBER	CATALOG NUMBER
Spring Charging Motor (52/M)	1	1	4, 6	1715F
Anti-Pump Relay (52Y)	1	1	6	OYF1
Motor Relay (52MR)	1	1	6	OMRF1
Opening Solenoid (52/TC)	1	1	11, 8	3TCF1
Closing Solenoid (52/CC)	1	1	11, 6	3XF1
Motor Limit Switch (52/LS)	1	1	5, 1	7LSF1
Auxiliary Switch	1	1	11, 4	1ASF1
Vacuum Interrupter Assembly	3	1	—	5002F
Blower & Housing Assembly (Applicable only to circuit breakers rated above 2000 amperes continuous current)	2	1	9, 2	5003F

**Minimum recommended requirements*

SQUARE D COMPANY

330 Weakley Road, Smyrna, Tenn. 37167

Manual 6065-1 3M CPS 12/90 Printed in U.S.A