JJ – MED VOLTAGE

IB 6.2.7.7-2F

Installation /Maintenance Instructions

Medium – Voltage
Vacuum Power Circuit Breakers

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5 VHK Model 23
5VHKX Model 23
15 VHK Model 20
15 VHKX Model 20
All @ 1200/2000 Amperes

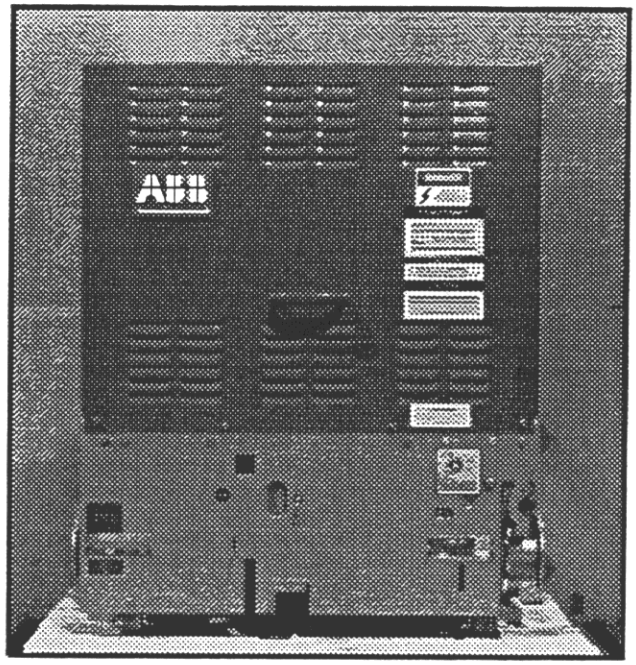


ABB Power T&D Company Inc.
ABB Power Distribution
Distribution Systems Division

CONTENTS

INTRODUCTION

These instructions for installation, operation and maintenance of 15VHK Model 20 series vacuum circuit breakers should be read carefully and used as a guide during installation and initial operation.

The specific ratings of each model circuit breaker are listed on the individual nameplates.

File these instructions in a readily accessible place together with drawings and descriptive data of the switchgear. These instructions will be a guide to proper maintenance of the equipment and prolong its life and usefulness.

RECEIVING AND STORAGE

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

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

Circuit breakers should be installed in their permanent location as soon as possible. If the breakers are not to be placed in service for some time, it is advisable to provide adequate means of protection. This may be done by keeping the breaker in its original shipping carton and storing in a warm, dry and uncontaminated atmosphere. If the circuit breaker cannot be stored properly, it must be thoroughly checked before going into service to insure it has not absorbed moisture, rusted or become generally contaminated in any way.

CIRCUIT BREAKER INSTALLATION

General

Prior to initial installation of the circuit breaker into the switchboard, certain preliminary inspections should be made to insure proper operation. The inspection procedures for this are given in this section.

The circuit breaker is shipped with contacts closed, closing springs discharged and opening springs charged. If the circuit breaker is furnished with an undervoltage device, the device will be lockwired to allow closing of the breaker for shipment. A tag will identify the lock wire. To remove the wire, open the breaker and reach behind the control panel from the right hand side. Using wire cutters, cut and remove the tagged wire.

WARNING WARNING WARNING WARNING

Prior to any disassembly or inspection of the circuit breaker, the closing springs must be discharged, and the breaker must be open.

Referring to Fig. 1, if it is necessary to raise or move the breaker, attach a lifting yoke (5) at point 4 on both sides of the truck, or a fifth wheel at point 6 to transport the breaker as required.

Installation Inspection

Inspect the condition of circuit breaker vacuum interrupters and electrical connections prior to installing the circuit breaker into the switchboard. Even though each circuit breaker is completely adjusted and tested at the factory, shipping and handling conditions could cause defects.

The front cover assembly (2, fig. 1) must be removed for access to and inspection of the vacuum interrupters, and their associated adjustments.

Removing Front Cover (See Fig. 1)

The assembly can be removed after first removing four (4) lower front cover screws (1) and one screw (7) on each side, inside the front cover.

Vacuum Interrupter Examination (See Fig. 2)

CAUTION CAUTION CAUTION CAUTION

After the interphase barrier has been removed, a grounding stick must be used to discharge the mid-band ring, on the vacuum interrupters (1) so equipped, before any work is done on the interrupters.

The insulated vacuum envelope (2) should be examined carefully for cracks in the area of the metal-to-insulation seals on both ends and around the mid-band ring. Since a certain amount of transmitted light is usually required to detect cracks, the inspection should be done in a well lighted area. If the mid-band ring, when so equipped, has been bent by an accidental impact, that area should be specially scrutinized for seal damage. Small external chips will not impair the useful life of the interrupter.

Insulation Structure

All insulated parts should be checked for damage. Any dust or dirt should be removed by air or wiped with a clean lintless cloth. The lead support moldings are polyester glass and occasionally have

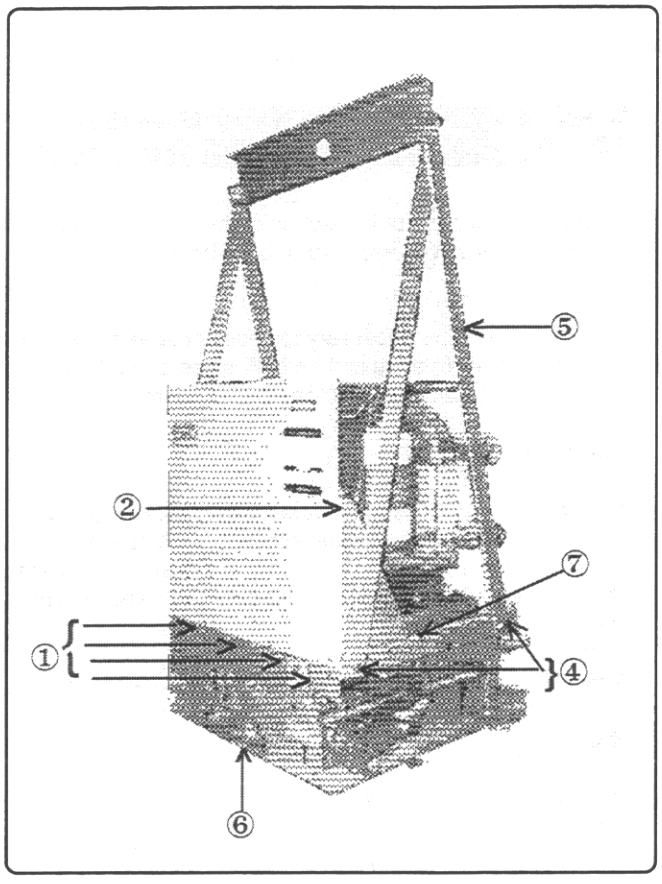


Fig. 1 - Circuit Breaker Assembly with Lifting Yoke Installed

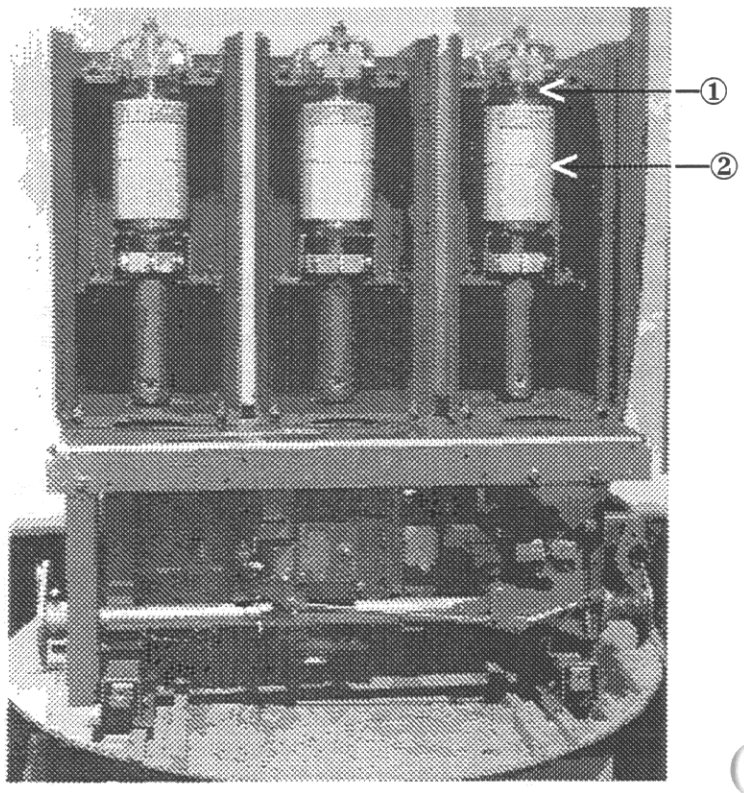


Fig. 2 - Circuit Breaker With Front Cover Removed

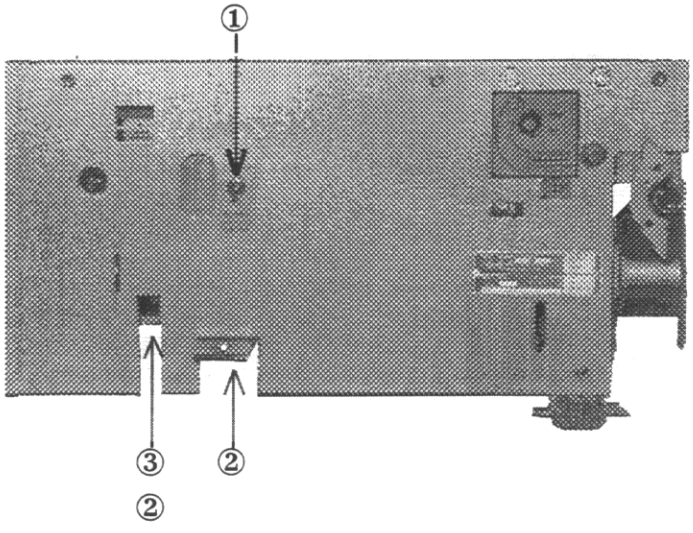
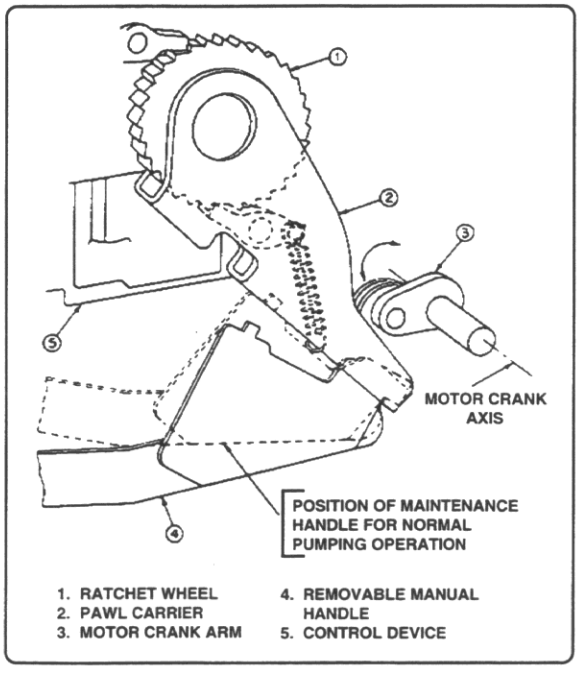


Fig. 3 - Front Circuit Breaker Panel & Accessories

(See Detail 3A)



Detail 3A - Manual Charging Of Electrically Operated Circuit Breakers

some resin rich cracks or crazing develop. These do not indicate defective material and should not cause concern.

Installing Front Cover (See Fig. 1)

Install the assembly and fasten with four lower front cover screws (1) and one screw (7) on each side, inside the front cover.

NOTE: It is recommended that a dielectric withstand test be made prior to putting this or any type vacuum circuit breaker into service. Refer to Dielectric Tests, in the Maintenance, Adjustments and Tests section of this bulletin, for the correct test procedure.

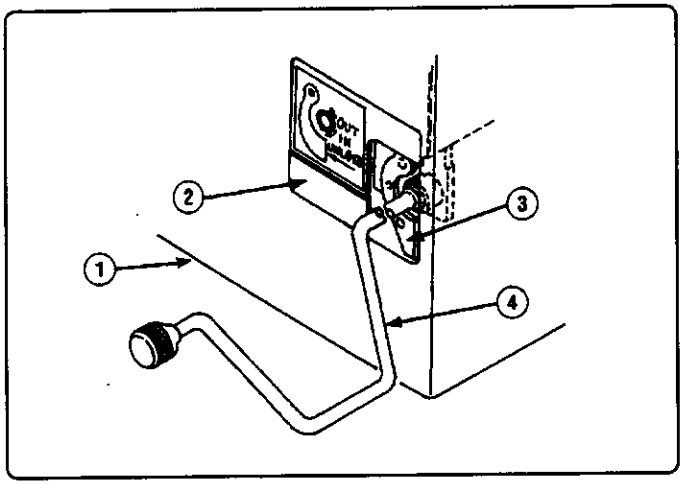


Fig. 4 - Method of Racking Circuit Breaker

Installing Circuit Breaker into Compartment (See Figs. 3 & 4)

NOTE: CLOCKWISE rotation of racking crank for inserting breaker. COUNTERCLOCKWISE rotation of racking crank for removal of breaker.

Turn motor disconnect switch (1, Fig. 3) to "OFF" position.

Engage racking crank (4, Fig. 4) and push racking unlocking lever (3) to left, then rotate racking crank counterclockwise only until resistance to motion is felt (DO NOT FORCE). If closing springs were left in the "CHARGED" condition, they will automatically discharge.

For installing the circuit breaker into the lower compartment, the fifth wheel is used to position the breaker so that it is lined up with the switchgear. Engage the fifth wheel with hole (2 Fig. 3). A lift device is required to lift and position the breaker for installation into the upper compartment. Guide and push circuit breaker into compartment until stopped. Again engage racking crank and rotate clockwise until racking mechanism automatically stops at "DISCONNECT" position. (Breaker is now held captive in compartment.)

To rack circuit breaker to "TEST" position, push racking unlocking lever (3, Fig. 4) to left, rotate racking crank approximately 1/4 turn clockwise, then release unlocking lever. Continue cranking until racking mechanism automatically stops at "TEST" position.
With the circuit breaker racked to "TEST" position, it should be checked for proper operation by operating all possible means of opening and closing, this includes control switches, relays, etc. Turn motor disconnect switch (1, Fig. 3) to "ON" position to charge the closing springs, and operate the breaker as required.

Manual Operation of Electrically Operated Models

Electrically operated circuit breakers may be charged manually by a removable maintenance handle for bench tests or emergency operation. To manually charge the closing springs, first position the maintenance handle hooked section in the long slot on the pawl carrier (Refer to Figure 3). The small tab on the maintenance handle will fit the small hole of the pawl carrier. Using a pumping motion, rotate the pawl carrier until the ratchet wheel no longer rotates. At this point, the spring charged indicator will indicate SPRINGS CHARGED. The circuit breaker can be closed manually with the manual close lever. NOTE: Occasionally the motor crank arm will stop in a position that will not allow manual spring charging. When this happens, the motor crank arm must be rotated manually by using a screwdriver to rotate the crank arm sufficiently so that the springs may then be manually charged with the maintenance handle.

WARNING WARNING WARNING WARNING

When racking circuit breaker to "CONNECTED" position, close compartment door (1, Fig. 4) and insert racking crank (4, Fig. 4) through sliding panel (2, Fig. 4).

Push unlocking lever (3, Fig. 4) to left and turn racking crank (4, Fig. 4) approximately 1/4 turn clockwise, then release unlocking lever. Continue cranking until racking mechanism automatically stops at "CONNECTED" position.

CAUTION CAUTION CAUTION CAUTION

Do not attempt to rack any further.

The circuit breaker may now be put in service and operated as required.

CIRCUIT BREAKER REMOVAL (See Fig. 4)

To remove circuit breaker from "CONNECTED" position, open the breaker as required.

Open sliding door (2) in front compartment door (1). Engage racking crank (4) and push racking unlocking lever (3) to left. Rotate racking crank (4) counterclockwise approximately 1/4 turn, then release unlocking lever. Continue cranking counter-

clockwise until racking mechanism automatically stops at "TEST" position.

The circuit breaker can now be positioned for withdrawal. If in the upper compartment the lift device must first be located in the correct position. For withdrawal from the switchboard, again push the racking unlocking lever to the left and turn the racking crank counterclockwise only until resistance to motion is felt. (Approximately 2-3 turns -- **DO NOT FORCE**.) The closing springs, if charged, will automatically discharge when the circuit breaker is moved to the withdrawn position. The circuit breaker can now be removed from the compartment by pulling on the handle located on the front barrier.

MAINTENANCE, ADJUSTMENTS AND TESTS

General Information

The 15VHK Model 20 & 5VHK Model 23 series circuit breakers are designed for mininum maintenance and tested to insure that only minimum maintenance will be required. The few adjustments that are noted are required only when an operational checks, all accessible bolts, units and screws should be routinely checked to insure that they are tight.

It is recommended that the circuit breaker be normally inspected after the first 2000 operations, regardless of the type of duty it is used for. These operations can be either no-load mechanical, load current switching, bulk capacitor or reactor switching operations, or for motor starting applications.

Vacuum interrupters, as used on the 15VHK Model 20 series circuit breakers, have an inherently long contact life and will provide trouble-free service under varied application conditions, as long as the circuit breaker is applied within its rating. The wear condition of the individual vacuum interrupters will vary, depending on circuit conditions and such variables as single phase versus three-phase interruption, X/R ratio (asymmetry) and relay delay times. **Of course, interrupting high short-circuit current will cause contact erosion to occur. The Model 20/23 series circuit breakerhas been tested up to 2000% KSI. It is unlikely that a circuit breaker will be subjected to this much duty during the life of a breaker and it is not expected that the interrupters will have to be replaced due to excessive erosion of contacts. There is, however, a check for contact wipe (contact pressure) which is also a measure of contact erosion. This check is covered under "Circuit Breaker Operation and Contacts." When contact wipe is less than the minimum specified and there is not a mechanical problem, then the interrupter should be replaced due to contact erosion.**

If, however after the first inspection period there is no indication of any problems, actual operating experience with specific circuits will indicate the future amount of maintenance needed for the various circuit breakers and the procedure can be modified as required.

Where unusual service conditions exist, as covered by ANSI Standard C37.04, it must be presumed that these conditions were considered at the time of order and that the equipment supplied was designed for the special application and that an appropriate supplemental maintenance program has been developed. These maintenance instructions only cover circuit breakers used under the standard service conditions.

At the selected maintenance period, the following tests and adjustments should be made:

NOTE: The following tabulated tests and adjustments are all that are normally necessary for proper maintenance and operation of the Model 20/23 series circuit breaker. The remaining portions of the breaker – close coil assembly, shunt trip device, control relay, auxiliary switch and motor – require no maintenance during the standard life of the circuit breaker regardless of the operating duty.

D.C. Millivolt Drop Test

During maintenance periods, the condition of the breaker current circuit can easily be determined by performing a millivolt drop test. This test should be performed regardless of whether the circuit breaker had interrupted low or high currents or has minimum operations.

The following table lists the millivolt drop and resistance values for the circuit breakers covered by this instruction book, from terminal to terminal, exclusive of the primary disconnects.

Circuit Breaker	Maximum MV Drop *	Maximum Micro-Ohms
500/750 1200 Ampere	8	40
500/750 2000 Ampere	7	35
* Millivolt drop with 200 amperes DC flowing.		

Insulation Cleaning

Any dirt, dust or grease should be removed from the surfaces of the entire current carrying structure, vacuum interrupter*, base insulation sheet and interphase barrier assembly. Wiping the surface with a clean lint free cloth is normally sufficient for this purpose.

*Remember to discharge mid-band ring on interrupters so equipped.

Circuit Breaker Operation, Contact Adjustment and Timing

Contact Adjustment

WARNING WARNING WARNING WARNING

Keep hands clear of all moving parts. Serious injuries can result if a person comes in contact with breaker parts when the breaker is being opened or closed, or closing springs are being charged or discharged. Use extension tools for manipulating breaker parts.

1. To check breaker operation, the breaker must be withdrawn from the switchboard, and the racking screw turned two to three turns clockwise until the racking unlocking lever engages into the first side hole in the racking screw, corresponding to the disconnect position.

2. Full Close Test: Insert manual charge handle into charging lever (fig. 3), and manually charge the closing springs. Close the breaker. Reinsert manual charging handle. During the initial portion of the upward charging motion of the handle, the closing springs should start charging via the ratchet mechanism. This can be felt by a definite and continual resistance against the handle, caused by the tension of the closing springs. This indicates that the breaker has closed and latched.

If instead, the handle and charging lever are met with no initial resistance, while simultaneously it is observed that the ratchet wheel spins around approx. 180° before the ratchet mechanism starts charging the closing springs, the breaker has not fully closed and latched. This is referred to as a *stall,* and it is caused by excessive loads on the mechanism (i.e., M.O.C. loads, excessive contact wipe, etc.) If this condition cannot be relieved, consult the factory.

3. Contact Wipe (Fig. 5): The contact wipe is set at the factory to .090"-.105" for the 750 & 250 MVA breakers, and .123"-.164" for the 500 MVA breakers , by adjusting the vertical position of the push rod and vacuum interrupter. This should not be changed in the field unless a change in contact sequence is required.

Contact erosion and wear of mechanical parts will cause a reduction in contact wipe over the life of the breaker, and a check should be made to insure that the wipe is not less than .039" (1mm). A measure of contact wipe gives a measure of contact wear and a relative contact pressure. If the wipe is less than .039", and there is no mechanical problem, then the interrupter should be replaced due to contact erosion.

After checking that the breaker is fully closing, the contact wipe measurement is made for each pole as follows:

1- Remove the lower front panel of the breaker.

2- Manually charge the closing springs.

3- Close the breaker.

4- Carefully measure the gap between the preload nut and the trunnion block of each contact spring assembly.

4. Contact Gap (Fig.5): The contact gap is set at the factory to the range of .31"-.48". This value will increase as the contacts erode. An inspection of the contact gap insures that the breaker is fully opening, and the resulting gap is sufficient to withstand the applied voltage.

After checking that the breaker is fully closing, the contact gap measurement is made for each pole as follows:

1- Open the breaker, and discharge the closing springs.

2- Apply a piece of masking tape to the inside surface of the molded interrupter support.

3- Lay a pen or pencil flat upon the push rod skirt, and draw a horizontal line on the tape.

4- Manually charge closing springs, and close the breaker.

5- Lay the pen or pencil flat upon the push rod skirt, and draw a second horizontal line on the tape.

6- The distance measured between the two lines is the contact gap. The acceptable limits are .31"-.58", with the upper limit being approached as the contact wipe approaches the minimum.

5. Contact Sequencing (Fig. 5). All three poles should make contact within two milliseconds of each other, at normal closing speeds, and have been adjusted so at the factory. An oscilloscope, oscillograph or other timing method may be used to check the two millisecond timing.

Before checking contact sequence, verify that the contact wipe and gap for each pole is correct (sections 3 and 4 above). It is not expected that the contact sequence should exceed the 2 millisecond limit; therefore, before attempting to readjust, verify that the test equipment and procedure are correct. Also consider, especially with electronic test equipment, that .002 seconds vacuum interrupter contact bounce is permissible during normal closing, and this bounce can influence the contact touch measurements.

If it is determined that the contact sequence is not within the 2 milliseconds, then adjustment is required. Usually, readjustment of one pole should suffice for all three poles to touch within 2 milliseconds. The gap of the pole to be changed should be decreased if the contacts of that pole touch after the other two poles, or increased if the contacts touch before the other two poles. The gap is decreased by turning push rod clockwise, viewing from the top of the breaker, and increased by turning counterclockwise.

Before the push rod can be turned, the breaker must be open, closing springs discharged and push rod pin removed. With the breaker open, vacuum in the interrupter maintains an approx. constant 25 lbs. upward force on the moving contact and push rod. A temporary spacer may be placed between the flex conductor clamp and the bottom of the interrupter, to hold the moving contact in place. After removing the retaining ring and pin, rotate push rod as required.

One quarter turn of the push rod will change the gap by approx. .019". After adjusting the push rod, carefully reposition the push rod to align the pin holes. Replace the pin and retainer, and remove the temporary spacer. During the readjustment procedure, note that the contact wipe and contact gap dimensions specified previously must be maintained. The contact gap and contact wipe are inversely related: increasing one decreases the other and vice-versa. Also, note that no more than one half turn total of the push rod should be required when readjusting for contact sequence.

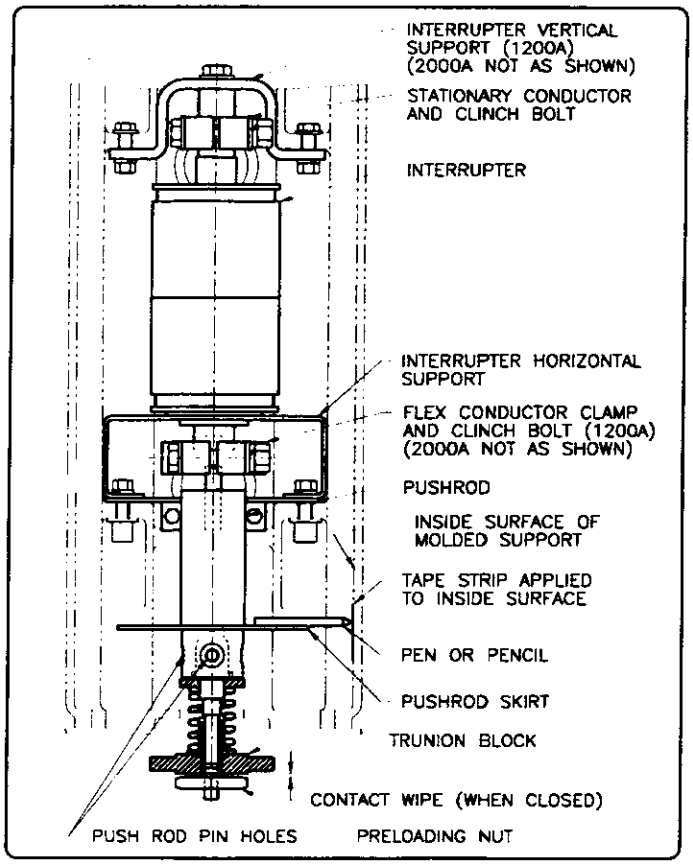


Fig. 5 - Contact Pressure

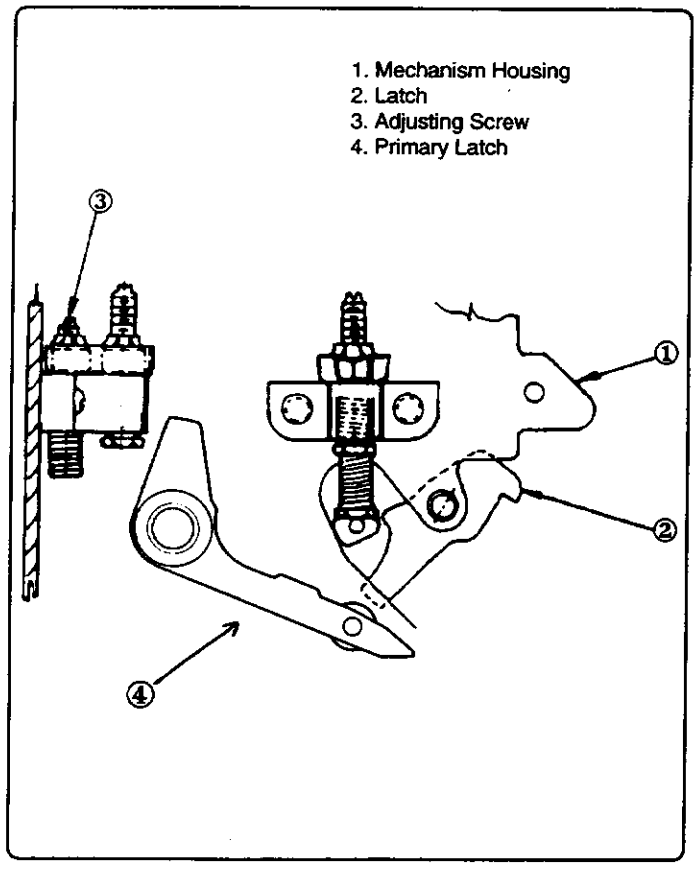


Fig. 6 - Trip Latch Engagement Adjustment

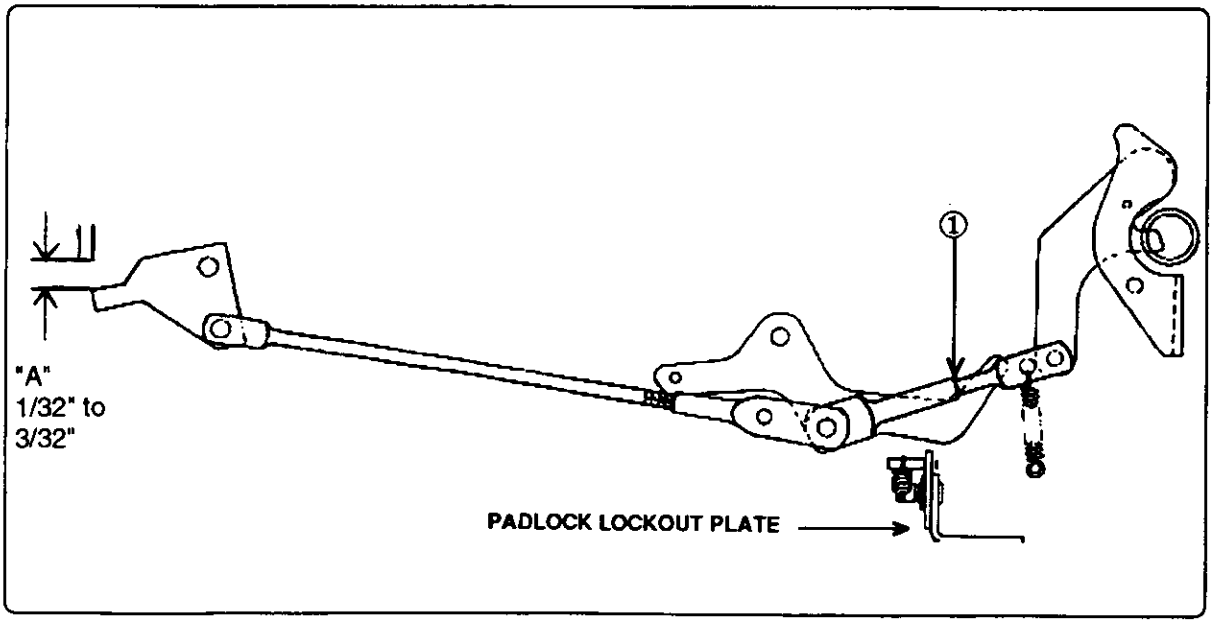


Fig. 7 - Racking Mechanism

Closing and Opening Times and Speeds

After the operation intervals noted previously, the closing and opening times are recommended to be checked by use of a cycle counter, travel recorder*, oscillograph, etc. to monitor the time from energizing to contacts touch or part.

* A potentiometer with mounting support, used in conjunction with an oscilloscope or oscillograph, and instructions are available on special order for specifically checking opening and closing speeds.

The circuit breaker closing and opening times should be within the following time ranges for normal operation.

Closing Time Range -- MS	Opening Time Range -- MS
30-50	14-24

NOTES:

1. Below 0°C, the closing times will increase (but with no reduction in closing force); and opening times will be within the limits.

2. Adjustments to correct speeds, if found to be outside limits, are critical and the nearest District Office should be contacted for recommendations.

Operating Mechanism

The various mechanism adjustments described in the following sections apply to all circuit breakers covered by this Instruction Bulletin.

Latch Engagement (Bite) (Refer to Fig. 6)

The latch engagement adjusting screw (3) is located to the right of the right-hand mechanism housing (1). It can be reached easily from the top of the circuit breaker.

To adjust the latch (2) engagement, proceed as follows:

1. Back off adjusting screw (3) to assure excessive latch engagement.

2. Close the circuit breaker.

3. Turn adjusting screw (3) down slowly until the latch just releases, tripping the circuit breaker.

4. Back off the adjusting screw (3) 2 turns.

Racking Mecahnism (See Fig. 7)

The circuit breaker racking mechanism is adjusted for proper operation and should not be disturbed unlewss it becomes possible to close the breaker during a racking operation.

It may be possible that interlocked blocking members are not positioned properly, which should be corrected as follows:

Remove the lower front mechanism coverplate and with the circuit breaker closed, make adjustments by regulating the length of connecting rod (1) for 1/32 inch minimum to 3/32 inch maximum clearence between trip link and blocking lever. The maximum adjustment should not exceed 3/32 inch.

Control Device (See Fig. 8)

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

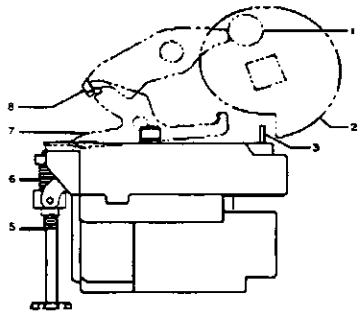
Close Latch Release Rod Overtravel

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

2. Charge the closing springs. Push up on close latch release rod (5) to the full extent of its travel. While holding the close latch release rod in this position, turn up on the close latch release rod (5) until the circuit breaker closes. Turn close latch release rod (5) up an additional 1 1/2 turns.

3. Test the adjustment by closing the breaker electrically. If the breaker does not close, the adjustment must be fine tuned. First back off the adjustent by turning the rod 1/2 turn down, and try to close the breaker electrically. If the breaker still does not close, turn rod one full turn up (which will position it 1/2 turn above original adjustment) and retest electrically.

4. If the breaker cannot be adjusted to close electrically, consult the factory.



1. ROLLER, CLOSE LATCH
2. CHARGING CAM
3. ACTUATOR, LIMIT SWITCH
5. CLOSE LATCH RELEASE ROD
6. SPRING, CLOSE LATCH RELEASE ROD
7. SECONDARY CLOSE LATCH
8. PRIMARY CLOSE LATCH

Fig. 8 - Close Latch Release Rod Overtravel

LUBRICATION

The 15VHK Model 20 series circuit breakers are lubricated during factory assembly as follows:

1. The primary disconnect contacts have been lubricated with NO-OX-ID special grade-A grease manufactured by Sanchem, Inc. (ABB No. 713222A, 1 Pt. can).

2. All other mechanism parts, bearings, pins, etc., have been lubricated with Anderol 757 manufactured by Nuodex, Inc. (formerly Tenneco Chemical, Inc). (ABB No. 712994A, 4 oz. tube).

If the grease should become contaminated or unduly oxidized (hardened and darkened) or if parts are replaced, any relubrication should be done with the lubricants noted.

NOTES:

1. It is recommended that the primary disconnects be maintained by renewing the grease. The mechanism should be periodically inspected for lubrication contamination; frequency of inspection is dependant on operating environment.

2. Do not use light oil to lubricate any mechanism parts. In emergency situations, Anderol 732 may be used as a temporary lubricant. In these cases, allow time for the solvents to evaporate prior to any mechanical operations. It is mandatory that the breaker undergo thorough lubrication with Anderol 757 at the next maintenance interval. Use of solvents to free contaminated lubricant is strictly forbidden without immediate relubrication using Anderol 757. Note that bearing surfaces must be repacked and this will require disassembly of the mechanism. Do not operate circuit breaker without completing this procedure.

3. The charging motor is sealed and no lubrication is required.

DIELECTRIC TESTS

It is recommended that dielectric withstand tests be made prior to use and then at routine maintenance periods to verify the integrity of vacuum interrupters. If, during the dielectric withstand test, the required test voltage cannot be sustained across the open contacts of the vacuum interrupter, the interrupter is faulty and must be replaced. Always insure that the contact air gap is correct before conducting primary circuit dielectric tests.

CAUTION CAUTION CAUTION CAUTION

While the procedure for dielectric testing a vacuum breaker is similar to that for any other type breaker, there are two areas which require extra CAUTION in handling.

1. The internal shield of a vacuum interrupter can acquire an electrical charge which is usually retained even after the voltage is removed. On certain types of interrupters, this shield is attached to the exposed mid-band ring and a grounding stick should be used to discharge the ring before working on the device.

2. Dielectric test voltages higher than rated voltage, applied across open contacts, may cause a vacuum interrupter to emit some X-radiation which could be a health hazard on prolonged exposure at close range. Accordingly, even though the emission is low and on for such a short period of time, it is considered appropriate to exercise caution.

Therefore, do not run any primary circuit dielectric withstand tests on isolated interrupters with open contacts, above rated voltage unless test personnel are adequately shielded or they are no less than six feet from the test unit.

It is noted that NO hazardous X-radiation is produced with closed contacts at any test voltage or with open contacts at rated voltage and there should be no cause for concern. Further, if the breaker is tested in its switchgear compartment, the enclosure steel provides sufficient shielding to protect personnel from X-radiation at the test voltages recommended below at the normal distances maintained for electrical safety.

The following test values should be used for dielectric testing the new breaker and are to be applied for a one-minute period.

Description	60Hz
Primary Circuit	36.0kV
* Secondary Circuit (Control)	1100V

Once in service, the primary circuit should be tested at 75% of this rating

*If it is desired to make a dielectric test on the secondary control wiring, turn the spring charging motor disconnect switch (1, Fig. 3) to the "OFF" position. Apply test voltage (1100V-AC) for one minute to each of the secondary disconnect contacts at the rear of the circuit breaker.

If it is desired to make a dielectric test on the spring charging motor, turn the motor disconnect switch (1, Fig. 3) to the "ON" position. Apply test voltage (540V-AC) for one minute to the motor circuit.

ELECTRICAL CHARACTERISTICS OF CONTROL DEVICES

For operating voltage ranges for various nominal control voltages, refer to Table 1.

For average current values at various nominal control voltages, refer to Table 2. The current values given in this table are average, steady state values and momentary inrush currents for all charging motors and AC coils are approximately six to eight times these values.

ELECTRICAL OPERATING SEQUENCE

Please refer to the specific schematic diagrams and other operational information furnished with your order.

Figure 10 and 11 are provided as typical schematics for general information on electrical operation.

DC CLOSING OPERATING SEQUENCE

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

1. Immediately upon the availability of control power, the spring charging motor (motor) is energized, which in turn charges the closing springs. When the closing springs are charged, limit switch contact "LSb" is opened, and limit switch contact "LSa" is closed.

2. Operation of the Close Control switch energizes the latch release coil (X) through the circuit breaker auxiliary switch "b" contact, the normally closed lockout relay contact "Yb", and the limit switch contact "LSa". The latch release coil (X) releases the closing latch. The springs then discharge to close the circuit breaker.

3. When the springs discharge, limit switch contact "LSb" closes and switch contact "LSa" opens.

4. When limit switch "LSb" in the motor circuit closes, the spring charging motor is energized, which in turn recharges the closing springs.

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

6. When the limit switch contact "LSb" closes, the lockout relay coil (Y) is energized and opens lockout relay contact "Yb", which deenergizes the latch release coil (X). Lockout relay contact "Ya" closes, which seals-in the lockout relay coil (Y) as long as the "close" contact is maintained. The purpose of the lockout relay coil (Y) is to prevent pumping of the closing mechanism when closing against a faulted circuit.

7. After the breaker has closed and when the "close" switch is released by the operator, the lockout relay coil (Y) is deenergized. This allows the normally-closed lockout relay contact "Yb" to close, and the normally-open lockout relay contact "Ya" to open.

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

9. The undervoltage device, if furnished, provides a direct acting lock-open and undervoltage tripping feature. This device must be energized to initially close the breaker, and also to maintain the breaker in a closed position.

10. The latch check switch, if furnished, insures that the tripping mechanism must be reset prior to energizing the closing latch release coil (X).

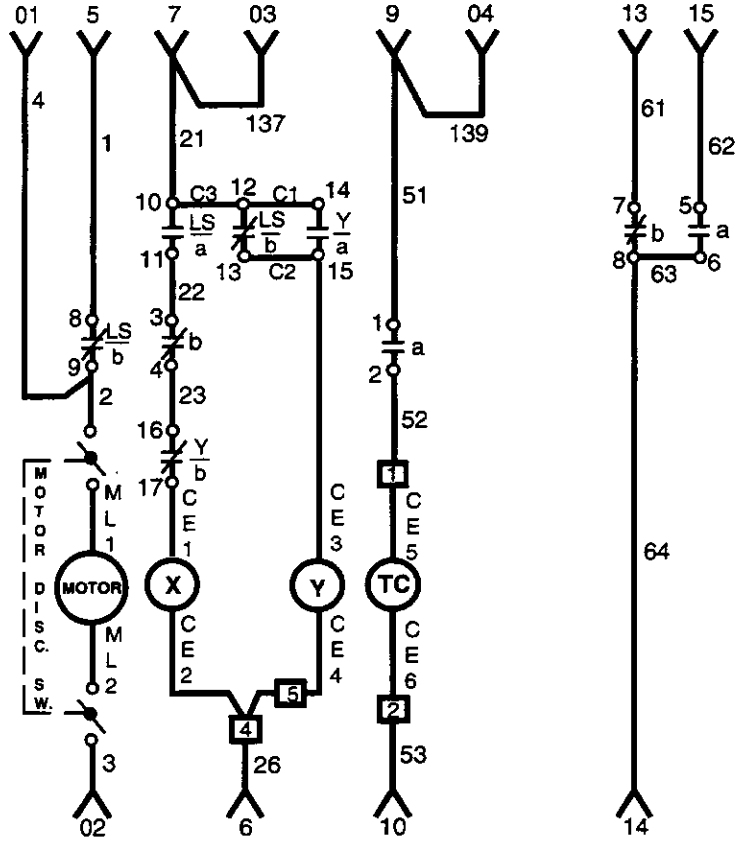
11. The stopping device switch, if applicable, prevents electrical reclosing of the circuit breaker after a manual trip until the stopping device has been manually reset.

Table 1 - Operating Voltage Range

Nominal Control Voltage	Spring Charging Motor	Close Coil	Trip Coil	Undervoltage	
				Pick-up Maximum	Drop-out
48 V dc	38 - 56	38 - 56	28 - 56	41	15 - 29
125 V dc	100 - 140	100 - 140	70 - 140	105	38 - 75
250 V dc	200 - 280	200 - 280	140 - 280	212	75 - 150
120 V ac	104 - 127	104 - 127	104 - 127	102	36 - 72
240 V ac	208 - 254	208 - 254	208 - 254	204	74 - 144

Table 2 - Average Current Values

Nominal Control Voltage	Spring Charging Motor	Close Coil	Trip Coil	Lockout Coil	Under Voltage	N.E.C. Fuse
48 V dc	25.0	10.7	3.14	0.15	0.3	30
125 V dc	10.0	5.0	5.0	0.06	0.2	30
250 V dc	5.0	2.2	0.65	0.03	0.1	30
120 V ac	10.0	4.5	6.5	0.40	0.5	30
240 V ac	5.0	2.3	1.15	0.20	0.2	30



LEGEND

a -------- Auxiliary Switch Contact Closed When Breaker Is Closed.
b -------- Auxiliary Switch Contact Open When Breaker Is Closed.
LCb ------ Latch Check Switch Contact Closed When Breaker Operating Mechanism Is Reset. (Option)
LSa ------ Limit Switch Contact Open When Springs Are Discharged. Closed When Springs Are Charged.
LSb ------ Limit Switch Contact Closed When Springs Are Discharged. Open When Springs Are Charged.
TC ------- Shunt Trip Coil.
X --------- Control Relay Release Coil.
Y --------- Control Relay Lockout Coil.
Ya ------- Normally Open Control Relay Contact.
Yb ------- Normally Closed Control Relay Contact.
□ ---------Terminal Block Point.
ML ------- Motor Lead.
CE ------- Coil Lead End.
C1, C2 -- Terminal Jumper (Control Device).
——< -- Female Secondary Disconnect Contact.

Figure 10 - Typical DC Schematic Diagram Of Control Circuit

AC CLOSING OPERATING SEQUENCE

With the circuit breaker open, the closing springs uncharged, and the control power source energized across disconnects "5" & "02" and "01" & "6", motor disconnect switch closed, operation occurs as follows:

1. Immediately upon the availability of control power at secondary disconnects "5" and "02", the spring charging motor (motor) is energized, which in turn charges the closing springs. When the closing springs are charged, limit switch contact "LSa" is closed. Also, upon availability of control power at secondary disconnects "01" and "6" and after the closing springs have been charged, the lockout relay coil (Y) will be energized through the circuit breaker auxiliary switch "b" contact and the parallel resistors R_1 and R_2. The lockout relay will pick up and close contact "Ya".

2. Connecting secondary disconnects "03 or "7" to control via operation of the close control switch energizes the latch release coil (X) through the circuit breaker auxiliary switch "b" contact, the normally open lockout relay contact "Ya", and the limit switch contact "LSa". The latch release coil (X) releases the closing latch. The springs then discharge to close the circuit breaker.

3. When the springs discharge, limit switch contact "LSb" closes and limit switch contact "LSa" opens.

4. When limit switch contact "LSb" in the motor circuit closes, the spring charging motor is energized, which in turn recharges the closing springs.

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

6. When the limit switch contact "LSa" opens, both the latch release coil (X) and the lockout relay coil (Y) are deenergized. Contact "Ya" opens the latch release coil (X) circuit. Contact "Yb" closes connecting resistors "R_1" and "R_2" directly to control power as long as the close control switch remains closed. The circuit breaker is prevented from any automatic reclosing in the event "LSa" and auxiliary switch "b" close because "Ya" remains open. The "Yb" contact shorts out the lockout relay coil (Y) through resistors "R_1" and "R_2". The purpose of the lockout relay is to prevent pumping of the circuit breaker's mechanism when closing against a faulted circuit.

7. After the breaker has closed and when the closing control switch is released by the operator, the lockout relay coil (Y) remains deenergized due to the auxiliary switch "b" contact in the closing circuit being open.

8. The circuit breaker can be tripped by operation of the "Remote Trip" switch, which energizes the circuit breaker trip coil (TC) through the auxiliary switch "a" contact.

9. The undervoltage device, if furnished, provides a direct acting lock-open and undervoltage tripping feature. This device must be energized to initially close the breaker, and also to maintain the breaker in a closed position.

10. The latch check switch, if furnished, insures that the operating mechanism must be reset prior to energizing the closing latch release coil (X).

11. The remote mounted capacitor trip feature, if furnished, provides an electrical energy storage network, whereby should a loss of control power occur at the instant of a tripping signal, sufficient energy will be furnished to insure an electrical tripping operation.

12. The stopping device switch, if applicable, prevents electrical reclosing of the Circuit Breaker after a manual trip until the stopping device switch has been manually reset.

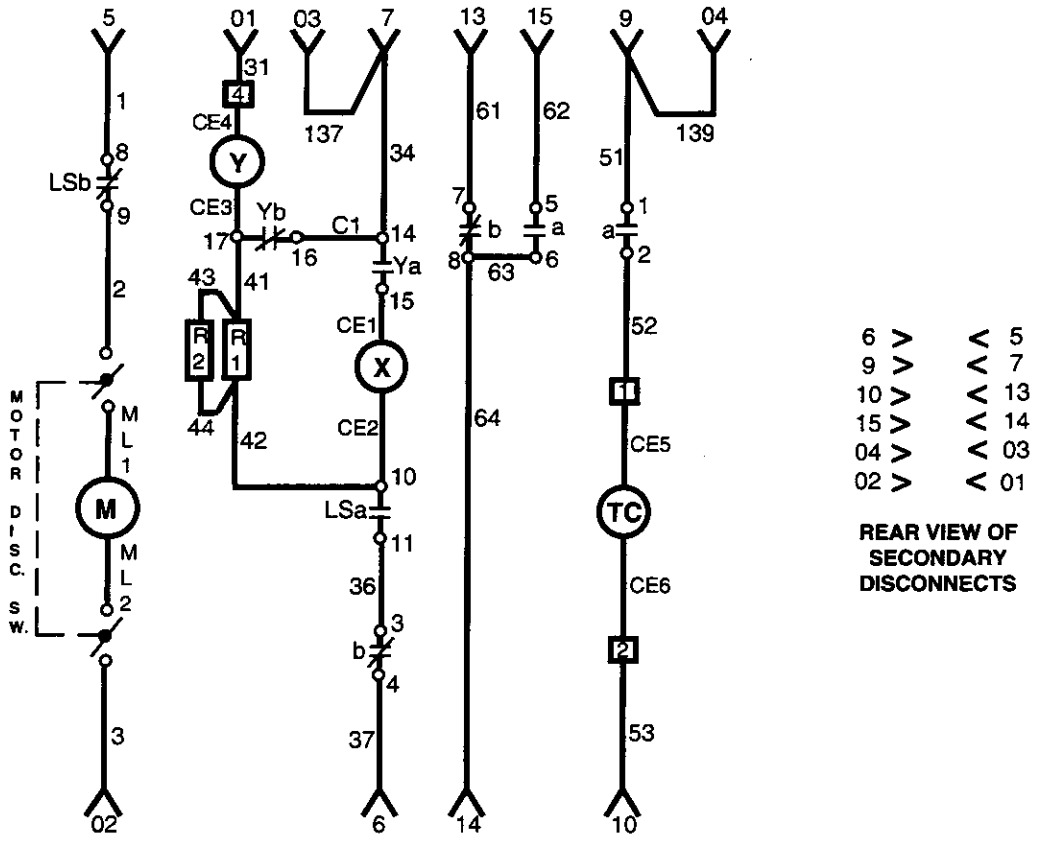


Figure 11 - AC Schematic Diagram Of Control Circuit

LEGEND

a ——— Auxiliary Switch Contact Closed When Breaker Is Closed.
b ——— Auxiliary Switch Contact Open When Breaker Is Closed.
LCb ——— Latch Check Switch Contact Closed When Breaker Operating Mechanism Is Reset. (Option)
LSa ——— Limit Switch Contact Open When Springs Are Discharged. Closed When Springs Are Charged.
LSb ——— Limit Switch Contact Closed When Springs Are Discharged. Open When Springs Are Charged.
TC ——— Shunt Trip Coil.
X ——— Control Relay Release Coil.
Y ——— Control Relay Lockout Coil.
Ya ——— Normally Open Control Relay Contact.
Yb ——— Normally Closed Control Relay Contact.
□ ——— Terminal Block Point.
ML ——— Motor Lead.
CE ——— Coil Lead End.
C1, C2 – Terminal Jumper (Control Device).
——<– Female Secondary Disconnect Contact.
R1, R2 – Resistors

We recommend only those renewal parts that will be required to insure proper and timely maintenance for normal operation of the 15VHK Model 20 & 5VHK Model 23 series circuit breakers be stocked. Copies of the applicable Renewal Parts Bulletin for specific circuit breakers will be furnished on request to the nearest District Office.

The minimum quantity of assemblies and items recommended in these bulletins are predicated on infrequent replacement of parts based on accumulated tests and operating experience. Total assemblies are recommended for fast replacement, when it is necessary to return the breaker to service as quickly as possible. Replaced assemblies can be returned to the factory for nominal reconditioning. The bulletins contain specific part ordering instructions. If desired, specific instructions regarding replacement of those part assemblies are also available.

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ASEA BROWN BOVERI

MS 3.2.1.9-2A

Maintenance and Surveillance

Medium-Voltage
Switchgear Equipment

HKII Switchgear
IB 3.2.4.7-1

5VHK250
IB 6.2.7.7-3

7.5VHK500 and 15VHK500/750
IB 6.2.7.7-2

5VHK350 & 15VHK1000
IB 6.2.8.7-1

RECOMMENDED MAINTENANCE & SURVEILLANCE 5VHK, 7.5VHK & 15VHK SWITCHGEAR EQUIPMENT

EQUIPMENT MAINTENANCE PROGRAM

This Bulletin augments the information and instruction provided in Instruction Bulletin 3.2.4.7-1.

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

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

FREQUENCY OF MAINTENANCE

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

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

RECORDS

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

SPARE PARTS

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

1. GENERAL

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

a. The following lubricants are recommended:

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

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

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

DRY THREAD TORQUE		
BOLT DIA.	TORQUE High Strength Steel	TORQUE Silicon Bronze
3/8"	15-25 ft. lb.	15-20 ft. lb.
1/2"	30-45 ft. lb.	25-35 ft. lb.
5/8"	50-75 ft. lb.	45-60 ft. lb.
3/4"	60-80 ft. lb.	65-75 ft. lb.

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

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

2. RECEIPT AND STORAGE

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

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

*If relative humidity above 50% is anticipated, localized heat sources should be provided to maintain equipment temperature above the dew point. One means of accomplishing this is to energize internal equipment space heaters, if furnished, and store circuit breakers within the equipment enclosures. Note that equipment must be on a flat level surface to avoid floor distortion.

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

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

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE.

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

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

c. Check all bolted connections for proper torque.

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

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

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

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

h. Check control wire connections - See 6c.

i. Check trip/racking interlock to verify no racking with breaker closed and no closing unless breaker is latched in position.

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

4. TWELVE TO EIGHTEEN MONTH INTERVALS

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE.

a. Identify and service circuit breakers which are due. See CIRCUIT BREAKER SERVICING section, page 6 of this Bulletin.

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

c. Inspect primary interface connections with other equipment for signs of excessive heat (Cable and bus connection, usually in the rear of the equipment.) Discoloration or embrittlement of adjacent insulating materials and conductor corrosion or discoloration may indicate a hot joint. See HOT JOINT MAINTENANCE, Page 5.

d. Inspect primary cable for chafing at conduits or supports and loose or missing stress relief grounds.

e. Exercise the racking mechanism.

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

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE.

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

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

c. Clean stationary breaker connection stabs in the enclosure with a solvent approved by NIOSH or local authority. Inspect for evidence of contact galling, excessive heat, arcing or corrosion. If found, proceed per HOT JOINT MAINTENANCE, page 5. Re-apply NO-OX-ID compound prior to reconnecting circuit breaker.

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

6. TEN YEAR MAXIMUM INTERVAL

CAUTION: TURN OFF ALL POWER BEFORE WORKING INSIDE.

CIRCUIT BREAKER REFURBISHMENT

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

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

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

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

JOINT COVERS - During surveillance it may be necessary to remove joint covers. It is possible that the cover may crack when it is flexed for removal or replacement due to embrittlement from loss of plasticizer. An isolated incidence of such cracking indicates that the joint has been operating at higher temperatures than normal. A cracked cover should not be reused. An embrittled cover which has not cracked will provide insulating capabilities at least as long as it took to embrittle. Generalized embrittlement of joint covers is not expected for twenty years or more. If the cover is cracked, its part number may be located in the inside part of the cover . Please contact the customer service group at the ABB Sanford facility for replacement.

CIRCUIT BREAKER SERVICING

Circuit breakers require inspection and servicing periodically to assure operability. Servicing should be accomplished based on number of operations since last serviced, with an elapsed time limit. The appropriate frequency of servicing depends on the duty of the circuit breaker. As experience warrants, the recommended frequency of servicing shown below should be adjusted on specific breakers to account for more/less severe duty than initially expected, based on the breaker condition when serviced. Variations in actual in-service duty will cause these intervals to change. These intervals should be used as a general guideline only.

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

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

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

5VHK-250, 7.5VHK-500, 15VHK-500/750 - 2000 operations.

5VHK-350, 15VHK-1000 - 1000 operations.

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

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

5VHK-250, 7.5VHK-500, 15VHK-500/750 - 750 operations.

5VHK-350, 15VHK-1000 - 400 operations.

FAULT INTERRUPTION

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

MECHANICAL OPERATING LIFE

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

5VHK-250, 7.5VHK-500, 15VHK-500/750 - 750, Total Operations - 10,000, Suggested Limit - 9,000.

5VHK-350, 15VHK-1000, Total Operations - 5,000, Suggested Limit - 4,500.

The following should be accomplished at each service interval:

CLEAN, INSPECT & LUBRICATE PRIMARY DISCONNECTS.

INSULATION CLEANING.

OPERATION CHECK

CONTACT PRESSURE CHECK**

MILLIVOLT DROP TEST

Instructions follow which clarify the above.

In addition, the hardware (bolts, nuts, screw and pin retainers) should be checked with a thorough inspection to be sure that they are in place and secure. There are other adjustments which may be required due to the operating or test abnormalities below:

TIMING TEST*

Recommended as a pertinent periodic test to evaluate breaker condition

CONTACT PRESSURE ADJUSTMENT**

Required if contact pressure check indicates a problem.

RACKING MECHANISM ADJUSTMENT**

Required if interlock fails to block closing while breaker is being racked in or out or racking latch is not blocked with breaker closed.

LATCH CHECK SWITCH ADJUSTMENT**

Required if circuit breaker fails to latch closed on reclosing.

LUBRICATION

The VHK circuit breakers are lubricated during factory assembly as follows:

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

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

The circuit breaker mechanism does not ordinarily require lubrication in the usual moderate service environment expected.

However, if operating difficulties are experienced, if grease becomes contaminated or if parts are replaced, relubrication with ANDEROL grease may be required. Extensive disassembly is required to properly relubricate the mechanism. Contact the nearest ABB Power Distribution district office for field assistance or factory refurbishing arrangements.

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

NOTES:

Do not use light oil to lubricate mechanism parts.

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

INSULATION CLEANING

Any dirt, dust or grease should be removed from the surfaces of the entire current carrying structure, vacuum interrupter, base insulation sheet and interphase barrier assembly. Wiping the surface with an oil-free solvent on a clean cloth or industrial wiper is normally sufficient for this purpose.

* Remember to discharge mid-band ring on interrupters so equipped.

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

OPERATIONS CHECK

During servicing it is desirable to verify breaker operability. It is recommended that this be done at the minimum expected control voltage level. (Typically 80% of nominal).

* Specific guidance on the timing test is included in the following instructions:
5VHK-250, 350 - IB 6.2.7.7-3, 7.5VHK-500, 15VHK-500/750 - IB 6.2.2.7-2 and 15VHK-1000 - IB 6.2.8.7-1.

** Consult the circuit breaker Instruction Bulletin for guidance in making the contact pressure check and adjustments.

MILLIVOLT DROP TEST

During servicing, the resistance of the circuit breaker current carrying parts can be checked with a millivolt drop test. This test should be performed regardless of circuit breaker duty or number of operations.

The following table lists millivolt drop and resistance values for the circuit breakers, from terminal to terminal, exclusive of the primary disconnects.

If the millivolt drop does not exceed 150% of the values, shown in the table on breakers with light loading, no contact maintenance is necessary. If the millivolt drop does exceed 150% of the values, contact the factory.

If breaker loading is 75% or more of rated current, it is recommended that the listed values be used as limits.

CURRENT RATING	MAXIMUM MV DROP (1)	MAXIMUM MICRO-OHMS
5VHK250 (26") 1200 Amp 2000 Amp	 8 6	 40 30
5VHK250 (36"),7.5VHK500 15VHK 500/750 MODEL 20 1200 2000	 7 6	 35 30
5VHK350, 15VHK1000 MODEL 05 1200 2000 3000	 6.5 5.5 5.0	 32.5 27.5 25.0

(1) Millivolt drop with 200 Amperes Flowing

TIMING TEST

Periodically, if functional check is desired, the closing and opening times should be checked by use of a time-travel analyzer*, oscillograph or cycle counter to monitor the time from energizing the control to the contacts being fully closed or fully open.

The circuit breaker closing and opening times should be within the following time ranges for normal operation.

NOTES: Below 0° C, the closing times will increase, opening times will be within the limits.

If timing is outside the limits, the factory should be contacted for recommendations.

CIRCUIT BREAKER	CLOSING TIME RANGE - MS**	OPERATING TIME RANGE - MS**
5VHK250 (26") 1200 Amp 2000 Amp	40-60	25-35
5VHK250 (36"), 7.5VHK500 15VHK 500/750 MODEL 20 1200 2000	40-60	25-35
5VHK250, 15VHK1000 MODEL 05 1200 2000 3000	40-60	25-35
** With 125VDC Control, timing may vary slightly at other control voltages.		

* Analyzer mounting support and instructions available on special order.