

AUTOMATIC CIRCUIT RECLOSERS

INSTRUCTIONS

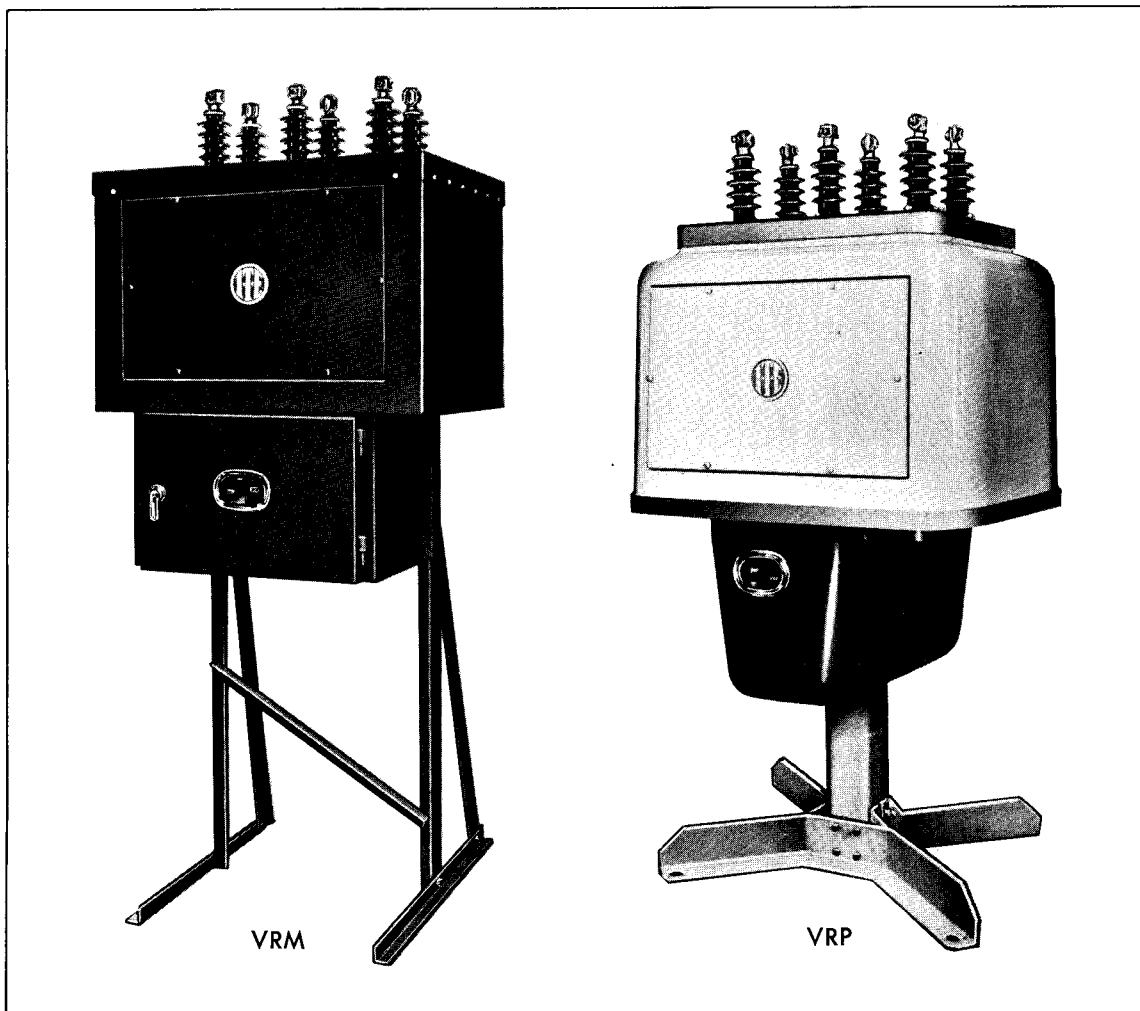
INSTALLATION, OPERATION AND MAINTENANCE

**VRM-15-12 AND VRP-15-12
VACUUM RECLOSERS**

2400 to 15,500 Volts

560 Amperes Continuous Current-Carrying Capacity

12,000 Amperes RMS Symmetrical Interrupting Capacity
with R101 Solid-State Control



I-T-E CIRCUIT BREAKER COMPANY



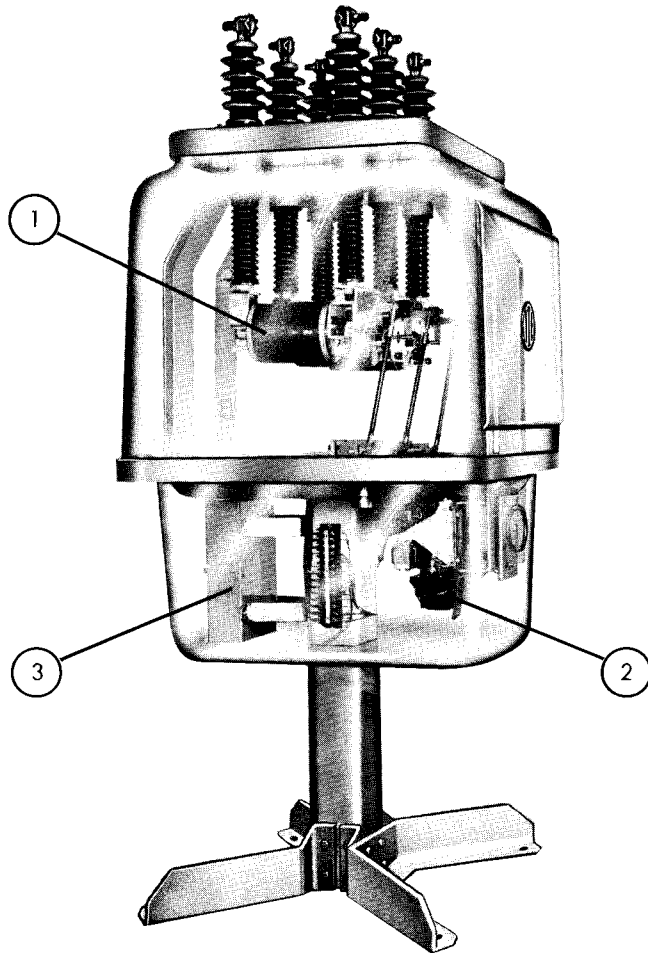
**INSTRUCTIONS FOR
INSTALLATION, OPERATION AND MAINTENANCE OF
VRM-15-12 AND VRP-15-12 VACUUM RECLOSERS**

GENERAL

This manual provides instructions for the installation, operation and maintenance of models VRM-15-12, metal-housed, and VRP-15-12, plastic-housed, three-phase vacuum reclosers.

It is recommended that this manual and the equipment drawings be reviewed before actual work is started on installing, operating and/or maintaining this equipment.

For a description of the I-T-E vacuum recloser and its functions, refer to I-T-E Catalog Section 1571-9.9.1.



- 1. VACUUM INTERRUPTERS
- 2. STORED-ENERGY OPERATING MECHANISM
- 3. SOLID-STATE CONTROL

**Fig. 1. Vacuum Recloser with Plastic Housing.
Phantom View with Interphase Barriers Removed.**

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I. INSTALLATION AND OPERATION
RECEIVING AND INSPECTION

Upon receipt of the recloser, examine it for in-transit loss or damage. Look particularly for such things as bent frame, dented housing and chipped porcelain bushings. If loss or damage is evident, file a claim at once with the carrier and notify the I-T-E Circuit Breaker Company.

The recloser is shipped in contacts-open position with both the opening and the closing stored-energy mechanisms discharged. For safety to personnel, the recloser should be stored in this condition.

Hook eyes are provided on the top of the housing for a crane lift. After removing the front portion of the crate and all packing material, lift the unit from the remainder of the crate. If the recloser is a metal-housed model, attach the supporting frame in accordance with Figure 2.

Look on the bottom of both the high voltage compartment and the low voltage compartment for any parts that may have been broken from the assemblies during shipment.

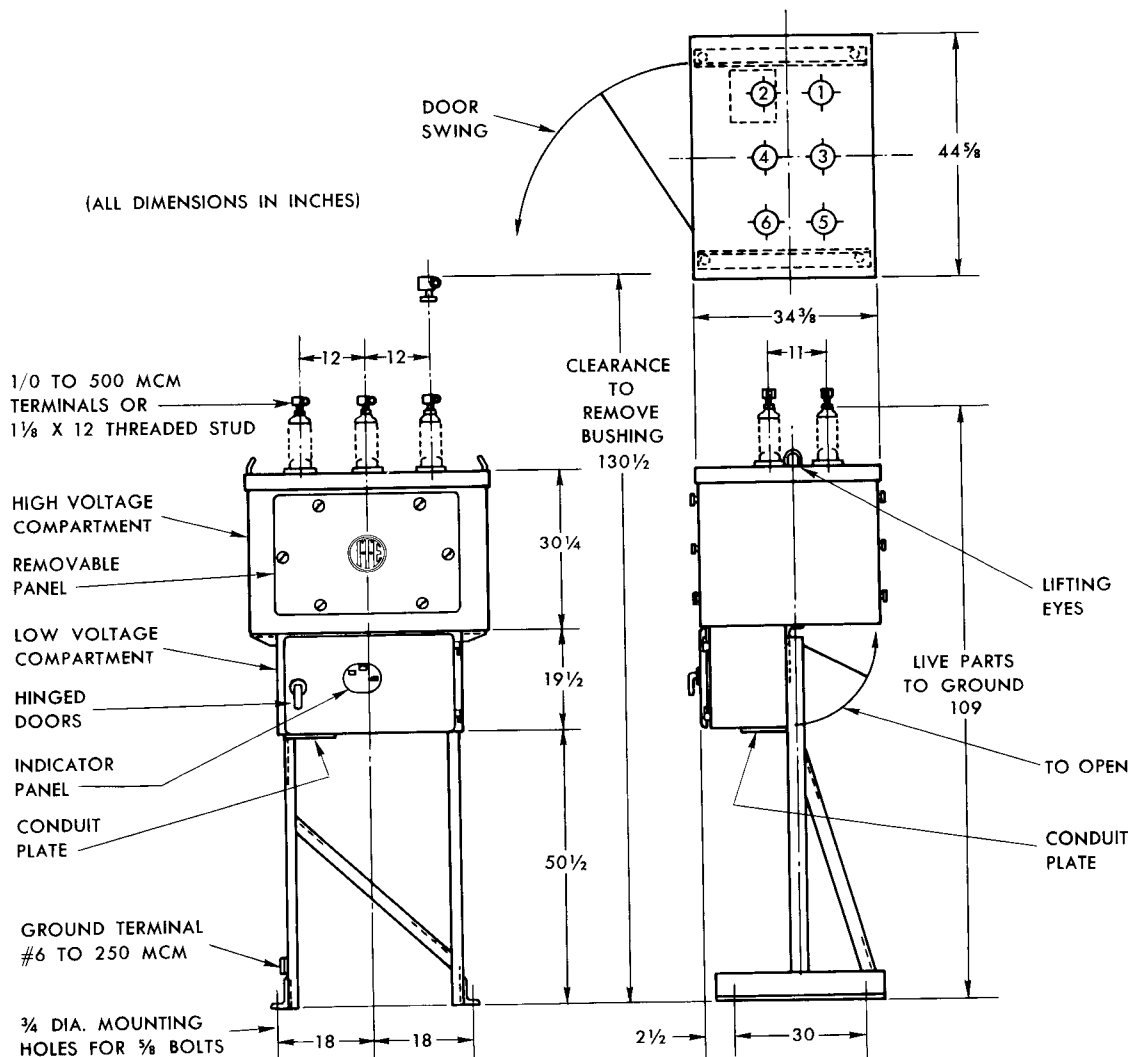


Fig. 2. Metal-Housed Recloser (Model VRM) Assembled for Station Mounting.



If the recloser is a plastic-housed model, it will be shipped with the standard pedestal and base assembled. If a pedestal extension has been ordered, it will be shipped in the same crate, but must be assembled at the site. Assemble as follows:

1. Uncrate the recloser and remove the pedestal extension from the crate.

2. Raise the total recloser assembly about 2 feet off the ground, using the hook eyes provided on top of the housing.

3. Unbolt the base and remove it from the pedestal.

4. Bolt the pedestal extension in place as shown in Figure 3.

5. Reassemble the base to the bottom of the pedestal extension.

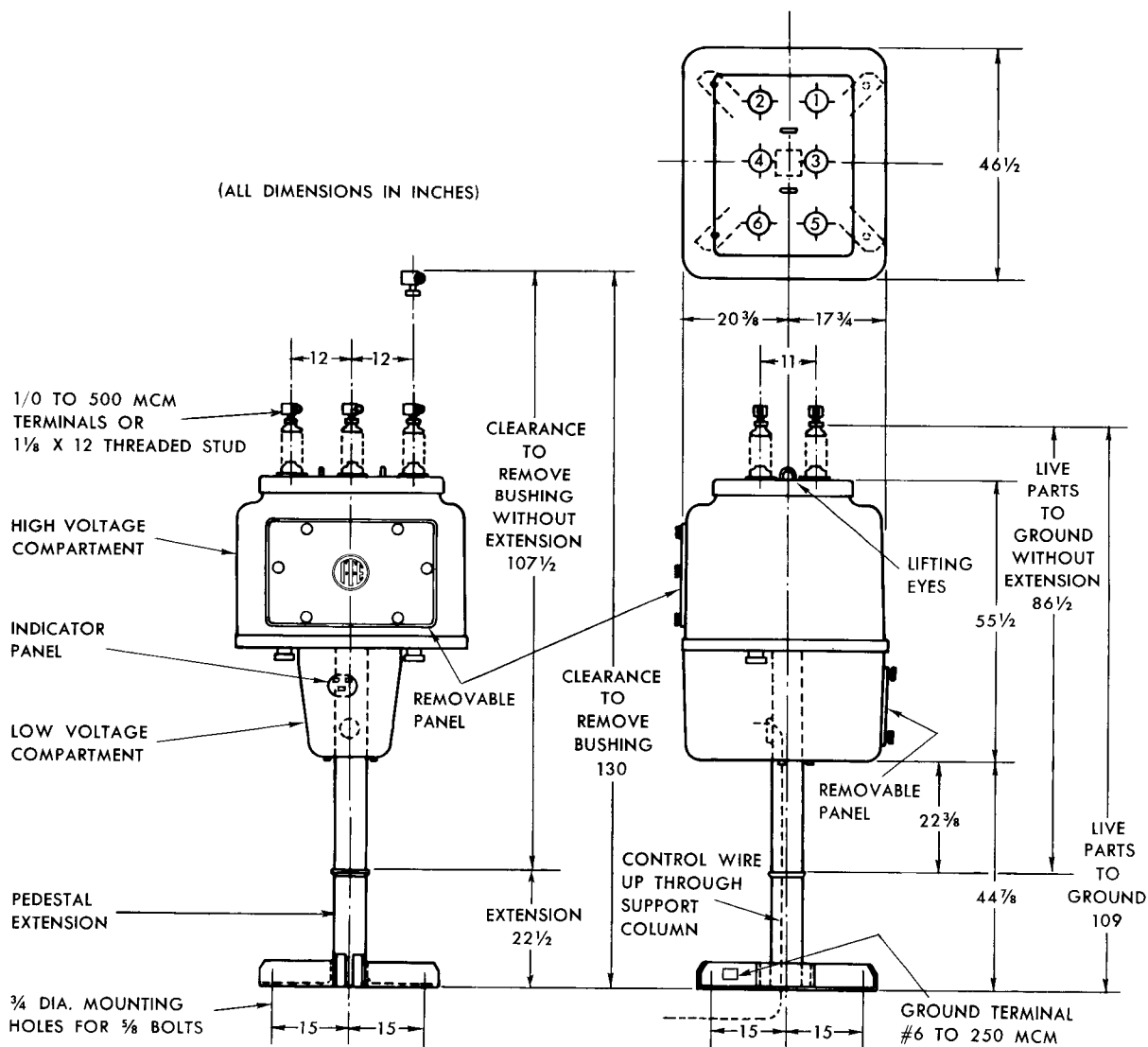


Fig. 3. Assembly of the Pedestal Extension on the Model VRP.



INSTALLATION

GENERAL

It is recommended that the recloser be installed with the closing and opening mechanisms discharged. However, if testing has charged these mechanisms, then it is necessary to discharge both the opening and closing springs of the stored-energy operating mechanism as follows:

1. Press the EMERGENCY TRIP BUTTON located on the indicator panel. See Figure 4.
2. Push up on the EMERGENCY CLOSE LEVER located on the indicator panel.
3. Press the EMERGENCY TRIP BUTTON again.

Assuming that no control power is present, all operating springs will now be discharged and the main contacts will be in the open position.

MOUNTING

Because of the absence of shock during operation of the vacuum recloser, the foundation may be as simple as two parallel timber beams. If a concrete foundation is used, it should be level, but need not be of conventional depth construction. A floating pad that does not extend below the frost line is adequate.

The general configuration, dimensions, location of foundation bolts, power line connections, access panels or doors, and provisions for conduit connections needed to mount both recloser models are shown in Figures 2 and 3. Refer also to equipment drawings for specific installations.

The recloser should be positioned on the foundation so there is enough accessibility for manual operation and inspection. All lifting should be done with a sling that is hooked into the lifting eyes that are provided.

CONTROL WIRING

After the recloser is in position on its foundation, it is recommended that the control wiring be installed next (control supply, heater supply, and remote close and trip, if specified). The supply wires should be large enough so that, with full control current flowing to the recloser for one second, the voltage across the control terminals of the recloser will be within the following limits for the particular control voltage being used:

- 125 volts dc: 90 to 130 volts—10 amperes
- 115 volts ac: 95 to 125 volts—10 amperes
- 48 volts dc: 35 to 50 volts—25 amperes

NOTE: For normal stand-by service, current requirements are in milliamperes. With the metal-housed model, the control conduit is brought into the low voltage compartment through the removable conduit plate that is provided. With the plastic-housed model, the control conduit is brought in through the bottom of the hollow main pedestal (Figure 3).

CONTROL CONNECTIONS

All control and sensor connections are made inside the low voltage compartment on the terminal boards provided. Figures 5 and 6 show typical schematic and connections diagrams. Refer to actual drawings for installation.

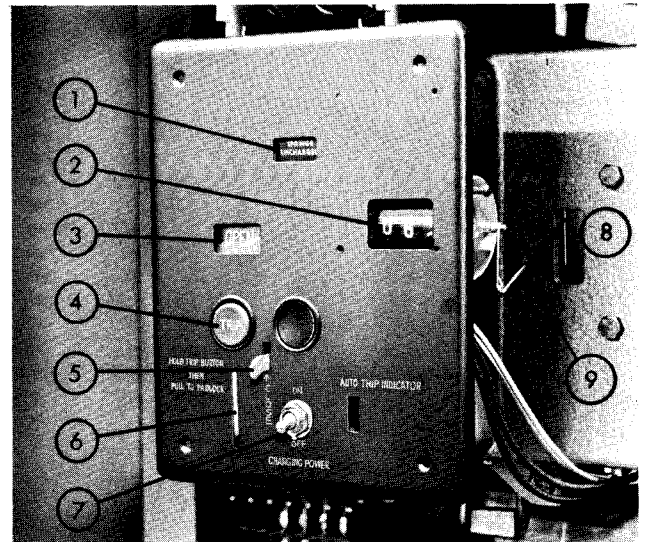
PRIMARY CONNECTIONS

The recloser bushings are fitted with integral clamp connectors that accommodate copper or ACSR cable sizes from 1/0 to 500 MCM, or, when specified, with 1/8 x 12 threaded studs.

The bushings are not designed to carry unnecessary strains from cable or bus bar. Therefore, the primary leads should be supported in a manner to avoid such strains on the bushings. If possible, leads should be brought down from above. Standard practices concerning electrical clearance between primary leads and parts of the recloser should be followed.

GROUND CONNECTIONS

The usual grounding practice is to connect a cable to the framework of the recloser and to the ground. A grounding pad with a bolted connector is provided on the recloser for this purpose . . . on the metal-housed model, it is located on one leg of the support frame . . . on the plastic-housed model, it is located on the pedestal base. The cable should be capable of carrying at least 25% of the continuous current rating of the recloser, but should not be smaller than 4/0.

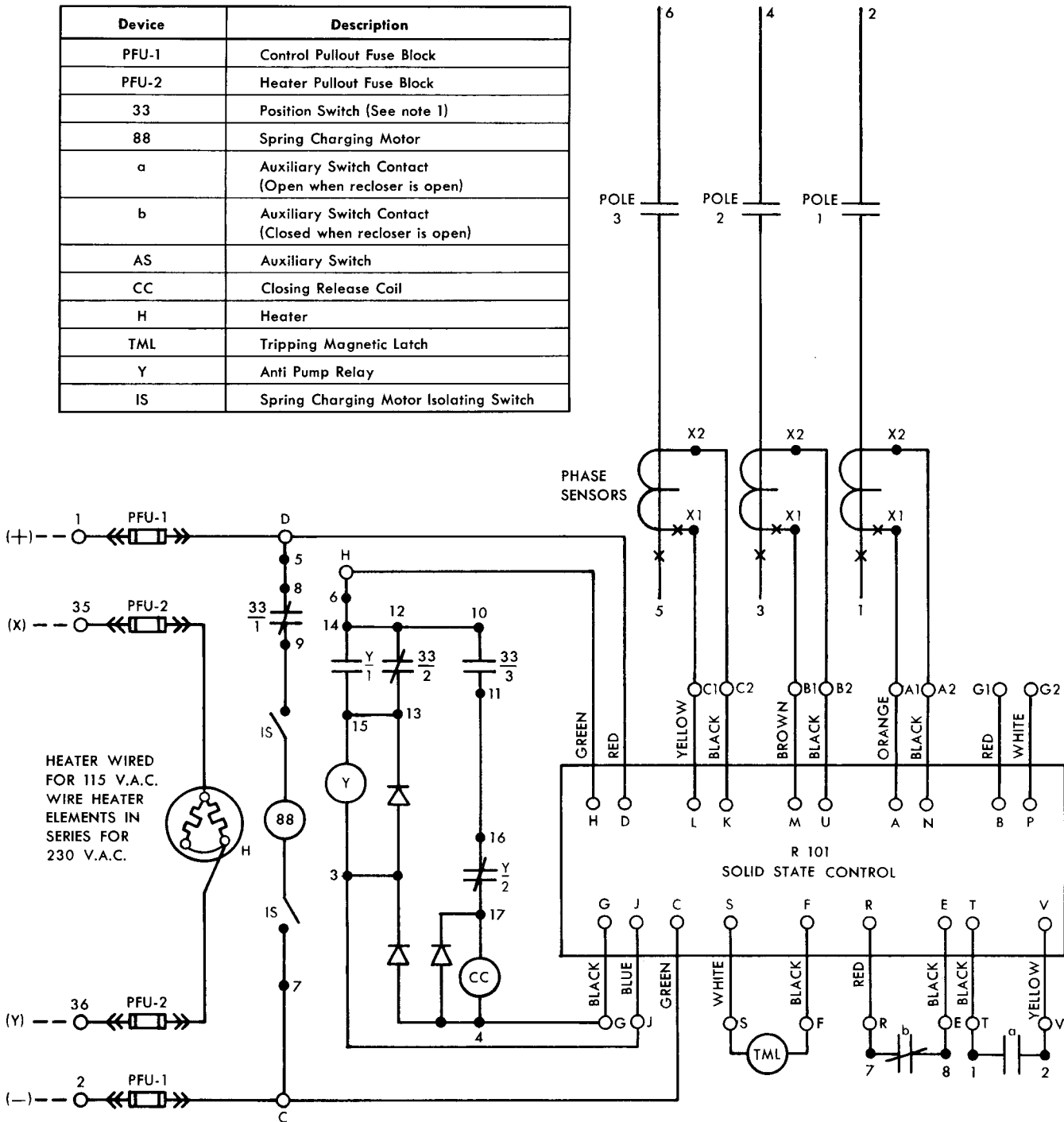


- | | |
|-------------------------------|----------------------------------|
| 1. CLOSING SPRING INDICATOR | 5. EMERGENCY CLOSE LEVER |
| 2. OPERATION COUNTER | 6. PROVISION FOR PADLOCKING OPEN |
| 3. CONTACT POSITION INDICATOR | 7. MOTOR SWITCH |
| 4. EMERGENCY TRIP BUTTON | 8. COUNTER OPERATOR ROD GUIDE |
| 9. COUNTER OPERATOR ROD | |

Fig. 4. Operating Mechanism Indicator Panel.



Device	Description
PFU-1	Control Pullout Fuse Block
PFU-2	Heater Pullout Fuse Block
33	Position Switch (See note 1)
88	Spring Charging Motor
a	Auxiliary Switch Contact (Open when recloser is open)
b	Auxiliary Switch Contact (Closed when recloser is open)
AS	Auxiliary Switch
CC	Closing Release Coil
H	Heater
TML	Tripping Magnetic Latch
Y	Anti Pump Relay
IS	Spring Charging Motor Isolating Switch



NOTE 1. Position Switch changes position when springs are charged.

NOTE 2. Schematic is shown with all devices deenergized, recloser open, and stored energy springs uncharged.

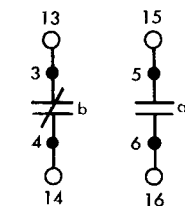


Fig. 5. Typical Schematic Diagram for Vacuum Recloser. Refer to Drawings for Actual.

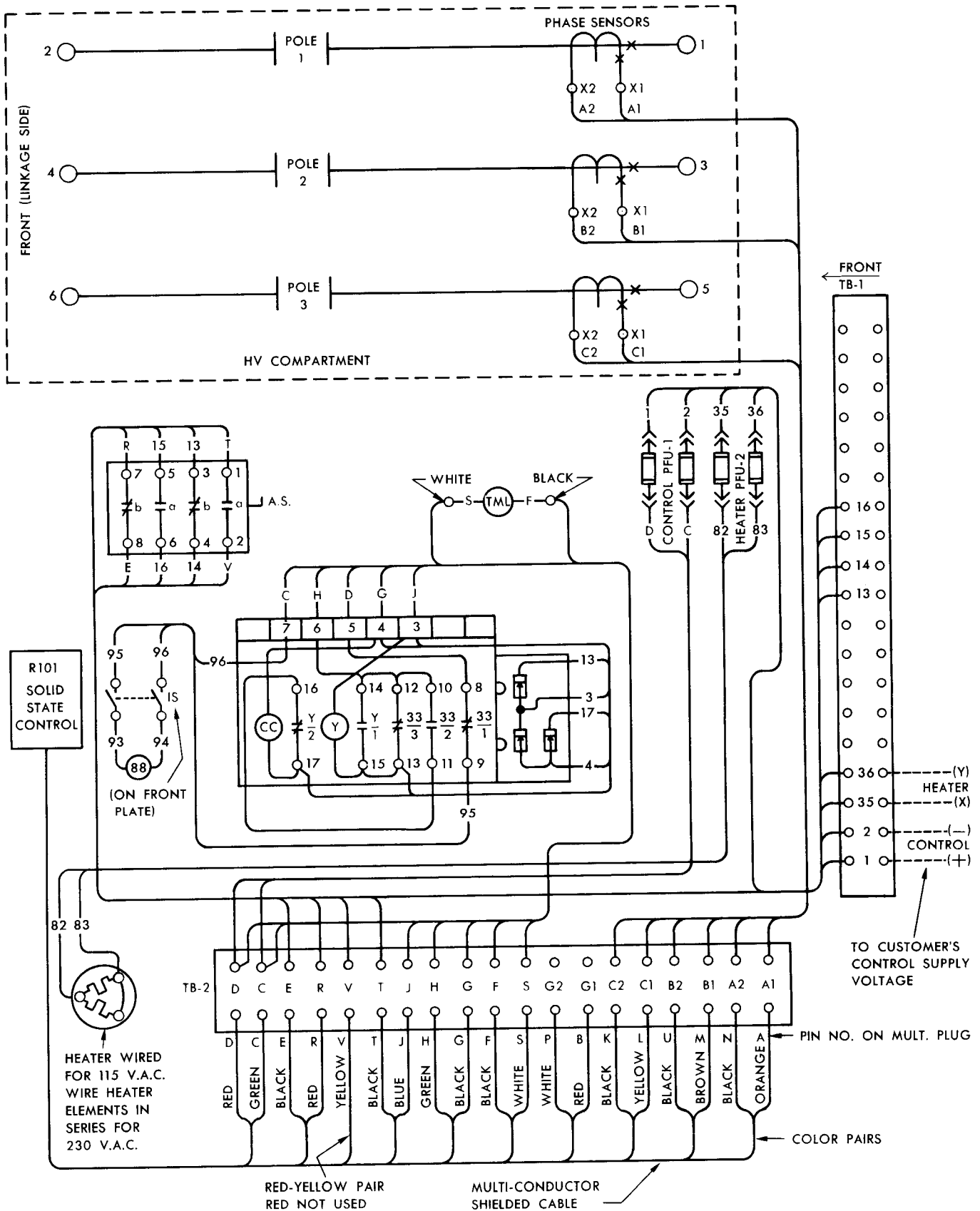


Fig. 6. Typical Connection Diagram for Vacuum Recloser (Rear View). Refer to Drawings for Actual.



PRE-OPERATION CHECKING

GENERAL

The recloser is not sensitive to deviations from true level, but, for sake of appearance, the level should be checked and corrected with shims if necessary. Make the following checks to be sure everything is in good order:

1. Examine the internal insulated wiring to be sure it has not been damaged during handling and installation.
2. Check to see that there are no loose nuts, washers, bolts, snap rings, cotter keys, terminal connections, etc.
3. Check that the conduit connections are properly installed and tightened.

Before energizing, the integrity of the vacuum interrupter may be checked by subjecting the recloser in the open position to a 35-kV withstand test.

MANUAL OPERATION

The following procedure should be followed to check out the manual operation of the recloser:

A. Manual-Mechanical Operation

1. Remove the control source fuse blocks—PFU-1 in Figure 6.
2. Manually charge the closing springs using the removable Maintenance Handle. Insert the handle in the two slots in the PAWL CARRIER (see Figure 7). Then raise and lower the handle in a pumping motion until the PAWL CARRIER no longer rotates the RATCHET WHEEL. The closing springs are now fully charged. Upon occasion, the MOTOR CRANK ARM may stop in such a position as to prevent a full racking stroke, requiring it to be rotated manually. If this happens, pry the motor crank arm off center with a large screw driver. You can move it either clockwise or counter-clockwise. The closing springs may then be charged as described above.
3. Close the main contacts by pushing up on the EMERGENCY CLOSE LEVER (See Figure 4).
4. Open the main contacts by pressing the EMERGENCY TRIP BUTTON (See Figure 4).

B. Manual-Electrical Operation

If the foregoing checks are satisfactory, then the fuse blocks may be inserted to complete the control power circuit. The recloser then is ready for electrical operation.

1. Turn the MOTOR SWITCH (see Figure 4) to ON. This will charge the closing springs. The opening springs are charged by the discharge of the closing springs.
2. Close and open the recloser by means of the manual-electric TRIP-CLOSE switch on the door of the solid-state control unit (see Figure 8).
3. Close and open the recloser from the remote control switch (if used) and check the operation of any devices connected to the auxiliary switches.

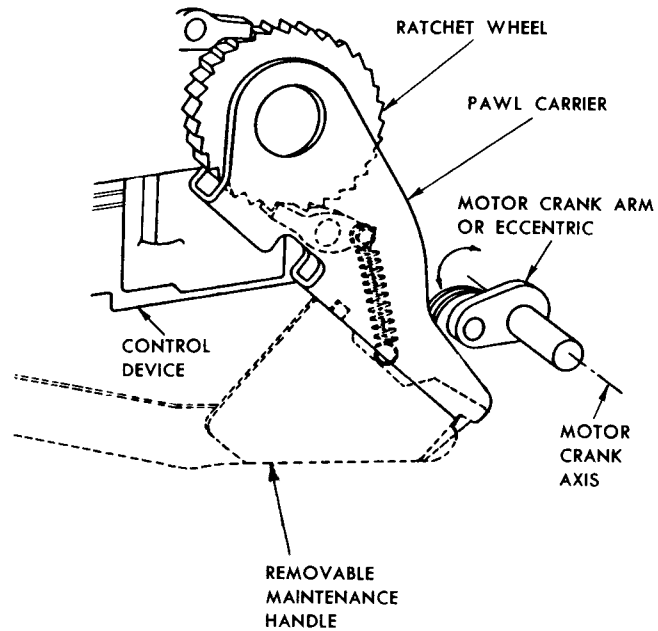


Fig. 7. How to Insert the Maintenance Handle.

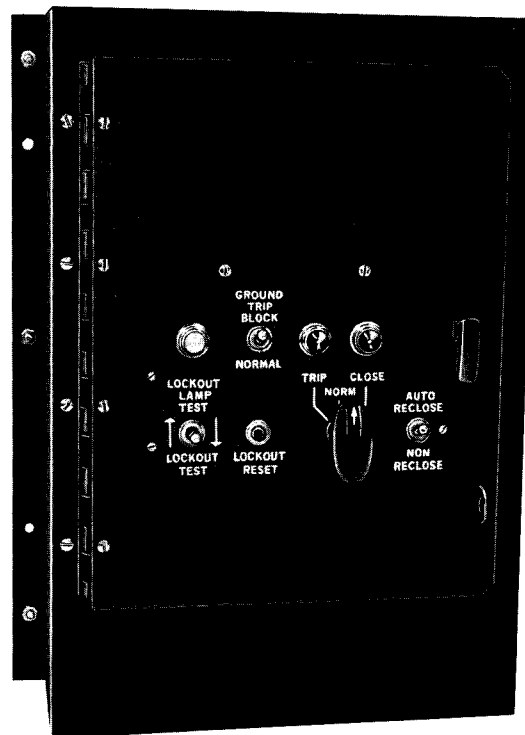


Fig. 8. Manual Operating Controls.



AUTOMATIC OPERATION

PROGRAM SELECTION

When the Vacuum Recloser is set for automatic operation, the only required procedure is to set the desired operation program on the solid-state control panel. A complete description of the various dials and their function is provided in I-T-E Catalog Section 1571-9.9.1.

The order in which a specific program is set on the solid-state control panel is not critical. However, the following order is recommended:

1. Set the desired *number of fast trips* on the NUMBER OF FAST TRIPS dial.
2. Set desired *total number of trips to lockout* on TRIPS TO LOCKOUT dial. The difference between total number of trips to lockout and number of fast trips will be the *number of time-delay trips* that will be performed. This sequence will be the same for phase and ground tripping.
3. Set the desired *phase fault pickup level* on the three PHASE PICKUP SETTING dials . . . one for each of the three phases. As explained in Catalog Section 1571-9.9.1, the dial calibrations indicate multiples of the phase fault sensors (from 1.0 to 2.0).
4. Set the desired *ground fault pickup level* on the one GROUND PICKUP SETTING dial (if used).

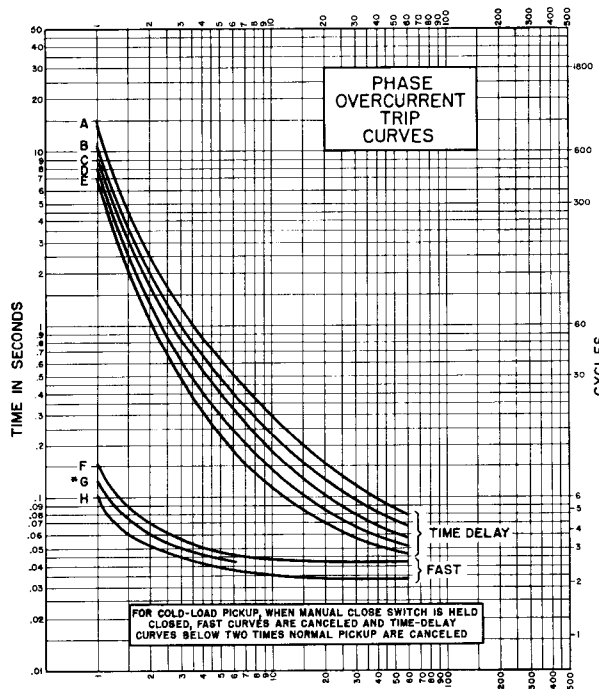
5. Set the desired *time-current curves* on the TIME-DELAY TIME CURRENT dials and the FAST TIME CURRENT dials.
6. Set the desired time (in seconds) for each *open interval* on the three OPEN TIME INTERVAL dials (1st, 2nd, and 3rd).
7. Set desired *reset time* (in seconds) on RESET TIME dial.

The open interval and reset timing will be the same for both phase and ground tripping.

The possible operating characteristics are shown in Figures 9 and 10. The curves shown correspond to the calibrations provided on the time-current dials. These dials may be set on the calibration markings to obtain the curves shown, or they may be set anywhere between calibrations to obtain any interpolated value.

There is provision for locking the access door to the program panel. This assures that only the relay engineer can alter any setting and that the program for a specific application will not be inadvertently altered by operating personnel who require access only to the manual operating controls, which are mounted on the door.

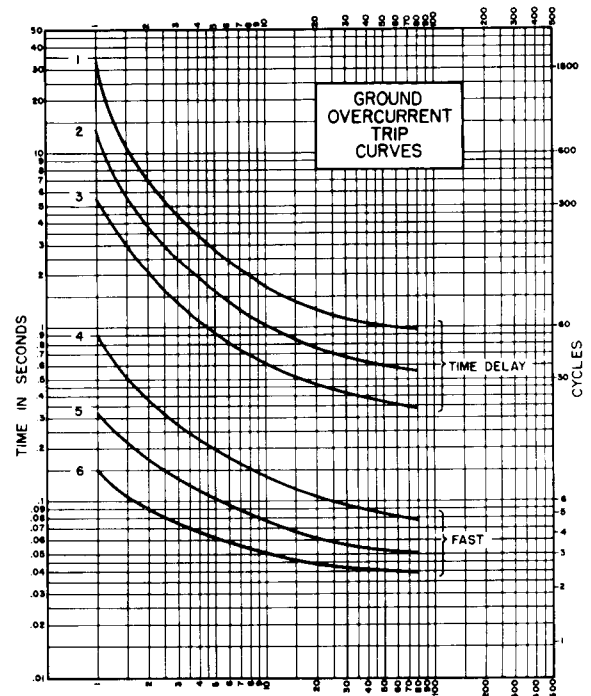
If a ground pickup of less than 25% of the phase pickup is required, refer to the nearest I-T-E Sales Office.



*Not significant beyond 4 times pickup.
CURRENT IN MULTIPLES OF PICKUP
FOR SENSORS RATED 100-140-200-280-400-560 AMPERES

- Time-delay curves are plotted to average test points so variations should be + or - 10% in current, or time whichever is greater for times above 0.1 second.
- Fast curves are plotted to maximum test points so variations should be negative.

Fig. 9. Phase Overcurrent Time-Current Characteristics.



CURRENT IN MULTIPLES OF PICKUP
FOR SENSORS RATED 50-70-100-140-200-280-400 AMPERES
Tolerance: + or - 10% of current or time, whichever is greater for time-delay curves.

Fig. 10. Ground Overcurrent Time-Current Characteristics.



EXAMPLES OF PRESELECTED PROGRAMS

The following examples illustrate how the vacuum recloser will respond to a hypothetical program that is set on the electronic control panel. Assume the following program:

1. Phase overcurrent sensors: rated at 400 amperes
2. Number of fast trips dial: set at 1
3. Number of trips to lockout dial: set at 3
4. Phase overcurrent pickup dials: all three set at 1.5
5. Time-delay time-current dial: set at B
6. Fast time-current dial: set at F
7. First open time interval dial: set at 0.33 seconds
8. Second open time interval dial: set at 5 seconds
9. Reset time dial: set at 2 seconds

EXAMPLE I:

Now, assume that the line experiences a 6000-ampere fault and it is a permanent type. The pickup level is 600 amperes (400-ampere sensors x 1.5) and thus the fault is 10 times pickup. Examining curve F in Figure 9, discloses that the recloser will interrupt the fault in 0.044 seconds on the fast trip. Curve B shows that the recloser will open in 0.23 seconds on the time-delay trips. Thus, the recloser will go through the following sequence when the 6000-ampere fault occurs:

1. Contacts open and interrupt the fault in 0.044 seconds
2. Reclose in 0.33 seconds
3. Contacts open again in 0.23 seconds
4. Reclose in 5 seconds
5. Trip again after another 0.23-second time delay
6. Lockout

EXAMPLE II:

Assume in a second case with the same program set on the control that the line experiences a 900-ampere fault which clears in 3 seconds on the third trip to lockout. The pickup level is still 600 amperes, but the fault is 1.5 times pickup or 900 amperes.

Referring to Fig. 9, curve F shows that the recloser will now trip in .09 seconds on the fast trip. Curve B shows that the recloser will open in 3.5 seconds on the time-delay trips.

Thus the recloser will go through the following sequence:

1. Contacts open in 0.09 seconds
2. Reclose in 0.33 seconds
3. Contacts open again in 3.5 seconds
4. Reclose in 5 seconds
5. Fault clears after 3 seconds

In the above example, the program is ready to reset during the time-delay trip after 2 seconds has elapsed. However, on the first time-delay trip, a fault is still present and *reset restraint* prevents the program from resetting. This is apparent as the program continues whereas if reset restraint had not prevented resetting, the third trip would have again been a fast trip rather than the time-delay trip called for on the control program.

Assume also that in the above example the line experiences a succeeding fault 0.5 seconds after the first fault has cleared.

The recloser will now be ready to start another complete sequence since the control was ready to reset its program

immediately after the first fault cleared, as the 2-second reset time had elapsed. Thus repetitive faults can be handled without sending the recloser to lockout and *reset restraint* prevents the program from being "scrambled."

EXAMPLE III:

Assume that in addition to the above program the recloser is equipped with ground overcurrent trip and the following settings are used:

1. Ground overcurrent sensors: rated at 100 amperes
2. Ground overcurrent pickup dial: set at 1.5
3. Ground time-delay dial: set at 1
4. Ground fast-time current dial: set at 6

If the line now experiences a 900-ampere phase fault, the current in the ground trip circuit can be expected to be about 500 amperes. The ground overcurrent pickup level is 150 amperes (100 ampere ground sensors X 1.5), thus the fault is 3.33 times ground pickup and 1.5 times phase pickup. From Fig. 9 we know that the recloser will trip in .09 seconds in response to the 900-ampere phase fault; however, Fig. 10 discloses that the recloser will trip in .07 seconds in response to the 500-ampere ground fault.

Curve B has previously shown that phase tripping will occur in 3.5 seconds and curve I shows that ground tripping will occur in 4 seconds.

In a case such as this, the curve which initiates tripping first is the governing curve so the sequence will now be:

1. Contacts open in 0.07 seconds
2. Reclose in 0.33 seconds
3. Open again in 3.5 seconds
4. Reclose in 5 seconds
5. Open in 3.5 seconds
6. Lockout

On finding the recloser open, the operator can confirm that it was locked out electrically by pressing the LOCKOUT TEST BUTTON and the red lamp will light on the control panel door. After the fault is repaired, the recloser is returned to automatic operation by blocking the GROUND TRIP and moving the TRIP-CLOSE SWITCH to the CLOSE position, and pressing the RESET PUSHBUTTON to re-establish the operating sequence.

If the primary circuit protected by the recloser has been out of service for some time, the starting current demanded by the connected load may be greater than the normal pickup and time-current-characteristic settings of the recloser. To pick up the load under these conditions, hold the TRIP-CLOSE SWITCH in the CLOSE position until the "cold load pickup" current subsides. With the control switch held in the CLOSE position, the fast trip operations are cancelled and the time-delay trips below two times normal pickup are cancelled. Thus, in the foregoing example, the recloser will not trip on a current of less than 1200 amperes.

Any overcurrent above the cold load pickup values will trip the recloser even though the TRIP-CLOSE SWITCH is held in the CLOSE position. When the TRIP-CLOSE SWITCH is released, it will spring return to NORMAL, and the normal pre-set pickup level, time-current characteristics, and sequence will be restored automatically.



NORMAL OPERATING PROCEDURE

1. Control Switch Operation:

- a. To Open Recloser - Move control switch to TRIP position. (Spring return to NORMAL)
- b. To Close Recloser - Move control switch to CLOSE position. (Spring return to NORMAL)

NOTE: If recloser is to be left open for an extended period of time, it is recommended that the right hand toggle switch be moved down to the NON-RECLOSE position. Restore to AUTO-RECLOSE position prior to reclosing.

2. Reclose From Electrical Lockout:

- a. Move ground switch (if supplied) up to GROUND TRIP BLOCK POSITION.
- b. Move control switch to CLOSE position and hold long enough to permit cold load inrush to subside. (Spring return to NORMAL.)
- c. Depress LOCKOUT RESET BUTTON to obtain reset.

d. Perform LOCKOUT TEST to verify reset. (If glow appears in signal lamp, repeat "c".)

e. Move ground switch (if supplied) down to NORMAL position.

NOTE: If recloser opens during step 2b, this indicates probability of a line fault that should be located and corrected.

3. Lockout Test:

a. Move toggle switch to LOCKOUT TEST position. A glow in the lockout test lamp discloses that a fault has sequenced the recloser to lockout. Reclose and reset will be in accord with steps 2a through 2e.

b. To test soundness of lockout test lamp, move toggle switch to LAMP TEST position. A glow in the lamp now proves a sound filament.

NOTE: Controls through Serial #150 use a push-button for the LOCKOUT TEST described in 3a. Step 3b cannot be performed on these controls.

MECHANICAL SAFETY LOCKOUT

To place recloser in Mechanical Lockout (Safety Lockout), push in and hold red emergency trip button on indicator panel and pull provision for padlocking. See Figure 4, page 5.

EMERGENCY OPERATING PROCEDURE

Should something happen that causes the control power to be lost, the recloser can be operated by mechanical means as follows:

1. To trip the recloser open:

Depress the red TRIP button on the indicator panel (see Figure 4, page 5).

2. To close the recloser:

Lift the EMERGENCY CLOSE lever located on the indicator panel (see Figure 4).

NOTE: If the closing springs are discharged, manually charge them by following the procedure described under "Manual Operation" on page 8.



NOTES



II. MAINTENANCE AND ADJUSTMENTS

GENERAL

Maintenance ordinarily will not be required except after prolonged usage. The only normal inspection is a visual check of the contact wear indicator. However, periodic checks can be made if desired by removing the recloser from service. Such checks may include: high-pot tests on the vacuum interrupters, mechanical operating checks and calibration checks on the R101 solid-state control as described on page 17. Figure 11 indicates the adjustments that are necessary following component replacement, as well as recommended trouble-shooting procedures.

SPECIAL NOTE: For a general inspection of the high voltage and low voltage compartments, be sure that the recloser is disconnected from all electric power (both high and low voltage). After the power lines have been disconnected, attach grounding leads before touching any of the recloser parts. Be sure the framework is well grounded. Also, do not touch any of the operating parts until the operating springs have been discharged.

ADJUSTMENTS FOLLOWING COMPONENT REPLACEMENT	
Component	Adjustments Required
Vacuum Interrupter . . .	(1) Contact travel (2) Contact wipe
Sensors	None required
Bushing Assembly . . .	Check Contact Travel Check Contact Wipe
Charging Motor . . .	None required
Mag Latch Assembly . .	(1) Mag latch trip spring clearance (2) Mag latch bias
Solid-state control . .	None required
Mech. Control Device .	Close latch release overtravel

TROUBLE SHOOTING PROCEDURE	
Symptom	Solution
Mechanism will not latch closed	(1) Check mag latch trip spring clearance. (2) Set mag latch bias.
Mechanism will not close electrically	(1) If closing solenoid is functioning, check close latch release overtravel. (2) If closing solenoid is not functioning, check control wiring. (3) If difficulty persists, replace closing control device.
Malfunction of solid state control (improper sequencing, timing, pickup levels, etc.)	(1) Set mag latch bias. (2) If above is properly adjusted, then check solid state control calibration. If still malfunctioning—replace with new unit. Do not tamper with control units.

Fig. 11. Adjustments and Trouble Shooting
Note: Perform steps in order listed.

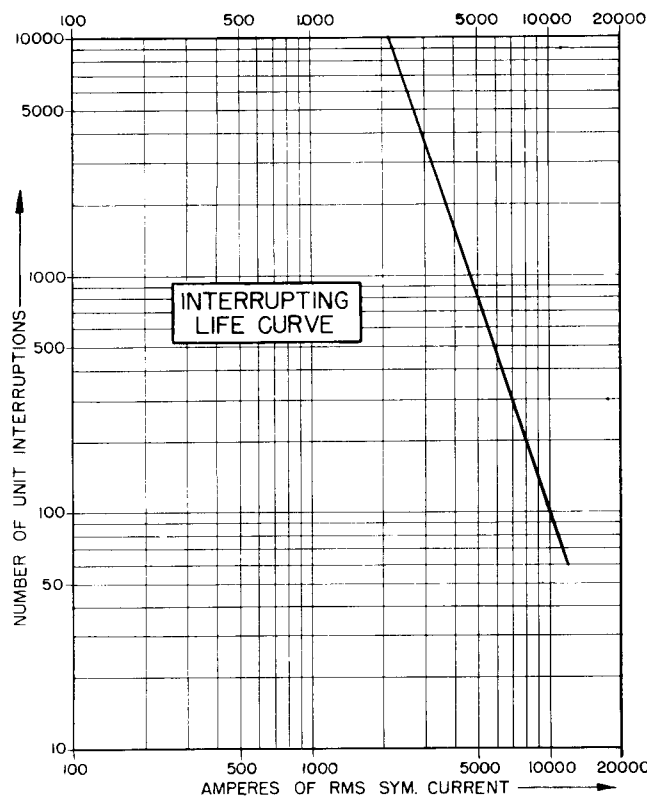


Fig. 12. Interrupting Life Curve.

INTERRUPTING LIFE CURVE IS BASED ON:

1. Three-phase grounded faults.
2. Sequences of four trips to lockout of two fast trips followed by two time-delay trips.
3. Open intervals of twenty cycles for the first, and two seconds for the second and third.
4. X/R of 16 for 10,000 to 12,000 amperes.

NOTE: Any lesser number of fast trips in the sequence, such as 1 fast and 3 time delay—1 fast and 2 time delay—0 fast and 1 to 4 time delay, will extend the interrupting life, as will longer than the basic open intervals or less than the X/R of 16.

CONTACT WEAR INDICATOR (Figure 13)

The WHITE BAND (42) just above the CONTACT PRESSURE SPRING (6) indicates the degree of contact wear. When a vacuum interrupter is new, the width of this band will be 1/8" (when the interrupter contacts are closed). As the contacts wear from erosion, this band will show less and less. When the point is reached where the WHITE BAND just disappears, the contacts have eroded 1/8" and the vacuum interrupter should be replaced.

Erosion is very slow . . . an estimate of operating life can be made from the INTERRUPTING RATING AND OPERATING LIFE DATA shown in Figure 12.

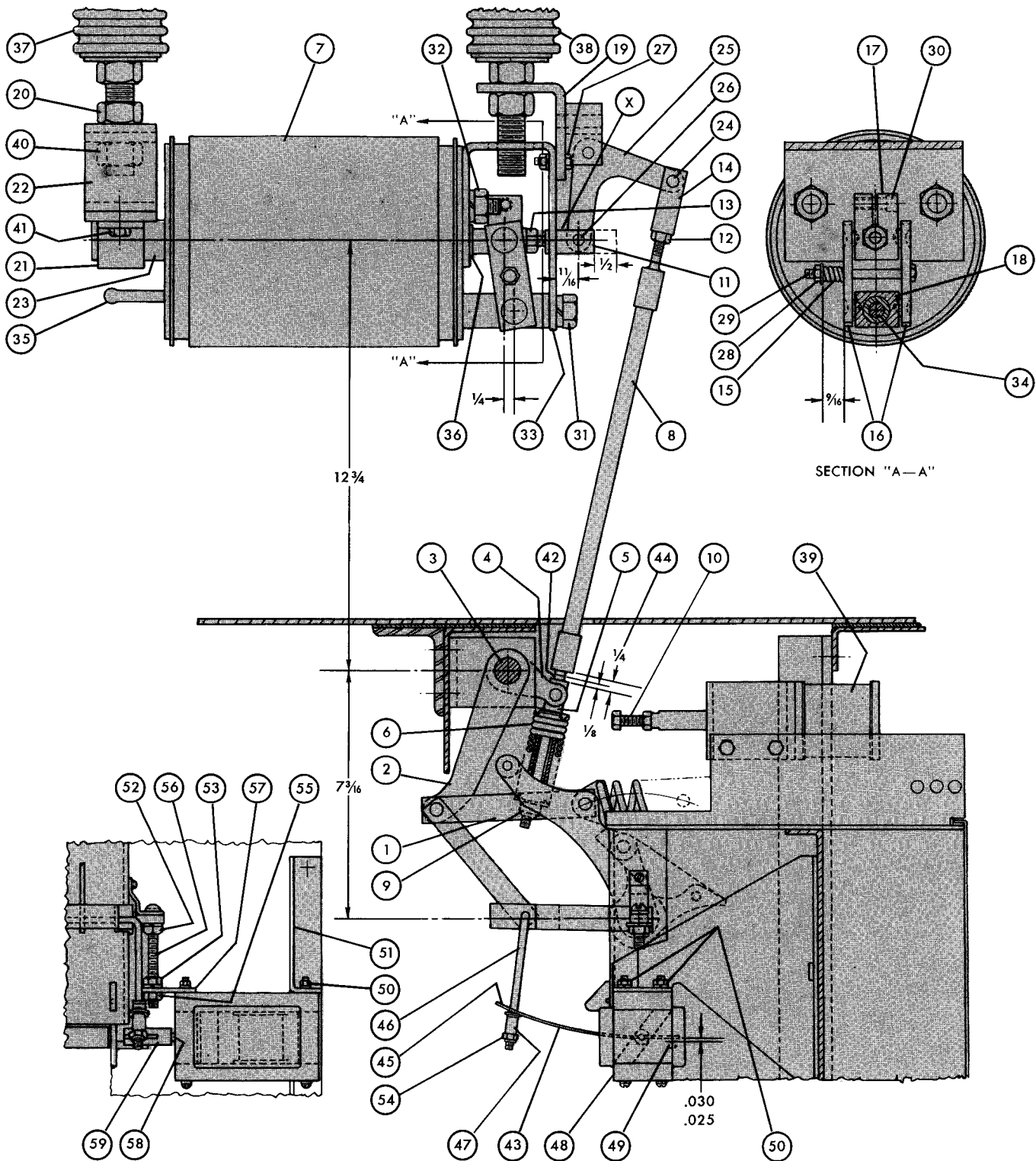


Fig. 13. Vacuum Interrupter and Mechanical Linkage.



CONTACT TRAVEL ADJUSTMENT (Figure 13)

Contact travel is adjusted only when a new vacuum interrupter is installed. This travel should be $\frac{1}{2}'' \pm \frac{1}{64}''$ from full closed position to full open position and may be measured at (11). Adjustment is made by loosening the LOCK NUT (12) and turning the INSULATED OPERATING ROD (8) in the required direction.

CONTACT WIPE (Figure 13)

The contact "wipe" (44) is adjusted at the factory at $\frac{1}{4}''$ with the recloser in the closed position and should be readjusted only when a new vacuum interrupter is installed. To close the contacts, the mechanism, through LINKS (1) and CRANK ARM (2), rotates the JACKSHAFT (3) in a clockwise direction. The SHORT CRANK ARMS (4) on each pole pull the INSULATED OPERATING ROD (8) down by a SLIDABLE HEAD (5) biased by CONTACT PRESSURE SPRING (6). When the primary contacts in the VACUUM INTERRUPTER (7) touch, the downward travel of the INSULATED OPERATING ROD (8) is stopped. At this point the SLIDABLE HEAD (5) is forcibly driven down, increasing the deflection of the CONTACT PRESSURE SPRING (6). With the contact travel properly adjusted, the wipe or overtravel may be adjusted by changing the total travel. Total travel from closed to open is controlled by the adjusting SCREW (10) on the BUFFER STOP PISTON (39).

TRIP LATCH ADJUSTMENT (Figure 14)

The TRIP LATCH ADJUSTING SCREW is located on the side of the OPERATING MECHANISM HOUSING, opposite the mag latch. To adjust the engagement of the TRIP LATCH, proceed as follows:

1. Back off the ADJUSTING SCREW (5) to assure excessive latch engagement.
2. Be sure there is trip spring clearance.
3. Close the recloser.
4. Turn the ADJUSTING SCREW down slowly until the TRIP LATCH (2) just releases, tripping the recloser.
5. Back off the ADJUSTING SCREW $1\frac{1}{2}$ turns.
6. Make sure self-locking NUT (4) is properly seated.

MAGNETIC LATCH TRIP SPRING CLEARANCE ADJUSTMENT (Figure 13)

With recloser closed, the clearance between the end of the TRIPPING SPRING (43) and the TRIP PIN (49) should be between .025" and .030". To adjust this clearance, raise or lower the end of the Mag Latch by first making sure the SUPPORT SCREW (56) is locked by NUT (52). Then, run MAG LATCH LOCKNUT (53) up on the screw and use ADJUSTING NUT (55) to make the adjustment. Secure the ADJUSTING NUT with the MAG LATCH LOCKNUT.

If the mechanism will not latch closed, the above clearance in the open position should be approximately $\frac{1}{32}''$. If the clearance does not appear to be sufficient, increase as described above. Should the difficulty persist, reduce the "Magnetic Latch Bias" as described on page 16.

NOTE: When making this adjustment, the TRIP LATCH EXTENSION (3) should be resting against its RESET STOP SCREW (5) located on the opposite side of the mechanism (see Figure 14).

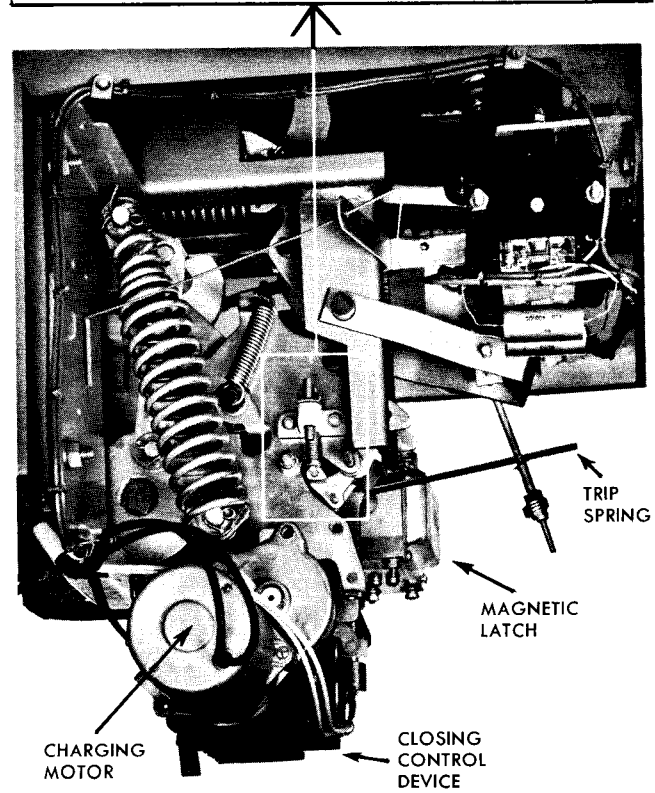
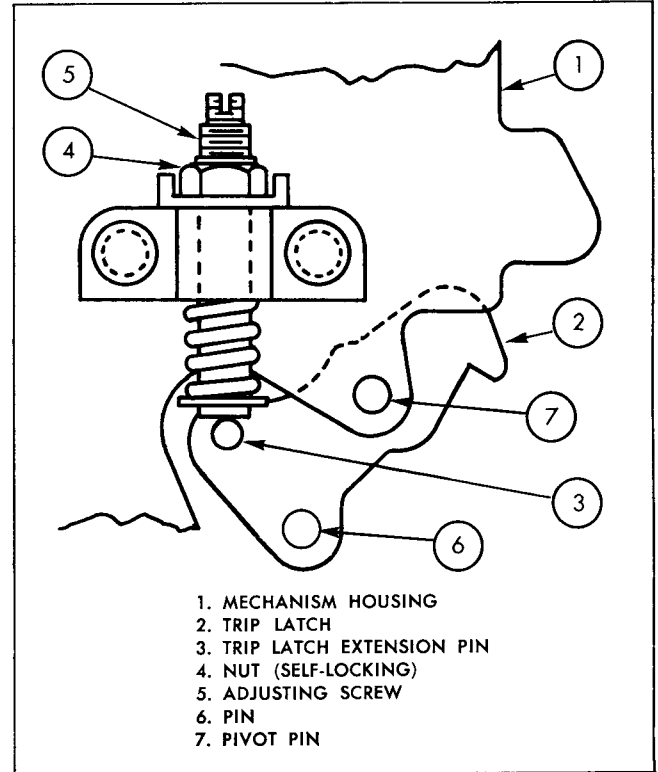


Fig. 14. Trip Latch Adjustment.



MAGNETIC LATCH BIAS ADJUSTMENT (Figure 13).

The magnetic latch is biased by a torque from the trip spring (43) and should be adjusted after the trip spring clearance has been properly set.

Initially set, the bias using the bias adjustment nut (54) on stud (46) so the latch fails to engage approximately half of the time for control switch closing. For example, the recloser should fail to hold closed when operated with the control switch on two out of four or five manual operations.

Having found this threshold level, the bias adjustment nut (54) should be backed off two full turns to obtain proper adjustment.

CLOSE LATCH RELEASE OVERTRAVEL ADJUSTMENT (Figure 16)

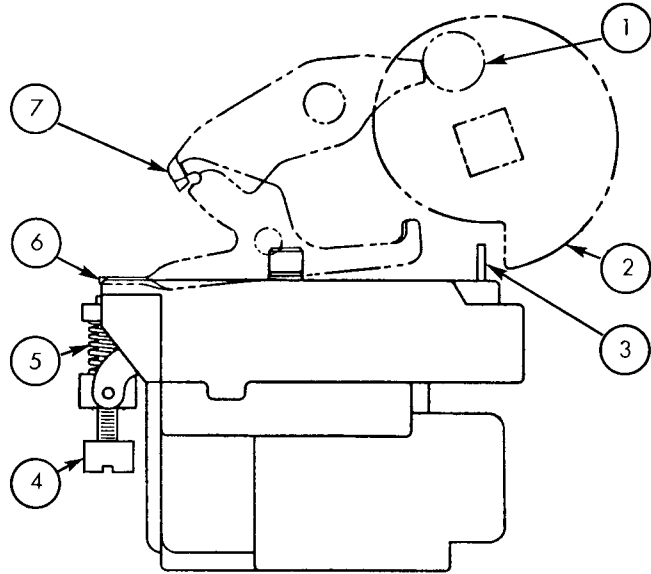
The CLOSING CONTROL DEVICE of the OPERATING MECHANISM does not require any adjustment in the field. However, if the CLOSING CONTROL DEVICE is ever replaced, the overtravel of the CLOSE LATCH RELEASE ROD (4) should be adjusted as described below. Do not attempt to adjust the internal relays or contacts of this device.

1. To remove the CLOSING CONTROL DEVICE (Figures 14 and 15) disconnect all wires and apply marked tape for identification. Remove the two mounting screws at the bottom of the mechanism mounting plate. Observe how the old assembly disengages from positioning keys for removal and replace the new one in the same manner.

2. Back off the CLOSE LATCH RELEASE ROD (4) until it will not strike the SECONDARY CLOSE LATCH (6) when the EMERGENCY CLOSE LEVER (item 5, Figure 4, page 5) is lifted as far as its travel will allow.

3. With the closing springs charged and the EMERGENCY CLOSE LEVER held up as far as possible, turn the CLOSE LATCH RELEASE ROD (4) clockwise until the closing springs are released, closing the recloser.

4. Turn the CLOSE LATCH RELEASE ROD (4) one additional turn in the same direction.



- | | |
|----------------------------|--------------------------|
| 1. ROLLER, CLOSE LATCH | 5. SPRING, TRIP ROD |
| 2. CHARGING CAM | 6. SECONDARY CLOSE LATCH |
| 3. ACTUATOR, LIMIT SWITCH | 7. PRIMARY CLOSE LATCH |
| 4. CLOSE LATCH RELEASE ROD | |

Fig. 16. Close Latch Overtravel Adjustment.

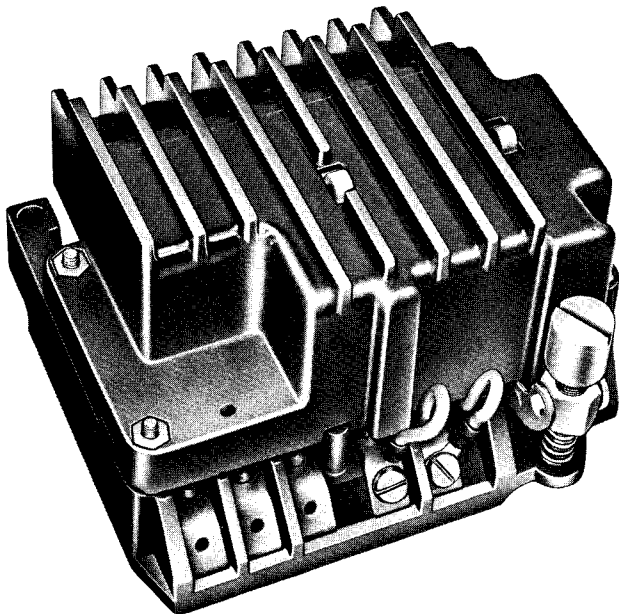


Fig. 15. Closing Control Device

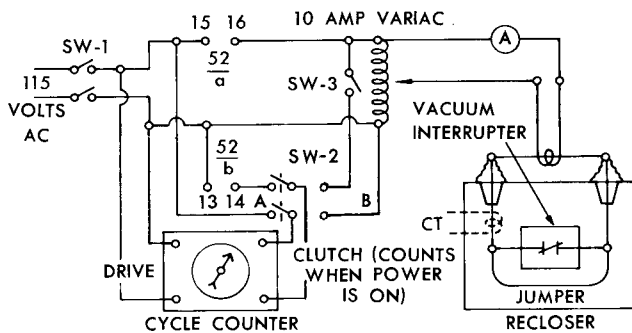


CALIBRATION TESTS ON SOLID-STATE CONTROL UNIT

GENERAL

To check the operation of the solid-state controlled recloser, in the field, the following tests can be made with either an I-T-E EL102 Calibration and Test Set or conventional test equipment following the diagram shown in Figure 17.

- A. Pickup sensitivity
- B. Time-Delay Curves
- C. Sequencing and lockout (including open time intervals)
- D. Reset time interval



$\frac{52}{a}, \frac{52}{b}$ —RECLOSER AUXILIARY SWITCHES

SW-1—SUPPLY SWITCH

SW-2—DPDT SELECTOR SWITCH

POSITION A—TIMES OPEN INTERVALS

POSITION B—TIMES CLOSED INTERVALS

SW-3—DISCONNECT SWITCH, OPEN DURING MINIMUM PICKUP TESTS.

Fig. 17. Circuit Diagram and Description of Components for Testing.

PROCEDURE

The following procedure should be used when using conventional test equipment as shown in Fig. 17:

1. Connect control power to terminal points 1 and 2 (see Figure 6, page 7). For the recloser equipped with d-c control, polarity markings must be followed.
2. If the recloser is equipped with 600/5 ratio, 10L100 or larger bushing current transformers in addition to the sensors, disconnect the ground leads from terminals of the current transformer terminal block.
3. Connect the test circuit output (Figure 17) to terminals X1 and X5 of any one phase. Jumper the bushing terminals and the interrupter of the same phase with short leads. Failure to jumper the interrupter may result in damage to current transformers.

NOTE: If recloser is not equipped with bushing current transformers, a 600/5 ratio 2.5L200 relay-type bushing current transformer may be supported on the jumper across the bushing terminals of the same phase. Connect the test circuit output to the 600/5 ratio leads and proceed. Keep leads as short as possible to minimize inductance.

4. Set the solid-state controls as desired except as indicated in specific test below:

A. PICKUP TEST

1. Set the GROUND SWITCH on the face of the control panel to GROUND TRIP BLOCK to measure phase pickup. Set this switch to NORMAL to measure ground pickup.
2. The solid-state control should be set on a fast trip.
3. Open switch SW-3 and close switch SW-1, then slowly advance the Variac from zero. Note the meter reading at the time the recloser trips. The pickup current is 120 times this reading.

B. TIME-DELAY CURVES TEST

1. Set the GROUND SWITCH on the face of the control panel to GROUND TRIP BLOCK to check the phase time-delay curves. Set this switch to NORMAL to check the ground time-delay curves.
2. Set the solid-state control for 0 fast trips and 1 trip to lockout.
3. Close switch SW-1 and set the current for two times pickup. (It may be necessary to temporarily advance the phase pickup dial and hold the control switch closed to prevent tripping.)

Open switch SW-1.

Close switch SW-3 and place switch SW-2 in Position "B". Close switch SW-1. The time to trip registered on the cycle counter should correspond to the times shown in Figures 9 and 10, page 9, for 2 times pickup.

C. SEQUENCE TEST

1. Set Variac at about $\frac{3}{4}$ full scale.
2. Close switch SW-1 and SW-3. The number of operations to lockout can be counted. With switch SW-2 in position "A", the length of each open interval can be timed using the cycle counter. Lockout can be verified by pressing the LOCKOUT TEST button and observing the red glow of test lamp.

D. RESET TIME TEST

Reset time is initiated at the instant of contact make when the recloser closes. Termination of reset time may be detected by a faint but audible click that can be heard from within the solid-state control box. Therefore, reset time can be registered by a stop watch, measuring the time interval from reclose to the audible click.

1. Set Variac at about $\frac{3}{4}$ full scale.
2. Open switch SW-3 and close switch SW-1. During an open time interval, open switch SW-1 and allow recloser to close. (It may be necessary to extend open interval time to allow removal of simulated fault signal accomplished by opening switch SW-1).
3. Start stop watch when the recloser closes.
4. Stop the stop watch when the audible click is heard.
5. Compare the elapsed time with the setting of the reset dial.



COMPONENT REPLACEMENT

VACUUM INTERRUPTER ASSEMBLY (Figure 18)

To remove the vacuum interrupter assembly, the recloser must be in the open position with closing and opening springs discharged. To remove an interrupter and avoid working against the CONTACT PRESSURE SPRING (6), proceed as follows:

1. Remove PIN (24). Here it is necessary to pry out the lower end of the BELL CRANK (25) at "X", with a thin bar, to relieve the pin load caused by atmospheric pressure on the interrupter moveable contact.
2. Loosen NUT (13) before removing PIN (26) to prevent transfer of torque to the interrupter's moving contact and bellows.
3. Remove PIN (26).
4. Loosen bolts holding CLAMP (21) approximately $\frac{1}{8}$ ".
5. Loosen and remove SUPPORT BOLTS (27).
6. Lower front end below SUPPORT (19) and slide vacuum interrupter assembly toward you until interrupter STATIONARY CONTACT (23) is free of CLAMP (21) and remove.

After removing a vacuum interrupter assembly from the recloser, the current-carrying parts must be removed from it and installed on the new interrupter. For removal of external current-carrying parts from the interrupter assembly, proceed as follows:

1. Remove LINKS (16) and SPRING (15) by turning NUT (28) off BOLT (29).
2. Remove CLEVIS (11) and NUT (13) from the interrupter's moveable contact rod.
3. Loosen CONTACT BLOCK (17) by backing out LOCKING SCREW (30).
4. Remove BOLT (31) and NUTS (32).
5. Turn CONTACT BLOCK (17) counter clockwise off contact rod which releases current-carrying SUPPORT PLATE (33) and CONTACT BLOCK (18).
6. Remove SPACER NUT (34).

Re-assemble current-carrying parts to the new vacuum interrupter as follows. Check to see that the contact surfaces on LINKS (16) and CONTACT BLOCKS (17) and (18) are not pitted and in good condition before assembling; otherwise use new parts.

1. Assemble SPACER NUT (34) on stud, making sure the SEAL TUBE (35) is in location as shown in Figure 18.
2. Slide CONTACT BLOCK (18) on SPACER NUT (34).
3. Assemble SUPPORT PLATE (33) and CONTACT BLOCK (17) together. Counterbored end of (17) goes toward vacuum interrupter and turn clockwise. *Important:* Be sure to include the NYLON BEARING (36) with SUPPORT PLATE (33).

4. Assemble BOLT (31) and NUTS (32) with lockwashers and secure.

5. Turn in CONTACT BLOCK (17) until the center of the tapered contact indent in each side is $\frac{1}{4}$ " nearer to the interrupter than is the center of the tapered groove in CONTACT BLOCK (18) as shown. *Important:* Be sure the side surfaces of the CONTACT BLOCKS (17) and (18) line up with each other (i.e. form a common plane) and secure LOCKING BOLT (30). Loosen BOLT (31) and retighten if necessary.

6. Assemble current-carrying LINKS (16), BOLT (29), NUT (28) and SPRING (15) as shown in section A-A.

7. Assemble CLEVIS (11) with NUT (13) loosely as shown, avoiding transfer of torque to the moving contact and its bellows.

To replace interrupter assembly in recloser housing, JACK SHAFT (3) must be in the open position with the closing springs discharged.

Proceed as follows:

1. Hold the vacuum interrupter on a little slant and insert the interrupter STATIONARY CONTACT ROD (23) into the loosely-hanging CLAMP (21) and push back. Lift front end and insert SUPPORT BOLTS (27) which are tightened first, then secure CLAMP BOLTS (41).

2. Adjust CLEVIS (11) to $\frac{1}{16}$ " dimension, insert PIN (26) and tighten NUT (13). Operate CRANK ARM (25) by hand to be sure it is free—no binding.

3. Pry out lower end of BELL CRANK (25) at "X" to line up holes to insert PIN (24).

4. Operate mechanism to closed position and check contact wipe and position of white band as shown. This can be adjusted by loosening the LOCK NUT (12) at end of CLEVIS (14), rotating the INSULATED OPERATING ROD (8) in required direction and retightening the lock nut.

5. Operate 50 times to seat the new contacts and then repeat item 4.

Important. Be sure all bolts are tightened and pin retainers are in place after replacements and adjustments are made.

Mounting the vacuum interrupter with a minimum of residual stresses is achieved by securely attaching the vacuum interrupter assembly to SUPPORT BRACKET (19) and allowing it to sag due to its own weight. Then, with UPPER CONTACT NUT (20) run all the way up, assemble CLAMP (21) and current-carrying SUPPORT BRACKET (22) to the STATIONARY INTERRUPTER STUD (23). Cautiously lift this end until slight resistance is encountered and note the total deflection. Let this end down to the mid point of the two observed positions, run up LOWER CONTACT NUT (40) to hold SUPPORT BRACKET (22) in the selected position and tighten down with UPPER CONTACT NUT (20).

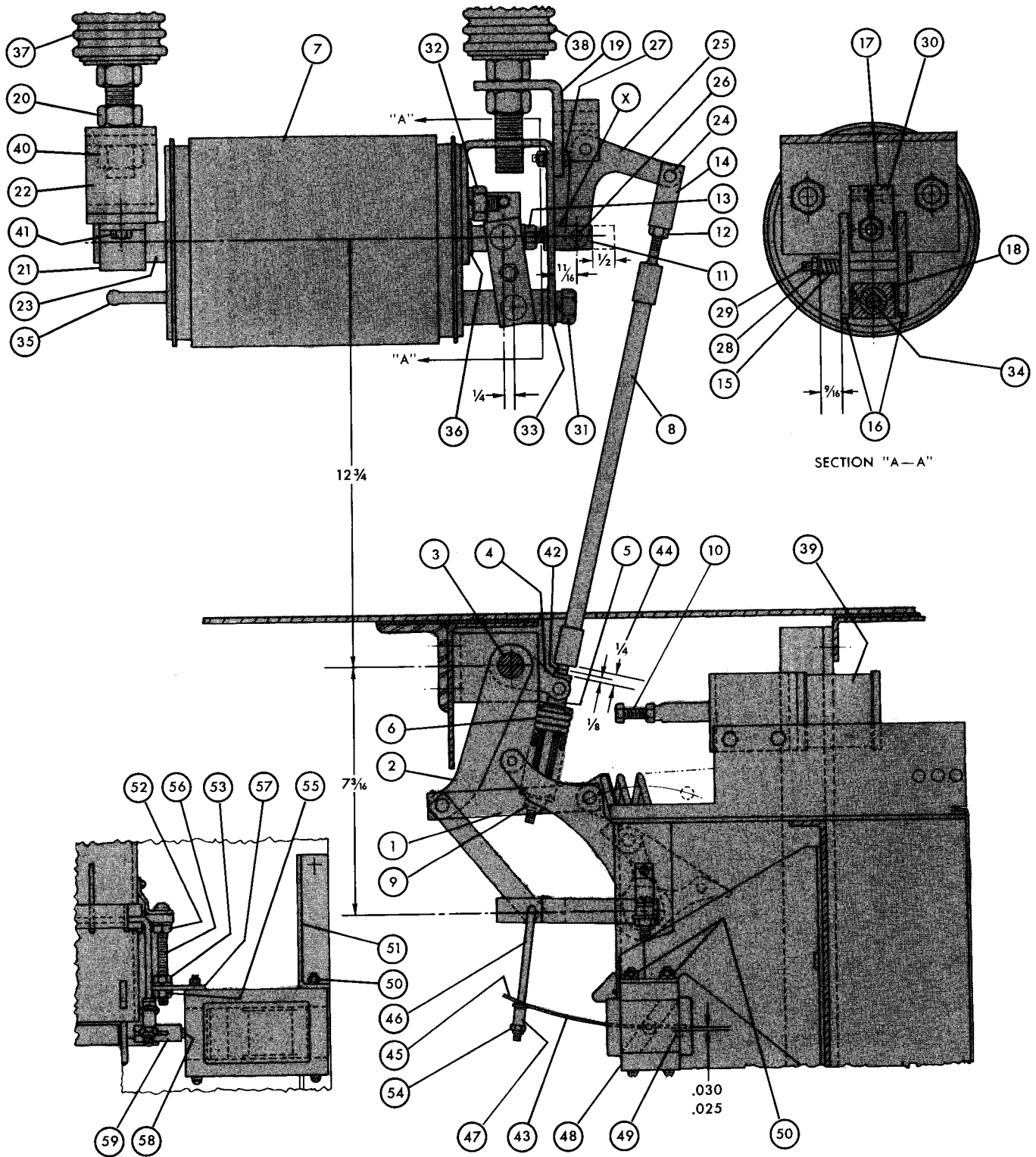


Fig. 18. Vacuum Interrupter and Mechanical Linkage.

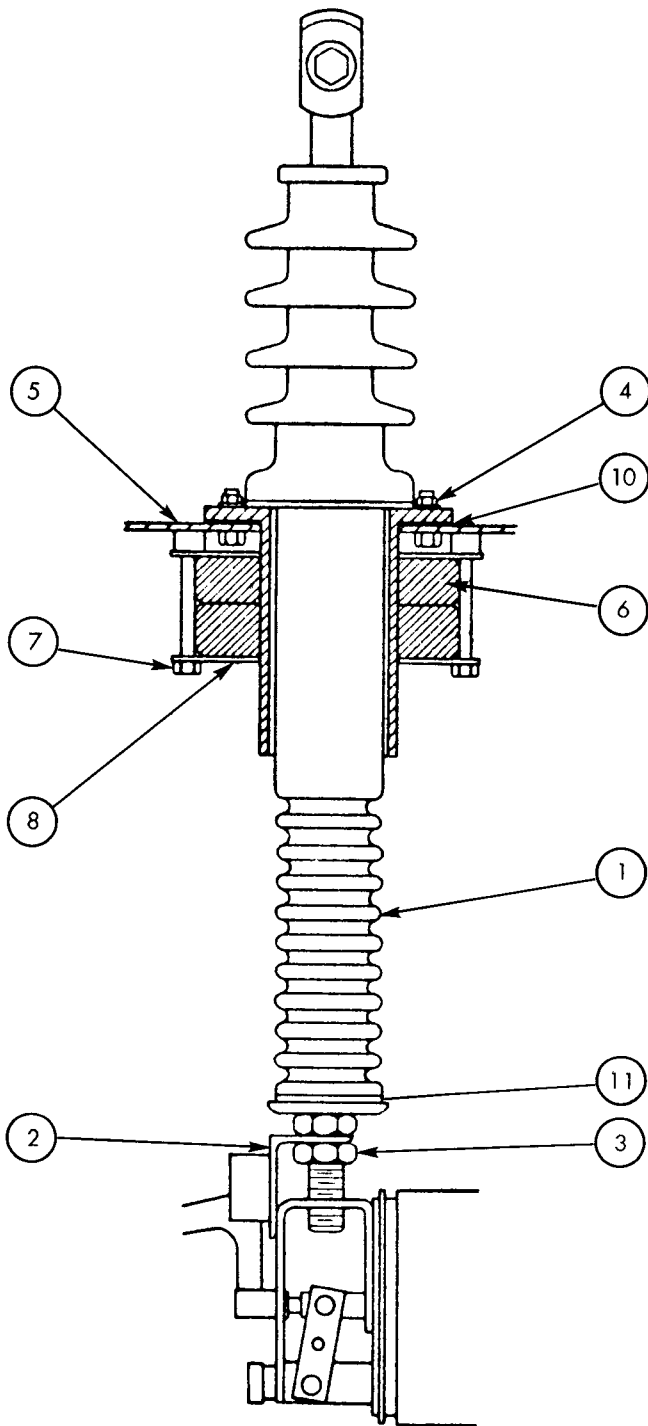


Fig. 19. Bushing Assembly and Sensors.

SENSORS (OVERCURRENT AND GROUND) (Figure 19)

Because of the wide range of currents that can be accommodated by one sensor, it is unusual to have to replace one. However, when replacement is necessary, it may be accomplished by observing the simple steps that follow:

1. Remove the LOWER CONTACT NUT (3) at the bottom of BUSHING (1).
2. Remove the three FLANGE NUTS (4) that anchor the bushing to the top of the HOUSING (5).
3. Remove the electrical connections to the SENSORS (6).
4. Remove the two BOLTS (7) that hold the diamond-shaped SUPPORT PLATE (8) against the bottom of the sensor. It is now possible to gently lower the SENSOR (6) to the bottom of the BUSHING (1).
5. Lift the BUSHING (1) a few inches, slide the SENSOR (6) out from below the BUSHING. Slide the new sensor into position. Be sure to replace the SUPPORT PLATE (8).
6. In reverse order, anchor the BUSHING with the three flange NUTS (4), raise the SENSOR (6) and SUPPORTING PLATE (8) to position and lock in position with two NUTS (7) on the supporting studs.

Connect the electrical leads to the SENSOR and replace the LOWER CONTACT NUT (3) at the bottom of the BUSHING CONDUCTOR (11), locking it snugly.

BUSHING ASSEMBLY (Figures 18 and 19)

Any one of the six bushing assemblies (see Fig. 19) may be readily exchanged by removing the LOWER CONTACT NUT (3) that clamps the interrupter SUPPORT BRACKET (2), and then removing the three FLANGE NUTS (4).

When installing the new bushing assembly items (37) and (38) (see Fig. 18), observe the precaution described under "Vacuum Interrupter Assembly" so as to position the height of the SUPPORT BRACKET (22) in a manner to avoid strain upon the interrupter assembly.

When replacing both bushings of a particular phase, complete the exchange of one bushing assembly before working on the second bushing assembly, replacing BUSHING (38) first. When BUSHING (38) is replaced, it may be necessary to adjust OPERATING ROD (8) to compensate for a different bushing length. See the Section "Adjustments".

NOTE: Contact Travel should be measured before removal of bushing and should be maintained when new bushing is installed.

CHARGING MOTOR

The charging motor is located by a ROLL PIN and is supported by two MOUNTING SCREWS. To remove the motor, slide back the insulating sleeves on the motor leads and disconnect. Turn out the MOUNTING SCREWS and remove the motor. The ROLL PIN will remain attached to the motor assembly.

To replace the charging motor, locate it by inserting the ROLL PIN into the proper hole in the housing and replace the MOUNTING SCREWS. Connect the motor leads and slide the insulating sleeves over the connections.



MAGNETIC LATCH ASSEMBLY (Figure 18)

To remove the Magnetic Latch Assembly (48), first put the recloser in the open position with operating springs discharged. Then proceed as follows:

1. Slide back the insulating sleeves and disconnect the coil leads.
2. Remove self-locking ADJUSTING NUT (54), and SLEEVE (47).
3. Loosen MAG LATCH LOCK NUT (53) and remove ADJUSTING NUT (55).
4. Remove the two NUTS (50) at OUTER SUPPORT BRACKET (51). Magnetic latch can now be removed.
5. Loosen two set screws that hold SPRING SUPPORT HUB (59) and slide off the ARMATURE SHAFT (58).
6. Remove SUPPORT PLATE (57) and replace the nuts and lock-washers on the Mag Latch Assembly.

To replace the Mag Latch Assembly, start by assembling the SUPPORT PLATE (57) and SPRING SUPPORT HUB (59), and then continue by reversing the above procedure. Make final adjustments as described under Magnetic Latch Trip Spring Clearance and Mag Latch Bias in the MAINTENANCE AND ADJUSTMENTS section of this manual.

SOLID-STATE CONTROL UNIT (Figures 20 and 21)

To remove the Solid-State Control Unit from a VRM model recloser (metal housed), proceed as follows: (See Figure 20).

1. Remove the CABLE DISCONNECT (1) from the bottom of the unit.

2. Remove the three leads connected to the small TERMINAL BLOCK (2) when used.

3. Place a support beneath the unit that will hold it in its original position when the bolts are removed.

4. Remove the two anchor CAP SCREWS (3) from the rear of the unit (these screws hold the control unit to the internal support structure).

5. Remove the two NUTS and LOCKWASHERS (4) holding the outer edge of the R-101 to the compartment supporting brackets. (Note - the brackets are not disturbed.)

6. Facing the front of low-voltage compartment, rotate right-hand edge of the control toward you and remove.

7. When replacing the control, reverse procedure 1 thru 5, making sure the left-hand edge of the control is positioned behind the support brackets.

To remove the Solid State Control Unit from a VRP model recloser (plastic housed), proceed as follows: (See Figure 21).

1. Remove the CABLE DISCONNECT (1) from the bottom of the unit.

2. Remove the three leads connected to the small TERMINAL BLOCK (2) when used.

3. Remove the four MOUNTING BOLTS (3) and take the control unit out.

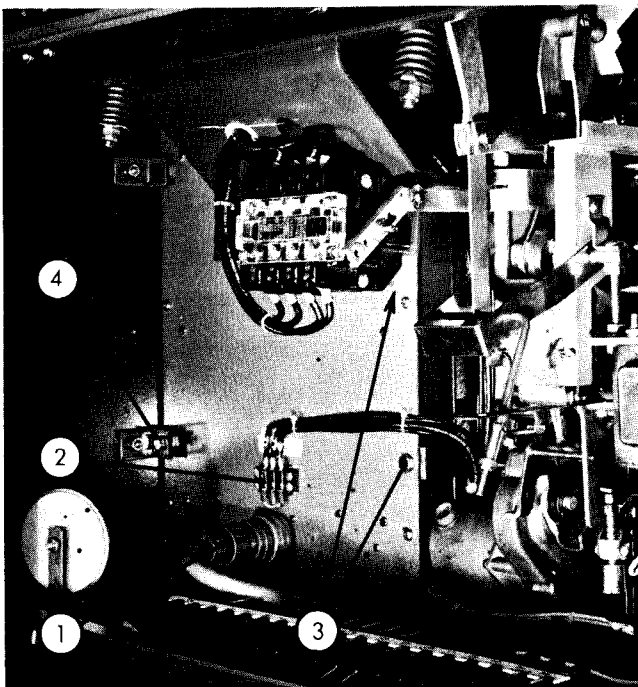


Fig. 20. Control Unit in a VRM Model Recloser.

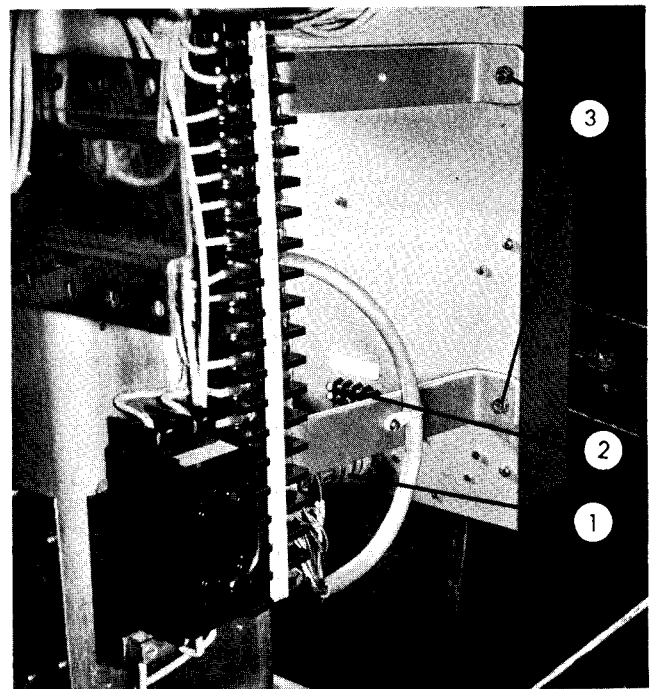


Fig. 21. Control Unit in a VRP Model Recloser.



RENEWAL PARTS

QUANTITY ON ONE RECLOSER	DESCRIPTION	CATALOG NUMBER	PAGE	REFERENCE FIGURE	ITEM
3	Vacuum Interrupter Unit	509600	19	18	7
3	Ground Sensor, 50 Amperes	774000	20	19	6
3	Ground Sensor, 70 Amperes	774001	20	19	6
3	Ground Sensor, 100 Amperes	774008	20	19	6
3	Phase Sensor, 100 Amperes	774002	20	19	6
3	Phase or Ground Sensor, 140 Amperes	774003	20	19	6
3	Phase or Ground Sensor, 200 Amperes	774004	20	19	6
3	Phase or Ground Sensor, 280 Amperes	774005	20	19	6
3	Phase or Ground Sensor, 400 Amperes	774006	20	19	6
3	Phase Sensor, 560 Amperes	774007	20	19	6
3	Moving Contact Current Transfer Block	163-388-001	19	18	17
3	Stationary Contact Current Transfer Block	163-387-001	19	18	18
6	Current Transfer Links	163-391-001	19	18	16
3	Insulated Connecting Link Operating Rod	208-427-301	19	18	8
1	Mag Latch	570124	19	18	48
1	Motor Switch	703270-A	5	4	7
1	Control Relay for 115/125 V, a-c/d-c Control	708392-T7	16	15	
1	Control Relay for 48 V, d-c Control	708392-T6			
2	Pull-out Fuse Block (Control PFU-1 and Heater PFU-2)	789150	21	21	
4	Fuse only—Chase Shawmut Tri-onic 15 Amperes	427028	6	5	
1	Mechanism Charging Motor	—	15	14	
1	Front Panel Glass	157-604-002	3	2	
1	Recloser Control—Standard: 48 V, dc 125 V, dc 115 V, ac	302428 302429 302430	21	20 and 21	
1	Recloser Control— with Ground: 48 V, dc 125 V, dc 115 V, ac	302431 302432 302433	21	20 and 21	
6	Bushing, Hardware	308-124-302	20	19	
6	Bushing, Porcelain	308-124-305	20	19	
6	Bushing Gasket, Flange	164-068-001	20	19	
6	Bushing Gasket, Lower	157-774-001	20	19	
1	Heater, 115 V, ac	473134	21	20	



NOTES



These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connections with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the nearest I-T-E Sales Office.



I-T-E CIRCUIT BREAKER COMPANY