Type R 15 kV 2000/3000 Amp

Instructions for Vacuum Circuit Breaker

ABB Power T&D Company Inc.
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SAFETY NOTICES

WARNING

HAZARDOUS VOLTAGE
CAN SHOCK, BURN,
OR CAUSE DEATH.

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

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 consequences 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.

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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; the function will be equivalent, however.

The Type R Vacuum Circuit Breaker (Figure 1) is a high voltage three pole a-c device incorporating three 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. 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. 15 kV Type R 2000/3000 Vacuum Circuit Breaker Ratings

Nominal Operating Voltage, kV 2.4-14.4
Maximum Design Voltage 15.5
Basic Insulation Level, kV, BIL 110
Dry Withstand, 60 Hertz, kV 50
Wet Withstand, 60 Hertz, kV 45
Phase Spacing, in. (mm) 14.5 (368)
Minimum External Creep Distance, in. (mm) 17.9 (454)
Minimum External Strike Distance, Terminal to Ground, in. (mm) 7.5 (190)
Minimum External Strike Distance Between Bushing Terminals, Phase to Phase, in. (mm) 10.4 (264)
Interrupting Time, 60 Hz. Base 3.5 Cycles or Less
Time Between Coil Energization and Contact Parting 3 Cycles Maximum
Closing Time 7 Cycles
Reclosing Time 0.5 Seconds
Continuous Current, Amps R-3 2000
Continuous Current, Amps R-4 2000/3000(5)
Interrupting Capacity, Sym. Amps R-3 20,000
Interrupting Capacity, Sym. Amps R-4 25,000
Momentary Rating, Asymm. Amps R-3 32,000
Momentary Rating, Asymm. Amps R-4 40,000

Notes:

(1) -- Rated frequency, 60 Hertz
(2) -- Voltage range factor (k) = 1.0, for all ratings
(3) -- Dimensions in mm shown in parentheses
(4) -- The three second rating is the same as the Interrupting Capacity.
(5) -- The 3000 Amp is obtained by forced air cooling.
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 of ASEA BROWN BOVERI.

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 R 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, and finished with corrosion-resistant paint. 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. Vents in the floor and doors of this cabinet provide passage for the convection (2000 Amp) or forced air (3000 Amp) cooling.

Porcelain Bushings

Type R 2000/3000 Circuit Breakers are equipped with high-strength porcelain bushings with a (2.00-12) stud terminal.

Bushing Current Transformers (BCT)

The high voltage bushings extend through the five-lead multi-ratio bushing current transformers mounted in the high voltage cabinet. 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 cabinet of the Vacuum Breaker. To change the ratio of the transformers, select the proper connections on the terminal blocks.

CAUTION: 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).

Table II identifies terminal markings, ratios, and d-c resistances for standard 2000:5 and 3000:5 BCT's.

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Table II. Current Transformer Connections

2000:5 Multi-Ratio Current Transformer

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Ratio</th>
<th>Ohms @ 75°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>X3-X4</td>
<td>300-5</td>
<td>.084</td>
</tr>
<tr>
<td>X1-X2</td>
<td>400-5</td>
<td>.113</td>
</tr>
<tr>
<td>X4-X5</td>
<td>500-5</td>
<td>.141</td>
</tr>
<tr>
<td>X2-X3</td>
<td>800-5</td>
<td>.225</td>
</tr>
<tr>
<td>X2-X4</td>
<td>1100-5</td>
<td>.310</td>
</tr>
<tr>
<td>X1-X3</td>
<td>1200-5</td>
<td>.338</td>
</tr>
<tr>
<td>X1-X4</td>
<td>1500-5</td>
<td>.423</td>
</tr>
<tr>
<td>X2-X5</td>
<td>1600-5</td>
<td>.451</td>
</tr>
<tr>
<td>X1-X5</td>
<td>2000-5</td>
<td>.564</td>
</tr>
</tbody>
</table>

3000:5 Multi-Ratio Current Transformer

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Ratio</th>
<th>Ohms @ 75°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>X3-X4</td>
<td>300-5</td>
<td>.075</td>
</tr>
<tr>
<td>X4-X5</td>
<td>500-5</td>
<td>.126</td>
</tr>
<tr>
<td>X3-X5</td>
<td>800-5</td>
<td>.201</td>
</tr>
<tr>
<td>X1-X2</td>
<td>1000-5</td>
<td>.252</td>
</tr>
<tr>
<td>X2-X3</td>
<td>1200-5</td>
<td>.302</td>
</tr>
<tr>
<td>X2-X4</td>
<td>1500-5</td>
<td>.378</td>
</tr>
<tr>
<td>X2-X5</td>
<td>2000-5</td>
<td>.504</td>
</tr>
<tr>
<td>X1-X3</td>
<td>2200-5</td>
<td>.554</td>
</tr>
<tr>
<td>X1-X4</td>
<td>2500-5</td>
<td>.630</td>
</tr>
<tr>
<td>X1-X5</td>
<td>3000-5</td>
<td>.756</td>
</tr>
</tbody>
</table>

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

Current Interrupter

The Type R Breaker utilizes three vacuum interrupters, supported by six station post insulators. Operating force from the mechanism is transmitted through porcelain operating rods to bell crank plates. Insulation -- between tank and interrupters -- between interrupters -- and between mechanical linkage and other components -- is provided by air. Switching and interruption are accomplished within the vacuum interrupter; there are no arc products generated. Aluminum heat sinks are bolted to the bus at both ends of the interrupter. The transfer of heat by these heat sinks maintains the required temperature at the interrupter - bus connection. Shock of interruption is virtually non-existent, and no venting is required.

Operating Linkages

Insulated operating rods transmit energy from the operating mechanism in the low voltage cabinet to the moving contact of the vacuum interrupters. (Figures 2 and 16)
LOW VOLTAGE CABINET

This compartment contains the control panel, forced air cooling fan (3000 Amp only), and mechanism to operate the vacuum interrupters. A filtered air vent is located in the floor of the low voltage cabinet. This vent, combined with the vents in the high voltage doors provides the air flow for convection cooling. (Figures 4, 5, & 7)

Forced Air Cooling Fan

The forced air cooling fan is located in the left rear corner of the low voltage cabinet. Two flexible ducts are connected between the fan housing and the floor of the high voltage cabinet (see Figure 7).

Forced air from these ducts is directed to flow over the heat sinks located at each end of the three 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 2) Each Vacuum Breaker is equipped with three such operating rod assemblies. The rotation of the main shaft imparts a vertical motion to the operating rod, upward for closing the interrupter, and downward for opening. This main shaft also carries the energy stored in the trip springs 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.

The Vacuum Breaker can be manually operated for service or maintenance. Manual tripping is accomplished by pulling a trip hook which extends to the outside of the low voltage cabinet, on the left hand side. For manual closing, the low voltage doors must be opened, permitting access to the "PUSH TO CLOSE" bar, which closes the breaker. In the absence of closing power, the closing springs can be manually charged (Figure 11).

Auxiliary Switch Assembly

The auxiliary switch assembly is mounted in the low voltage cabinet (see Figure 4). Standard breakers are supplied with two mechanically-driven rotary type switches, with 8 sets of contacts, four "a" (make) and four "b" (break). The usual breaker operation requires three "a" and four "b" (See Figure 15 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 in Table III.

Operation Counter and Position Indicator

The red and green targets of the position indicator are marked "CLOSE" and "OPEN" to show contact position. The operations counter is mounted below the indicator window. (See Figure 5)
Table III. Interrupting Capacity of Auxiliary Switch Contacts

<table>
<thead>
<tr>
<th></th>
<th>Non-Inductive Circuit</th>
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<th>Inductive Circuit</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Volts</td>
<td>Single Contact</td>
<td>Two Contacts</td>
<td>Single Contact</td>
<td>Two Contacts</td>
</tr>
<tr>
<td></td>
<td>in Series</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24/48 VDC</td>
<td>40 Amps</td>
<td>40 Amps</td>
<td>20 Amps</td>
<td>40 Amps</td>
</tr>
<tr>
<td>125 VDC</td>
<td>11 Amps</td>
<td>25 Amps</td>
<td>6.25 Amps</td>
<td>12.5 Amps</td>
</tr>
<tr>
<td>250 VDC</td>
<td>2 Amps</td>
<td>5.5 Amps</td>
<td>1.75 Amps</td>
<td>3.5 Amps</td>
</tr>
<tr>
<td>115 VAC</td>
<td>75 Amps</td>
<td>75 Amps</td>
<td>15 Amps</td>
<td>22 Amps</td>
</tr>
<tr>
<td>230 VAC</td>
<td>40 Amps</td>
<td>70 Amps</td>
<td>8.5 Amps</td>
<td>15 Amps</td>
</tr>
</tbody>
</table>

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

Heaters

Heaters are continuously energized, except when cooling fan is in operation, to prevent the condensation of moisture inside the mechanism compartment. 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.

Terminal Blocks

Terminal blocks terminate the control wiring and the secondary leads from the bushing current transformers (BCT's). These are located in the low voltage cabinet on the right hand and rear panels.

CAUTION: 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.

Side Panel

A third panel bolted to the left inside wall of the control cabinet mounts the control relays, low voltage circuit protection devices, and terminal blocks for the control wiring. Optional equipment, such as a capacitor trip device, remote control relay, or additional terminal strips are mounted on this panel. There is a provision in the bottom of the cabinet for conductor entrance.
MOUNTING PROVISIONS

Formed steel supports mount the vacuum breaker to its foundation, and are adjustable in height in six inch (152 mm) intervals.

STANDARD PRODUCTION TESTS

Standard production tests, made in accordance with USA Standard C37.09-5, include:

1. Verification of components.
2. Verification of BCT's, style number, polarity, ratios, and connections.
3. Verification of all wiring, per pertinent connection diagrams.
5. Electrical operation:
   a) Close, trip and latch check switch (IEEE Device No. 52/LC).
   b) Spring charging motor, closing device, and tripping device, per Table IV below.

<table>
<thead>
<tr>
<th>Nominal Control Voltage</th>
<th>Closing Power Devices</th>
<th>Closing Control Devices</th>
<th>Tripping Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>24V/DC</td>
<td>N/A</td>
<td>N/A</td>
<td>14-28V</td>
</tr>
<tr>
<td>48V/DC</td>
<td>36/56V</td>
<td>36/56V</td>
<td>28-56V</td>
</tr>
<tr>
<td>125V/DC</td>
<td>90-140V</td>
<td>90-140V</td>
<td>70-140V</td>
</tr>
<tr>
<td>120V/AC</td>
<td>104-127V</td>
<td>104-127V</td>
<td>104-127V *</td>
</tr>
<tr>
<td>240V/AC</td>
<td>208-254V</td>
<td>208-254V</td>
<td>208-254V *</td>
</tr>
</tbody>
</table>

*CAUTION: IF AC CONTROL POWER IS TAKEN FROM THE LINE THE BREAKER IS PROTECTING IT COULD, UNDER SYSTEM FAULT CONDITIONS, DROP BELOW THESE MINIMUM VALUES. IF THIS OCCURS, THE BREAKER WILL NOT TRIP. THIS THEN WOULD REQUIRE THE FAULT BE CLEARED BY AN UPLINE DEVICE.

(Devices are checked at minimum and maximum values).

c) Measure of opening time of interrupter after rated voltage is applied to trip coil; maximum allowable time is .05 seconds (three cycles on 60 Hertz basis).
6. Check on functioning of all switches: control, non-reclosing, ground fault bypass, etc.

7. Contact resistance: Three readings are taken on each phase of a complete breaker using a Biddle low resistance ohm meter. Typical values do not exceed 350 micro ohm (.00035 ohms).

8. Contact Speed: One of the outside phases is equipped with a Hewlett Packard Transducer, Model 7DCDT-500; a Gould travel recorder records the analogue voltage to permit recording of time from open to closed, and is repeated to measure time from closed to open.

9. Wiring insulation:
   a) The charging motor is isolated and given an overpotential test of 900 volts AC to ground.
   b) The terminal block connections are given an overpotential test of 1500 volts AC to ground.
   c) The BCT terminals (with secondaries short-circuited) are given an overpotential test of 2500 volts AC to ground for one minute.

10. Voltage Withstand: The complete breaker is tested: a) between live parts and cabinet, (b) across open contacts, and (c) between phases. The breaker must withstand the applied 60 Hertz voltage for one minute, in accordance with appropriate "dry withstand" values, per Table I.

11. Power Factor: All bushings are tested:
    a) Individually (with breaker open), and
    b) in phases (with breaker closed): Maximum allowable limit: 3%

12. Reference Dimension: The exact horizontal displacement of the closed contact of each interrupter (from a reference location) is measured and recorded for each interrupter. This measurement permits future comparison to establish the extent of contact erosion.

DESCRIPTION OF OPERATION

The following paragraphs describe the Type R breaker mechanism. The mechanism, of the stored energy type, consists of two parts:

(1) The stored energy, or spring charging mechanism, and (2) the closing and opening mechanism. The basic parts are combined into one sub-assembly. A universal type motor automatically charges the two closing springs. The closing operation serves to charge the opening spring.

The mechanism has a spring release device which can be actuated to close the breaker manually (locally), or can be electrically operated, through a control switch, or other circuit-making device, for remote closing.

The breaker can be opened manually (locally), or can be tripped electrically, through a remote control switch.

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In the absence of control voltage (or whenever desirable), the closing springs can be charged manually, with the manual charging handle.

Referring to Figures 8, 9, 10, 12, the basic elements are mounted on the crankshaft (15), which has four flats machined on it, and the crankarms (17) attached to the ends. Each arm connects to its closing spring (18) by a formed end (38), while the rear of the spring is anchored to the mechanism frame. The crank arms (17), motor cutoff switch cam (25), close cam (5), and drive plates (12) have flats matching the crankshaft flats to anchor them to the shaft. The spring charge indicator (26), ratchet wheel (10), oscillator (14), and manual charge device (16) do not have matching flats but are mounted on separate bushings and are free to rotate on the crankshaft.

Motor-Driven Operation of Charging the Closing Springs

When power is applied to the motor, its roller (41) drives the oscillator (14) counterclockwise, and the oscillator pawl (9) pushes on a tooth in the ratchet wheel (10) to rotate the wheel slightly more than one tooth in the counterclockwise direction. The hold pawl (11) snaps behind the corresponding advanced tooth, holding it against the torque of the closing springs (18), while the oscillator, driven by the oscillator spring (39), rotates back clockwise to catch another tooth on the ratchet. The counterclockwise rotation of the oscillator thus continues until the ratchet wheel pin (40) engages the two drive plates (12), and through them, the oscillator drives the crankshaft until its arms (17) are slightly past horizontal dead center. (This rotation of the shaft carries the close cam (5), keyed to it, around by the same angular amount, as well as the stop roller (6). Just after horizontal dead center of the crank arms is reached, the torque applied by the closing springs starts to rotate the crankshaft further, independent of the driving motor/oscillator/pawl action. The stop roller on the close cam stops and holds the crank from further rotation just past horizontal dead center by coming to rest against the spring release latch (7). This is the "spring charged" position.

At the instant that the closing springs snap over dead center and are held there, the lobe of the left hand drive plate (12) raises the pawl lifter (35), thus preventing the oscillator pawl (9) from engaging the next tooth in the ratched wheel (10). The oscillator is then free to move back and forth; at the same time, the motor cutoff switch cam (25) operates the switch (28) through a lever (27), and the motor stops. The cam (25) also operates the spring charge indicator. Since the oscillator is free-running, the exact point at which the motor stops is not critical.

Manual Operation of Charging the Closing Springs

When it is desired to charge the closing springs manually, the manual charge handle (23) must be used to rotate the charging device (16) on the shaft. Six to eight strokes are required. This action carries the manual charge pawl (13), which engages the ratchet wheel (10), imparting to it the same counterclockwise motion which results from operation of the motor, and charging the closing springs (See Figure 14).
Closing the Breaker

As described above, the charged closing springs (18) are prevented from rotating the crankshaft (15) by the restraint of the spring release latch (7) on the stop roller (6) of the close cam (5). Release of the close cam occurs when the front end of the spring release latch is lowered: the close cam is then free to rotate approximately 180° under the force of the closing springs, to apply force to the lower end of the mechanism link (50), and, through it, to the mechanism lever assembly (46). Rotation of the mechanism lever assembly then applies force to the main drive lever (84), causing the crankshaft drive to close the breaker. The closing operation also compresses the opening springs (85). During rotation, the drive plates move away from the ratchet wheel pin. The ratchet wheel does not rotate during the closing operation, thus preventing excessive wear on the teeth and pawls. Rotation of the crankshaft causes the motor cutoff switch (28) to reclose, and if motor power is available, the motor again operates the oscillator and, through it, the ratchet wheel, and again the closing springs are recharged.

Closing of the breaker can be effected manually, by the application of force on the "PUSH TO CLOSE" bar (62), which depresses the spring release latch through a bell crank link (59), releasing the close cam. Figure 13 illustrates the interlock which prevents a manual "close" effort from being effective when applied to a breaker already in the closed position.

The breaker can also be closed electrically by energizing the coil of the spring release device (6). (IEEE Device No. 52/CC

Latch Check Switch

The operating point of the latch check switch is adjustable as shown in Figure 18. The switches are operated by a common lever which is actuated by the adjusting screw. The screw adjustment should be set such that the trip latch is firmly engaged by the trip shaft before the switches are operated. This ensures that the closing circuit cannot be energized until the latch is fully reset.

Opening the Breaker

Referring to Figure 2 and Figure 14, the force of the opening springs (85), acting through the main drive lever (84), and the mechanism lever assembly (46), applies a downward force to the mechanism link (50). This downward force on this link pulls on the pivot point between it and the trip latch constraining link (3), tending to move that link (3) in a counterclockwise direction. However, as shown in the enlarged view of the trip shaft latch details (figure 14), the trip latch (4) cannot move, because of interference with the trip shaft (2). Thus, a slight counterclockwise rotation of the trip shaft will release latch (4), link (3), and link (50), allowing the opening spring to collapse the linkage, and the operating shaft lever (86) to move the breaker to the open position.
Opening the breaker can result from a manual tripping operation in which case a pull of the external trip rod (82), which projects outside of the low voltage cabinet, moves connected linkages which (a) rotates the trip shaft (2), allowing the unit to open, as previously described, and (b) open the manual lockout switch (IEEE Device No. 69) to block subsequent attempts to reclose without a manual reset operation. This reset is accomplished by manually returning the lockout switch to its closed position.

The breaker can be opened by energizing the shunt trip coil (1), causing the trip shaft (2) to rotate as described in the preceding paragraph; however, such opening action does not open the manual lockout switch.

Trip Free Operation

Referring to Figure 14 and Figure 18, if the closing springs are charged, and if a fault exists, the associated circuitry will, when the breaker auxiliary switch closes, energize the shunt trip coil (1) (IEEE Device No. 52/TC). This in turn rotates the trip shaft (2) counterclockwise to release the trip latch (4); an attempt to close the breaker manually will not succeed, since there is no restraint on the trip latch constraining link (3), and no force is applied on the mechanism link (50).

FORCED AIR COOLING FAN

Description

The fan is controlled by a single ratio 3000/5 bushing current transformer (BCT), 1.33 times rated, C50 relay class, metering class 0.3.

A six (6) volt AC relay (52P) with a variable 225 watt 10 ohm resistor (R1) is connected across the output of the BCT. A 50 watt 20 ohm resistor (R2) is connected in series with the 52P relay coil to limit the current at pickup and dropout.

[Diagrams of Typical Fan Control Schematic and Undervoltage Alarm Contact]
Adjustment

Adjust R1 resistor so that the 52P relay picks up at 2000 amperes (3.5 volts across the 52P coil). Dropout will occur at approximately 1700 amperes.

Voltage across the 52P coil at the maximum current of 3000 amperes will be approximately 5.4 VAC.

Operation

Pickup of the 52P relay starts the fan, energizes the alarm relay (30)*, and turns off the cabinet heaters. When the air flow starts the normally closed, air flow switch (63) will open. Should this not occur within the five (5) second time delay setting of the 30 relay, the alarm contacts will operate. The five (5) second delay is provided to prevent erroneous operation of the alarm contacts.

Test switch (43) is provided to allow manual checking of the fan and alarm operation.

*Timer delays pickup for approximately five (5) seconds.

OPERATIONAL CHECK PRIOR TO INSTALLATION

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

Operational Check -- Manual
(See Figure 8 and Figure 2)

If the indicator shows "SPRING DISCHARGED," insert the manual charge handle (23) into the manual charge device (16) and crank the closing springs by pulling forward, six to eight times, on the upper end of the handle. This action rotates the ratchet wheel (10) until the crank arms (17) go over center, charging the closing springs: the indicator flag then shows "SPRING CHARGED".

If the breaker position flag shows "OPEN", depress the "PUSH TO CLOSE" bar to close the breaker contacts; this action will (a) move the flag to "CLOSED", (b) move the spring indicator to "SPRING DISCHARGED", and (c) compress the opening springs (85).

If the breaker is already closed, the "PUSH TO CLOSE" bar is inoperative, and the unit should be tripped open, by pulling the trip handle projecting from the side of the control cabinet. (This action operates the manual lockout switch.) The breaker can be reclosed manually, as described above, but subsequent electrical operation requires resetting the manual lockout switch.

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Operational Check -- Electrical

Reference to Figure 15 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.

NOTE:
Consult nameplate for proper voltage. A single-phase, 60 Hertz source 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).

CAUTION: 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, 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.

If the breaker is tripped manually, this action opens the lockout switch (IEEE Device No. 69), and the breaker cannot be closed electrically until this switch is reset manually.

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 close coil failure.

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.

3. The reclosing relay should not reclose in the sequence for which it is programmed. The breaker should remain open until 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.

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

6. If a ground (neutral) CO relay is present, move bypass switch--"GCO"--to "cutout" 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 level and may be shimmed if necessary. Four 3/4 inch (19 mm) diameter bolts are recommended for mounting to the foundation. Refer to the outline drawing for location of mounting bolts.

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 no distinction between line and load terminals. However, the location and function of the internally mounted current transformers may dictate line connection. Thus, the designation of "line" and "load" side must be made with knowledge of 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.

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CAUTION: IF AC CONTROL POWER IS TAKEN FROM THE LINE, THE BREAKER IS PROTECTING IT COULD, UNDER SYSTEM FAULT CONDITIONS, DROP BELOW THE MINIMUM VALUES (TABLE IV). IF THIS OCCURS, THE BREAKER WILL NOT TRIP. THIS THEN WOULD REQUIRE THE FAULT BE CLEARED BY AN UPLINE DEVICE.

CAUTION: PRECAUTIONS MUST BE TAKEN TO INSURE THAT ALL WIRES 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

CAUTION: 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 the 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 12 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 IV, "Operating Voltage Range".

Conduit should be used for control circuits as much as practical. 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 conductors at least 4/0 AWG (0.460 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 level on its foundation.

2. Make a check for the tightness of hardware on stationary and moving contacts, shunts, pull 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. If desired, a dielectric test can be made, duplicating details of production tests, as described earlier in this book. 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 micro-ohm 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. 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.

CAUTION

- MINIMAL X-RAY RADIATION only
- When vacuum interrupter is operated above rated voltage
- Read instruction book before overvoltage testing

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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 (hipot) tests:

9. 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.

10. 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.

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

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 operations which occasionally occur, will soon establish a maintenance schedule which will give assurance of proper breaker reliability.

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 crankshaft should be resting firmly against the white teflon stop located directly above the two opening springs.

CAUTION: 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 overtravel spring causes the linkage to follow the moving contact, ensuring adequate contact pressure in the closed position, and accommodates to the phase-to-phase variations in the individual interrupters. At the time of manufacture the length of the moving contact stem (dimension K, Figure 16) is measured and recorded on each interrupter nameplate (Figure 17). As the contact is eroded away this K-dimension decreases by an amount equal to the amount of erosion. When this difference equals 0.125 inches, the life of the contact has been reached and the interrupter should be replaced.

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.

1. Determination of Contact Erosion
   a) Following production test, the Dimension K Figure 16 is measured and recorded on the travel nameplate Figure 17. A line is also scribed on the moving conductor of each interrupter. This line is 0.125 inches from the interrupter support bracket (92).
   b) As contact erosion takes place, these dimensions will decrease. When the difference between the field measurement and the original factory reference is 0.125 inches, or the scribe mark is in line with the support bracket, the interrupter should be replaced. See Section 5 for interrupter replacement procedure.

2. Determination of Contact Travel
   a) With the breaker in the closed position, measure the length of Dimension K, (Figure 16).
   b) With the breaker in the open position, again measure this length.
   c) The difference between this measurement and the one taken in the closed position is the contact travel.
   d) If it is outside the permissible travel limits on the nameplate, proceed to check overtravel and then follow the adjustment procedure.

3. Determination of Overtravel
   a) With the breaker in the closed position, measure the overtravel, Figure 16.
b) The permissible overtravel limits are 0.125 to 0.260 inches. If the measurements obtained are outside these limits, follow the adjustment procedure.

4. Contact Travel and Overtravel Adjustment Procedure

CAUTION: CONTACT TRAVEL AND OVERTRAVEL ADJUSTMENTS SHOULD ONLY BE MADE ON INTERRUPTERS WHICH HAVE NOT REACHED THEIR CONTACT EROSION LIMIT.

a) With the breaker in the closed position, loosen the jam nut on the operating rod (see Figure 16).

b) Open the breaker and remove the pin which connects the operating levers to the interrupter moving stem.

c) Adjust the length of the cap screw to obtain the desired change in travel and overtravel. One full turn will change the travel by 0.062 inches.

d) After adjustment, reinsert the connecting pin and check contact travel and overtravel as described previously.

NOTICE: JAM NUT SHOULD BE TIGHTENED AND LOOSENED ONLY WITH THE BREAKER IN THE CLOSED POSITION. A TWIST OF THE MOVING CONTACT STEM MORE THAN 2° OF ROTATION MAY DAMAGE THE BELLOWS.

5. Replacement of Interrupters

When it has been determined that the erosion of the interrupter contact has reached its limit, the interrupter should be replaced. The detailed steps listed below should be followed. (Figures 2 and 16)

a) With the breaker in the closed position, loosen the jam nut on the moving contact stem.

b) Open the breaker and remove the pins which connect the operating levers (89) to the moving contact stem (90) and pivot bracket (98).

c) Disconnect the interrupter from the bushing at the moving contact by removing the bus which connects it to the support bracket (92). Loosen but do not remove the bus and split contact block which makes the connection at the fixed end.

d) Remove the three bolts which secure the support bracket (92) to standoff insulator (86). The interrupter assembly can then be removed from the high voltage cabinet.

e) Remove the threaded cap screw and jam nut from the interrupter. These parts are required for the new interrupter.
f) Remove the guide outer bus and pull the roller assembly (100) straight forward. Do not change the compression of the roller springs.

g) Remove the support bracket (92) from the interrupter by removing the 4 bolts which secure it.

h) Secure the support bracket (92) (to the replacement interrupter) using the 4 nuts removed from the old interrupter.

Note: The maximum torque applied to these nuts should be 10 foot-pounds.

i) Push the current carrying rollers in place and replace the outer bus.

j) Screw the threaded cap screw into the moving contact stem. Jam nut should be in place but do not tighten.

NOTE: DO NOT TIGHTEN THE JAM NUT. A TWIST OF THE MOVING CONTACT STEM MORE THAN 20 OF ROTATION MAY DAMAGE THE BELLows.

k) Install the interrupter in the breaker in the reverse described in steps c and d.

l) Replace pin that connects the operating levers (89) to the pivot bracket (98).

m) With the breaker mechanism in the open position, screw the threaded cap screw in or out until the pin can be inserted through the operating levers and the cap screw.

n) Screw the threaded cap screw in six (6) full turns. Pull the moving contact stem straight forward and insert the pin to connect it to the operating levers.

o) Close the breaker and tighten the jam nut.

p) Follow the procedure previously described for measuring contact travel and adjustment. Since contact travel increases with contact erosion, the initial travel should be set between the average and lower limit specified on the nameplate.
q) Operate the breaker 20 to 30 times. Recheck the contact travel and overtravel. Adjust as required and record the values for reference in checking contact erosion. A change of 0.125 inches of the K dimension when breaker is in the closed position indicates that an interrupter change is required.

6. Trip Latch and Trip Coil Adjusting Procedure (Refer to Figure 18)

a) With mechanism open and closing springs charged, apply downward force on back of trip latch. Slowly rotate trip shaft adjusting screw clockwise until the trip shaft releases. (This is "no overlap" position.) To obtain recommended trip latch wipe, rotate adjusting screw 8 1/2 turns in a counterclockwise direction.

b) Trip coil lever should be adjusted to clear the trip lever .25 (6.3 mm) with a 0.1 (2.5 mm) minimum overlap by adjusting the trip coil mounting position.

c) Set latch check switch adjustment screw to trip switch after the trip latch is latched.

MECHANISM INSPECTION AND MAINTENANCE

ABB recommends the use of Moly 33 for any lubrication required on the mechanism. Environmental conditions will have effect on frequency of required lubrication and the recommendation listed here may require modifications for unusual and severe conditions. As a guide, ABB would recommend that the mechanism be inspected after one year of service or 500 operations. The primary concern will not be aging or degradation of the lubricants, but for contamination that may be present. Required inspection times can then be better assessed after the first year's inspection and customer then may make decisions of frequency and subsequent maintenance that must be performed.

1. Mechanism Inspection

a) Remove front cover plate of mechanism.

b) Remove the closing springs and if a .005" gauge can be inserted between the turns of the springs, replace springs.

c) Visually inspect mechanism components for any physical damage or signs of excessive wear.

d) Rotate the closing cam by hand until the mechanism is in the mechanism open, spring charged position. This position is as shown in Figure 2. The stop roller (6) should be against the spring release latch (7). The trip latch (4) should engage the trip shaft (2) and the spring position indicator should move to the charge position.
e) Push the manual close button or lift up on the back of the spring release latch (7) and rotate the trip shaft (2) to release the trip latch (4). This will allow the closing cam (5) to rotate to the mechanism open, spring discharge position Figure 14. This is a trip free operation and the mechanism should offer little resistance. Measure resistance using a 5-10 pound spring gauge. Rotate crank arm (17) to lowest position and install spring gauge on crank arm pin and spring reading should not exceed 2 pounds. If this force is exceeded, the right hand side of the mechanism must be disassembled to determine the cause.

2. Mechanism Relubrication (Refer To Figure 9)

a) Remove the crank arm on the right hand side of the mechanism.

b) Unload the spring from the stop bracket (32), slide washer and manual charge devices (16) off right hand end of shaft.

c) Disconnect spring on back side of oscillator (14) and rotate assembly forward to clear motor and slide sleeve (30) and oscillator off shaft.

d) Remove drive pawl (12) and ratchet wheel (10) off shaft (15). This will include items ratchet bushing (29) and spacer (31).

e) Place these items in a grease dissolving fluid and wash off all residue. With a cloth, wash the face of the bearing hub on side plate free of all residue.

f) Refer to Figure 8, assemble first drive pawl (12) as shown in relation to position of cam. Check for .005" minimum clearance between drive pawl (12) and face of bearing hub. Tap left hand end of shaft lightly to obtain minimum .005" clearance.

g) Apply a thin film of Moly 33 to ratchet bushing (29) and slide on shaft with one spacer (31) next to pawl.

h) Slide ratchet wheel (10) over bushing (29). Make sure hold pawl (11) engages and fits contour of tooth of ratchet wheel (10).

i) Assemble one spacer (31) onto ratchet wheel, then other drive pawl (12).

j) Apply a thin film of Moly 33 to sleeve (30) inside and outside diameter and place on shaft.

k) Add one spacer (31) next to pawl (12).

l) Assemble oscillator (14) and rehook spring to hold oscillator against motor crank roller.
m) Lubricate thrust bearing (33) with Moly 33 and place on oscillator (14).

n) Apply thin film of Moly 33 to the inside diameter of manual charging device (16) and assemble onto shaft.

o) Rehook leg of spring behind stop bracket (32).

p) Place on shaft flat washer and extra spacer (31), if present.

q) Place crank (17) on shaft in alignment with left hand crank arm (17) and tighten set screw.

r) Recheck shaft assembly for torque required to turn. If it is too high, disassemble and check position of spacers (31). They should be located over outside diameter of sleeves and not between pawls (12) or ratchet wheel (10).

s) Rotate the closing cam of the mechanism to the open, spring discharged position before installing the closing springs (Moly 33 lubricant should be applied to both sides of the spring end plates and to the hole that fits over the crank arm pin). Assemble closing spring, using a hook device to extend the spring over the pins and secure with new X washers.

t) Using the manual charging handle, charge the closing springs until the spring charged indicator moves up.

u) Remove bottom three bolts on left hand side plate and loosen top two bolts. Lean plate out far enough to remove trip shaft from mechanism. With solvent, clean shaft and bearings. Lubricate with a thin film of Moly 33 and reassemble. Check for free movement through full rotation of trip shaft.

Note: Check trip latch and trip shaft per procedure described on page 24.

3. Complete Mechanism Replacement Instructions

CAUTION: BEFORE DOING ANY OF THE STEPS IN THIS SECTION, MAKE CERTAIN CONTROL POWER HAS BEEN REMOVED. OPEN AND CLOSE AND OPEN BREAKER TO DISCHARGE CLOSING SPRINGS AND TO HAVE BREAKER IN THE OPEN POSITION.

a) Tag and remove control wiring from terminal blocks on the side of the existing mechanism.

b) Remove pin 47 which connects main drive link to the mechanism lever assembly (Figure 2).
c) Remove mechanism by unbolting the top four mounting bolts.

d) Prior to the installation of a new mechanism, check linkage of auxiliary switches for free movement. Also check main bearings and bumper stop of main shaft for wear or damage.

e) Put new mechanism in position and install the four top mounting bolts finger tight.

f) Reconnect terminal wiring to terminal block on side plate.

g) Position mechanism so that mechanism link pin 47 can be freely installed and tighten the four top mounting bolts.

h) Check contact travel and overtravel as described on page 21.

RENEWAL PARTS

A list of renewal parts recommended to be maintained in stock will be furnished on request. When ordering renewal parts, specify the name of the part, identify the breaker by including the type, amperes, volts, and general order (G.O.) number as indicated on the nameplate.

Standard hardware items, such as bolts, nuts, and washers should be purchased locally. For replacement part prices, contact the nearest Sales Office of ASEA BROWN BOVERI.
Figure 1. Type R Vacuum Circuit Breaker
Figure 2. Mechanical Arrangement

Figure 3. Typical Bushing Current Transformer Nameplate
Figure 4. Mechanism and Cabinet Details, Rear View

a. Mechanism Front View

b. Mechanism Details, Cover Removed, Front View

Figure 5. Mechanism
Figure 6. Breaker Nameplate

Figure 7. Typical Control Panel
Figure 8. General Arrangement of Principal Parts of Mechanism

1. Shunt Trip Coil (IEEE Device 52/TC)
2. Trip Shaft
3. Trip Latch Constraining Link
4. Trip Latch
5. Close Cam
6. Stop Roller
7. Spring Release Latch
8. Spring Release Device (IEEE Device 52/CC)
9. Oscillator Pawl
10. Ratchet Wheel
11. Hold Pawl
12. Drive Plate
13. Manual Charge Pawl
14. Oscillator
15. Crankshaft
16. Manual Charge Device
17. Crankarm (2)
18. Closing Spring (2)
19. Closing Spring Anchor
20. Manual Trip Lever
22. Motor (52/M)
23. Manual Charge Handle
24. Motor Crank Arm
46. Mechanism Lever Assembly
107. Trip Lever
Figure 9. Front View of Principal Parts of Crankshaft Assembly
Note: Main cam position for this crank shaft position is shown in Fig. 23a

5. Close Cam
9. Oscillator Pawl
10. Ratchet Wheel
11. Hold Pawl
12. Drive Plate
14. Oscillator
15. Crank Shaft
17. Crank Arm
18. Closing Spring (2)
30. Oscillator Bushing

35. Pawl Lifter
39. Oscillator Spring
40. Ratchet Wheel Pin
41. Motor Crank Roller

10. Ratchet Wheel
12. Drive Plate
17. Crank Arm
38. Spring End
40. Ratchet Wheel Pin

Figure 10. Details of Closing Springs
10. Ratchet Wheel
11. Hold Pawl
13. Manual Charge Pawl
16. Manual Charge Device
23. Manual Charge Handle
42. Stop Bracket

Figure 11. Details of Manual Charge Device
5. Close Cam
10. Ratchet Wheel
12. Drive Plate
14. Oscillator
15. Crankshaft
16. Manual Charge Device
17. Crankarm (2)
25. Motor Cut-off Switch Cam

30. Oscillator Bushing
52. Precision Spacer (3)
53. Ratchet Bushing
54. Bearing Race (2)
55. Thrust Bearing
56. Charge Device Return Spring
57. Spring Retainer

Figure 12. Details of Crankshaft Assembly
Figure 13. Details of Close Interlock

6. Stop Roller
7. Spring Release Latch
8. Spring Release Device (IEEE Device 52/CC)
58. Bell Crank Pivot Pin
59. Bell Crank Link

60. Spring Release Latch Link
61. Spring Release Latch Link Pin
62. "Push to Close" Bar
63. Close Bar Pivot Pin
64. "Open-Close" Indicator Pin
a) Mechanism Open—Springs Discharged (Trip Latch Not Reset)

b) Mechanism Closed—Springs Discharged

c) Mechanism Closed—Springs Charged

2. Trip Shaft
3. Trip Latch Constraining Link
4. Trip Latch
46. Mechanism Lever Assembly
50. Mechanism Link
51. Main Roller

aa) Trip Latch Held
bb) Trip Latch Released
d) Trip Shaft Latch Details

Figure 14. Details of Linkages of Mechanism and Closing Spring Charge Condition
Figure 15. Typical Breaker Schematic Diagram
Figure 16. Mechanism at Moving Contact End of Interrupter
Figure 17. Travel Limit Nameplate

Figure 18. Details of Shunt Trip Coil (IEEE Device 52/TC) and Latch Check Switch (IEEE Device 52/LC)