Padmounted Reclosers

Types PWH and PWVH; Three-Phase; Hydraulically Controlled Installation Instructions

S285-70-1
Service Information

RADIATION WARNING

See Service Information S280-90-1.

CONTENTS

GUARANTEE

Performance guarantees shall be limited to correction by repair or replacement, at McGraw-Edison Company's option, of such reclosers or components that may fail due to defects in material or workmanship within a period of one year from date of shipment. This guarantee is valid only if the recloser has been properly inspected upon receipt, properly installed, and has not been subjected to abnormal conditions. The Company will not be liable for consequential damage or any expenses incurred in installation or transportation.

SHIPPING

Each PWH and PWVH recloser is completely assembled, factory-calibrated and -inspected, and filled with insulating oil to the correct level before shipment. All reclosers are in good condition when accepted by the carrier for shipment.

INITIAL INSPECTION

All reclosers are factory-tested and -adjusted to operate according to published data. Preinstallation testing is unnecessary. However, should verification of recloser operation prior to startup be required, follow the procedures beginning on page 9 to check minimum-trip current, closing solenoid operation, operating sequence, non-reclosing feature, vacuum integrity of the interrupter, and options. Test results should verify nameplate and data plate information.

1. Upon receipt, inspect the recloser thoroughly for damage and loss of parts or oil incurred during shipment. If damage or loss is discovered, file a claim with the carrier immediately.
2. Check to make sure that all options ordered are present on the recloser. Options will be on the inside of the right door of the recloser, on the accessory panel.
3. Check for oil leakage.
4. Tighten all bolts that may have loosened during shipment.

GENERAL DESCRIPTION

Types PWH and PWVH reclosers (Figure 1) are three-phase, self-contained devices that sense and interrupt fault currents on distribution systems. If a fault is temporary, the recloser automatically recloses to restore service. If the fault is permanent, the recloser locks out after two, three, or four preset trip operations. If the fault clears before lockout, the recloser resets for another sequence of operations.

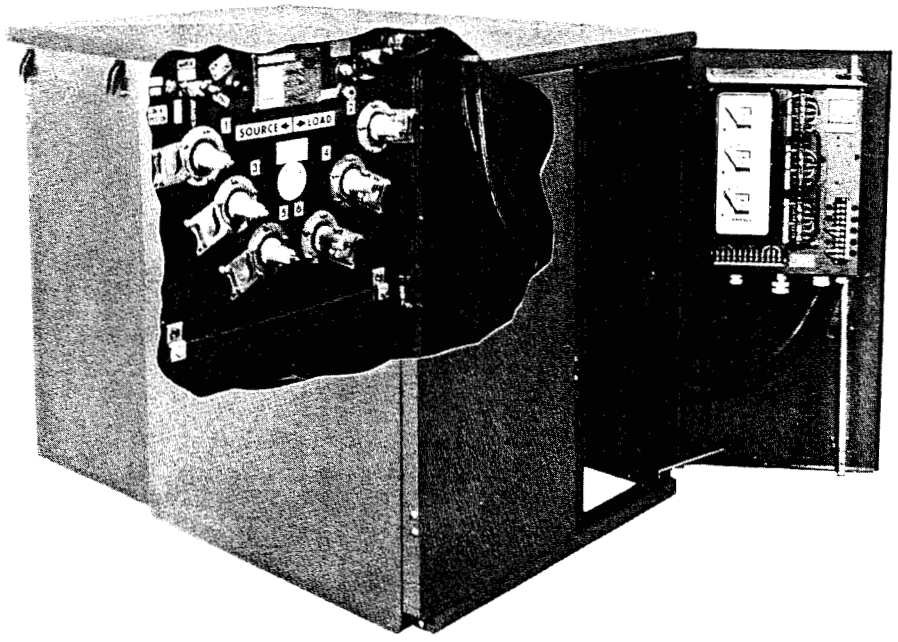


Figure 1.
Types PWH and PWVH hydraulically operated padmounted vacuum reclosers.

These instructions do not claim to cover all details or variations in the equipment, procedure, or process described, nor to provide directions for meeting every possible contingency during installation, operation, or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, please contact your McGraw-Edison Power Systems Division sales engineer.

Opening sequences of the recloser can be all fast, all delayed, or any combination of fast followed by delayed operations, up to a total of four. Fast operations clear temporary faults before branch-line fuses can be damaged; delayed openings allow time for fuses to clear, confining the permanent faults to smaller sections of the line.

Inverse time-current tripping is provided by series-trip coils operating in conjunction with hydraulic time-delay units in each phase. In series tripping, the tripped energy is taken directly from the fault current itself. All three phases are operated simultaneously regardless of the number of phases sensing fault current. Typical time-current characteristics are shown in Figure 2.

Vacuum interrupters extinguish currents safely, quietly, and with maximum low-energy fault clearing. Oil—the insulating medium—provides maximum dielectric strength in a compact size.

Construction

A rectangular, oil-filled tank houses the recloser mechanism. To provide deadfront construction, the recloser bushings and operating controls are brought out through the side of the recloser tank and into the cable-terminations compartment. Blind-hinged double doors, secured with a three-point latch and locked with a penta-head bolt, provide access to this compartment. An overall roof completes the housing structure.

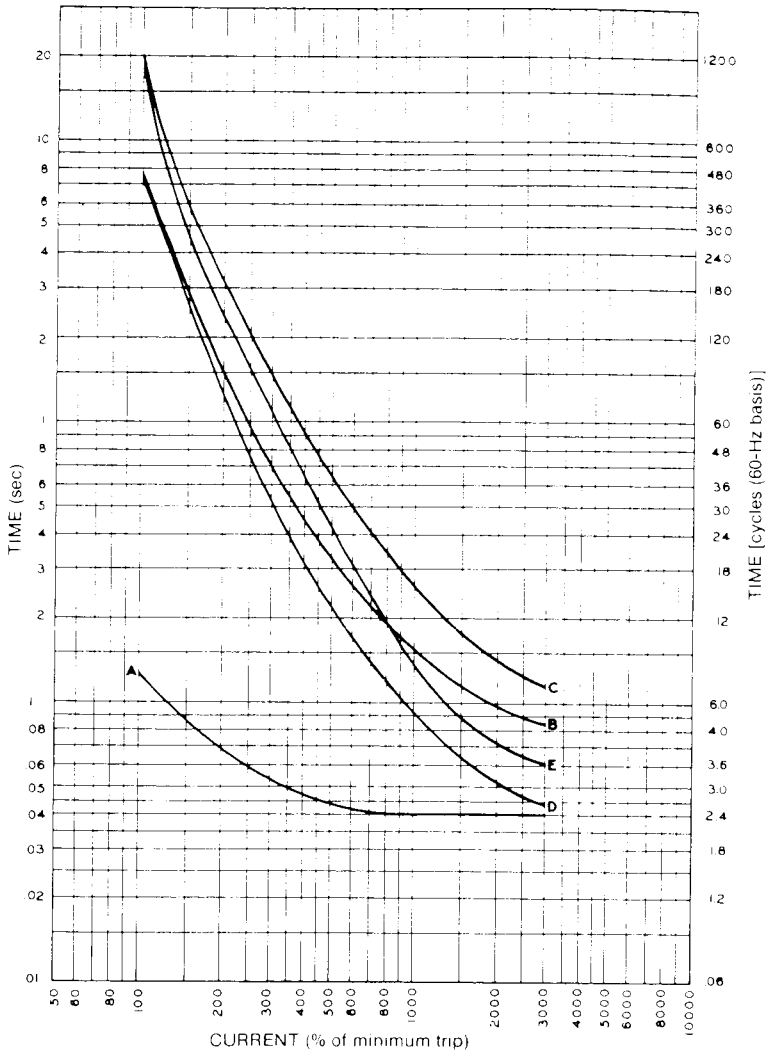


Figure 2.
Typical time-current characteristics—phase-tripping.
(To determine operating data, refer to time-current curves in Reference Data R280-91-6).

RATINGS AND SPECIFICATIONS

TABLE 1
Voltage Ratings

Voltage	Type PWH	Type PWVH
Nominal voltage class (kV rms)	14.4	24.9
Rated maximum voltage (kV rms)	15.5	27.0
Rated impulse withstand voltage (BIL; kV crest)	95	125
Low frequency withstand voltage (1 min.; kV rms)	35	40
Dc withstand voltage (15 min.; kV)	53	78
Partial discharge level (corona extinction @ 20 pC; kV)	11	19

TABLE 2
Current Ratings

Current	Type PWH	Type PWVH
Rated continuous current (amps)	560	560
Maximum interrupting current at rated maximum voltage (symmetrical amps)	12000	12000
Maximum momentary current (asymmetrical amps)	20000	20000
Rated magnetizing interrupting current (amps)	19.6	19.6
Rated cable-charging current (amps)	10	25

TABLE 3
Interrupting Current

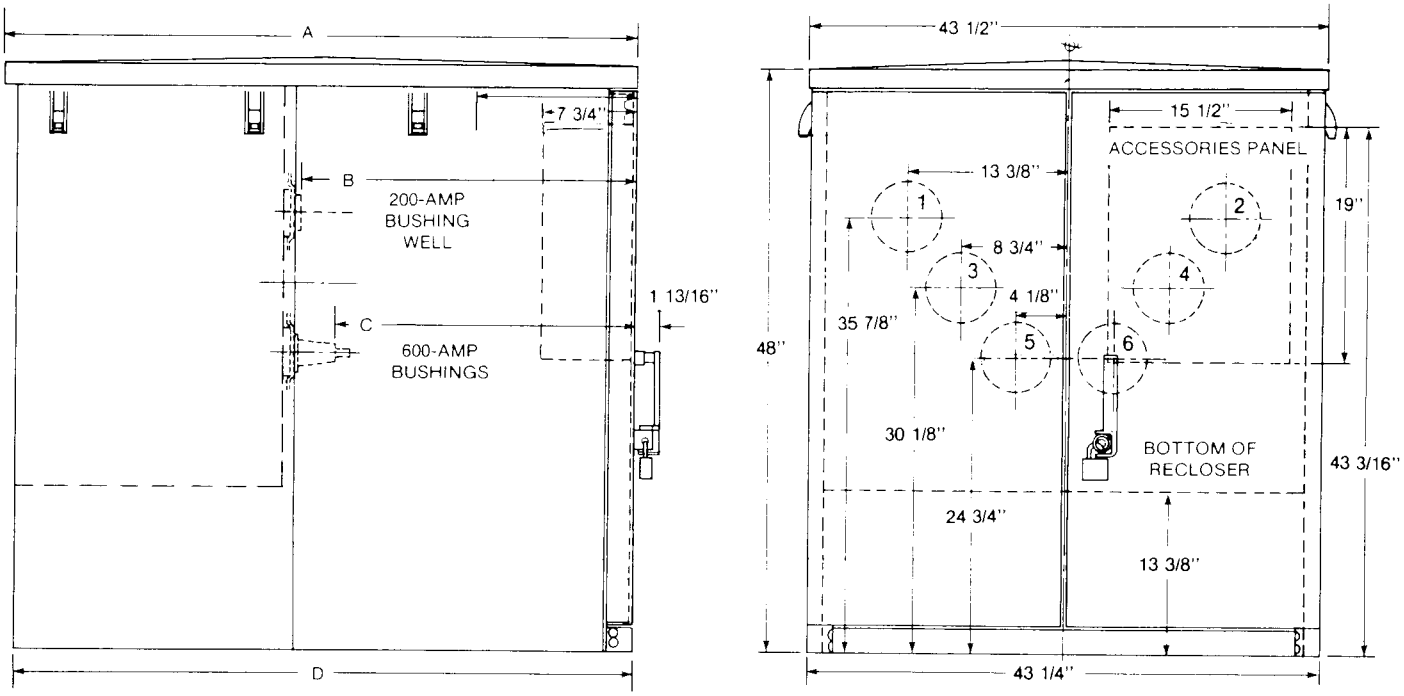
Series Coil Current Rating (amps)	Minimum-Trip Current (amps)	Interrupting Current (symmetrical amps)
50	100	3000
70	140	4200
100	200	6000
140	280	8400
160	320	9600
185	370	11100
225	450	12000
280	560	12000
400X	560	12000
400	800	12000
560X	750	12000
560	1120	12000

TABLE 4
Duty Cycle

Percent of Interrupting Rating	X/R Ratio	Number of Operations	
		Type PWH	Type PWVH
15—20	4	88	44
45—55	8	112	56
90—100	15	32	16
	Totals:	232	116

TABLE 5
Mechanical Specifications

Mechanical life (minimum operations)	2500
Operating temperature limits (degrees C)	-30 to +50
Close mechanism	Solenoid-operated
Open mechanism	Spring-operated
Contact close time (cycles)	0.75
Contact open time (cycles)	0.50
Allowable contact erosion (in.)	0.125
Nominal reclosing time (sec)	2
Resetting time (sec/operation at 25 C)	75—90



Enclosure Size (in.)	Dimensions (in.)			
	A	B	C	D
52	52	27	24	51
62-1/4	62-1/4	37-1/4	34-1/4	61-1/4

WEIGHT (WITH OIL AND CONTROL)—52" ENCLOSURE—1495 LB
—62-1/4" ENCLOSURE—1520 LB

OIL CAPACITY—95 gallons

Figure 3.
Dimensions of Types PWH and PWVH reclosers.

CONTROL DESCRIPTION

Figure 4 shows the manual operating controls and indicators on the front of the recloser tank in the cable-terminations compartment. The bushings, grounding bus, and accessory wiring interfaces also are located here.

Contact Position Indicator

To show the position of the main contacts, a red pointer, directly coupled to the recloser mechanism, indicates either OPEN or CLOSED.

Manual Operating Handle

The yellow hotstick-operated manual operating handle must be in the CLOSE position for the recloser to operate. When the recloser operates to lockout, the handle turns to LOCKOUT. It must be reset manually to close the recloser. Turning the handle to CLOSE manually closes the closing solenoid contactor; if the source-side bushings are energized, the solenoid will close the main recloser contacts. The handle is trip-free and lockout-free. It will not impact a blow to the operator if the recloser trips while the handle is held in CLOSE; the recloser will operate to lockout even though the handle is held in CLOSE.

If the recloser is closed, it may be manually opened and locked out by turning the handle to LOCKOUT.

Non-Reclosing Handle

In the NON-RECLOSING position, this hotstick-operated handle provides one-trip-to-lockout operation without disturbing the normal recloser operating sequence. Fault timing is in accordance with the first operation in the sequence.

Manual-Close Access Port

Removing a pipe plug provides access to the recloser mechanism, allowing the manual operating tool to slow-close a deenergized recloser during servicing or maintenance procedures. A closing tool, mounted to the inside wall of the cable-terminations compartment, is provided with the recloser.

CAUTION
Do not attempt to close with the manual closing tool on an energized line.

Oil-Level Indicator

A bubble-float gage in the window of the recloser tank provides a direct visual means for checking the oil level.

Remote Operating Accessories Wiring Interface

If the recloser is equipped with any of the remote operating accessories, a receptacle and cable assembly are provided to electrically interface the accessory installed on the recloser mechanism with the terminal block for customer connections mounted on the accessory panel on the inside of the enclosure door.

Auxiliary Switch Accessory Wiring Interface

If the recloser is equipped with the auxiliary switch accessory, a receptacle and cable assembly electrically interface the auxiliary switch (mounted on the recloser mechanism) with a terminal block on the accessory panel inside the enclosure door.

BCT Accessory Cable

If the recloser is equipped with the BCT accessory, a cable is provided to hard-wire the current transformers to terminal blocks on the accessory panel inside of the accessory door.

Ground-Trip Accessory

If the recloser is equipped with a ground-trip accessory, a cable is provided to wire the ground-trip shorting switch (on the accessory panel) to the accessory (in the recloser tank).

Connector Bushings

The connector bushings are compatible with separable deadfront elbow connectors for UD cable rated for 600-amp, 15- and 27-kV service. The recloser can also be equipped with universal bushing wells which are compatible with all industry-standard plug inserts for loadbreak and non-loadbreak separable UD cable connectors rated for 200-amp, 15- and 27-kV service. Bushing wells can be installed on either the load or the source side or on both load and source sides. Connector parking-stand brackets are also provided at each bushing.

Oil-Sampling-and-Drain Valve

Near the bottom corner of the recloser tank, a 1/2-in. gate-type valve allows oil to be drained from the tank and samples to be drawn for testing.

Grounding Bus

A 1/2-in. diameter copper bus is provided across the bottom of the recloser tank for grounding concentric cable neutrals and cable connectors.

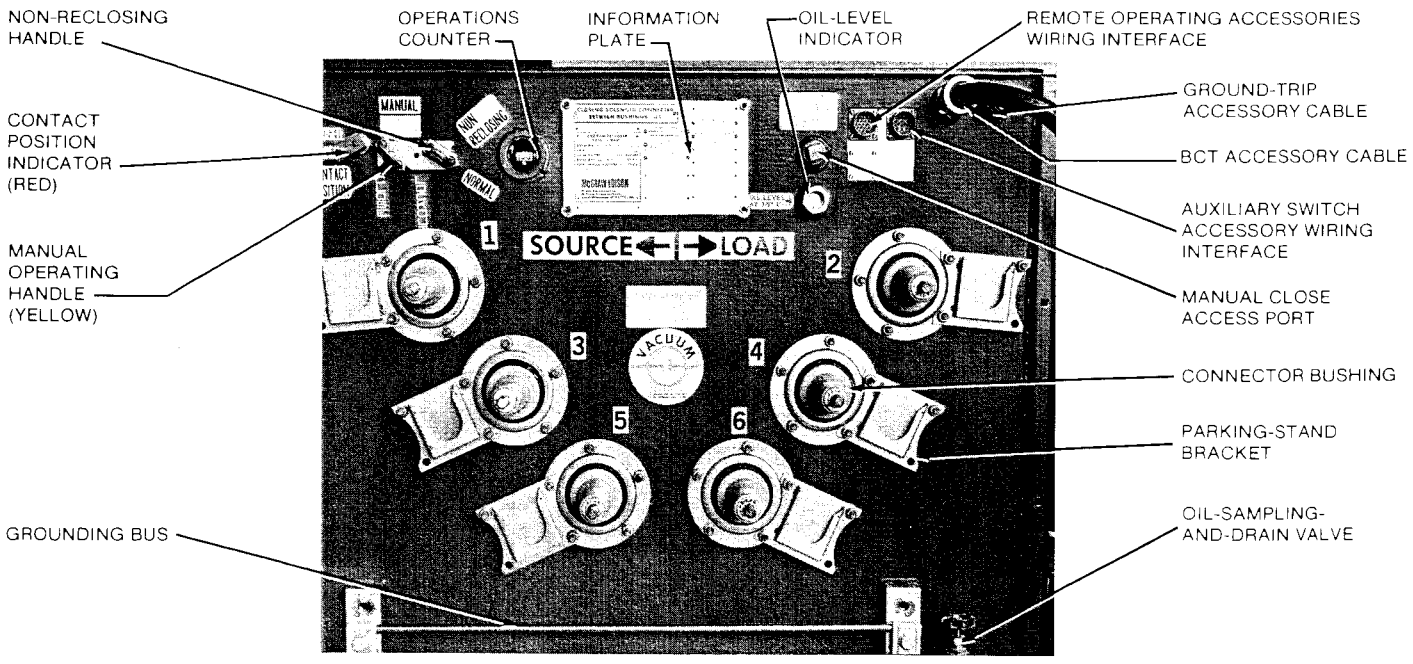


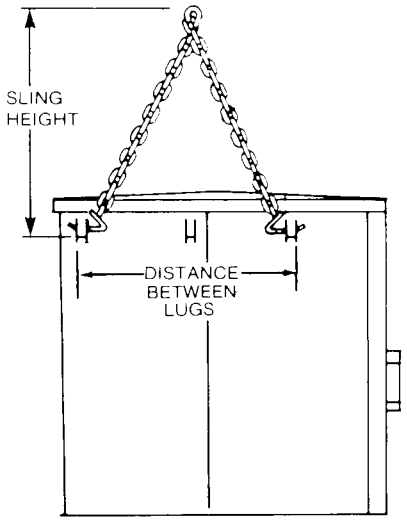
Figure 4.
Manual operating controls and indicators for PWH and PWVH reclosers are mounted on the face of the recloser tank.

MOVING THE RECLOSER TO THE INSTALLATION SITE

Follow approved safety practices when making hitches and lifting a recloser. Lift the recloser smoothly; do not allow it to shift.

The recloser has lifting lugs; the outboard lugs must be used when lifting the entire structure. Maximum strength is attained with a vertical lift attached to the lugs. Use a spreader bar with a fixed attachment point for the hook at the load center.

If a sling is used for lifting the recloser, it must have a fixed attachment point at the load center. Rig the recloser so that the sling height is equal to—or greater than—the distance between lifting lugs.



Lifting a recloser.

INSTALLATION

PWH and PWVH reclosers are shipped completely assembled and ready for mounting. They are designed specifically for padmounted installation. Essential mounting dimensions and suggested cable openings in the pad are shown in Figure 5.

1. Prepare the concrete slab.
2. Check the recloser to make sure the oil is at the correct level.
3. If the recloser has been stored for some time or is being relocated, test the oil in accordance with ASTM-approved dielectric test procedures. On new equipment, the oil must have a dielectric strength of at least 26 kV. Filter the oil as necessary to restore its dielectric strength to acceptable minimum levels.

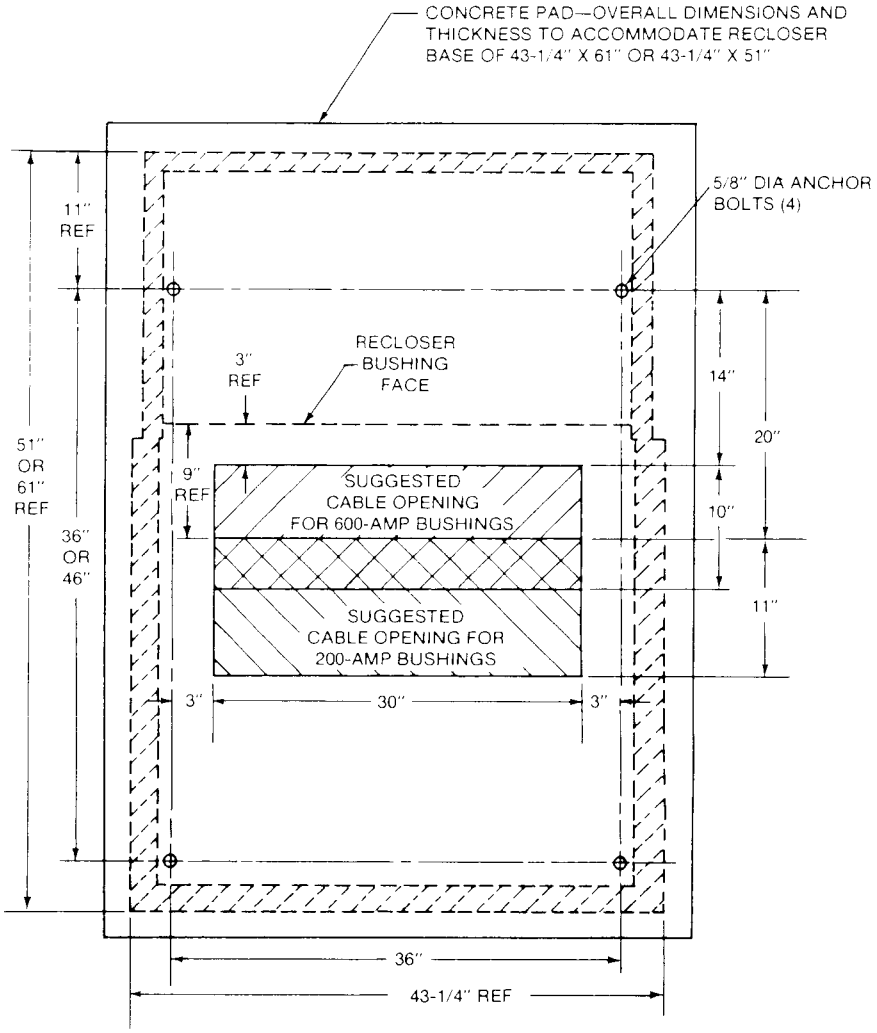


Figure 5.
Mounting dimensions of PWH and PWVH reclosers.

Main Wiring

1. PWH and PWVH reclosers are equipped with UD cable bushings to accommodate separable, deadfront, elbow connectors rated for 600-amp, 15- to 27-kV service. The 200-amp universal bushing wells accommodate the plug inserts of all interchangeable, industry-standard loadbreak and non-loadbreak connectors for 15- and 27-kV service. When preparing cable terminations, follow the procedures recommended by the connector manufacturer.

   NOTE: To energize the closing solenoid, the source leads must be connected to bushings 1, 3, and 5 as shown in Figure 6. The closing solenoid is connected across bushings 3 and 5, as specified on the information plate of the recloser.

2. Make all concentric cable neutral and connector grounding connections to the 1/2-in.-diameter copper grounding bus which is on the recloser tank's face below the bushings.

Accessory Wiring

Terminal blocks are provided on the accessory panel assembly (Figure 7) mounted to the inside of the right-hand door of the enclosure for all accessories requiring auxiliary power and/or external connections. See ACCESSORIES section at the back of this publication for specific information.

INITIAL OPERATION

After making all connections, energize the source-side lines. Then, with a hotstick, move the manual operating handle to the CLOSE position. The recloser should close immediately and be in service.

ROUTINE OPERATION

After the recloser is in service, it operates automatically as overcurrent conditions demand. However, once locked out, it must be manually closed by rotating the manual operating handle to the LOCKOUT position and then to the CLOSE position.

When the recloser operates to lockout, the hydraulic mechanism quickly resets and the unit is ready for another full operating sequence whenever the manual operating handle is returned to CLOSE. If the operating sequence does not reach lockout (temporary fault cleared), the mechanism resetting time is approximately 90 seconds per operation at an oil temperature of 25 C. Another fault occurring prior to complete reset of the mechanism may result in fewer operations to lockout for the second fault.

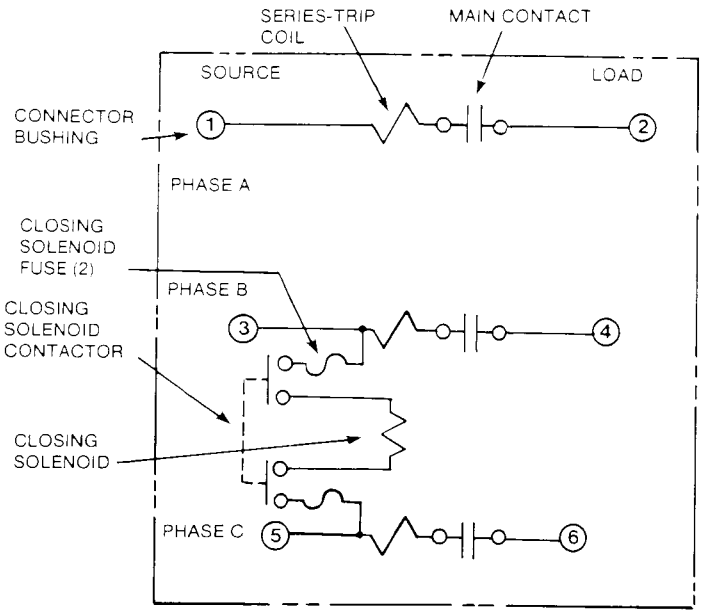


Figure 6.
Schematic diagram of PWH and PWVH reclosers.

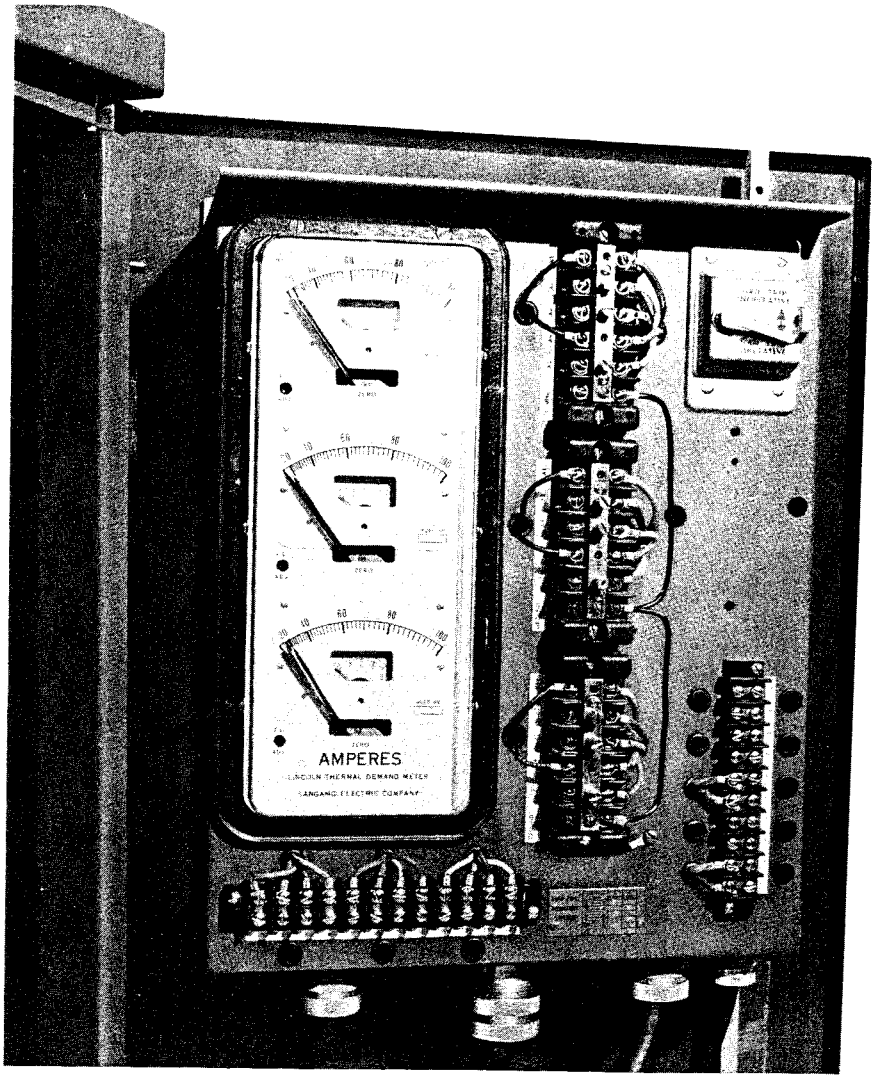


Figure 7.
Accessory panel assembly is mounted inside right-hand door of PWH and PWVH reclosers.

ADJUSTMENTS

The factory-calibrated and -set number of operations to lockout and time-current curve of the recloser—shown on the nameplate—can can be changed in the shop or the field by following simple adjustment procedures:

1. Remove the enclosure roof and recloser tank cover to gain access to make adjustments.
2. To change the number of operations to lockout:
   A. Hold the lockout piston linkage (B, Figure 8) and push out the lockout bar (A, Figure 8) to release the engagement.

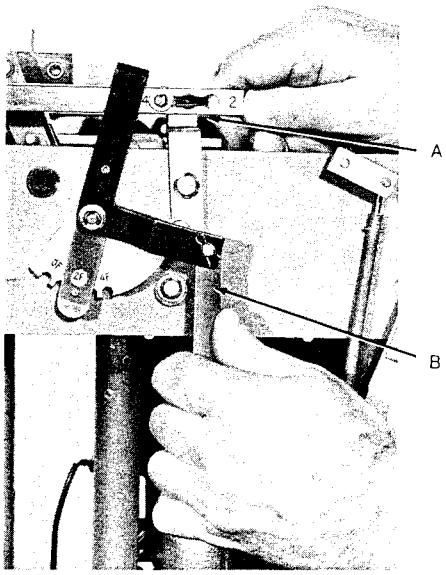


Figure 8.
Setting number of operations to lockout.

   B. Move the bar to the notch corresponding to the desired number of operations to lockout. The outer notches, marked 2 and 4, correspond to two and four operations to lockout; the middle notch corresponds to three operations to lockout.
   C. Push back the bar to lock the setting.
3. To change the number of fast operations:
   A. Lift the spring clip (B, Figure 9) to disengage the indexing pin.
   B. Rotate the plate (A, Figure 9) until the desired number of fast operations appears in the window of the spring clip.
   C. Release the spring clip, making sure the indexing pin seats properly in the plate notch.

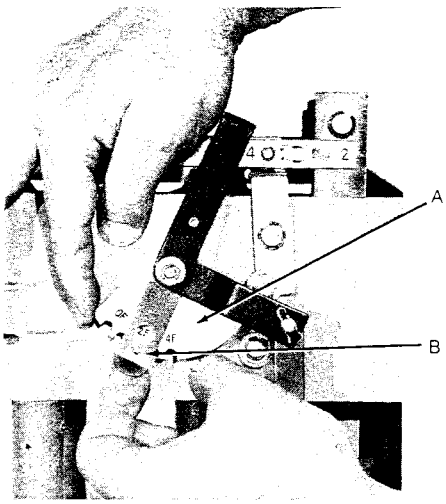


Figure 9.
Setting number of fast operations.

4. The recloser is equipped with time-delay units that can provide two different delayed time-current characteristics (B or C; D or E; see Figure 2). One unit provides the B and C curves; another unit provides the D and E curves. To change from one time-delay characteristic to the other:
   A. Loosen the thumbscrew (Figure 10).

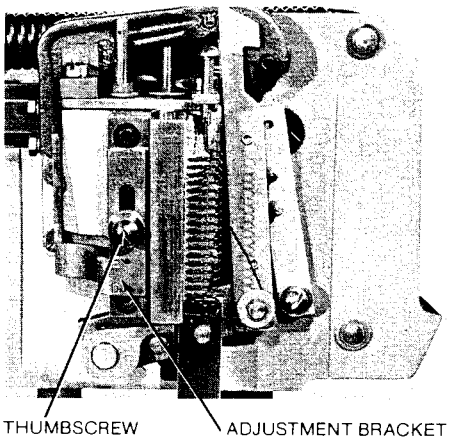


Figure 10.
Setting time-delay characteristics.

   B. Move the adjustment to engage the indexing pin in the other hole.
   C. Retighten the thumbscrew.

NOTE: A separate time-delay unit is provided for each phase. Make sure all three units are set to the same characteristic curve.

TESTING

All reclosers are carefully tested and adjusted at the factory to operate according to the published data. Well-equipped test facilities, a detailed testing procedure, and thoroughly trained personnel assure accurately calibrated units. Each recloser leaves the factory ready for installation.

Pre-installation testing is not necessary. However, should verification of operation prior to installation be desired, procedures are included for checking the following:

- Minimum-trip current.
- Closing solenoid operation.
- Operating sequence.
- Non-reclosing feature.
- Vacuum integrity of the interrupter.

Test results should verify nameplate and data-plate information.

WARNING

To check minimum-trip current, the recloser can be closed manually and tripped with a low-voltage ac source. However, for automatic reclosing, a high-voltage ac source is needed to operate the closing solenoid.

For personnel safety, enclose the high-voltage transformer in a test cage to prevent accidental contact with the high-voltage parts. Locate all metering and measuring equipment outside the test cage.

Use proper termination hardware to apply the high voltage to the recloser bushings.

CAUTION

Do not trip a PWH or a PWVH recloser using a dc source such as a battery. The vacuum interrupters may be severely damaged if interruption of a dc arc is attempted.

NOTE: If the recloser is equipped with a ground-fault trip mechanism accessory, be sure to disable the ground-trip function during phase-trip testing. The ground-trip disable switch is on the accessories panel mounted to the inside of the right door of the enclosure.

Test Circuit

Test circuits are designed to use available equipment for testing particular types and sizes of reclosers. For PWH and PWVH reclosers, a suggested test circuit is shown in Figure 11. Circuit requirements are listed in Tables 6 and 7 for the following set of conditions. Satisfactory operation and reasonable test accuracy should be achieved if these conditions are met:

1. Nominal test current is equal to twice the minimum-trip current.
2. Resistive series loading (equal to ten times the reactance of the trip-solenoid coil with plunger up) is included to minimize the effect of a decreasing test-current envelope caused by rapidly increasing coil reactance as the trip-solenoid plunger starts to move down.

Variations from these recommendations can be made according to the results desired; for example, test equipment with lower ratings can be used, but the effects of decreasing current will be more pronounced. Also, at higher multiples of the minimum-trip current, series-coil reactance variations decrease due to saturation.

Test Equipment

The following equipment is required for the recommended test setup:

1. High-voltage transformer (T1) to operate the closing solenoid.
   A. High-side rating should equal the voltage rating of the recloser.
   B. Be sure minimum allowable voltage shown in Table 6 is maintained at the recloser during the four-to-five cycle interval when the closing coil is energized.
   C. In general, a 50-kVA transformer having an impedance of approximately 3% will be satisfactory provided the source impedance is reasonably low.

WARNING

For personnel safety and to prevent accidental contact with the high-voltage parts, enclose the high-voltage transformer in a test cage. Locate all metering and measuring equipment outside the test cage.

Use proper termination hardware to apply the high voltage to the recloser bushings.

2. Low-voltage transformer (T2) to operate the trip solenoid.
   A. Ratio and kVA size depend on trip-coil size and maximum test current used.
   B. Table 7 shows the approximate test voltage (kVA) and series loading requirements of the various trip coils at twice minimum-trip setting.

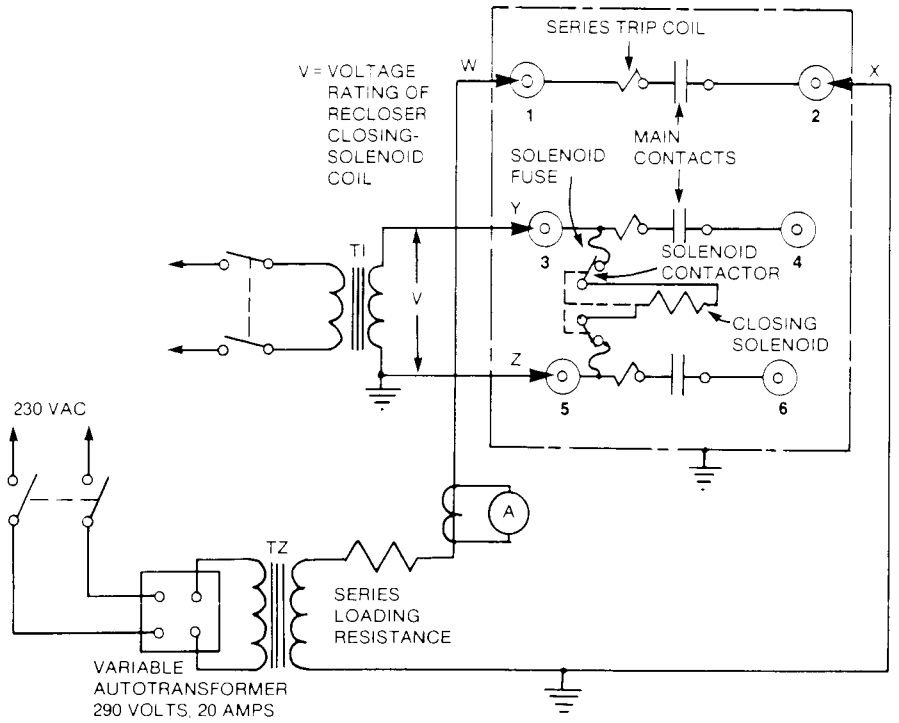


Figure 11.
Suggested test circuit.

TABLE 6
Closing Solenoid Voltage Requirements

Solenoid Coil Rating (kV)	Coil Code No.	Minimum Voltage* to operate Solenoid (volts)
2.4	1	2040
3.3	10	2800
4.16—4.8	2	3540
6.0	6	5100
7.2—8.32	3	6120
11.0	9	9350
12.0—13.2	4	10200
14.4	5	12240
17.0	12	14450
20.0	11	17000
23.4—24.9	13	19900

*Minimum voltage must exist during energizing of closing solenoids.

TABLE 7
Low-Voltage Test Circuit Requirements

Coil Size (amps)	Series Loading Resistance* (ohms)	Test Current (2X Minimum Trip) (amps)	Test Voltage (volts)	Short-Time Test** (kVA)
50	0.086	200	17.2	3.5
70	0.047	280	13.2	3.7
100	0.024	400	9.6	3.8
140	0.012	560	6.7	3.8
160	0.010	640	6.4	4.1
185	0.0074	740	5.5	4.1
225	0.0058	900	5.2	5.2
280	0.0037	1120	4.2	4.8
400X	0.0034	1120	3.8	4.3
400	0.0027	1600	4.3	6.9
560X	0.0022	1500	3.3	50.0
560	0.0015	2240	3.4	7.6

*Loading resistance calculated at 10 coil reactance. Larger coil sizes may not require series loading because impedance of source, leads, and recloser may be large with respect to coil impedance.
**Test intervals are short so rating of transformer may be smaller if short-time rating equals values shown.

3. Variable autotransformer to vary the output of T2.
   A. A 240-Vac, 20-amp unit is recommended.
4. Ammeter to measure test current.
   A. A current transformer may be required to measure the test current magnitudes.

      NOTE: A commercial recloser testing unit manufactured by EIL Instruments, Inc. (Sparks, Maryland) can provide the functions of test Items 2, 3, and 4 above. In addition, this unit can monitor the trip and reclosing timings.

Testing Procedures

ELECTRICAL CLOSING

1. Assemble and connect the equipment as shown in Figure 11.

WARNING
Solidly ground leads X and Z and interconnect to the grounding bus. DO NOT connect leads W and Y to the SAME PHASE. Dangerous voltages to ground exist on the phase connected to Y.

2. With the high-voltage source energized, move the manual operating handle to CLOSE to close the recloser.

MANUAL CLOSING

Since there are no high voltages involved in manual closing, the high-voltage transformer and its asociated equipment, wiring, and precautions are eliminated.

A manual closing tool is mounted on the inside wall of the enclosure near the left door.

WARNING
Never use the manual closing tool on a recloser energized at rated voltage.

To manually close the recloser:

1. Remove the pipe plug from the access port on the front of the recloser.
2. Insert the closing tool into the port and engage the pin on the main operating shaft.
3. Set the manual operating handle on CLOSE and turn the closing tool counterclockwise.

CAUTION
To avoid shearing the pin, do not force the closing tool beyond the stop.

4. After each trip operation, about two seconds will elapse (normal reclosing time) while the closing solenoid plunger moves up to reset the main toggle latch.
5. After the main toggle latch resets, the closing tool can be operated to again close the recloser.
6. When manual closing is used during the operating sequence verification test, the recloser should be closed and tripped quickly. Otherwise, extra operations to lockout may occur due to the trip piston resetting between operations. The best procedure is to have one person operate the closing tool while a second operates the tripping circuit and observes the test results.
7. After testing, replace the pipe plug in the access port on the front of the recloser.

MINIMUM-TRIP CURRENT

The minimum-trip current of each phase can be checked by closing the recloser manually and tripping electrically with the low-voltage ac source. Assemble and connect the low-voltage ac source. Assemble and connect the low-voltage test setup shown in Figure 11 and proceed as follows:

1. Phase A
   A. Connect the low-voltage test leads X and W to bushing terminals 1 and 2 respectively.
   B. With the manual operating handle in CLOSE, manually close the recloser.
   C. Slowly raise the variable autotransformer voltage from zero and note the ammeter reading.
   D. As the trip solenoid plunger starts to move, the trip coil impedance will rise and cause a decrease in current. The minimum-trip current is the maximum reading before the current decreases.
2. Phase B
   A. Connect the low-voltage test leads X and W to bushing terminals 3 and 4 respectively.
   B. Repeat steps B, C, and D of Paragraph 1.
3. Phase C
   A. Connect the low voltage test leads X and W to bushing terminals 5 and 6 respectively.
   B. Repeat steps B, C, and D of Paragraph 1.

OPERATION OF CLOSING SOLENOID

The operation of the closing solenoid can be verified by tripping the recloser manually and closing it electrically with the high-voltage ac source. Assemble and connect the high-voltage circuit portion of the test setup shown in Figure 11 and proceed as follows:

1. With the high-voltage leads Y and Z connected to the solenoid coil as shown in Figure 11, trip open the recloser manually and then move the manual operating handle to CLOSE.
2. Energize high-voltage transformer T1. The recloser will close immediately, indicating correct closing solenoid operation.

OPERATING SEQUENCE

The operating sequence can be verified by tripping the recloser electrically (with the low-voltage ac source) and closing the recloser electrically (with the high-voltage ac source).

NOTE: The recloser may be closed manually during the operating sequence to eliminate the high-voltage transformer T1 (Manual closing operation, page 9).

Assemble and connect the test circuit as shown in Figure 11 and proceed as follows:

1. Set the current output of T2 high enough (at least twice minimum-trip current) to readily operate the recloser.
2. With the recloser manual operating handle set on CLOSE, energize high-voltage transformer T1 to close the recloser. The recloser should perform its operations sequence and lock out.
3. By observing the operation of the counter through the window in the recloser tank, check the number of fast operations and the number of operations to lockout.

NON-RECLOSING FEATURE

Using the same test setup and test current settings, the operation of the non-reclosing feature can be verified immediately after the operating sequence testing. Proceed as follows:

1. Place the non-reclosing handle in the NON-RECLOSING position.
2. With the recloser manual operating handle set on CLOSE and T2 energized, energize high-voltage transformer T1 to close the recloser. The recloser should lock out after the first trip operation.

VACUUM INTERRUPTERS

The following procedure can be used to check the vacuum integrity of the interrupter assemblies:

With the recloser in the open position, perform a high-pot test for one minute across each open vacuum interrupter assembly at the following voltage:

PWH recloser; 26.2 kV rms or 37.1 kV dc;
PWVH recloser; 30 kV rms or 42.4 kV dc.

CAUTION
Use the proper termination when applying test voltages directly to submersible bushing-stud terminals.

The interrupter should withstand the test voltage and should not load down the source.

WARNING
At voltages up to the specified test voltages, the radiation emitted by the vacuum interrupter is negligible. However, above these voltages, radiation injurious to personnel may be emitted. See RADIATION WARNING in *Service Information S280-90-1* for further details.

ACCESSORIES

The following accessories are available to adapt Types PWH and PWVH reclosers to a variety of applications. Some accessories modify the normal operating functions while others increase operating versatility; still others provide indicating functions.

For each accessory installed on a particular recloser, a description plate is mounted on the information plate of the recloser.

Where required, accessory leads are brought out of the recloser tank through an oiltight receptacle/plug interface to terminal blocks for exernal customer connections. The terminal blocks are located on the accessory panel mounted to the inside of the right-hand door of the enclosure as shown in Figure 7. A connection diagram for the accessories is shown in Figures 12 and 13.

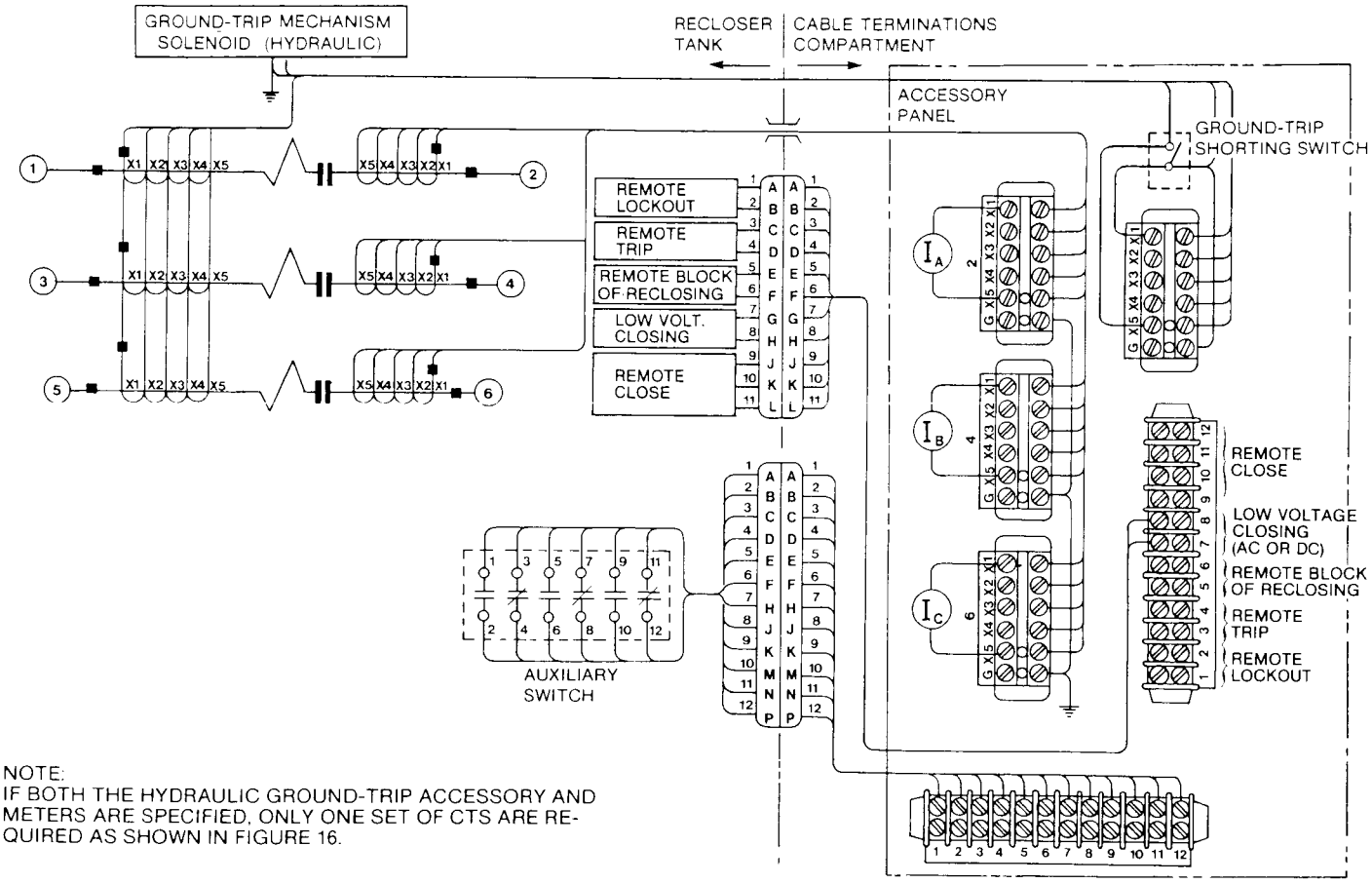


Figure 12.
Accessories connection diagram.

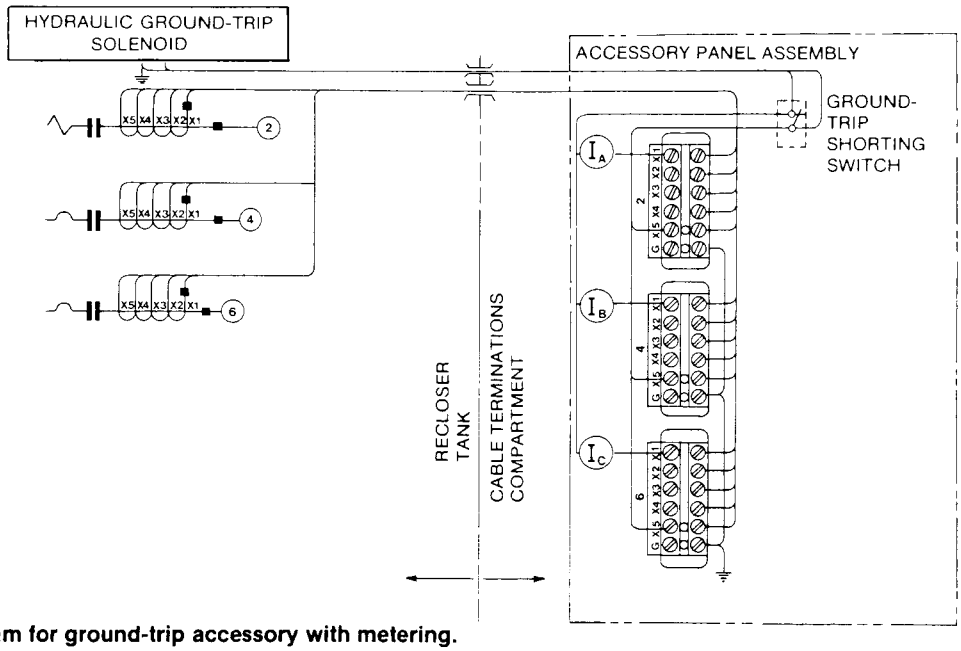


Figure 13.
Connection diagram for ground-trip accessory with metering.

Bushing-Type, Multi-Ratio Current Transformer

CAUTION
The recloser is shipped with shorting thumbscrews (Figure 14) in the CT terminal block(s). DO NOT REMOVE these thumbscrews until the external connections have been made to the block(s). Energizing the recloser with the shorting thumbscrews removed and the CTs not externally connected may generate dangerous voltages in the CT secondaries.

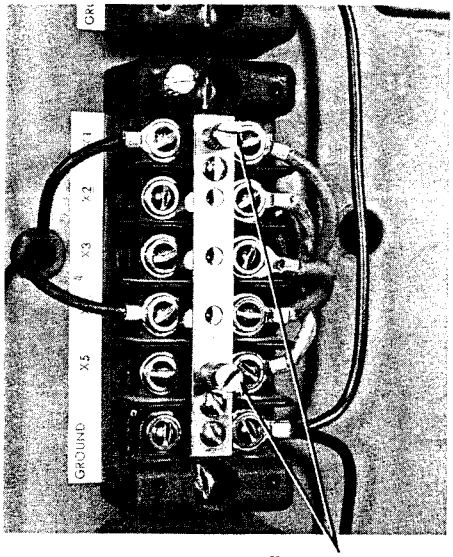


Figure 14.
Position of shorting thumbscrews in terminal block for one multi-ratio bushing current transformer.

The 600:5 or 1200:5 multi-ratio current transformers for operating meters or separate relays are mounted on loadside bushings 2, 4, and 6 (Figure 15). These transformers have only one primary turn, the bushing rod. Taps on the secondary winding, brought out to terminal blocks on the accessory panel can be connected to provide ten different current ratios (Figure 16).

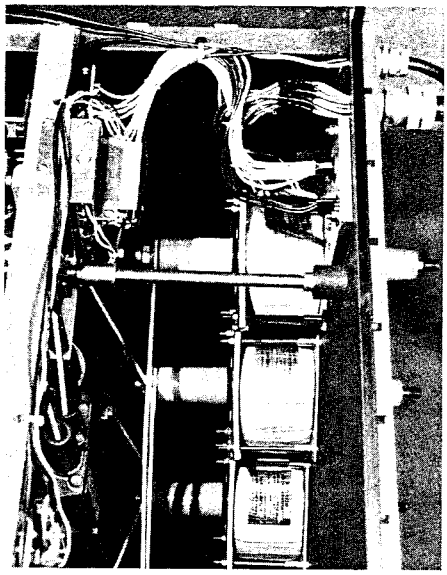


Figure 15.
Multi-ratio CTs are mounted on the load-side bushings inside the recloser tank.

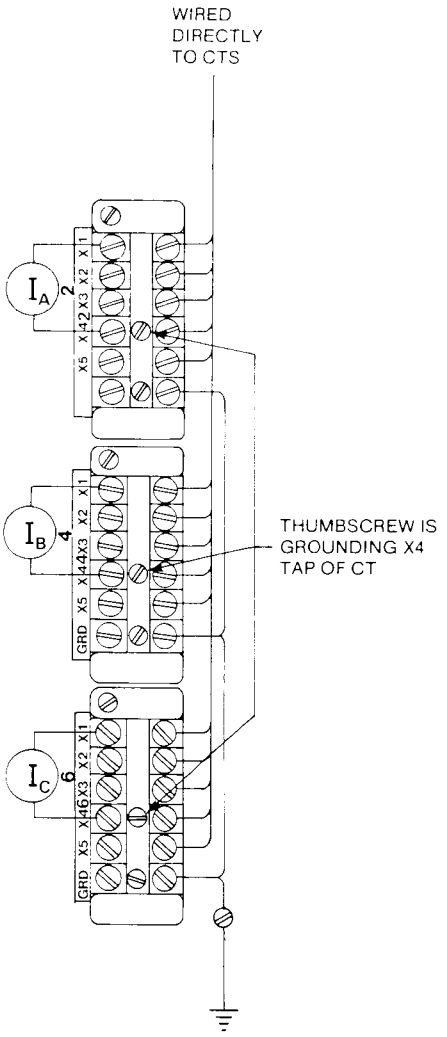


Figure 16.
Load meter wiring to multi-ratio CT terminal blocks (400:5 amp ratio, terminals X1—X4 illustrated here).

Table 8 lists available ratios and their terminal block connections.

TABLE 8
Terminal Block Connections for Multi-Ratio Bushing Current Transformers

Ratio	Ratio	Terminals
600:5	1200:5	X1—X5
500:5	1000:5	X2—X5
450:5	900:5	X3—X5
400:5	800:5	X1—X4
300:5	600:5	X2—X4
250:5	500:5	X3—X4
200:5	400:5	X4—X5
150:5	300:5	X1—X3
100:5	200:5	X1—X2
50:5	100:5	X2—X3

Hydraulic Ground-Trip Mechanism

If the rated minimum zero-sequence (ground) current is exceeded, the hydraulic ground-trip mechanism—an oil-dashpot-type solenoid connected to paralleled BCT secondaries—trips the recloser. The hydraulic ground-trip mechanism accessory enables the recloser to protect against ground-fault currents lower than the recloser's minimum phase-trip setting. For ground-fault currents greater than the minimum phase-trip setting, recloser opening is governed by either the phase-trip series solenoids or the ground trip solenoid, whichever is faster.

The solenoid coil is operated from the bushing-type, multi-ratio current transformers mounted on the source-side bushings (1, 3, and 5) to produce the minimum ground-trip currents shown in Table 9. The transformers are provided as part of the accessory.

TABLE 9
Ground-Trip Solenoid Operating Data

Bushing Current Transformer Ratio	Minimum Zero-Sequence Trip Current (primary amps)	
	Series-Connected Coil	Parallel-Connected Coil
50:5	N/A*	N/A*
100:5	63.5	110
150:5	87	156
200:5	110	204
250:5	133	250
300:5	156	300
400:5	204	400
450:5	227	450
500:5	250	500
600:5	300	600

*Not applicable; BCT output too low to operate solenoid.

To disable the ground-trip feature during startup and testing, a ground-trip block switch is mounted in the upper right corner of the accessory panel (Figure 7). The connection diagram for the hydraulic ground-trip mechanism is shown in Figure 12. Figure 13 details connections for the accessory when metering is also provided.

The minimum-trip rating, operating sequence, and time-current characteristics are factory-set and -calibrated and are shown on a data plate attached to the recloser sleet hood. If required, they can be changed in the shop or in the field, using the following procedures.

MINIMUM-TRIP SETTING

The minimum ground-trip current depends on the current transformer ratio and the solenoid coil connection (Table 9). To change the transformer ratio, change the connections at the appropriate terminal block(s) (Figures 12 and 13). Series- and parallel-connected solenoid coils are shown in Figure 17.

NUMBER OF OPERATIONS TO LOCKOUT

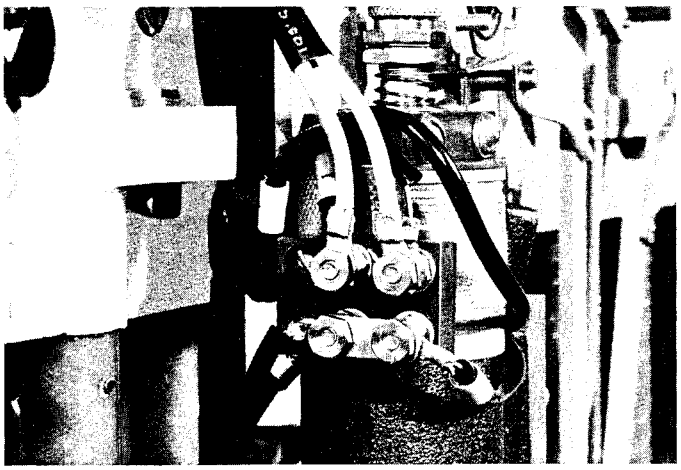
The total number of operations to lockout on ground trip is determined by the phase-trip operations-to-lockout setting of the lockout bar. See page 7.

NUMBER OF FAST OPERATIONS

The number of fast operations on ground trip is independent of the phase-trip fast-operations settings.

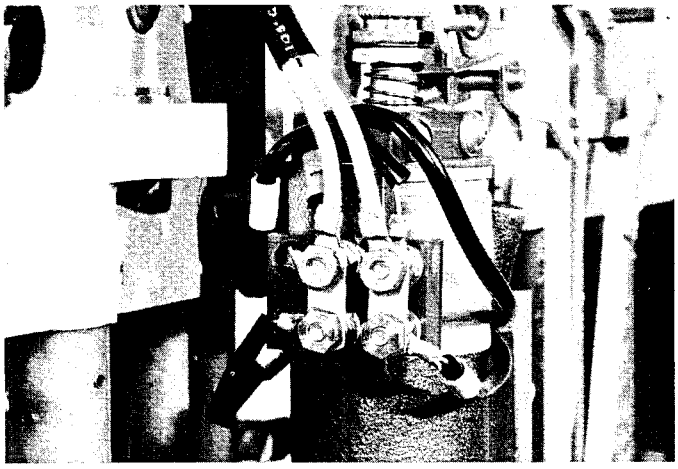
To change the number of fast operations:

1. Pull and turn the indexing plate (Figure 18) until the desired number (0F, 1F, 2F, 3F, or 4F) appears in the plate window.
2. Release the indexing plate, making sure the pin is seated in the proper index hole.



SERIES CONNECTION

1. Connect both copper straps across lower terminals 2 and 3.
2. Connect the current transformers to upper terminals 1 and 4.



PARALLEL CONNECTION

1. Connect the copper straps across the left-side terminals 1 and 2 and the right side terminals 3 and 4.
2. Connect the current transformers to upper terminals 1 and 4.

Figure 17.
Connections for ground-trip solenoid.

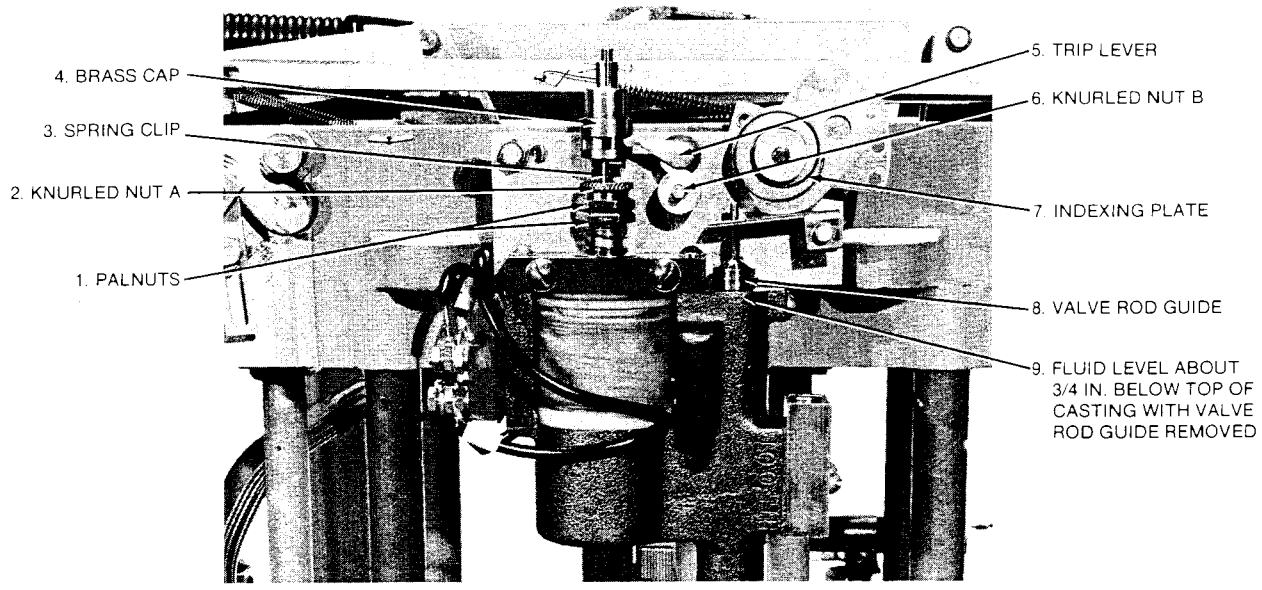


Figure 18.
Ground-trip solenoid adjustments.

INVERSE OR DEFINITE TIME DELAY

The ground-trip mechanism can be set to operate along inverse (Figure 19) or definite (Figure 20) time-delay curves.

To select inverse time-delay tripping:

1. Pull knurled nut A (Figure 18) down to release it from the spring clip.
2. Holding the lower palnut with a wrench, turn knurled nut A clockwise until it is tight against the upper palnut.

To select definite time-delay tripping:

1. Holding the upper palnut with a wrench, turn knurled nut A counterclockwise until it is free of threads.
2. Push knurled nut A up to engage it with the spring clips.

TIME-DELAY CURVES

Two inverse time-delay curves (2—3) and three definite time-delay curves (7—8—9) are available (Figures 19 and 20).

NOTE: The fast-trip component of an inverse time curve is prefixed by the numeral 1; the fast-trip component of a definite time curve is prefixed by the numeral 5. Thus, if Curve 3 is selected, fast ground-trip operations will follow Curve 1—3; if Curve 8 is selected, fast ground-trip operations will follow Curve 5—8.

To change from one time-delay curve to another:

1. Loosen knurled nut B (Figure 18) to release the trip lever from the grooves in the brass cap.
2. Turn the brass cap to align the correct groove with the trip lever.

   NOTE: The numbers stamped above each groove correspond to the time-delay curve numbers shown in Figures 19 and 20.
3. Tighten knurled nut B.

CAUTION

Changing from inverse to definite time-delay tripping—or vice-versa—or from one delay curve to another may result in the ground-trip solenoid operating outside published limits. If these changes are made, return the solenoid to the factory for recalibration.

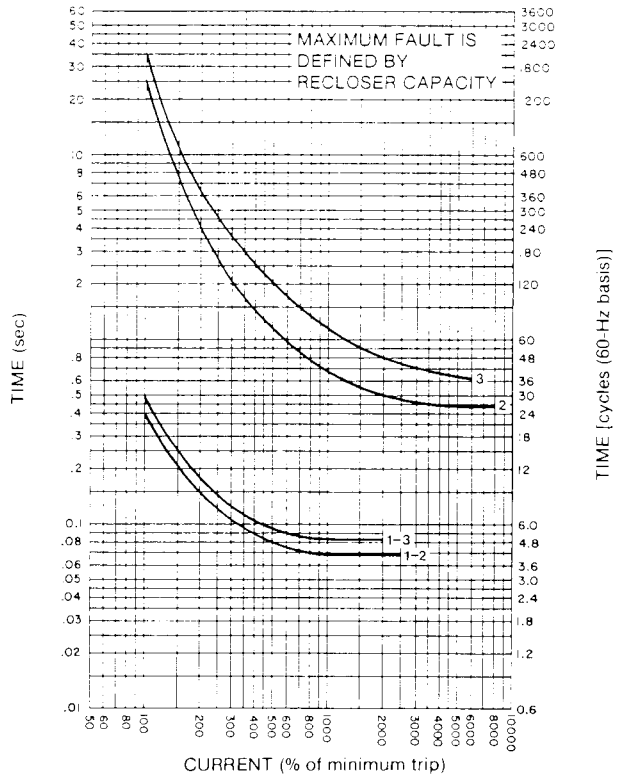


Figure 19.
Typical time-current characteristics—inverse-time ground tripping. (To determine operating data, refer to time-current curves in Reference Data R280-91-7.)

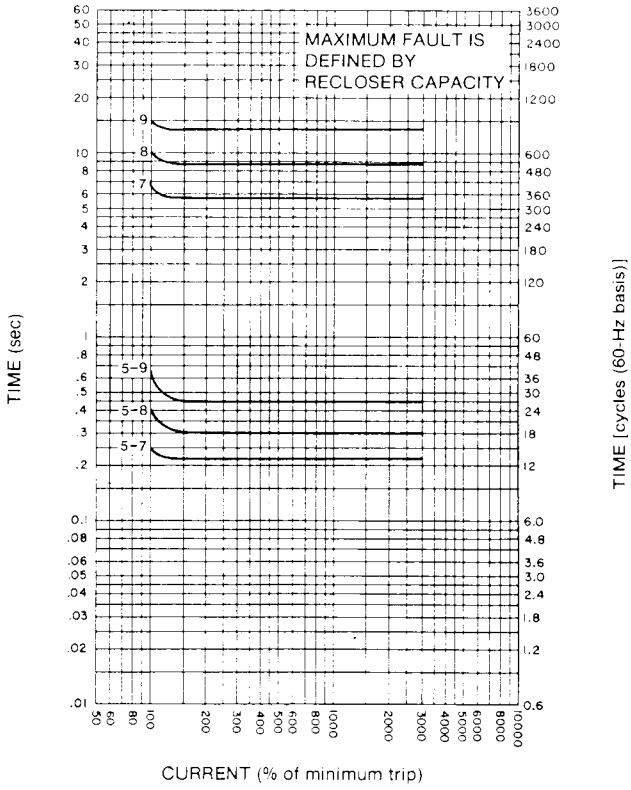


Figure 20.
Typical time-current characteristics—definite-time ground tripping. (To determine operating data, refer to time-current curves in Reference Data R280-91-7.)

Electronic Ground-Trip Mechanism

Self-contained, independent, low-level, ground-fault tripping is also available with an electronically controlled ground-trip accessory. Mounted internally on the recloser operating mechanism frame, this accessory provides dual-timing characteristics with a choice of 11 minimum-current trip values and nine definite time-current delay curves. Inverse time-current delay is not available with the electronic ground-trip mechanism accessory.

Zero-sequence (ground) current is sensed by three parallel-connected current-sensing transformers mounted on the source-side bushings inside the recloser tank. Power to operate this accessory is obtained from the line by these same current transformers.

Additional components of the accessory include a solid-state electronic control circuit board, a low-energy tripping mechanism, and a dual-timing switch with indexing plates for setting operations sequence (Figure 21). Figure 22 is a connection wiring diagram of the ground-trip accessory.

All adjustments are accessible under the recloser head casting and can be field-changed by lowering the tank. The following settings and adjustments can be made to the electronic ground-fault-trip accessory:

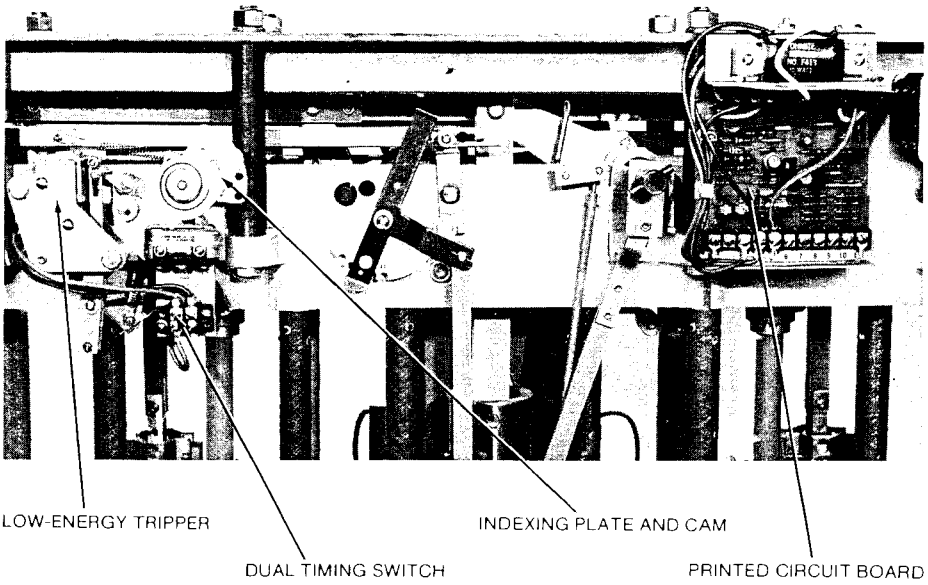


Figure 21.
Components of electronic ground-fault trip accessory.

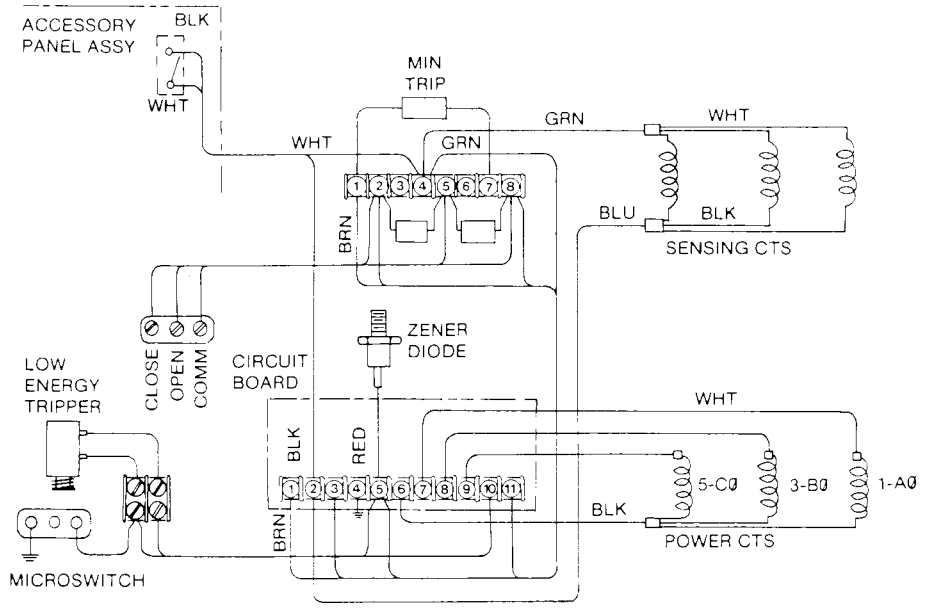


Figure 22.
Connection diagram for electronic ground-fault trip accessory.

MINIMUM-TRIP SETTING

Minimum zero-sequence (ground) trip current is determined by resistors (Figure 23) and can be changed by substituting resistors of different values. The following trip values are available: 5, 10, 20, 35, 50, 70, 100, 140, 200, and 560 amps.

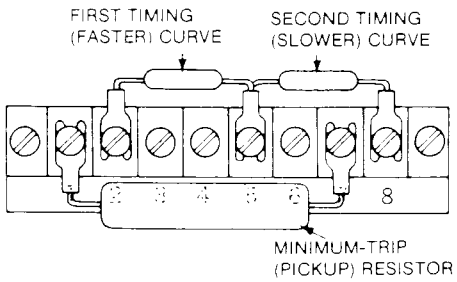


Figure 23.
Ground-trip programming components.

TIME-CURRENT CURVES (TCCs)

The nine available clearing time-current curves are determined by different resistors. (The TCCs are published in *Reference Data R280-91-9*).

NOTE: This accessory has dual timing. The first timing curve resistor should always be faster (lower number) than the second timing resistor. Either curve can be changed by changing the timing resistor (Figure 23).

NUMBER OF OPERATIONS TO LOCKOUT

The total operations to lockout on either ground or phase trip is determined by the lockout bar setting (see page 7). The recloser may lock out on all phase-trip operations, all ground-trip operations, or any combination of the two that reach the lockout setting.

NUMBER OF FAST OPERATIONS

The number of initial (fast) operations is independent of the phase-trip fast operations setting and is determined by the setting of the cam on the ground-trip mechanism (Figure 24). The cam can be manually indexed for 0, 1, 2, 3, or 4 operations on the first timing curve. The remaining operations to lockout will occur on the second (slow) timing curve.

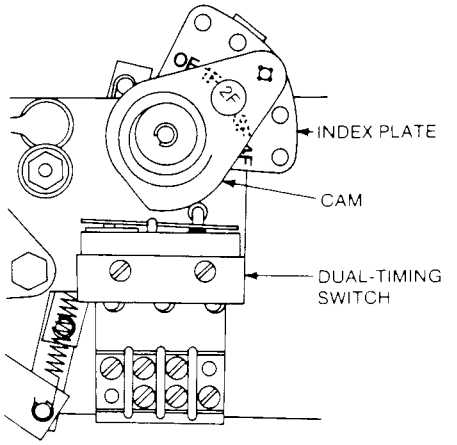


Figure 24.
Components for setting dual timing.

Testing the Ground-Fault Trip Accessory

The following procedure can be used to test either the hydraulic or electronic ground-fault trip accessory:

TEST EQUIPMENT

A suggested test circuit is shown in Figure 25. The following equipment is required for the recommended test setup:

1. Variable autotransformer (T1): 230V, 20 amps.
2. Low-voltage transformer (T2) to operate the ground-trip accessory.
   A. Ratio and kVA size depend on trip coil size and maximum test current used.
   B. See Table 7 for requirements of various trip coils at twice minimum-trip rating.
3. Ammeter: Full-scale deflection should be at least twice the minimum-trip current.

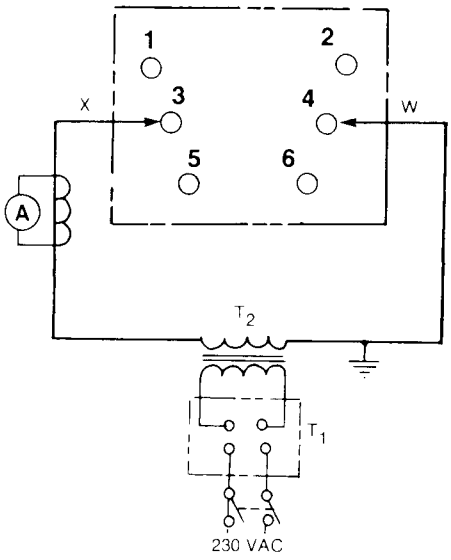


Figure 25.
Test circuit for checking ground-trip accessory.

MINIMUM-TRIP CURRENT

The minimum ground-trip current can be verified by manually closing the recloser (with the manual closing tool) and tripping it electrically (with the low-voltage ac source) as described below:

1. Connect low-voltage test leads X and W to the bushings of Phase B or C (terminals 3 and 4, or 5 and 6). See Figure 25.
2. With the manual operating handle in the CLOSE position, manually close the recloser with the closing tool. Refer to page 9 for manual closing instructions.
3. Slowly increase the variable autotransformer voltage from zero and note the ammeter reading when the recloser trips.

OPERATING SEQUENCE

Operating sequence of the ground-fault trip accessory is checked by passing current in excess of the minimum ground-trip level, but lower than the phase-trip level through Phase B or C of the recloser and reclosing manually after each trip operation:

1. Connect low-voltage test leads X and W to the bushings of Phase B or C (terminals 3 and 4, or 5 and 6; Figure 25).
2. With the manual operating handle in the CLOSE position, use the closing tool to manually close the recloser. Refer to page 9 for manual closing instruction.
3. Set the variable autotransformer high enough to cause ground trip, but lower than the minimum phase-trip level.
4. Energize low-voltage transformer T2. The recloser should trip.
5. After each trip operation, approximately two seconds (normal reclosing time) will elapse while the main toggle latch resets.
6. Immediately after the mechanism resets, the recloser can be closed again with the manual closing tool. The recloser should trip again.
7. To avoid extra operations due to partial resetting of the lockout piston, close and trip the recloser quickly.
8. Observe the number of fast ground-trip operations, the number of slower trip operations, and the number of ground-trip operations to lockout. When lockout is reached, the manual operating handle will drop down and the manual closing mechanism will become inoperative.

Auxiliary Switch

Remote indication of recloser contact position or switching of other devices can be accomplished with an auxiliary switch. A three-stage switch is mounted on the recloser frame as shown in Figure 26. Each stage or section has two independent contacts *a* and/or *b*. When the recloser's main contacts are open, the *a* contacts are also open and the *b* contacts are closed. Table 10 shows the recloser/switch contact relationship.

Switch contacts are insulated for 600 volts and have a continuous current rating of 10 amps. The interrupting ratings of the auxiliary switch contacts are shown in Table 11.

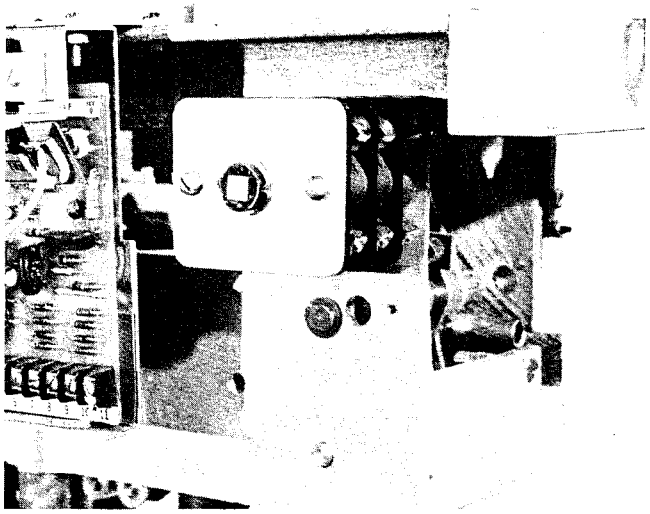


Figure 26.
Three-stage auxiliary switch.

TABLE 10
Related Recloser/Switch Contact Position

Recloser Contacts	Closed	Open
Auxiliary a contacts are	Closed	Open
Auxiliary b contacts are	Open	Closed

TABLE 11
Interrupting Ratings of Auxiliary Switch

Volts	Inductive ac	Noninductive ac	Inductive dc	Noninductive dc
24	—	—	15	20
48	—	—	7.5	10
120	50	80	—	—
125	—	—	1.5	2
240	25	40	—	—
250	—	—	0.45	0.5

The auxiliary switch leads are brought out of the recloser tank through an oiltight receptacle/plug interface to a terminal block at the bottom of the accessory panel assembly (Figure 12).

Unless otherwise specified, each switch state consists of one *a* and one *b* contact. Contacts can be changed for either *a* or *b* operation by repositioning the cams inside each switch section.

To change any cam position:

1. Drive out the roll pin attaching the operating linkage to the square shaft of the switch assembly.
2. Loosen the two round-head machine screws which attach the switch to the mechanism frame and lift out the entire switch assembly.
3. Remove the cotter pin and collar from the square shaft.
4. Starting with the inboard section, lift the cams off the square shaft.
5. Reposition the cams in the desired position as shown in Figure 27.
6. Reposition the switch sections on the two machine screws.
7. Replace the collar and cotter pin on the shaft.
8. Remount the switch to the mechanism frame and attach the operating linkage to the square shaft.
9. See Figure 12 lead wiring identification.

Electrical ratings of the auxiliary switch are listed in Table 12.

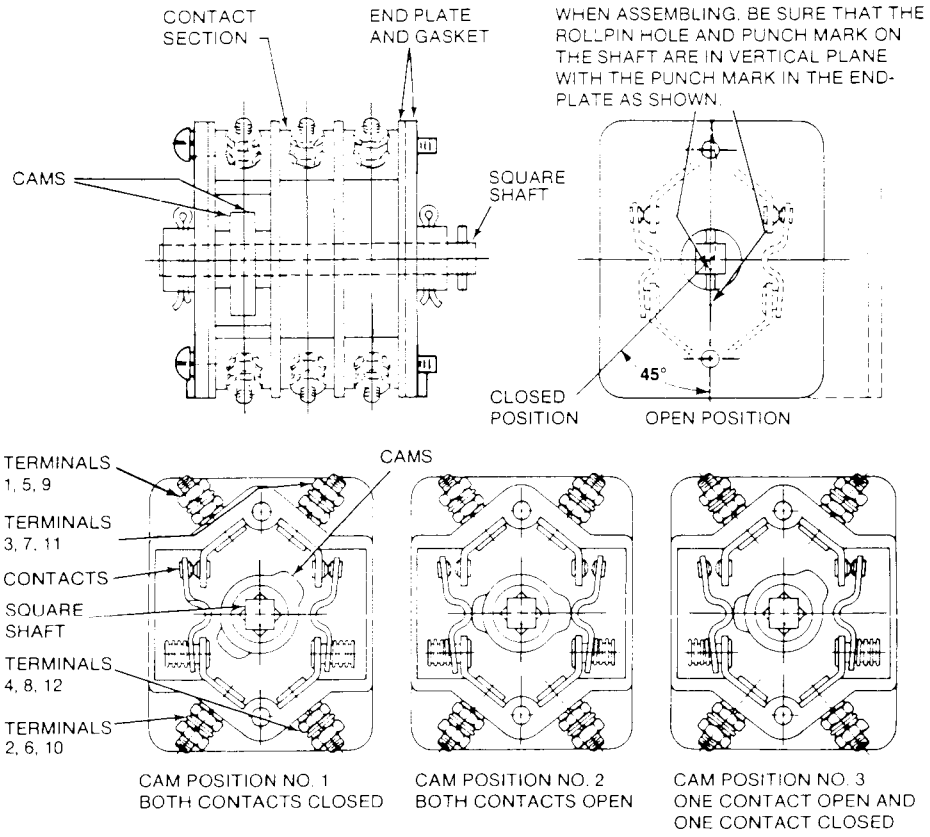


Figure 27.
Auxiliary switch cam positions.

Remote Trip

NOTE: The remote-trip accessory cannot be installed on a recloser equipped with a ground-trip accessory (hydraulic or electronic) since both occupy the same space and operate the same trip-lever mechanism.

When energized from an external source, the remote-trip solenoid (Figure 28) trips the recloser, just as when the series-trip solenoid operates. Normal automatic reclosing follows. Reclosing will occur even if the solenoid remains energized. Should this condition occur, the recloser will operate to lockout. The remote-trip accessory leads are brought out of the recloser tank through the wiring and receptacle assembly interface to terminals 3 and 4 of the vertical terminal block on the accessory panel (Figure 12). Electrical ratings are shown in Table 13.

TABLE 12
Electrical Ratings of Auxiliary Switch

Catalog Number	Rated Voltage (Vac)	Operating Voltage Range (Vac)	Steady-State Current at Rated Voltage (amps)
KA58PWHA	120	95—125	1.3
KA58PWHB	240	190—250	0.65

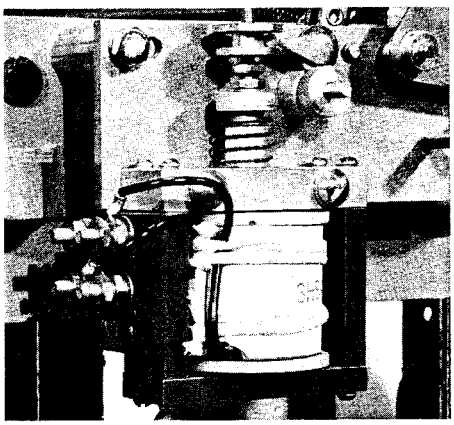


Figure 28.
Remote-trip solenoid.

TABLE 13
Electrical Ratings of Remote-Trip Accessory; Intermittent Duty Only

Catalog Number	Rated Voltage (Vac)	Operating Voltage Range (Vac)	Steady-State Current at Rated Voltage (amps)
KA57PWHA	120	95—125	0.36
KA57PWHB	240	190—250	0.18

Remote Lockout

NOTE: To provide complete remote operation, the remote lockout accessory is usually employed with the remote closing of a locked-out recloser accessory.

The remote lockout solenoid (Figure 29) enables an external control to trip the recloser and operate the lockout mechanism. The accessory leads are brought out of the recloser tank through the wiring and receptacle assembly interface to terminals 1 and 2 of the vertical terminal block on the accessory panel (Figure 12). Electrical ratings are shown in Table 14.

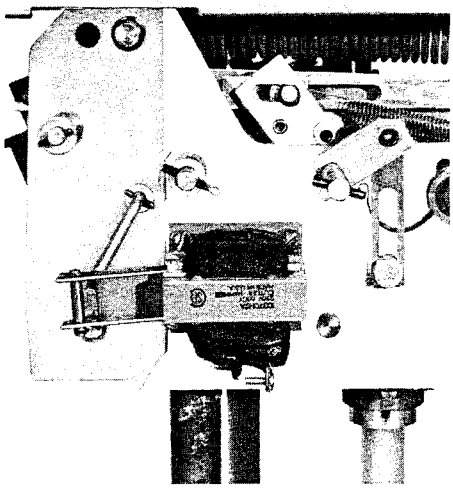


Figure 29.
Remote-lockout solenoid.

Remote Close of Locked-Out Recloser

When energized from an external source, the remote-close accessory moves the manual operating handle on the recloser to CLOSE, actuating the high-voltage closing solenoid contactor to close the recloser.

The external control circuit for this accessory requires a three-wire connection that includes a customer-furnished normally open momentary contact. Closing this contact energizes a relay in the accessory to close the circuit to the motor that drives the manual operating handle. After the closing operation, a limit switch deenergizes the relay to stop the motor and reset the circuit.

The accessory leads are brought out of the recloser tank through the wiring and receptacle assembly interface to terminals 9, 10, and 11 of the vertical terminal block on the accessory panel (Figure 12).

Remote Block-of-Reclosing

The remote-block-of-reclosing accessory (Figure 30) blocks automatic reclosing. Two mechanisms (KA59PWHA and KA59PWHB, see Table 15) block reclosing when the recloser is deenergized; two others (KA59PWHC and KA59PWHD, see Table 15) block reclosing when the recloser is energized. The accessory leads are brought out of the recloser tank through the wiring and receptacle assembly interface to terminals 5 and 6 of the vertical terminal block on the accessory panel (Figure 30). This accessory—rated for continuous duty—requires 120 or 240 Vac. Ratings are shown in Table 15.

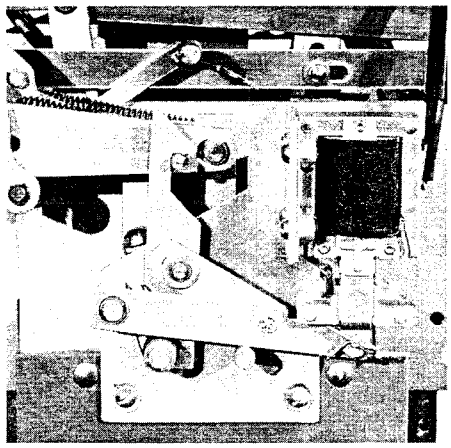


Figure 30.
Remote-block-of-reclosing mechanism.

Low-Voltage Dc Closing

With the substitution of a special dc closing solenoid and associated wiring, the recloser can be closed by an externally controlled low-voltage dc power source rather than from the primary high-voltage source. Low voltage is especially desirable in loop and load-transfer schemes where the recloser can be operated regardless of which side of the unit is energized. Current requirements for dc closing are 55 amps at 125 Vdc; 30 amps at 250 Vdc.

The accessory leads are brought of the recloser tank through the wiring and receptacle interface to terminals 7 and 8 of the vertical terminal block on the accessory panel (Figure 12).

Low-Voltage Ac Closing

With the addition of a modified closing contactor equipped with a full-wave diode bridge (Figure 31), the dc closing solenoid can be operated from a low-voltage ac source. Current requirements for ac closing are 50 amps at 120 Vac; 34 amps at 240 Vac.

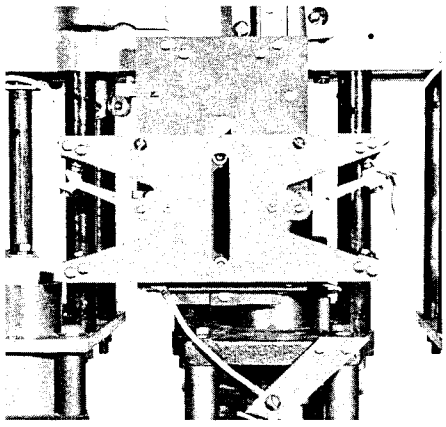


Figure 31.
Low-voltage ac closing accessory.

TABLE 14
Electrical Ratings of Remote Lockout Accessory

Catalog Number	Operating Voltage (Vac)	Inrush Current (amps)	Steady-State Current (amps)	Operating Time (sec)
KA62PWHA	120	1.25	0.5	2
KA62PWHB	240	0.63	0.25	2

TABLE 15
Electrical ratings of Remote-Block-of-Reclosing Accessory

Catalog Number	Rated Voltage (Vac)	Operating Voltage Rating (volts)	Steady-State Current (amps)	Status
KA59PWHA	120	95—125	0.2	Blocks when
KA59PWHB	240	190—250	0.1	deenergized
KA59PWHC	120	95—125	0.2	Blocks when
KA59PWHD	240	190—250	0.1	energized

Closing-Coil Contactor-and-Transfer Switch

The closing-coil contactor-and-transfer switch allows the high-voltage closing solenoid to be energized from either side of the recloser. This accessory consists of a mechanically operated combination DPST closing contactor and DPDT transfer switch and is an alternative to the standard closing solenoid contactor of the recloser. It mounts in the same position (Figure 32) and is operated in a similar manner.

No external customer connections are required to operate the closing-coil contactor-and-transfer switch.

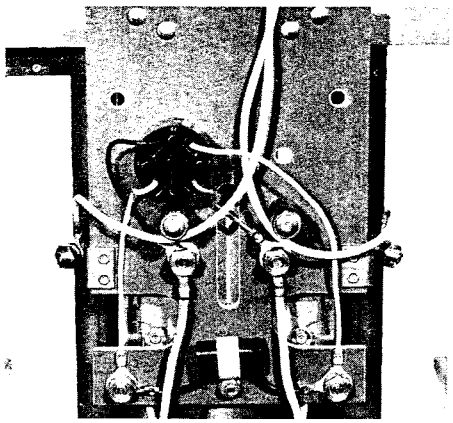


Figure 32.
Closing solenoid coil contactor-and-transfer switch accessory is mounted in recloser mechanism in place of standard closing solenoid contactor.

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KA2048-0256 Rev: R