I.B. 38-921-9C

Type V

Instructions for Type V Vacuum Circuit Breaker

ABB Power T&D Company Inc.

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LIST OF ILLUSTRATIONS

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local ABB Power T&D representative should be contacted.

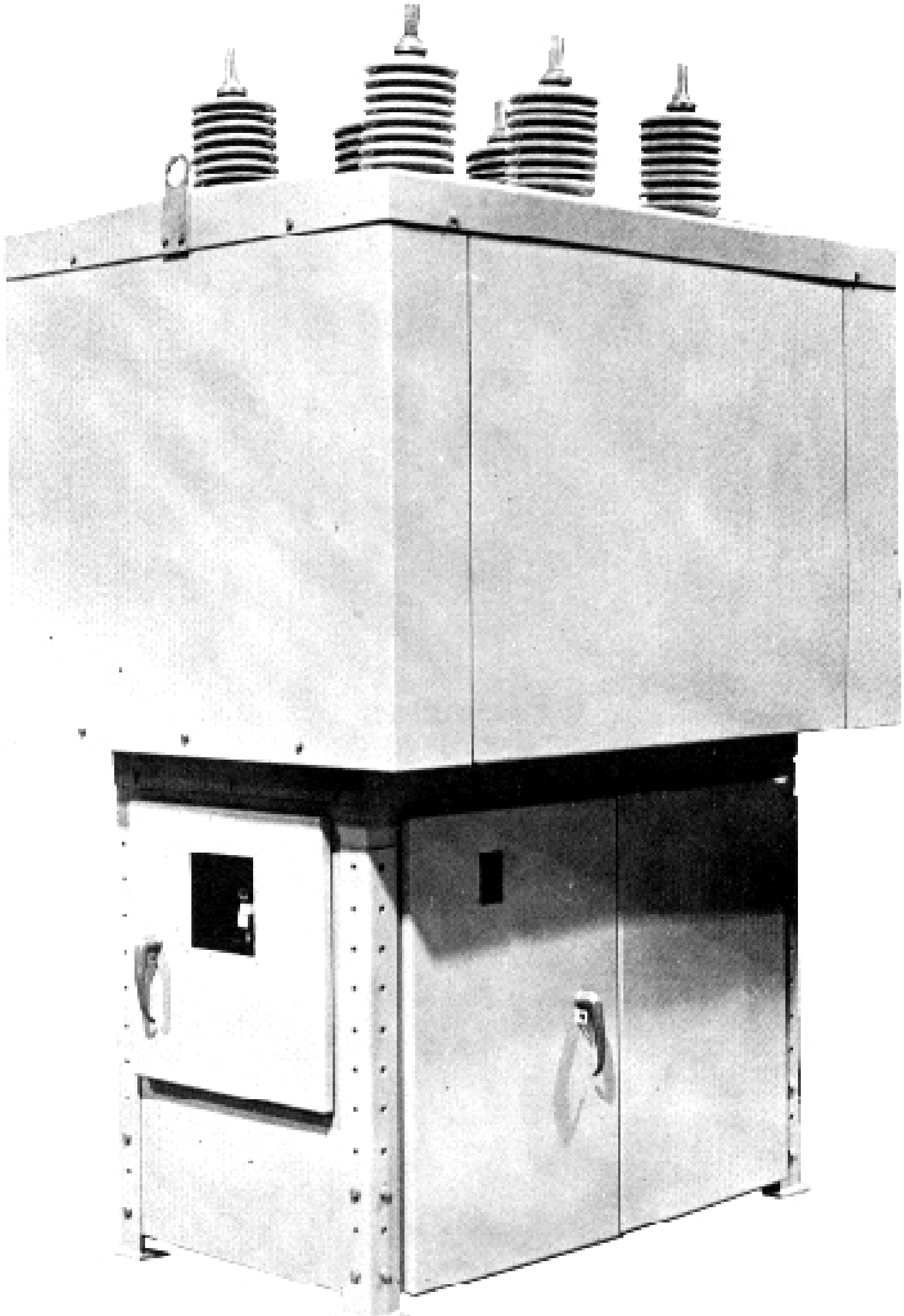


Figure 1. 38 kV Vacuum Circuit Breaker

⚠ WARNING

HAZARDOUS VOLTAGE CAN SHOCK, BURN, OR CAUSE DEATH.

Do not attempt to handle, install, use or service this product before reading instruction book.

234P051H01A

SAFETY NOTICES

This breaker should be installed within the design limitations as described on its nameplate and in these instructions.

Follow your company's safety procedures.

This breaker should not be used by itself as the sole means of isolating a high voltage circuit; for the safety of personnel performing maintenance operations on the breaker or connecting equipment, all components should be electrically disconnected by means of a visible break, and should be securely grounded.

This product is intended to be operated and maintained by qualified persons who are thoroughly trained and who understand the hazards involved. This publication is written only for such qualified persons and is not intended to be a substitute for adequate training and experience in safety procedures for this device.

WARNING

Detailed descriptions of standard repair procedures, safety principles and service operations are not included. It is important to note that this document contains some warnings and cautions against some specific service methods which could cause Personal Injury to service personnel or could damage equipment or render it unsafe. Please understand that these warnings could not cover all conceivable ways in which service, whether or not recommended by ABB, might be done or of the possible hazardous consquences of each conceivable way, nor could ABB investigate all such ways. Anyone using service procedures or tools, whether or not recommended by ABB, must satisfy himself thoroughly that neither personal safety nor equipment safety will be jeopardized by the service method or tools selected.

All information contained in this manual is based on the latest product information available at the time of printing. The right is reserved to make changes at any time without notice.

INTRODUCTION

In the interest of clarity, a single set of identification numbers is used throughout this book, with a particular number referring to the same component, or device, in every relevant figure or diagram. To avoid confusion, any circuit component or device having a function or purpose as defined in ANSI C37.2 has a second identification in accordance with this standard. For example, the spring release device is identified as (8) as well as IEEE Device 52/CC.

These instructions do not attempt to provide the user of this equipment with information to resolve every possible difficulty which may occur in its application, installation, operation, and maintenance. Also, as improvements in parts and assemblies are made, some parts may differ in appearance from the items as depicted in illustrations; function will be equivalent, however.

This circuit breaker should be installed within the design limitations as described on its nameplate (Figure 13) and Table 1 in these instructions.

The Type V Vacuum Circuit Breaker (Figure 1) is a high voltage three pole a-c device incorporating six vacuum interrupters; when equipped with appropriate transformers and relays, the breaker will sense an overload condition and automatically first open, then (after an adjustable time delay) reclose the circuit to which it is connected. If the overload condition still exists, the unit will again automatically open and reclose the circuit to which it is connected. When equipped with the Type RC Reclosing relay, the breaker will cycle as many as four times before automatically locking open. A service visit can then determine the cause of the overload. A counter in the Vacuum Breaker provides a convenient record for service and maintenance purposes.

Satisfactory performance of this breaker is contingent upon correct installation and adequate maintenance and servicing. Careful study of these instructions will permit the user to obtain the maximum benefits from this device.

Table I - Type V Vacuum Circuit Breaker Ratings

Rated Frequency	60 Hertz
Rated Maximum Voltage	38 kV
Voltage Range Factor	1.0
Basic Insulation Level (BIL)	150 kV Phase to Ground 200 kV Phase to Phase
60 Hertz Withstand	
Voltage-Dry One Minute	80 kV
Voltage-Wet Ten Seconds	75 kV
Rated Continuous Current	1200 Amps
Maximum Rated Interrupting Capability	25000 Amps Symmetrical
Interrupting Time	.050 Seconds

RECEIVING, HANDLING AND STORAGE

Each breaker is completely assembled and tested at the factory prior to being prepared for shipment.

This equipment was packed and shipped in perfect condition. If damage is noted, call the carrier at once for inspection, and request an inspection report. File formal claim with the carrier, supported with paid freight bill, inspection report, and invoice. The local ABB Sales Office should be notified.

Receiving Inspection

Upon receipt, it is important to inspect promptly to be certain that the correct material has been received. In case of shortage, immediately notify the local Sales Office.

Check all parts against the shipping list as they are unpacked. Instructions and literature packed with the breaker should be kept with the unit. The low voltage control cabinet provides a convenient place to keep this instruction book, a copy of the schematic diagram, and the card carrying the service record of the unit. Additional copies may be obtained upon request from the local Sales Office.

If the breaker is not to be placed in service immediately, it is essential that proper care be exercised in the handling and storage, to insure good operating conditions in the future.

Handling

CAUTION

LIFT COMPLETE BREAKER USING TWO-CHAIN HOIST. HOOKS SHOULD ENGAGE THE TWO LIFTING BRACKETS. DO NOT LIFT BY THE BUSHINGS OR TERMINAL CONNECTORS, AND EXERCISE CARE THAT HOOKS OR CHAIN DO NOT DAMAGE THE PORCELAIN BUSHING INSULATORS.

Storage

The breaker is shipped completely assembled and may be stored as received, in an indoor or outdoor location. If stored outdoors or in a location of high humidity, the heaters should be energized to maintain insulating members and mechanism parts free of condensation. Breakers with rechargeable batteries should have power of the proper voltage and frequency supplied to the input of the charger assembly; a periodic check of battery voltage is also advised.

GENERAL DESCRIPTION

The Type V Vacuum Circuit Breaker is made up of three basic sections: The high voltage cabinet, the low voltage or control cabinet, and the mounting provisions.

High Voltage Cabinet

The high voltage cabinet is fabricated of steel, finished with corrosion-resistant paint. (Figure 2) It encloses the lower section of the bushings, the current transformers (when present), the vacuum interrupter assemblies, and the operating linkages. Copper studs through the porcelain entrance bushings connect the high voltage terminals to the vacuum interrupters. The floor of the high voltage cabinet isolates the high voltage components from the low voltage cabinet.

Porcelain Bushings

Type V Circuit Breaker is equipped with high-strength porcelain bushings which have stud type terminals (1.250-12) to match its 1200 ampere ratings.

Bushing Current Transformers (BCT)

The high voltage bushings extend through the five lead multi-ratio bushing current transformers mounted in the high voltage compartment. The transformers may be used for additional instrumentation such as a thermal demand ammeter, but be certain that total burden is not exceeded. Consult schematic diagram for complete information.

The bushing current transformer tap connections are wired to terminal boards in the control compartment of the Vacuum Breaker. To change the ratio of the transformers, select the proper connections on the terminal blocks.

NOTICE

Prior to shipment, shorting screws are placed in the terminal blocks to which the current transformers are connected. These shorting screws should be removed only after verification that the current transformer terminals are connected to instruments, meters, or other control devices. Never disconnect such devices without first verifying that the shorting screws are securely in place.

Refer to wiring diagram or nameplates for specific information on BCT's. (Figure 3 illustrates a typical BCT nameplate).

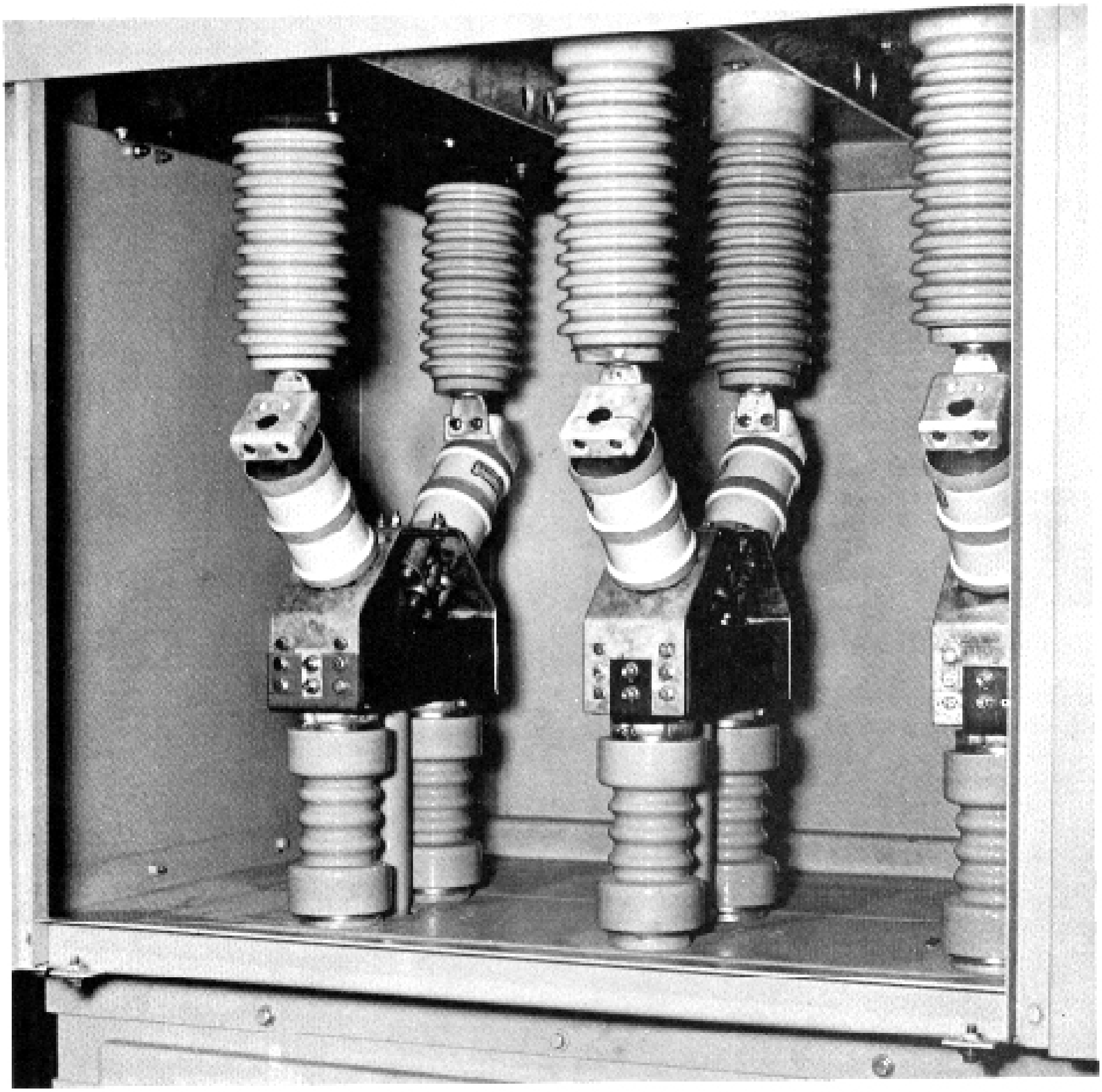


Figure 2. High Voltage Compartment, 38 kV Vacuum Circuit Breaker

Table II identifies terminal markings, ratios, and d-c resistance for standard 1200:5 BCT's.

Table II-Current Transformer Connections

Terminal	Ratio	Ohms @25°C
X_2-X_3	100-5	.052
X_1-X_2	200-5	.104
X_1-X_3	300-5	.156
X_4-X_5	400-5	.208
X_3-X_4	500-5	.260
X_2-X_4	600-5	.312
X_1-X_4	800-5	.416
X_3-X_5	900-5	.468
X_2-X_5	1000-5	.520
X_1-X_5	1200-5	.624

Thermal rating is 90 times rated current for one second; mechanical, momentary rating is 180 times rated current.

Vacuum Interrupter Assemblies

The Type V Vacuum Circuit Breaker is equipped with six vacuum interrupters - two, series connected, per phase. The two interrupters for each phase are mounted on two station post insulators (Figure 2). They are operated by a common operating rod located in the center of the phase assembly.

LOW VOLTAGE CABINET

This compartment contains the control panel and mechanism to operate the vacuum interrupters.

Mechanism

The operating rod assembly provides attachment between the movable contact of the vacuum interrupter and the main operating shaft of the breaker. (Figure 5) Each Vacuum Breaker is equipped with three such operating rod assemblies. The horizontal movement of the main shaft is transformed, through a bell-crank arrangement, to a vertical motion of the operating rod, upward for closing the interrupter, and downward, for opening. This main shaft also carries the energy stored in the trip spring and is arranged so the power to trip the interrupter is present any time the interrupter is in the closed position, thus assuring positive breaking operation.

Opening the mechanism door to the left hand end of the breaker gives access to the manual "PUSH TO CLOSE" and "PUSH TO OPEN" buttons. With the closing springs in the charged position, the breaker can perform a CLOSE-OPEN operation. In the absence of closing power, the closing springs can be manually charged. This is accomplished by using the special tool provided (Figure 4). If the closing springs are charged with the breaker in the closed position, a manual OPEN-CLOSE-OPEN sequence can be performed without control power.

Auxiliary Switch Assembly

The auxiliary switch assembly is mounted in the low voltage relay compartment, behind the mechanism assembly (See Figure 6). Standard breakers are supplied with two, four-pole, mechanically-driven rotary type switches, providing 8 sets of contacts, four "a" (make) and four "b" (break). The usual breaker operation requires three "a" and four "b" (See Figure 11 for typical schematic diagram); extra contacts are available, when ordered, for external use, as desired. Three additional auxiliary switches can also be supplied on request, adjusted for any specified combination of "a" and "b" contacts. The contacts of these switches will carry 15 amperes continuously, with interrupting capacity as shown on Table III below.

Heaters

Heaters are continuously energized to prevent the condensation of moisture inside the mechanism compartment. (Figure 6) When specified, extra heaters, with thermostat control can be supplied. Consult pertinent connection or schematic diagram for the specific breaker, to ascertain types and ratings of heaters supplied.

Table III - Interrupting Capacity of Auxiliary Switch Contacts

	Non-Inductive Circuit		Inductive Circuit	
Volts	Single Contact	Two Contacts In Series	Single Contact	Two Contacts In Series
24/48 VDC	40 Amps	40 Amps	20 Amps	40 Amps
125 VDC	11 Amps	25 Amps	6.25 Amps	12.5 Amps
250 VDC	2 Amps	5.5 Amps	1.75 Amps	3.5 Amps
115 VAC	75 Amps	75 Amps	15 Amps	22 Amps
230 VAC	40 Amps	70 Amps	8.5 Amps	15 Amps

Contacts will carry 15 Amps continuously or 250 Amps for 3 Sec.

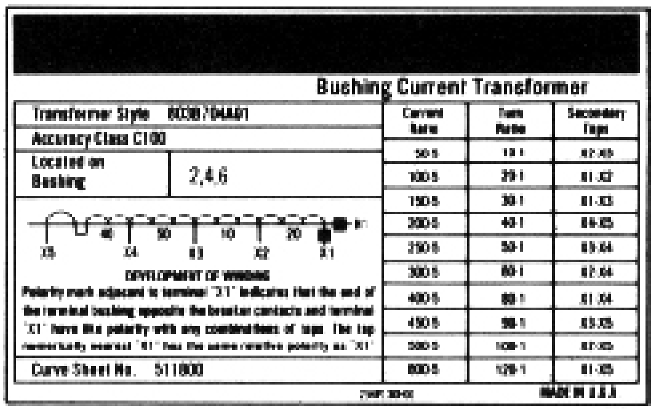


Figure 3. Typical Bushing Current Transformer Nameplate

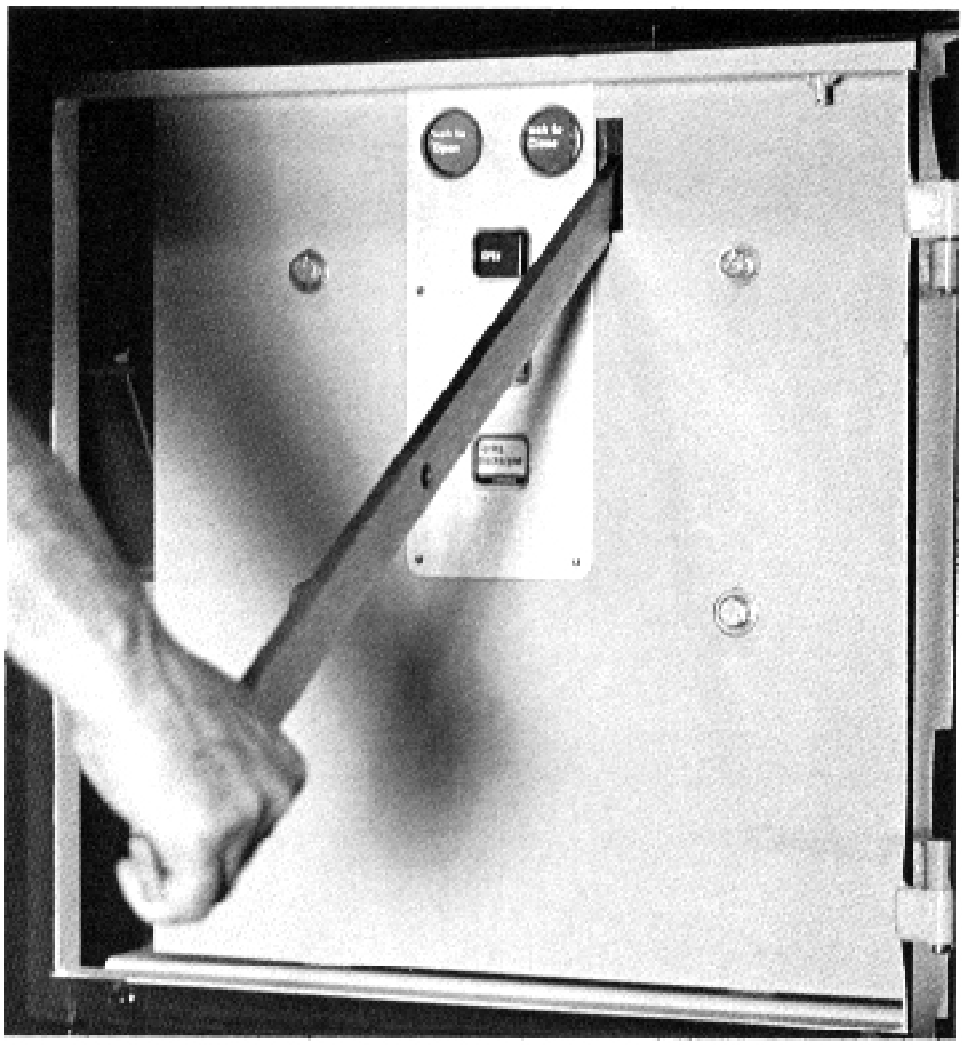


Figure 4. Operation of Manually Charging the Closing Springs

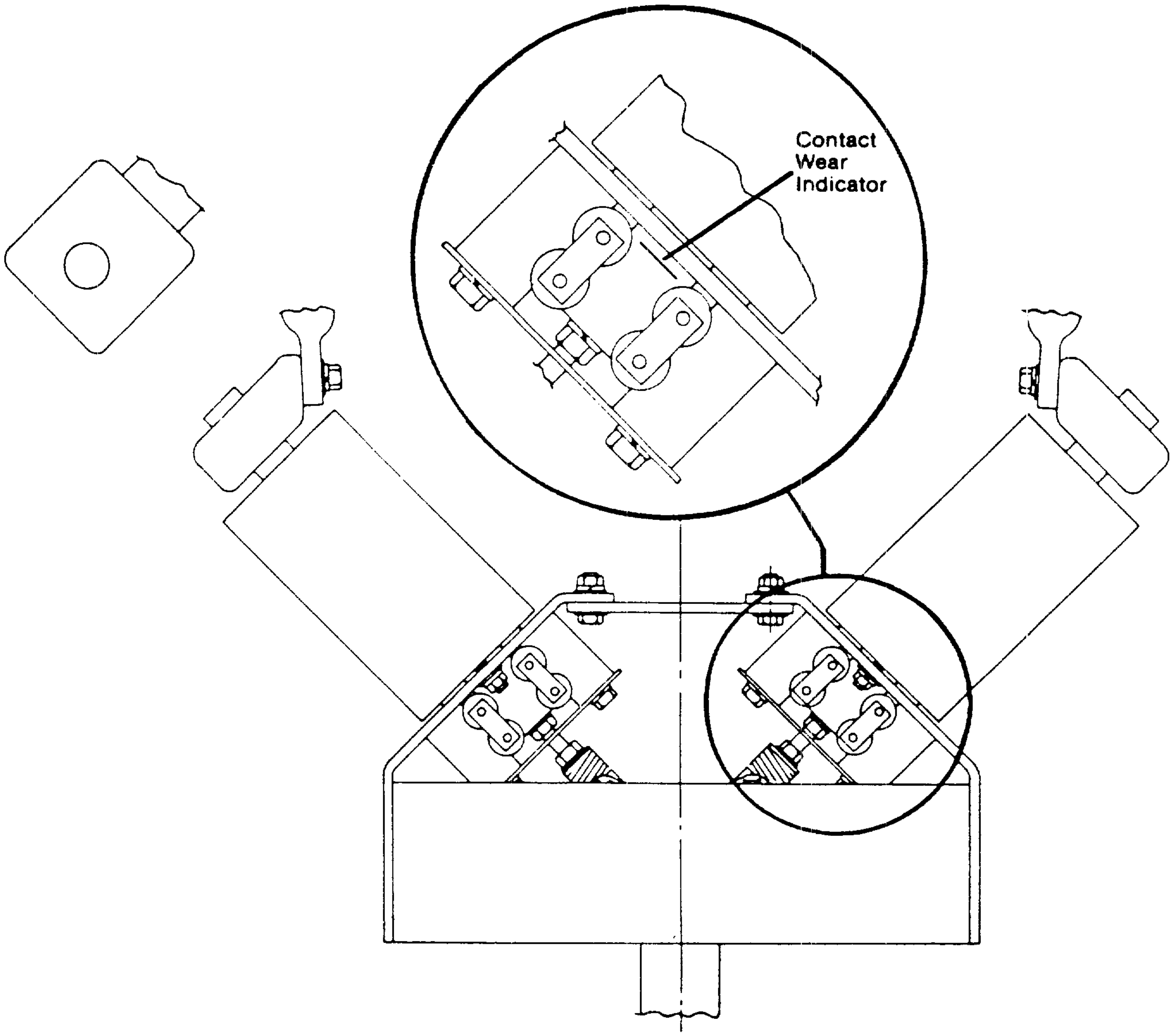


Figure 5. Phase Assembly

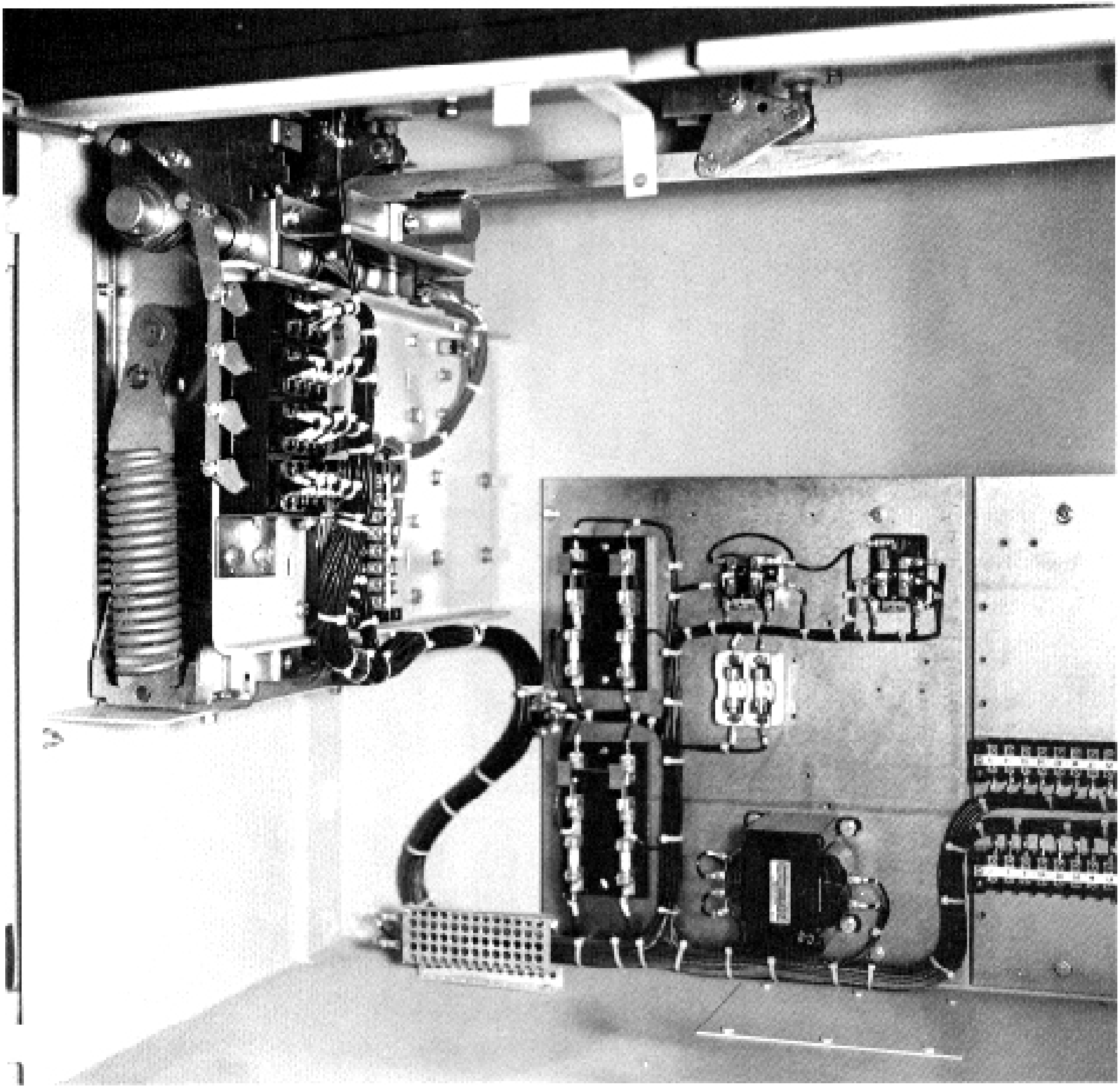


Figure 6. Auxiliary Switch and Control Wiring

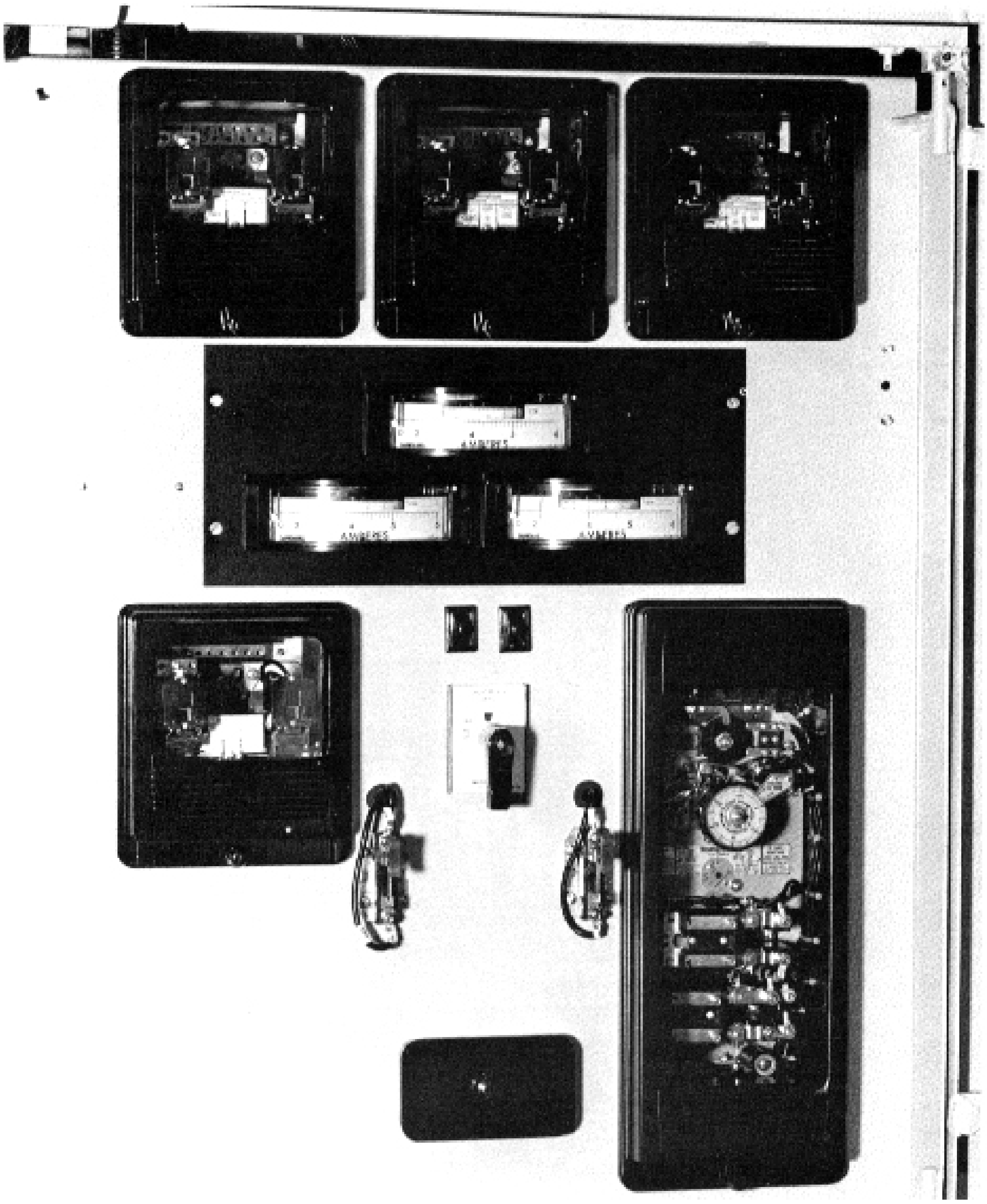


Figure 7. Typical Control Panel

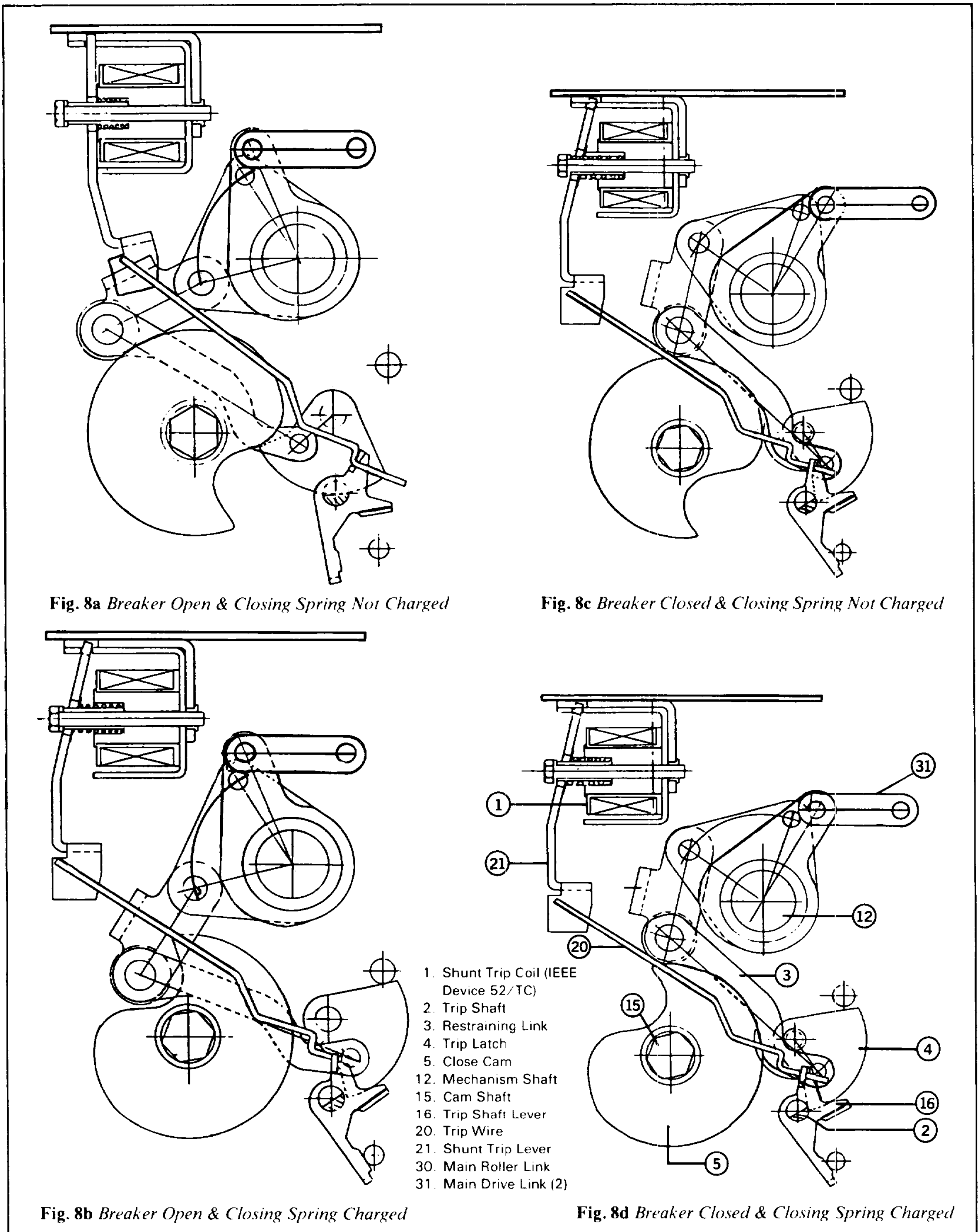


Fig. 8a *Breaker Open & Closing Spring Not Charged*

Fig. 8c *Breaker Closed & Closing Spring Not Charged*

Fig. 8b *Breaker Open & Closing Spring Charged*

Fig. 8d *Breaker Closed & Closing Spring Charged*

Figure 8. Four Positions of Closing Cam and Trip Linkage

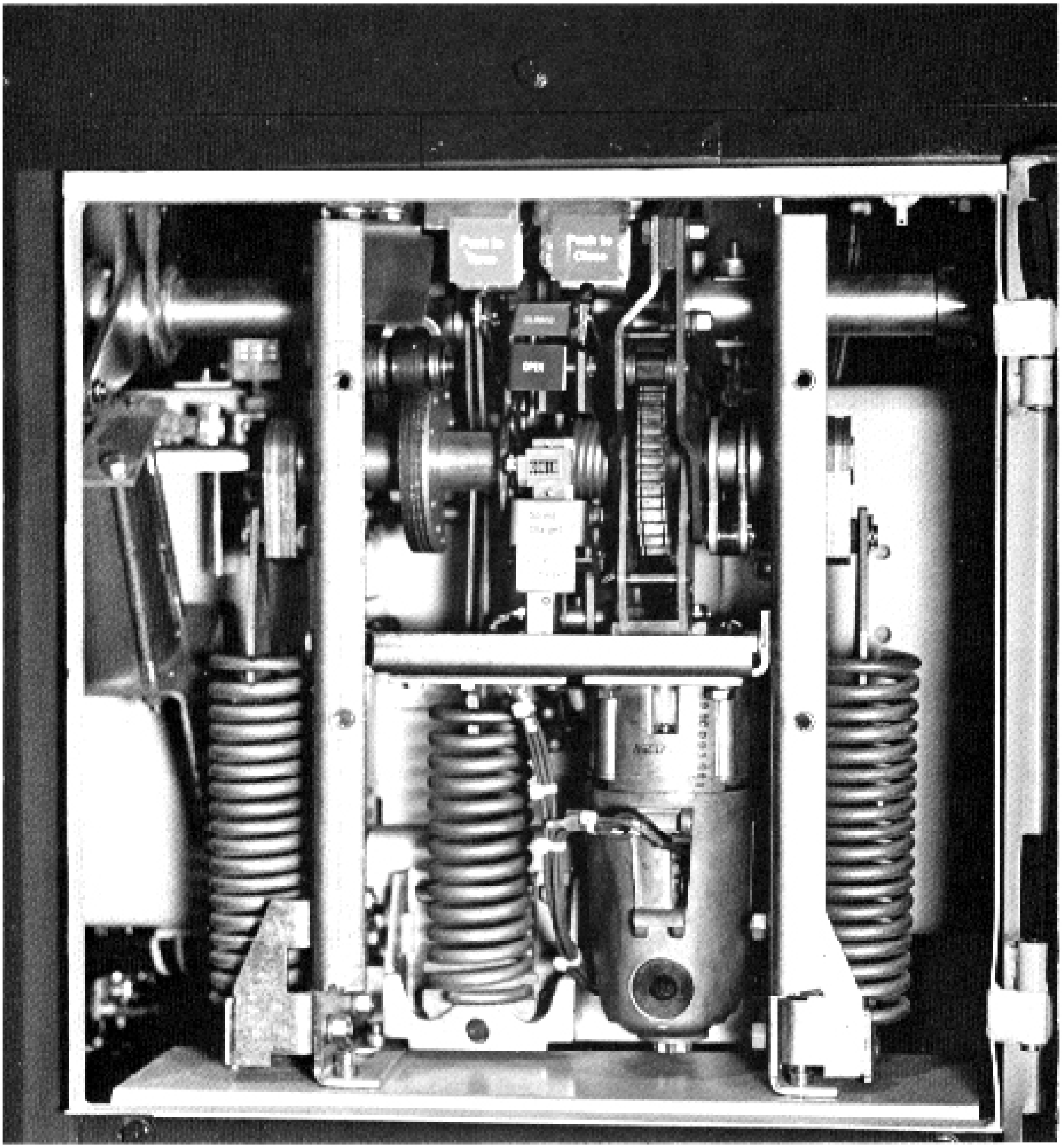


Figure 9. Mechanism With Front Cover Removed

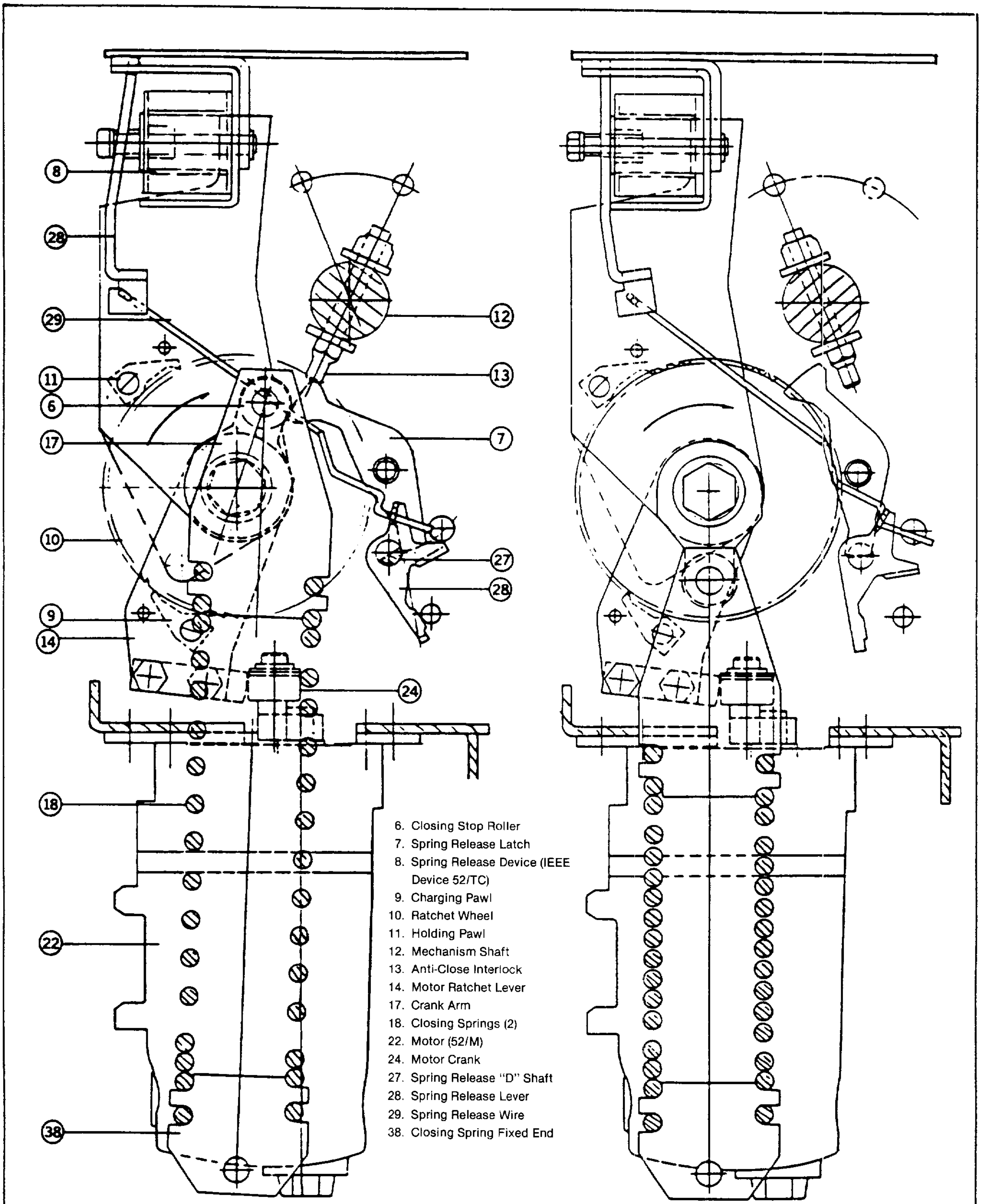


Fig. 10a *Breaker Closed, Springs Charged*

Fig. 10b *Breaker Open, Springs Discharged*

Figure 10. Stored Energy Mechanism

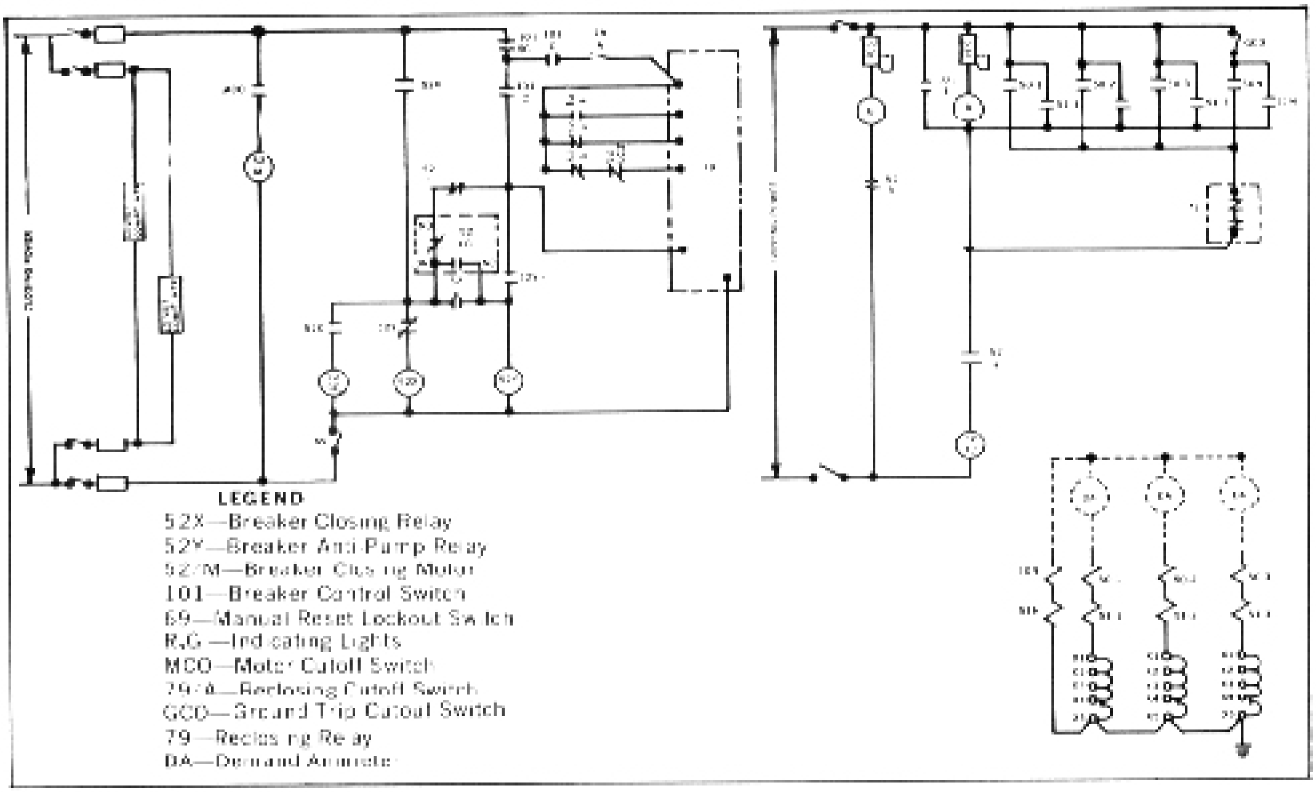


Figure 11. Typical Breaker Schematic Diagram

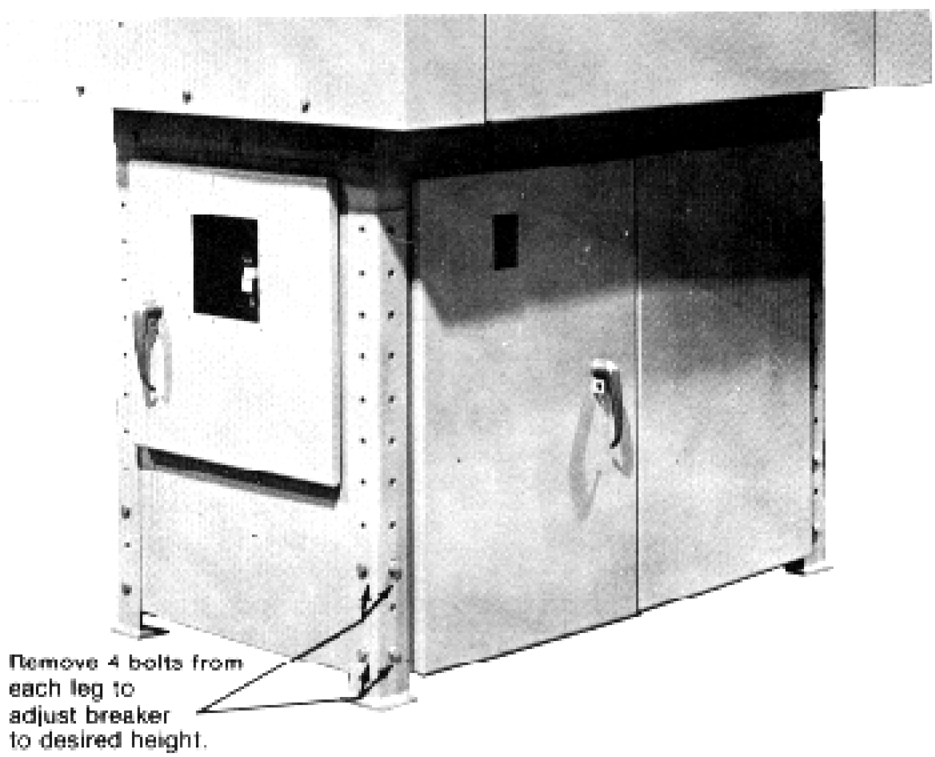


Figure 12. Attachment of Adjustable Legs to Breaker

Terminal Blocks

Terminal blocks terminate the control wiring and the secondary leads from the bushing current transformers (BCT's).

NOTICE

Prior to shipment, shorting screws are placed in the terminal blocks to which the current transformers are connected. These shorting screws should be removed only after verification that the current transformer terminals are connected to instruments, meters, or other control devices. Never disconnect such devices without first verifying that the shorting screws are securely in place.

Operation Counter and Position Indicator

The typical hinged control panel (Figure 7) accomodates the following:

1. Breaker Control Switch with red and green indicating lights.
2. Overcurrent relays, including:
   Three Type CO Phase Relay
   One Type CO Ground Relay and
   Ground Bypass Switch (optional)
3. Thermal demand ammeters.
4. One Type RC automatic reclosing relay and RC relay cutoff switch.

For operating and maintenance of the Type CO overcurrent relay, see I.L. 41-100 and I.L. 41-101. For operation and maintenance of the Type RC automatic reclosing relay, see I.L. 41-661. These instruction leaflets are available from the nearest Sales Office.

Breaker Control Switch

The breaker control switch allows an operator to manually open or close the interrupters by electrical means.

Panel Lights

The red panel light indicates the interrupters are closed and the vacuum breaker is functioning properly. The green panel light indicates the interrupters are open, but does not necessarily indicate an overcurrent condition exists, because the unit may have been manually tripped.

Ground Cutout Switch

The ground cutout switch (optional) has two positions. In the NORMAL position, when an overcurrent is detected in the ground circuit, or an out of balance condition between the phases is detected, the Vacuum Breaker will react in the same sequence that it would if an overcurrent were detected in one of the phases. With the toggle switch in the blocked position, an overcurrent in the ground circuit, or an out of balance condition between the phases will be ignored by the sensing relays.

RC Cutoff Switch

The RC cutoff switch has two positions. In the AUTO position, the reclosing relay is allowed to perform the functions for which it is adjusted. In the NON-AUTO position, the breaker will lock open following the first interruption.

Rear Panel

The second planel bolted to the inside wall of the low voltage cabinet mounts the control relays, low voltage circuit protection devices, and terminal blocks for the control wiring (Figure 6). Optional equipment, such as a capacitor trip device, remote control relay, or additional terminal strips are mounted on this panel. There is provision in the bottom of the cabinet for conductor entrance.

DESCRIPTION OF OPERATION

Mechanism

The spring-stored energy type operating mechanism includes all the basic elements of storing the energy, closing and tripping functions of the breaker, manual and electrical controls and interlocks. Manual controls are all in the front and most readily accessible. Mechanism motion to close and open the interrupter contacts is provided through the mechanism shaft. This shaft is directly connected to the bell cranks of the interrupter assemblies.

The mechanism is mechanically trip free. Closing springs may be charged manually with the help of maintenance tool or electrically through the charging motor. Closing of the interrupter contacts is accomplished by releasing the energy stored in the closing springs either manually or electrically. The energy released by the closing springs closes the contacts, charges the overtravel springs, charges the opening spring and overcomes the frictional forces encountered during the closing operation. The breaker may be opened manually or electrically with the energy provided by the overtravel springs and opening springs.

Operation of Stored Energy Mechanism

The spring-stored energy essentially stores the closing energy by charging the closing springs and applies the released energy to close the breaker, charge the overtravel springs and opening spring. The mechanism may rest in any one of the four positions shown in Figure 8 as follows:

a. Breaker open, closing springs discharged.
b. Breaker open, closing springs charged.
c. Breaker closed, closing springs discharged.
d. Breaker closed, closing springs charged.

Figure 9 shows the front view of the stored energy mechanism.

Closing Springs Charging

Figure 10 shows the schematic views of the spring charging parts of the stored energy mechanism.

The major component of the mechanism is a cam shaft assembly which consists of a hex cam shaft to which are attached the crank arms (one on each end), the ratchet wheel and the closing cam.

The ratchet wheel is actuated by a ratcheting mechanism driven by an electric motor. As the ratchet wheel rotates, the crank arms and closing cam rotate with it.

The crank arms have spring ends connected to them which are in turn coupled to the closing springs. As the cranks rotate, the closing springs are charged.

Figure 10a and Figure 10b are schematic views of the spring charging portions of the stored energy mechanism. Figure 10a shows the springs charged, breaker closed position. Figure 10b shows the springs discharged, breaker open position, Rotation of the motor crank causes the driving plate and motor ratchet lever to oscillate. The charging pawl, being part of the ratchet lever assembly also oscillates rotating the ratchet wheel counterclockwise. As the ratchet wheel rotates, the crank arms also rotate pulling the spring ends with them to charge the closing springs (one extension spring on each end of the cam shaft).

Closing Operation

When the closing springs are completely charged, the crank arms go over the center and the closing stop roller comes against the spring release latch Figure 10. The closing springs are now held in charged position. They can be released to close the breaker by moving the spring release latch out of the way. This may be done manually or electrically by depressing the spring release lever which turns the spring release "D" shaft through the spring release wire. The force of the closing springs rotates the cam shaft. The closing cam which is attached to the cam shaft also rotates causing the breaker to close.

Figure 8 shows the positions of the closing cam and tripping linkage. Note that in 8a in which the breaker is open and the closing springs discharged, the trip shaft and the latch are in unlatched position. (Near the end of spring charging operation.) The trip latch snaps into the fully reset or latched position as in 8b.

In Figure 8c, the linkage is shows with the breaker in the closed position and before the closing springs have been recharged. Note that the closing cam has rotated about one-half turn corresponding to the rotation of the cam shaft and the ratchet wheel of Figure 10. Rotation of the closing cam pushes the main link roller uipward so as to rotate the mechanism shaft and close the breaker contacts. This is possible because the restraining links between the main link roller and the trip latch prevent the main link roller from moving off the cam to the left. The restraining links cause the trip latch to push against the trip shaft. Figure 8d shows the breaker in the closed position after the closing spring has been recharged.

Note that the closing cam has rotated about one-half turn. The cam for this portion of the travel is cylindrical and causes no further movement of the main link roller. This rotation corresponds to the spring charging rotation of the ratchet wheel shown in Figure 10.

Anti-Close Interlock

This is an interlock that prevents discharge of closing springs electrically or manually when the breaker is already closed - see Figure 10a. Regardless of how the spring release shaft may be upset, spring release latch is prevented from getting out of the way of the roller by the anti-close interlock screw head.

Opening Operation

Depressing the shunt trip lever either by hand or by the shunt trip coil turns the trip shaft through the trip wire and permits the trip latch to turn counter clockwise under the influence of contact loading springs via main link and restraining link. This permits the linkage to collapse and open the breaker. The linkage then assumes the position shown in Figure 8b.

Trip Free Operation

Referring to Figures 8 and 11 with the closing springs charged, if a fault exists, the action of closing the breaker by means of the control switch CS (101/C), causes a trip signal to reach the shunt trip coil (1) (IEEE Device No. 52/TC), through the auxiliary switch 52a, as soon as the breaker closes.

Thus the breaker reopens, but, since the 52Y relay is held closed, through the 100/C and 52Y-NO, the 52X relay remains de-energized, as does the 52CC, and no further closing action occurs. In addition, if the breaker is tripped manually and held in the "trip" position, the breaker cannot close when a close operation is attempted since, with the trip shaft (2) rotated (by the manual trip operation) there is no restraint on the trip latch restraining link (3) and no force is applied on the mechanism link (50) by the closing springs (18).

OPERATIONAL CHECK PRIOR TO INSTALLATION

The breaker should be test operated for mechanical and electrical operation before delivery to the installation site. Open the mechanism compartment so as to observe the mechanical operations.

Operational Check - Manual

The breaker is shipped with its contacts open and the closing springs discharged. The indicators on the front panel, visible when the mechanism cabinet door is open, should confirm this.

Insert the spring charging handle in the slot to the right of the "push-to-close" button, Figure 4. Charge the closing springs by pumping the handle up and down about 20 times until crisp metallic "click" is heard. This indicates that the closing springs are charged and is confirmed by the closing spring "charged" (yellow) indicator. Operate the "push-to-close" button. The breaker should close as confirmed by the breaker contacts "closed" (red) indicator. Operate the "push-to-open" button. The breaker should trip as confirmed by the breaker contacts "open" (green) indicator. After completing this initial check, leave the closing springs "discharged" and breaker contacts "open."

Operational Check - Electrical

Reference to Figure 11 will help to illustrate general features of the circuitry of a typical breaker; this is merely a guide, since all electrical connections to the control circuit should be made only in accordance with the diagrams supplied for the specific breaker.

NOTICE:

Consult nameplate for proper voltage. A single-phase, 60 Hertz sourse is to be connected to the input terminals—"X" and "Y." Close the main power switch. If the springs are discharged, the motor will immediately run, charging the closing springs, and cutting off the motor through the MCO switch (28).

Prior to shipment, shorting screws are placed in the terminal blocks to which the current transformers are connected. These shorting screws should be removed only AFTER verification that the current transformer terminals are connected to instruments, meters or other control devices. NEVER disconnect such devices without first verifying that the shorting screws are securely in place.

Many relays are protected by the addition of devices to prevent movement of contacts, levers, etc., during shipment. Such devices should be removed prior to operational checks.

Induction disk relays are frequently adjusted to the "O" position, effectively completing the trip circuit to the trip coil. For checking operation of such relays, first verify and, if necessary, adjust time dial accordingly. Failure to do this, on units supplied with capacitor trip, prior to energizing the trip circuit will damage the capacitor trip device.

Electrical Close

Observe indication lamps; if green lamp is on, breaker is open. Move handle of "101" switch (IEEE Device "CS") to "close," energizing the coil of 52X relay through 52Y-NC, 52/LC-1-NO (held closed by trip latch [4]), 52b, CS-C, and CS-SC. The 52X relay picks up, closing in two 52X-NO contacts, energizing spring release device (8), and the breaker closes. The 52Y relay picks up, through 52a and 52X-NO contacts, seals itself in through its 52Y-NO contacts, CS-C and CS-SC; 52X drops out as 52Y-NC opens. Release of the CS handle allows 52Y also to drop out.

Anti-Pump Feature

As described earlier under "Trip-Free Operation," the 52Y relay is held closed until 101/C is opened by release of the CS handle. Thus, if the breaker should be closed into a fault, an immediate trip follows, and there is no subsequent reclosing or "pumping."

Electrical Trip

Observe indicator lamps; if red lamp is on, breaker is closed. Move handle of "101" switch (IEEE Device "CS") to "open" applying full trip voltage to shunt trip coil (1-IEEE Device 52/TC). The breaker opens, and 52/TC drops out.

An external manual trip lever is provided. It is on the side of the breaker to the left of the mechanism. Moving this lever to its "down" position trips the breaker and opens the lockout switch (IEEE Device No. 69). With this lockout switch open, the breaker cannot be closed electrically. Returning the manual trip lever to its "up" position resets the switch to its normal closed position. This returns the control to its automatic reclose mode.

The breaker may also be tripped manually by the "push to open button," however, lockout will not occur following this operation.

Operational Check—Relays and Instruments

In addition to manual operation (without power) and electrical operation (using control switch—101,or IEEE Device "CS"), an operational check of relay functions should be performed. The steps involved in this check depend on the number of overcurrent (CO) relays present, their type, as well as the type and mode of operation (setting) of the reclosing relay being used.

Overcurrent Relays

The operation of each of these relays can be checked (a) electrically: by passing current from a high-current source—such as a "Multi-amp"—through each phase pair of bushing terminals, simulating fault current, or (b) mechanically: by manually rotating the induction disc, or manually closing the contacts of the instantaneous element (if such is present). Either method provides a trip signal.

Reclosing Relay

Choose a mode of operation—set the reclosing times, trips to lockout per the instructions of the reclose relay supplied. Second and third reclose times must be 6 seconds or longer. This time is required to charge the closing springs. A setting below this time will cause mechanism damage.

Procedure

1. Move control switch ("CS") to "close" position; breaker should close and red light should come on.

2. Move control switch ("CS") to "open" position; breaker should open and green light should come on; release "CS" to neutral position. The breaker should remain open.

3. The reclosing relay should not reclose in the sequence for which it is programmed. The breaker should close only when the control switch ("CS") is moved to the "close" position.

4. Operate each phase CO relay, as described under "Overcurrent Relays," above. The breaker should trip and reclose in accordance with its reclosing control program.

5. If a "non-reclosing" switch is available, switch to the "blocked" position, and again trip the breaker with the CO relay. The unit should trip and lock out.

6. If ground (neutral) CO relay is present, move bypass switch—"GCO"—by "blocked" position, and check ground CO relay, per 4 above. The breaker should not trip unless the switch is returned to "normal" position.

7. The steps outlined above, when performed in accordance with recommendations relating to each breaker, will serve as an operational check both for reclosing relay as well as overcurrent relays.

PERMANENT INSTALLATION

Location and Mounting

The Vacuum Breaker should be located so that it is readily accessible for manual operation and inspection. All overhead construction work should be completed before the unit is installed. Care should be exercised when transporting the unit so that the lifting devices do not come in contact with the bushings.

The breaker is adjustable in height to meet various electrical codes and flexibility of installation. The foundation should be reasonably level and may be shimmed if necessary. Four 5/8 inch (16 mm) diameter bolts are recommended for mounting to the foundation. Refer to the outline drawing for location of mounting bolts. (Also see Figure 12).

Connections

After the Vacuum Breaker has been secured on the foundation, the electrical connections may be made. Precautions must be taken to insure that all wires to be connected to the unit are not energized.

Primary Wiring

The breaker may be connected in series with the line, facing either direction, as there is not distinction between line and load terminals. However, the location and functions of the internally mounted current transformers (BCT's) may dictate line connectin. Thus, the designation of "line" and "load" side must be made with knowledge of the location BCT's and the control circuit involved. Power to operate the breaker mechanism, when tapped from the conductors being protected, must be taken from the line side for proper reclosing.

WARNING:

IF AC CONTROL POWER IS TAKEN FROM THE LINE THE BREAKER IS PROTECTING, THE VOLTAGE COULD, UNDER SYSTEM FAULT CONDITIONS, DROP BELOW THESE MINIMUM VALUES (SHOWN IN TABLE 4). IF THIS OCCURS, THE BREAKER WILL NOT TRIP. THIS THEN WOULD REQUIRE THE FAULT CLEARED BY AN UPLINE DEVICE.

CAUTION

PRECAUTIONS MUST BE TAKEN TO INSURE THAT ALL WIRE TO BE CONNECTED TO THE UNIT ARE NOT ENERGIZED.

Installation should be designed with overhead leads if possible. Adequate electrical clearance must be provided between these leads and parts of the station such as walls and metal parts. Leads should be supported in such a manner that the breaker bushings are not subjected to excessive strains. The bushings should not carry the strain of the cables or bus bars. The leads must have a capacity at least equal to the maximum (emergency) operating current of the circuit. Connections are made to bolted terminals on the bushings and must be securely tightened to assure good contact. All joints should be clean and bright.

Control and Secondary Wiring

NOTICE:
Consult nameplate, schematic, or connection diagrams for proper voltage source.

All electrical connections to the control circuit should be made in accordance with the diagrams supplied for the specific breaker.

The heaters and spring charging motor require a single-phase, 60 Hertz voltage source (as indicated on nameplate and pertinent diagrams), obtained from a secondary circuit on the source side of the breaker, or from an independent source. It should be capable of supplying 16 amperes with a maximum voltage drop of 20%, for units having AC close and trip functions. For units having DC close and trip functions, the voltage of the source, under load, must be within the limits outlined in Table 4.

Conduit should be used for control circuits as much as practicable. Control wires should be run separately and remotely from high voltage wiring to prevent possible inductive coupling between them. Control wires should be adequate to handle full operating current to avoid dropping voltage below that specified on the nameplate. All conduits should be sealed off at their entrance to the equipment enclosure.

Control wiring and bushing current transformer connections are made inside the low voltage compartment where the necessary terminal boards are provided for convenient installation.

Connection diagrams are supplied for each breaker showing the proper connections for control.

Grounding

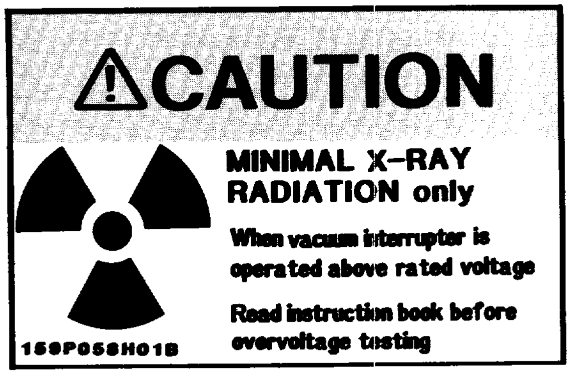
The breaker cabinet and mounting frame should be well grounded, using conductor at least 4/0 AWG (.460 in:11.7 mm).

FINAL INSPECTION

When the breaker has been installed and all mechanical and electrical connections completed, EXCEPT ENERGIZING THE POWER LINE, the following points of inspection are recommended.

Mechanical and Electrical Inspection

1. See that the unit is properly bolted in place and essentially level on its foundation.
2. Make a check for the tightness of hardware on stationary and moving contacts, shunts, pulled rods, trip rods, etc.
3. See that the operating mechanisms are free of packing or foreign material, and operate freely. Lubrication is generally not required and should be applied sparingly if necessary.
4. Terminal connections should be securely tightened.
5. Check control cable entrance fittings for tightness.
6. Examine control wiring insulation for evidence of chafing or abrasion. Check connections, according to schematic or connection diagrams.
7. See that all covers and bolted connectors are securely tightened.
8. Make a continuity check, preferably one which involves measuring resistance in the microhm magnitude, to determine tightness of bolted joints. (Refer to section covering "Production Tests" for typical resistance values.) Also, make an overvoltage test on each interrupter to verify there has been no loss of vacuum. Perform this test by opening the breaker, and applying a 35 kV, 60 Hertz voltage to each interrupter for at least one minute. This requires that the bus connecting the series interrupters be grounded during this test. Experience has indicated that, if the interrupter has lost vacuum, the open contacts quickly flashover, in a positive manner, well before the adjustable hi-pot tester can reach 35 kV.



High voltage applied across an open gap in a vacuum can produce X-radiation. No X-radiation is emitted when this breaker is closed since no gap exists. Also when the breaker is open to the specified contact spacing in service or tested within the voltages as specified, X-radiation at one meter is below the level of concern. A danger could exist during testing at voltages above or contact spacing below that specified on the nameplate. To insure safety the following precautions should be taken when performing insulation withstand (hi-pot) tests:

CAUTION

BEFORE APPLYING TEST VOLTAGE, REMOVE THE REAR COVER OF THE HIGH VOLTAGE CABINET AND CHECK CONTACT SPACING. IF THE CONTACT SPACING IS LESS THAN THAT SHOWN ON THE NAMEPLATE, CHECK OPERATING LINKAGES AND ADJUST TO NAMEPLATE VALUE BEFORE TESTING.

FRONT AND REAR COVERS OF THE HIGH VOLTAGE CABINET SHOULD BE IN PLACE DURING TESTING AND TEST PERSONNEL SHOULD BE AT LEAST ONE METER AWAY FROM THE PHASE BEING TESTED.

THE TEST VOLTAGE ACROSS THE OPEN VACUUM GAP SHOULD BE LIMITED TO 37.5 kV.

To avoid any ambiguity in the ac high potential test due to leakage or displacement (capacitive) current, the test unit should have sufficient volt-ampere capacity; it is recommended that the equipment be capable of delivering 10 mA of current for one minute.

Table IV - Breaker Stored Energy Mechanism Control Power Requirements

Rated Control Voltage	Spring Charge Motor Run Amperes	Spring Charge Motor Time Sec.	Close or Trip Amperes	Voltage Range Close	Voltage Range Trip	Indicating Light Amperes
48V DC	9.0	6	16	38-56	28-56	.035
125V DC	5.0	6	7	100-140	70-140	.035
250V DC	3.0	6	4	200-280	140-180	.035
120V AC	5.0	6	16	104-127	104-127	.035
240V AC	3.0	6	8	208-254	208-254	.035

INSPECTION, MAINTENANCE, AND ADJUSTMENT

Periodic Inspection

The safety and successful functioning of apparatus or systems connected to the breaker depends to a large extent on proper and reliable operation of this unit. To this end, the breaker must have systematic inspection at regular time intervals. Operating experience, based on the number of operations, magnitude of current, and any unusual operation which occasionally occur, will soon establish a maintenance schedule which will give assurance of proper breaker reliability. Until experience has established a maintenance schedule, the breaker should be inspected at least once a year.

The Vacuum Breaker may be inspected without opening the high voltage circuit as long as the high voltage compartment is not opened and reasonable care is practiced. The high voltage circuit is not admitted to the control compartment; therefore, only control voltage is present where the inspection is made.

The Vacuum Breaker may be tripped by either the manual electrical or manual mechanical means during maintenance and inspection with the high voltage circuit in operation. Closing the breaker may be accomplished in either of the two methods described earlier.

In the open position, the main operating link should be resting firmly against the white teflon stop.

WARNING:

IF THE FRONT PLATE IS TO BE REMOVED FOR MECHANISM SERVICE, ALL SPRINGS SHOULD BE FIRST DISCHARGED, LEAVING THE MECHANISM IN THE "OPEN" POSITION. THE INDICATING FLAG WILL SHOW WHETHER OR NOT THE MAIN SPRINGS ARE CHARGED.

Contact Erosion, Contact Travel, and Overtravel; Measurement and Adjustment

As a vacuum interrupter continues to perform its normal function, some material of the contacts is gradually eroded away, and the moving stem is driven deeper and deeper into the interrupter by the operating mechanism. The contact pressure spring causes the linkage to follow the moving contact, ensuring adequate contact pressure in the closed position, and accomodates to the phase-to-phase variations in the individual interrupters.

Contact erosion also reduces the compression of the overtravel springs, which in turn increases the contact travel. To insure proper operation, the following inspection and adjustment procedures should be followed during breaker maintenance.

CAUTION

THE BREAKER MUST BE ISOLATED FROM THE HIGH VOLTAGE CIRCUIT BEFORE OPENING THE HIGH VOLTAGE COMPARTMENT FOR INSPECTION OR MAINTENANCE.

A line, located 0.125 inches (3.2 mm) from the interrupter mounting bracket (Figure 5), is scribed on each interrupter moving contact conductor. As the contacts wear, the dimension between this line and the mounting bracket will decrease. When they are in line with each other, the interrupter should be replaced.

This line can also be used to determine the contact travel. This is accomplished by subtracting the wear indicator dimension in the breaker closed position from the dimension in the breaker open position. This difference is the interrrupter contact travel.

Contact travel is factory adjusted within the limits of 0.437 inches (11.1 mm) and 0.562 inches (14.2 mm). As the contacts wear, this will increase but no field adjustment should be required during the life of the interrupter.

If the contact travel should exceed 0.625 inches (15.8 mm) before the interrupter life has been reached, a careful inspection of the operating linkages should be made. Provided no other cause is found, the contact travel should be adjusted to a value between 0.500 inches (12.5 mm) and 0.562 inches (12.6 mm) by turning the interrupter nut in a counterclockwise direction (Figure 5).

The contact overtravel is a function of the mechanism stroke and contact travel adjustment. Correct contact travel adjustment will provide the required overtravel. No further adjustment is required.

Vacuum Interrupter Replacement

If it has been determined, either by electrical test or contact wear measurements, that an interrupter replacement is required, the following procedure should be followed. (Refer to Figure 5)

1. With the breaker in the closed, spring discharged, position, loosen the jam nut which locks the threaded stud to the interrupter movable conductor, then trip the breaker to its open position.

NOTICE:
Do not twist this end of the interrupter; more than 2° of rotation may damage the bellows.

2. Disassemble and remove the current carrying roller assembly (2 sets).

3. Disconnect the vacuum interrupter fixed conductor from the bushing assembly.

4. Remove the nuts which fasten the interrupter to the bus assembly. The interrupter will then be held in place only by the force of the contact pressure spring.

5. To remove the interrupter, turn the threaded stud assembly in a counterclockwise (off) direction. The friction between the interrupter operating nut and the threaded stud should be sufficient to allow it to be used to remove the assembly. Note: The use of 9/16 inch ratcheting box wrench will greatly reduce the time required for this operation.

   If excessive torque is required, check to make sure that the jam nut has been loosened as per Step 1.

   Installation of the new interrupter can be accomplished by repeating steps 1 through 5 in the reverse order.

NOTICE:

Do not lock jam nut to the interrupter movable stem until all parts are assembled and the breaker is in the closed position.

Do not twist the movable end of the interrupter; more than 2° of rotation may damage the bellows.

To insure proper contact pressure, the current carrying roller backup compression springs must be torqued to an overall length of 0.406 inches (10.1 mm).

Contact Travel Adjustment

With the breaker in the closed position, use a pencil or suitable marking pen. Make a mark on the movable conductor at the end of the contact wear indicator.

Trip the breaker and measure the distance this mark moves. This represents the contact travel and it should be approximately 0.5 inches. If is exceeds 0.562 inches (15.6 mm), turn the interrupter operating nut in a counterclockwise direction until it is less than this value.

Operate the breaker approximately 30 times to set the contacts. Check the contact travel as previously described and adjust with the 0.468 (11.7 mm) and 0.500 inches (12.5 mm) by turning the interrupter operating nut in the required direction.

Mechanism

Make a careful visual inspection of the mechanism for any loose parts such as bolts, nuts, pins, rings, etc. Check for excessive wear or damage to the breaker components. Operate the breaker several times manually and electrically to make certain the operation is crisp and without any sluggishness.

Lubrication

All parts that require lubrication have been lubricated during the assembly with molybdenum disulphide grease, ABB M No. 53701QB. Over the period of time, this lubricant may be pushed out of the way or degrade. So, proper lubrication at regular intervals is essential for maintaining the reliable performance of the mechanism.

Once a year or every 2000 operations (1000 operations for 3000 amp breakers) whichever comes first, the following areas should be lubricated with light machine oil such as Mobil 1 applied sparingly.

1. Wire link ends.
2. Spring charged/discharged indicator cam surface.
3. Trip latch surface/trip pin mating surfaces.
4. Spring release latch/spring release pin mating surfaces.
5. Closing and opening springs crank pins.
6. Bell crank pins in pole unit area.

Roller bearings are used on the pole shaft, the cam shaft, the main link and the motor eccentric. These bearings are packed at the factory with a top grade slow oxidizing grease which normally should be effective for many years. They should not be disturbed unless there is definite evidence of sluggishness or dirt, or unless the parts are dismantled for some reason.

If it becomes necessary to disassemble the mechanism, their bearings and related parts should be thoroughly cleaned off old grease in a good grease solvent. Do not use carbon tetrachloride. They should then be washed in light machine oil until the cleaner is removed. After the oil has been drawn off, the bearings should be packed with ABB Grease 53701QB or equivalent.

TYPE	VACUUM CIRCUIT BREAKER		
SERIAL NO.	S.O.	DATE of MFR.	RATED MAX. KV
RATED FREQUENCY 60 Hz.	RATED CONTINUOUS AMPS.	KV RANGE FACTOR K	
RATED SHORT-CKT. AMPS.	FW IMPULSE WITHSTAND KV	RATED INTER. TIME CYCLES	
CLOSING CONTROL VOLTAGE RANGE		DIAGRAM NO.	
TRIPPING CONTROL VOLTAGE RANGE		WEIGHT KG LBS.	
BEFORE INSTALLING READ INSTRUCTION BOOK			
153P046H01A			

Figure 13. Breaker Nameplate

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