MCGRAW-EDISON
Power Systems Division

Reclosers
Type KF
Maintenance Instructions

S77056-E
Service Information

Applies to serial number below 2000A and below 500B.

CAUTION:
Do not energize this equipment out of oil.

RADIATION WARNING
See page 10.

Figure 1.
McGraw-Edison Type KF hydraulically controlled vacuum recloser.

Table of Contents

INTRODUCTION

Service Information S77056-E provides the maintenance instructions for Type KF hydraulically controlled, three-phase vacuum reclosers. Included is a general description of the recloser and its operation, instructions for periodic inspection and routine maintenance, recommended test procedures, and instructions for shop repairs. A service-parts list keyed to exploded-view drawings of the recloser is included at the back of the manual.

DESCRIPTION AND OPERATION

The Type KF recloser is a self-contained, three-phase current interrupting device. It senses line current and automatically interrupts all three phases of the distribution circuit to which it is connected when line current exceeds a preset minimum-trip level. Sensing of line current, timing of its opening operation, and sequencing from fast to delayed timing (when programmed) are all done separately on each phase. Current interruption, counting operations to lockout, and actual recloser lockout are on a three-phase basis.

Arc interruption takes place within the three sealed, vacuum interrupters. Oil is used in KF reclosers for electrical insulation, but is not involved in arc interruption. The insulating oil also is used in the counting and sequencing mechanisms and in the timing of opening and reclosing operations.

The moving contacts in the vacuum interrupters are driven by release of an opening spring. Trip solenoids in series with the main recloser contacts release the opening spring (by plunger movement) when current above minimum-trip level is sensed.

Type KF reclosers equipped with ground (earth) fault tripping sense zero sequence current through sensing current transformers located inside the recloser. When the zero sequence current exceeds the selected minimum ground-trip level and remains above that level through the selected timing period, the ground-trip mechanism operates to release the contact opening spring.

Closing energy, as well as energy to charge the opening spring, is supplied by a high-voltage closing solenoid momentarily connected phase-to-phase through a high-voltage contactor.

Figures 2A and 2B show the location of the various operating components of the KF recloser. Major components involved in recloser operations are the closing solenoid, series-trip solenoids, the counting, timing/sequencing, and lockout mechanisms, and the vacuum interrupters. Being aware of the location of these components and their part in the recloser operation will permit a quicker and clearer understanding of the recloser maintenance and repair procedures that follow.

SPECIFICATIONS AND RATINGS

Type KF reclosers are available in two continuous current ratings:

280 amps
400 amps

With exception of a limitation of 280 amps on the series coil used in the 280 amp KF, all ratings and specifications are identical.

Voltage

Nominal operating . . . . 2.4-14.4 kv
Maximum design . . . . 15.5 kv
Impulse withstand (BIL) 1.2 x 50
microsecond wave, crest . . . 110 kv*
60 hertz withstand, rms
Dry, one minute . . . . 50 kv
Wet, ten seconds . . . . 45 kv
RIV (1000μ V max.)
@ 1000 khz . . . . 9.41 kv
Operating frequency . . . . 50-60 hz

*Not always applicable across open contacts of vacuum interrupter.
Insulation capabilities for this condition may be less than 110 kv.

Operating Times

Normal reclosing
times . . . . 1.5-2 seconds
Resetting times @ 25°C
Sequence piston in time-delay unit; Lockout integrator piston — 1-1.5 minutes per recloser operation

Duty Cycle

Number of Operations	Percent of Interrupting Rating	Maximum Circuit X/R Ratio
96	15-20	3
120	45-55	7
32	90-100	14
248 Total Operations		

Current and Interrupting

Series-Trip Coil (continuous amps)	Minimum Trip Current (amps)	Interrupting (rms symmetrical amps) at 14.4 kv
5	10	500
10	20	1000
15	30	1500
25	50	2500
35	70	3500
50	100	5000
70	140	6000
100	200	6000
140	280	6000
160	320	6000
185	370	6000
225	450	6000
280	560	6000
400*	800	6000
400X*	560	6000

*Applies to 400 amp recloser only.

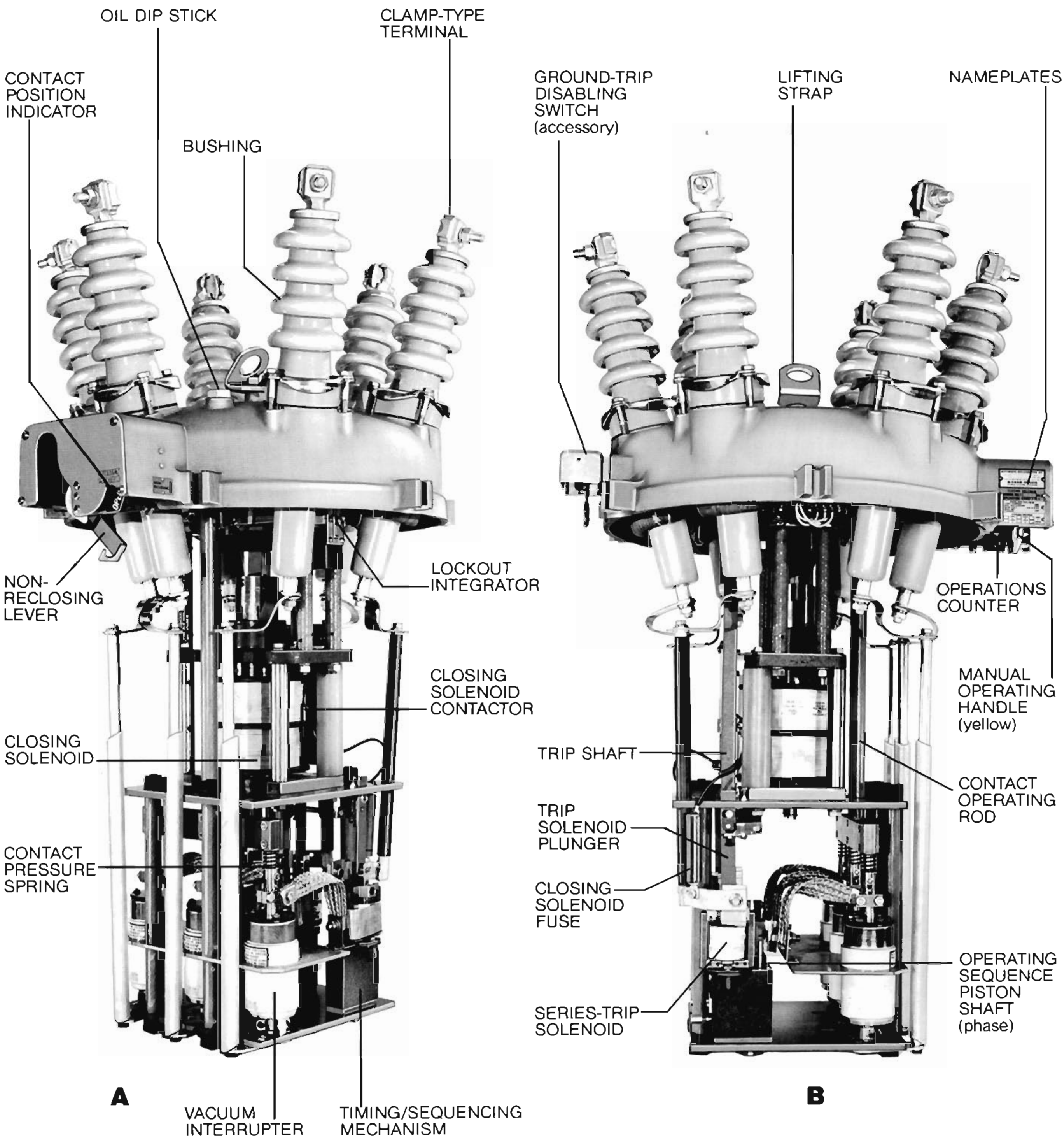


Figure 2.
Untanked view locating operating components.

RECLOSER OPERATION

Effective recloser maintenance and efficient repair can result from a thorough understanding of KF recloser operation. The basic recloser operation is explained here in detail to provide a source for such understanding.

Figure 3 is a simplified representation of the recloser operating components. It should be used in the study of the recloser's operation to recognize how the operations of various components are interrelated.

It is best to begin by considering the recloser as locked out (yellow manual operating handle down) and that its bushing terminals are connected to the high-voltage distribution system as described under MAIN CONNECTIONS in Bulletin 72042. For this example, it is assumed that the recloser is programmed to operate on a two fast, two delayed sequence (four operations to lockout).

To close the recloser from lockout, and prepare it to interrupt a fault current, the yellow handle is moved up to its CLOSED position. This causes a high-voltage contactor to close, connecting the closing solenoid to the high-voltage lines (source-side bushings No. 1 and 5). Energization of the closing solenoid causes the solenoid plunger to be accelerated downward, which through the recloser mechanism causes the:

1. Contact operating rod to move downward closing the vacuum interrupter contacts and compressing the contact pressure springs.
2. High-voltage contactor to open, deenergizing the closing solenoid.
3. Contacts opening spring to be charged and recloser mechanism to be set up for a trip operation.
4. Solenoid plunger to latch in its down position as it charges the plunger return spring.

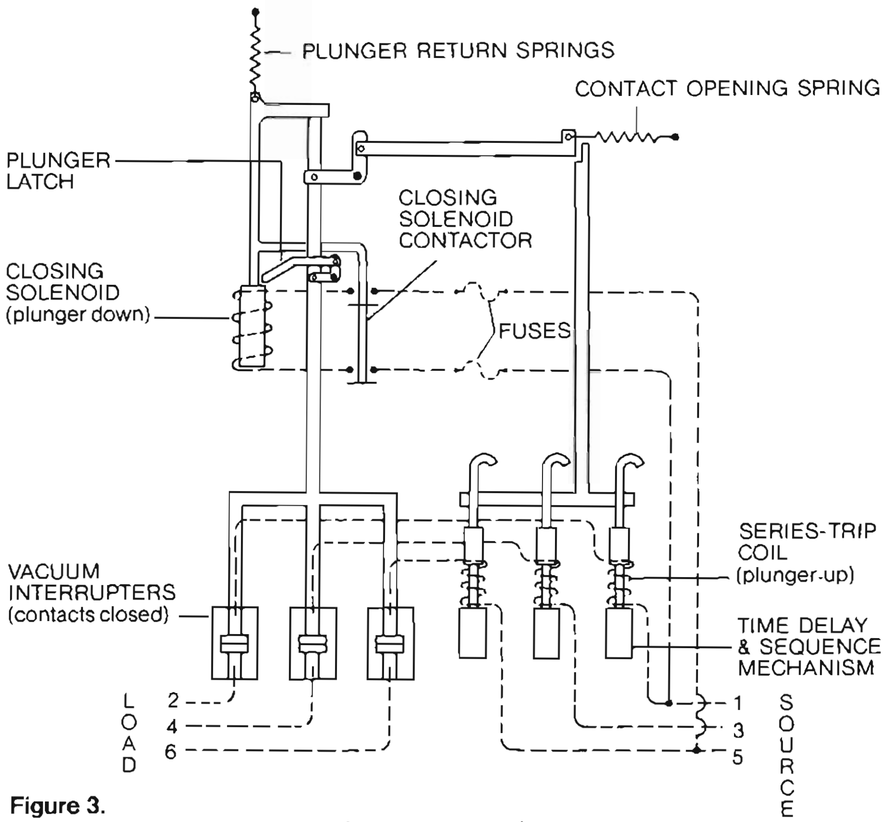


Figure 3.
Diagrammatic representation of recloser operation.

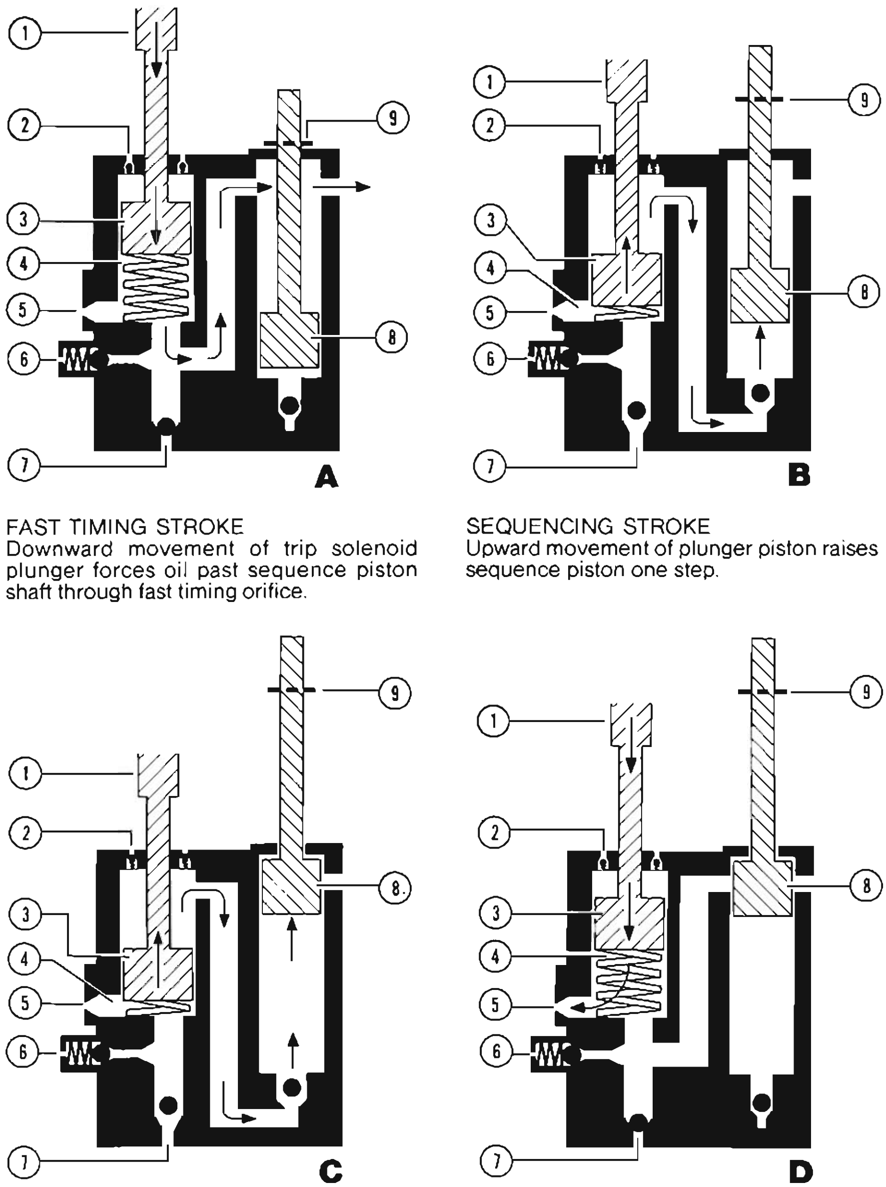
First Operation

When line current on one or more phases of the system reaches or exceeds the series coil minimum-trip value, the increased magnetic field pulls a plunger down into the coil. This pulls a single trip shaft, common to all three phases, downward. Near the end of the downward stroke, a latch that holds the contact opening spring in its charged position, is released. The energy released from this spring is imparted to the recloser mechanism causing it to open the contacts in all three vacuum interrupters.

Timing of contact opening operations is governed by timing/sequencing mechanisms mounted beneath the series trip coils on each phase. Shown cutaway in Figure 4, each mechanism is totally immersed in oil. As the series coil plunger moves downward, (Figure 4A) it pushes a plunger piston downward, which forces oil out of the piston chamber. On fast trip operations, the displaced oil flows freely through closed channels and out past the sequence piston shaft. No intentional delay is caused by the timing mechanism on fast trip operations.

Opening the vacuum contacts breaks the circuit and deenergizes the series coil. This removes the downward force on the trip solenoid plunger allowing the plunger piston to be forced upward by its return spring. Upward movement of the plunger piston pumps a measured amount of oil (Figure 4B) from the chamber above it, through closed channels to beneath the sequence piston. This raises the sequence piston one step. A one-way ball check valve prevents return flow. This pumping action occurs each time the plunger piston returns after a fault current interruption. In this manner, the recloser counts its operations.

When the mechanism opens the vacuum contacts, it also releases the latch holding the closing solenoid plunger. This permits the plunger to be drawn upward by its return spring. Oil flow into the chamber being evacuated



FAST TIMING STROKE
Downward movement of trip solenoid plunger forces oil past sequence piston shaft through fast timing orifice.

SEQUENCING STROKE
Upward movement of plunger piston raises sequence piston one step.

FINAL SEQUENCING STROKE
Sequence piston blocks fast timing orifice.

DELAYED TIMING STROKE
Oil is forced through delayed timing orifice slowing the downward movement of the plunger piston.

1. Trip solenoid plunger
2. Downstroke intake valve
3. Plunger piston
4. Plunger piston return spring
5. Timing orifice
6. High current orifice
7. Upstroke intake valve
8. Sequence piston
9. Fast operations setting

Figure 4.
Simplified diagram of timing and sequencing mechanism operation.

by the upward movement of the plunger is regulated by a timing orifice in its base. This retards the upward movement of the plunger to provide a 1.5 to 2 second reclosing time. As the plunger reaches the top of its stroke, the high-voltage contactor closes to again energize the closing solenoid. The same sequence of events then occurs as was described earlier when the yellow handle was moved to close.

At this point, the recloser has completed one trip-and-reclose operation. It has counted that operation and is set for the next sequence of events.

Second Operation

If the problem on the system that caused the fault current was temporary (such as wind-blown wires or tree branches) and removed itself during the contacts-open period, the recloser remains closed and no second operation occurs. The count registered by movement of the sequence piston is "forgotten" by a gravity resettling of the piston in its chamber. Reset time at 25C is one to 1.5 minutes per count.

If the fault still exists, the series coil will sense overcurrent as soon as reclosing occurs. Another opening operation will commence immediately, followed by a reclosing. Events will occur the same as described for the first operation, and the sequence piston will be raised one further step.

Third Operation

If the fault still exists after the second reclosing, overcurrent again is sensed and a third opening operation commences. Being set for two fast, two delayed operations, the recloser now times its third opening on a delayed time-current curve.

The change from fast to delayed timing occurs automatically in the timing/sequencing mechanism. As was described in the first and second operations, when the series-coil plunger piston returns upward it pumps a measured quantity of oil into the chamber beneath the sequence piston. This raises the sequence piston a specific distance. If the recloser is set for two fast, two delayed operations, two such pumps of oil will raise the sequence piston to a level where it blocks the fast-timing exhaust port (Figure 4C). Therefore, on the third fault-current interruption (when the series-coil plunger piston is again being pushed *downward*), the oil can flow out of the chamber only through the timing orifice (Figure 4D). The high-current orifice also permits oil flow when higher fault currents create sufficient pressure to cause its spring-loaded valve to open. Oil flow through these smaller orifices is much slower, which retards the downward movement of the series-coil plunger, which in turn delays the contact opening.

Reclosing occurs after the contact opening in the same manner as described earlier.

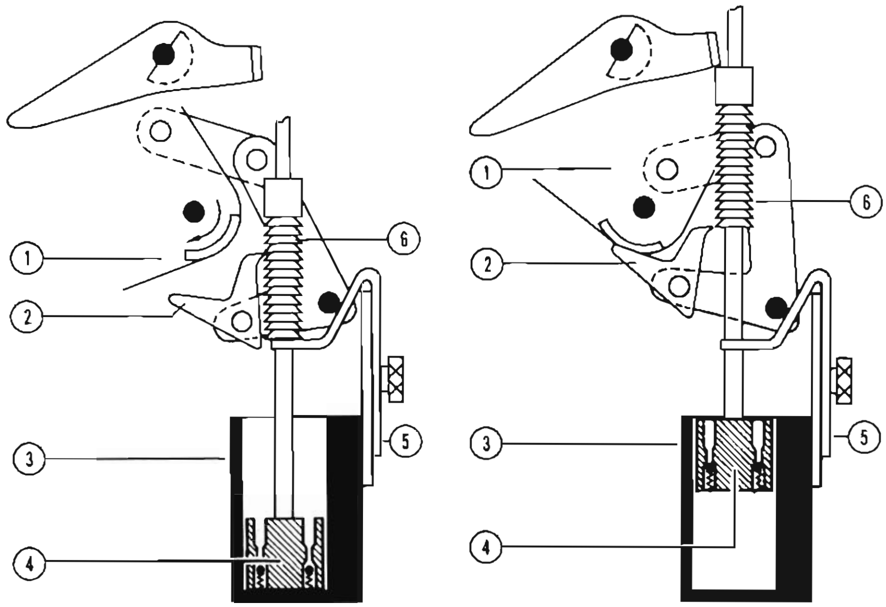
Fourth Operation

If the fault still exists after the third reclosing, overcurrent again is sensed and a fourth opening operation commences, again on the delayed time-current curve. This time however, the lockout mechanism of the recloser is tripped by the lockout integrator to prevent a reclosing operation.

Counting to Lockout

Recloser operations are "counted" by a piston-and-ratchet assembly mounted on the recloser mechanism (Figure 5). Both phase and ground operations register. Two, three, or four operations to lockout are set at this assembly; one operation to lockout is accomplished by pulling the non-reclosing handle under the sleet hood to its downward position (Figure 2A).

When a recloser operation occurs (phase or ground), a spring-biased pawl is moved upward by pivoting mechanism linkage, shown by arrows in Figure 5. Being spring biased, the pawl engages the ratchet rod, raising it approximately $\frac{5}{16}$ inch. At the top of its stroke, the tail of the pawl hits the



1. Plunger lever
2. Pawl
3. Integrator housing
4. Lockout piston
5. Settings bracket
6. Ratchet rod

Figure 5.
Simplified diagram of lockout integrator operation.

plunger lever in the recloser mechanism and disengages from the ratchet rod.

The ratchet rod is attached at its lower end to a lockout piston which moves in an integrator housing chamber filled with recloser oil. One-way valves in the piston permit unimpeded upward travel, but downward movement only at a calibrated resettling rate.

As soon as the pawl releases from the ratchet (this occurs as the closing solenoid plunger reaches the top of its return stroke) the ratchet rod and piston begin gravity reset. The reset time is one to 1.5 minutes per recloser operation at 25C.

The pawl moves upward and returns with each recloser mechanism operation. Each subsequent operation further elevates the ratchet rod. When the number of operations to lockout is reached, the top of the ratchet rod trips the lockout mechanism which prevents a reclosing operation.

To close the recloser from lockout requires raising the yellow manual operating handle under the sleet hood.

Recloser Operation Settings

Operations To Lockout

The number of operations to lockout is determined by the position of the lockout settings bracket on the lockout integrator, Figure 6. The position of this bracket determines the reset position of the ratchet rod, which determines the number of trip operations required to raise the rod to the lockout position. The bracket can be positioned for two, three, or four operations to lockout. One operation to lockout is programmed by pulling down the nonreclosing lever under the sleet hood.

Fast Phase Trip Operations

The number of fast phase trip operations is determined by position of the E-ring on the grooved step rod of the time delay and sequencing mechanism, Figure 7. Position of the E-ring determines the effective operating length of the step rod, which in turn determines the number of recloser operations required to block the fast trip orifice. Zero, one, two, or three fast trip operations can be programmed on the step rod. The remaining operations to lockout will be on a retarded time-current curve. When no retarded operations are required, the piston and step rod are removed from the mechanism.

Each phase on the KF recloser includes its own timing/sequencing mechanism. The sequence piston, position of which determines whether the recloser operates on fast or delayed timing, steps only on those phases experiencing overcurrent sufficient to cause the trip-solenoid plunger piston to pump. The sequence piston does not step on phases not experiencing this overcurrent.

The Ground (Earth) Fault Tripping Accessory with dual timing includes its own sequencing control. See Page 22. If the ground minimum trip current setting is below the phase setting, and timing is faster, the phase sequence piston will not step on ground-trip operations.

The lockout mechanism counts all recloser operations whether they are caused by phase-trip or ground-trip operations.

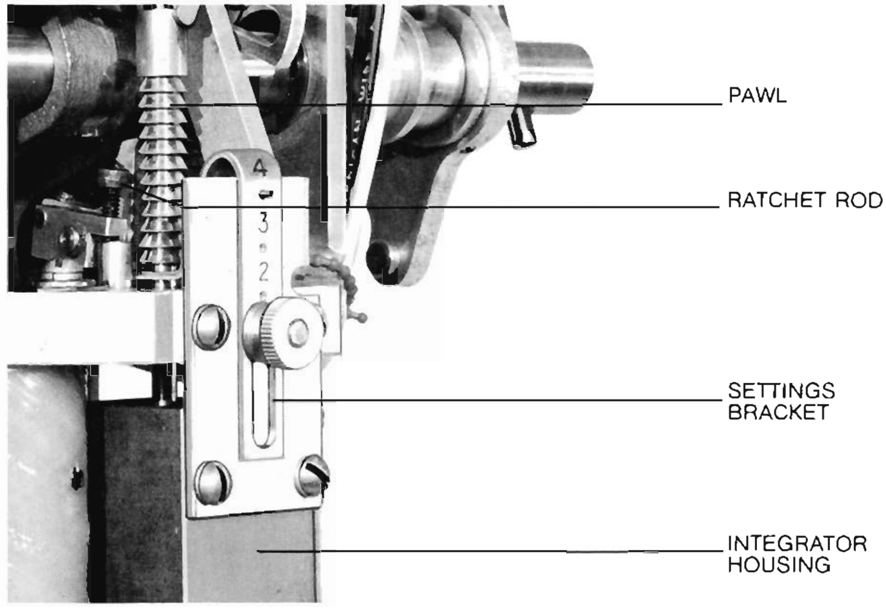


Figure 6.
Number of operations to lockout is set by position of settings-bracket which determines the effective operating length of the ratchet rod.

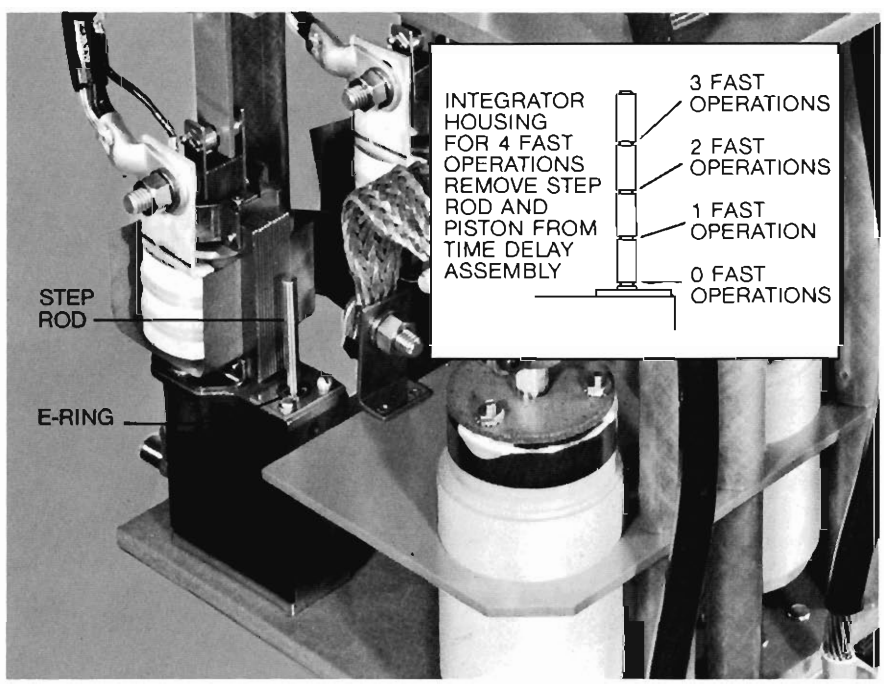


Figure 7.
Number of fast phase trip operations is set by position of E-ring on step rod which determines the effective operating length of the rod.

Trip Timing

Three time-current trip curves are available for the KF recloser and are designated Curves A (fast), B (delayed), and C (extra-delayed). The recloser may be programmed for all fast, a combination of fast followed by either of the delayed, or all delayed characteristics as previously described.

The B or C timing characteristic is determined by the position of the orifice plate on each of the three timing mechanisms, which in turn determines the timing orifice in use (Figure 8).

A typical set of timing curves is shown in Figure 9. A complete set of curves for all trip solenoid coil sizes is published in McGraw-Edison Bulletin 73003.

MAINTENANCE AND INSPECTION

Frequency of Maintenance

Because reclosers are applied under widely varying operating and climatic conditions, maintenance intervals are best determined by the user based on actual operating experience. To operate properly, reclosers must be maintained when they have operated the equivalent of a complete duty cycle and before the dielectric strength has deteriorated below prescribed levels. In the absence of specific operating experience, the following recommendations and procedures are submitted as a minimum maintenance program.

- When Type KF reclosers are operated under usual service conditions as defined in ANSI (American National Standards Institute) C37.60, "Standard Requirements for Automatic Circuit Reclosers for Alternating Current Systems," it is recommended that the following maintenance procedure be performed at the completion of an equivalent duty cycle.

  NOTE: The standard duty cycle for the Type KF recloser is 248 fault interruptions at the fault current distribution shown under "Specifications," page 2. ANSI C37.61-1973, "Guide For The Application, Operation and Maintenance of Automatic Circuit Reclosers," gives a procedure evaluating the actual operating duty of a recloser in terms of its standard duty cycle.

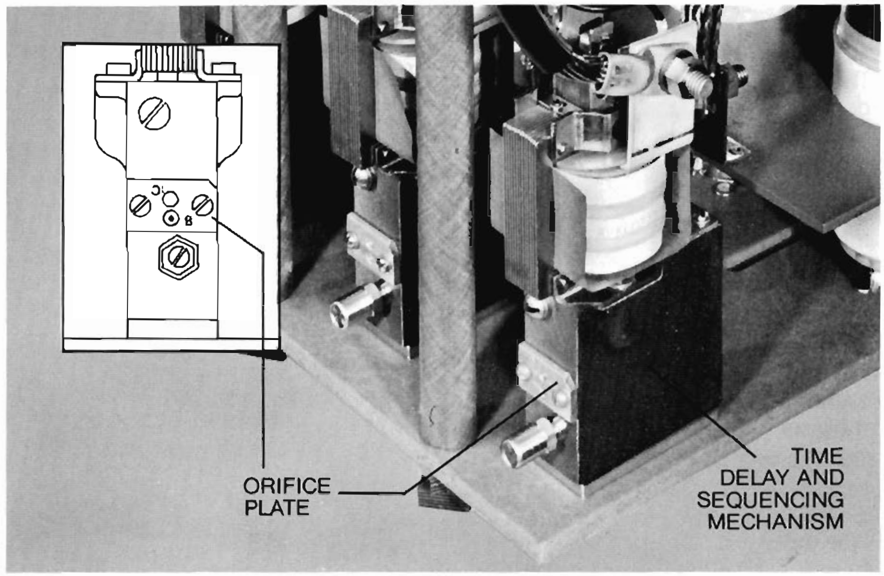


Figure 8.
B (delayed) or C (extra-delayed) trip timing is determined by position of orifice plate. The "right-side-up" letter indicates the timing curve in use.

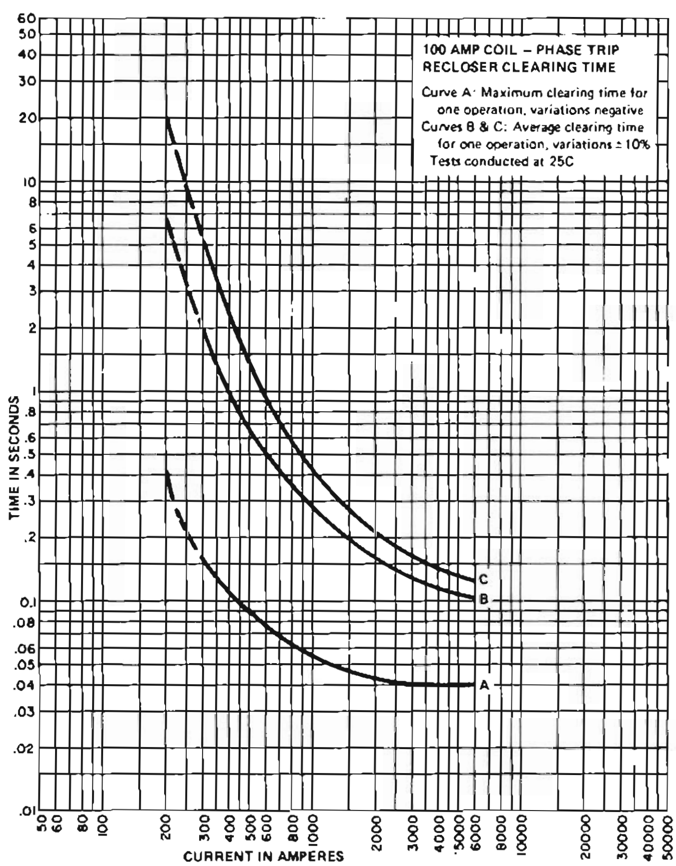


Figure 9.
Typical set of time-current curves for phase-trip operations.

- However, if the recloser has not completed an equivalent duty cycle within *three years,* it is recommended that an external inspection, oil-level check, and a check of the dielectric strength of the oil be made at that time. (See steps 1, 2, and 8 of "Maintenance Procedure" below.)
- Also it is strongly recommended that the vacuum interrupters be replaced after 1000 operations of the recloser.

Maintenance Procedure

Each periodic maintenance inspection at the completion of a duty cycle should include at least the following:

1. Bypass and remove the recloser from service.
2. Inspect external components.
   A. Check for broken or cracked bushings. Replace as necessary.
   B. Check for paint scratches and other mechanical damage; paint to inhibit corrosion.
   C. Note counter reading and enter into the record log.
3. Perform a dielectric withstand test (page 10) to check the insulation level of the recloser and the vacuum integrity of the current interrupters.
4. Untank the recloser.
   A. Loosen the six bolts that secure the head casting to the tank.
   B. Carefully pry apart the head and tank to break the gasket seal, taking care not to damage the gasket.
   C. Lift the head and mechanism assembly from the tank and allow the oil to drain off.
5. Clean all internal components.
   A. Remove all traces of carbon by wiping with a clean, lint-free cloth.

   NOTE: Although fault interruption occurs in a sealed vacuum chamber, the contacts of the closing coil contactor operate in oil and will produce carbon deposits.

   B. Flush the mechanism with clean transformer oil.

CAUTION:

Never use volatile solutions, detergents, or water-soluble cleaners.

6. Check contact erosion of the vacuum interrupters.
   A. Locate the scribe mark on the moving contact rod at the top of each vacuum interrupter, Figure 10.
   B. If the scribe mark falls below the top surface of the phenolic rod guide when the recloser contacts are closed, the interrupter has reached the end of its expected life and must be replaced.
7. Inspect tank liners.
   A. Two liners are used. The inner liner is fibrous and readily absorbs any moisture present. Soft or spongy areas indicate free water has been absorbed. Replace the liner if this condition exists.
   B. The outer polypropylene liner need not be replaced unless it is damaged.
8. Check the dielectric strength of the insulating oil.
   A. An oil sample taken near the bottom of the recloser tank should have a dielectric strength of not less than 22 kv rms.
   B. Low dielectric strength indicates the presence of water or carbon deposits and the oil should be replaced.
9. If oil must be replaced, drain the tank and clean out all sludge and carbon deposits.

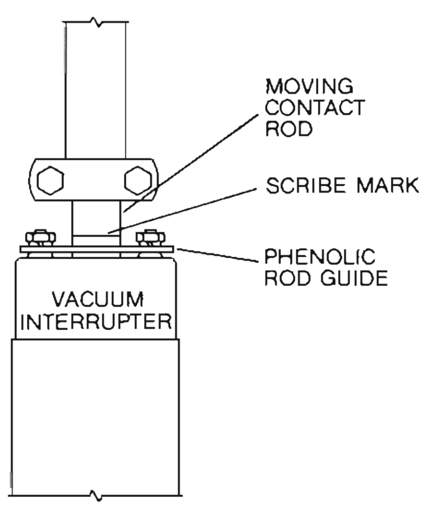


Figure 10.
Scribe mark on moving contact rod indicates amount of contact erosion.

10. With the mechanism removed, fill the tank with new, clean insulating oil to the yellow mark on the tank liner. If there is no yellow mark, the oil level should be 76 mm (3 inches) below the top edge of the tank. Tank capacity is approximately 125 liters (33 U.S. gallons). See "Oil Condition," page 10.
11. Examine the head gasket. Replace if it is cracked, checked, cut or otherwise damaged, or if it has been permanently deformed.
12. Retank the recloser.
    A. With the recloser contacts open (yellow handle down), lower the recloser into the oil-filled tank to the point where series-trip coils are totally submerged.
    B. Manually pump each trip solenoid plunger link (item 38, Figure 36A) at least twelve times to expel the air trapped in the hydraulic timing/sequencing mechanism.
    C. Then, without exposing the three time delay mechanisms to the air, continue lowering the recloser into the tank.
    D. As the head casting nears the tank lip, check that no wires inside the recloser head project into the gasket groove on the casting.
    E. With the head centered just above the tank, orient the sleet hood with respect to the tank mounting brackets. Align the head mounting lugs with the bolts and gently lower the recloser into the tank.

    Important: Check all around that the gasket does not twist as the head is being seated. Gasket twist can occur if the head is not centered over the tank.

    F. Replace the head bolts and torque to 35-50 N-m (25-35 ft-lbs) alternating on opposite bolts. This results in evenly distributed gasket sealing pressure.
13. Repeat the high-voltage dielectric withstand test (Step 3) to make sure that dielectric clearances within the tank have not been compromised.
14. Perform the tests described on page 11 to check that the recloser is operating properly before returning recloser to service.

NOTE: If the recloser is equipped with the Ground Fault Trip Accessory see page 21 for testing and troubleshooting instructions.

Insulation Level Withstand Tests

High potential withstand tests of the recloser should be performed at 37.5 kv rms, 50-60 hertz (75 percent of rated low-frequency withstand voltage). The following tests should be performed.

Test 1: Proceed as follows:

1. Close main contacts of recloser.
2. Ground recloser tank and head.
3. Connect all three source-side bushings (1, 3, and 5) together.
4. Apply test voltage to source-side bushings.
5. The recloser should withstand the test voltage for 60 seconds.

Test 2: Proceed as follows:

1. Close main contacts of recloser.
2. Ground recloser tank and head.
3. Ground Phase A (bushing 2) and Phase C (bushing 6).
4. Apply test voltage to Phase B (bushing 3).
5. The recloser should withstand the test voltage for 60 seconds.

Test 3: Proceed as follows:

1. Open main contacts of recloser.
2. Ground recloser tank and head.
3. Connect and ground all three load-side bushings (2, 4, and 6).
4. Connect all three source-side bushings (1, 3, and 5).
5. Apply test voltage to source-side bushings.
6. The recloser should withstand the test voltage for 60 seconds.
7. Reverse connections: ground source-side bushings (1, 3, and 5); apply test voltage to load-side bushing (2, 4, and 6) for 60 seconds.
8. The recloser should withstand the test voltage for 60 seconds.

RADIATION WARNING

It is possible for x-radiation to result when voltage in excess of the 15.5 kv rated maximum voltage is applied across the *open-contact gap* of the vacuum interrupter in Test 3. Such radiation can become a health hazard on long exposure at close range. When performing high-voltage tests on Type KF vacuum reclosers, personnel safety can be assured by noting the following information and taking the necessary precautions.

1. American National Standard C37.09-1964 (R169) "Test Procedure A-C High Voltage Circuit Breakers" allows tests after delivery which include application of 75 percent of rated low-frequency withstand voltage across open contacts of the interrupters. For the KF recloser this test voltage is 37.5 kv ac rms.
2. At this test voltage, radiation is negligible when the vacuum interrupters are mounted in the recloser operating mechanism structure, installed in the oil-filled recloser tank, and have their contacts open to the nominal 3/8 inch open contact gap.
3. Testing at higher voltage than specified in 1, may cause radiation emission injurious to personnel. If testing is to be performed at higher than specified voltage, additional shielding is required.
4. Testing vacuum interrupters above 50 kv ac rms is not recommended.

Test Results: These high potential withstand tests provide information on the dielectric condition of the recloser mechanism and the vacuum integrity of the interrupters.

A. If the recloser passes the closed-contacts tests (Tests 1 and 2) but fails the open-contacts test (Test 3), a deteriorated vacuum in one or more of the interrupters may most likely be the cause. Retest each vacuum interrupter individually to determine the failed phase (or phases) and replace the vacuum interrupter(s). Retest to confirm the repair.

B. If the recloser fails the closed-contacts tests (Tests 1 or 2) the cause is likely to be found in the recloser mechanism assembly. After correcting the problem, retest the recloser with contacts closed (Tests 1 and 2) to confirm repair and the contacts open (Test 3) to check vacuum condition.

Oil Condition

Oil plays an important role in the proper functioning of the recloser. It provides the internal insulation barrier between phases and from phase to ground, and acts as the timing and counting medium. For effective recloser operation, the oil must be replaced before it deteriorates below a safe level. Oil that has been contaminated with carbon sludge or has a dielectric strength of less than 22 kv should be replaced.

New oil should always be filtered before using though it may be obtained from an approved source. Passing the oil through a blotter press will remove free water and solid contaminants such as rust, dirt, and lint. When filtering the oil, aeration should be kept to a minimum to prevent moisture in the air from condensing in the oil and lowering its dielectric strength.

Used oil must be treated before reusing. Filtering may remove absorbed and free water and other contaminants to raise the dielectric strength to acceptable levels. However, filtering does not always remove water-absorbing contaminants and the dielectric strength of the oil may fall rapidly after being returned to service. Therefore the recloser should be filled with new oil or oil that has been restored to like-new condition. Oil used in the Type KF recloser conforms to ASTM Standard D3487, Type I; its property limits are shown in Table 1.

Table 1.
Property Limits of Insulating Oil Used in Type KF Reclosers

Characteristic	Acceptable Value	ASTM Test Designation
Color	0.5 max.	D1500
Reaction	Neutral	
Neutralization No.	0.03 mg KOH/g max.	D974
Corrosive sulfur	Noncorrosive	D1275
Steam emulsion No.	25 seconds max.	D1935
Flash point	145°C	D92
Pour point	−40°C	D97
Viscosity index		
100°C	3.0 cST/36 SUS	D445
40°C	12.0 cST/66 SUS	D88
0°C	76.0 cST/350 SUS	
Specific gravity at 15°C	0.91 max.	D1298
Coefficient of expansion	0.0007-0.0008 (Typical at 25-100°C)	D1903
Interfacial tension	40 dynes per cm. min.	D971
Dielectric constant	2.2	D924
Dielectric strength	30 kv min.	D877
Water content (by Karl Fischer Test)	35 parts per million max.	D1533 or D1315
Weight per liter	0.9 kg	

TESTING

The Type KF recloser uses a low-impedance, series-trip coil for opening and a high-voltage shunt solenoid for closing. It can be test-tripped with a low-voltage a-c source, but for automatic (electrical) closing a high-voltage a-c source is required. The unit can also be tested by substituting manual closing for electrical closing to eliminate the high-voltage test circuit. Test procedures for both methods of closing are included in this section.

> **WARNING:**
> Do not attempt to trip the Type KF recloser using a d-c source such as a storage battery. The vacuum interrupters can be severely damaged if interruption of a d-c arc is attempted.

Personnel Safety

When high-voltage closing is used, both the recloser and the high-voltage test transformer should be enclosed in a test cage to prevent accidental contact with live high-voltage parts. All metering and measuring equipment should be located outside the test cage, and proper grounding and test procedures should be observed.

> **CAUTION:**
> Do not energize this recloser out of oil.

Test Circuit

Test circuits usually are designed to utilize available equipment to test particular types and sizes of reclosers. A suggested test circuit for the Type KF recloser is shown in Figure 11. Circuit requirements are listed in Tables 2 and 3 for the following set of conditions:

A. Nominal test current is equal to twice the minimum trip current of the recloser.

B. Series loading is resistive and is equal to ten times the reactance of the trip solenoid coil with the plunger up. (Series loading is included in the test circuit to minimize a decreasing test current envelope due to rapidly increasing coil reactance as the trip solenoid plunger starts to move downward.)

Satisfactory operation and reasonable test accuracy generally will be achieved if these conditions are met.

Variations from these recommendations can be made according to the results desired. For example, test equipment having lower ratings can be used, but the effects of decreasing current will be more pronounced and the possibility of incomplete operation will be increased. Also at higher multiples of the minimum trip current, series loading can be reduced because 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. Low-side rating should equal the voltage rating of the available power source.
   B. High-side rating should equal the voltage rating of the recloser. Be sure minimum allowable voltage shown in Table 2 is maintained at recloser terminals during the two-to-three cycle interval the closing solenoid is energized.
   C. In general, a 50 kva transformer having an impedance of about three percent will be satisfactory provided the source impedance is reasonably low.

2. Low-voltage transformer (T2)—to operate the trip solenoid.
   A. Ratio and kva size depends upon the size of the trip coil and the maximum test current to be used.
   B. Table 3 shows the test voltage, kva, and series loading requirements for all ratings.
3. Variable autotransformer—to vary the output of T2. A 240 vac, 20 amp unit is recommended.
4. Ammeter (A)—to measure test current. Full-scale deflection should be at least 300 percent of recloser rating. Use of a current transformer may be required.

Test Procedures—Electrical Closing

Assemble and connect the equipment as shown in Figure 11.

> **WARNING:**
>
> Solidly ground leads X and Z and interconnect to the recloser tank. DO NOT connect leads W and Y to the SAME PHASE. Dangerous voltages to ground exist on the phase connected to Y.

If the recloser is equipped with the Ground (Earth) Fault Tripping Accessory, be sure to disable the ground trip function by moving the ground trip disabling switch handle down to the BLOCKED position when performing phase trip tests. The ground trip disabling switch handle is mounted on the recloser head opposite the manual operating handle.

NOTE: If recloser is not equipped with the disabling switch, jumper terminals 2 and 3 on the accessory circuit board (Figure 27) to disable the Ground Fault Tripping Accessory during the phase tripping tests.

Operation of the Closing Solenoid

The operation of the closing solenoid can be verified by tripping the recloser manually and closing electrically with the high-voltage a-c source (T1).

1. Trip the recloser manually by moving the yellow manual operating handle down to LOCKOUT position, then up to the CLOSED position to close the closing solenoid contactor.
2. Energize the high-voltage transformer T1. The recloser should close immediately, indicating correct operation of the closing solenoid.

Table 2.
Closing Solenoid Voltage Requirements

Closing Solenoid Rating (kv)	Solenoid Code Number	Minimum Voltage at Recloser When Solenoid is Energized (volts)
50 Hertz Coils		
6.0	51	5100
11.0	52	9350
13.2	53	11220
14.4	54	12240
60 Hertz Coils		
2.4	21	2040
4.16-4.8	22	3540
12.0-13.2	30	10200
14.4	27	12240

Table 3.
Low-Voltage Test Circuit Requirements

Coil Size (amps)	Series Loading Resistance* (ohms)	Test Current (2x Min. Trip) (amps)	Test Voltage	Short-Time Test kva†
25	.42	100	42	4.2
35	.18	140	25.2	3.5
50	.106	200	21.2	4.2
70	.047	280	13.2	3.7
100	.026	400	10.4	4.2
140	.012	560	6.7	3.8
160	.010	640	6.4	4.1
185	.0074	740	5.5	4.1
225	.0058	900	5.2	4.7
280	.0037	1120	4.2	4.7
400x	.0034	1120	3.8	4.3
400	.0027	1600	4.3	6.9

*Loading resistance calculated at 10x 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 in table.

Minimum Trip Current

Phase A (Bushings 1 and 2)—With the test setup connected as shown in Figure 11 proceed as follows:

1. Raise the yellow manual operating handle to its CLOSED position and energize high-voltage transformer T1 to close the recloser.
2. Deenergize T1 to prevent unit from reclosing once it has tripped.
3. Energize T2 and slowly raise the voltage from zero until the unit trips while observing the ammeter reading.
4. As the trip-solenoid plunger starts to move, the coil impedance will rise and may cause a decrease in current.

   The *maximum* ammeter reading before the current decreases and/or the unit trips is the *minimum trip current.*

Phase B (Bushings 3 and 4)—Connect lead X to bushing terminal 3 and lead W to bushing terminal 4 and repeat steps 1, 2, 3, and 4 above.

Phase C (Bushings 5 and 6)—Reverse the high-voltage transformer leads; connect grounded lead Z to bushing terminal 5 and hot lead Y to bushing terminal 1. Then connect the low-voltage transformer test leads—X to bushing 5 and W to bushing 6, and repeat steps 1, 2, 3, and 4 above.

Operating Sequence Verification

With the test circuit connected as shown in Figure 11 proceed as follows:

1. Move the yellow manual operating handle to the CLOSE position and energize T1 to close the recloser. Leave T1 energized.
2. Adjust the current output of T2 high enough to cause the recloser to trip readily (300 percent of the series trip coil continuous current rating is suggested.)
3. Energize T2. The recloser should trip, reclose, and continue tripping and reclosing through its programmed sequence to lockout.
4. Observe the contact position indicator on the sleet hood and count the number of fast and delayed operatings to lockout. (The yellow operating handle will drop down when lockout is reached).
5. The number of fast operations and operations to lockout should agree with the trip sequence data plate mounted on the sleet hood.

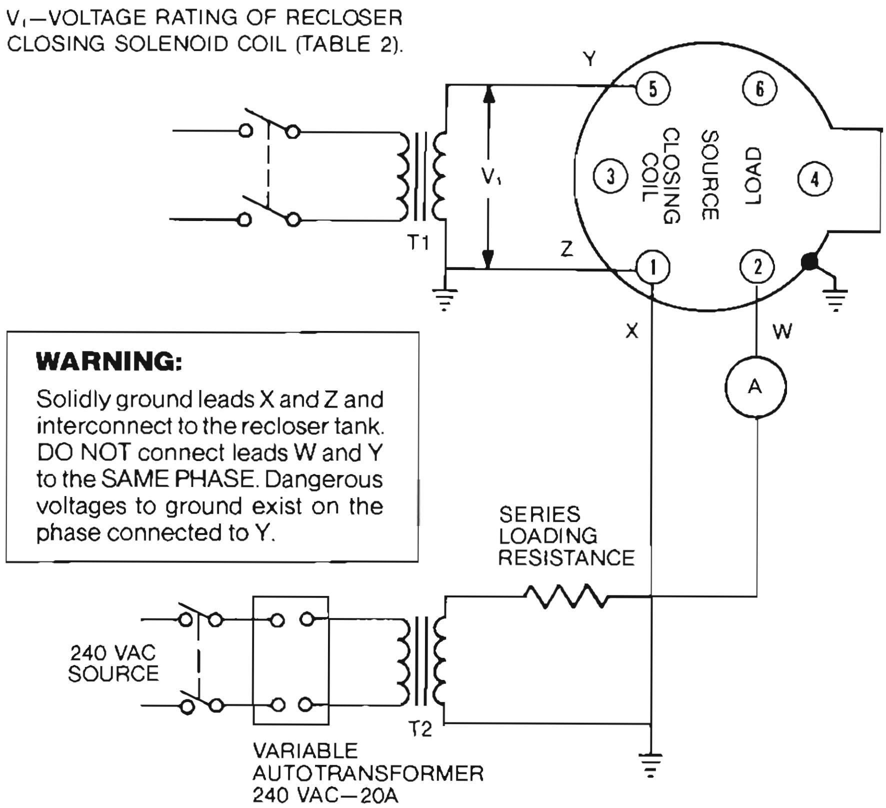
Although the number of operations to lockout will be the same regardless of which phase experiences the overcurrent, the number of fast operations is set individually on each phase and each phase should be checked to verify the settings. Repeat the above test with tripping initiated on Phases B and C. Be sure to reverse the high-voltage transformer leads Y and Z before attempting to trip on Phase C. (See "Minimum Trip Current—Phase B" and "Phase C"). Make all connections carefully and be aware of the WARNING statement in Figure 11.

NOTE: When repeating tests, be sure to allow enough time for sequence piston and lockout integrator piston to reset fully. Reset time is one to 1.5 minutes per recloser trip operation.

Operation of Non-Reclosing Feature

While testing on any phase as described under "Operating Sequence" above, the non-reclosing feature also can be verified.

1. Pull down the non-reclosing lever.
2. Repeat test steps 1, 2, and 3 above.
3. The recloser should not reclose after the first trip and the yellow handle should drop indicating recloser lockout.



WARNING:

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

Figure 11.
Suggested test circuits for low-voltage tripping and high-voltage closing. Be sure to check "Personnel Safety" on page 11.

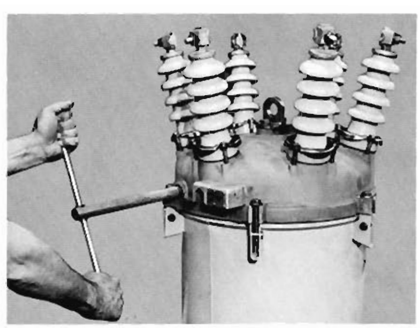


Figure 12.
Closing recloser with manual closing tool (KA90R).

Test Procedures—Manual Closing

When manual closing is substituted for electrical closing, the high-voltage transformer and its associated equipment, wiring, and precautions are eliminated since there are no high voltages involved.

Manual Closing Procedure

The two-handled manual closing tool, Catalog Number KA90R, (furnished as standard equipment with each recloser) is used to manually close the recloser.

CAUTION:

Never use the KA90R closing tool on a recloser energized at rated voltage.

1. Remove the pipe plug in the side of the recloser head.
2. Insert the closing tool into the port and engage the pin on the main operating shaft (Figure 12).
3. To close the recloser, raise the yellow operating handle (under the sleet hood) into the up or CLOSED position and turn the closing tool

clockwise. Avoid forcing the closing tool beyond the stop; doing so may shear the pin.

4. After each trip operation about two seconds elapse (normal reclosing time) while the closing solenoid plunger is moving upward. Near the end of this time period two metallic clicks will be heard. The first is the main toggle latch resetting; the second is the closing-solenoid contactor closing. As soon as these clicks are heard, the closing tool can be operated to close the recloser.
5. When manual closing is used during the "Operating Sequence Verification" tests, the recloser should be closed and tripped without appreciable delay between operations. Otherwise, extra operations to lockout may occur due to partial resetting of the sequence and lockout pistons. The best procedure is to have one man operate the closing tool while a second man regulates the tripping circuit and observes test results.
6. Be sure to replace the pipe plug in the head casting upon completion of testing.

Minimum Trip Current

Phase A (Bushings 1 and 2)—With the *low-voltage transformer T2* and its circuit connected as shown in Figure 11, proceed as follows:

1. Raise the yellow manual operating handle up to its CLOSED position and manually close the recloser.
2. Energize T2 and slowly raise the voltage from zero until the unit trips while observing the ammeter reading.
3. As the trip solenoid plunger starts to move, the coil impedance will rise and may cause a decrease in current. The *maximum* ammeter reading before the current decreases and/or the unit trips is the *minimum trip current.*

Phase B (Bushings 3 and 4)—Connect lead X to bushing 3 and lead W to bushing 4 and repeat steps 1, 2, and 3 above.

Phase C (Bushings 5 and 6)—Connect lead X to bushing 5 and lead W to bushing 6 and repeat steps 1, 2, and 3 above.

Operating Sequence Verification

On Type KF reclosers, the number of fast operations is set separately on the sequence mechanism of each phase. Therefore, to be sure that the number of fast operations is set as required, the recloser should be tested with overcurrents initiated on each phase.

To check the number of fast operations on Phase A, connect leads X and W on low-voltage transformer T2 to bushing terminals 1 and 2 respectively, and proceed as follows:

1. Move the yellow manual operating handle to its CLOSED position and manually close the recloser.
2. Set the test current high enough to cause the recloser to trip readily (suggest 300 percent of series trip solenoid current rating).
3. Energize the low-voltage transformer T2. The recloser should trip.
4. Immediately after hearing the two clicks, close the recloser manually for the next trip operation.
5. Observe the number of fast trip operations and the number of operations to lockout. When lockout is reached, the yellow manual operating handle will drop down and the manual closing mechanism will become inoperative.
6. The number of fast operations and operations to lockout should agree with the trip sequence data plate mounted on the side of the sleet hood.
7. Repeat steps 1 through 6 with tripping initiated on Phase B (Bushings 3 and 4) and Phase C (Bushings 5 and 6).

SHOP MAINTENANCE PROCEDURES

The operations described in this section should be performed under the cleanest conditions possible. The repair work, except for bushing replacement, will be simplified if the work bench is arranged so the mechanism can be inverted (bushings down). The recloser mechanism is so oriented in all procedures and illustrations in this section of the manual.

Bushings

Bushing maintenance generally consists of a thorough cleaning and a careful examination for chips, cracks, or other damage while the recloser is lowered for service. Bushings must be replaced whenever damage is discovered.

A damaged bushing can be replaced with the recloser either tanked or untanked, depending upon the circumstances of the damage.

- If the bushing porcelain is accidentally chipped during installation maintenance and it is obvious that no other damage has occurred, the bushing porcelain only can be replaced without untanking the recloser.
- If the bushing has been damaged while in service or storage, the recloser must be untanked. Water or other contaminants may have entered the tank (check tank liners and test the oil), the bushing lead may be damaged (either mechanically or electrical flashover), and pieces of porcelain may have fallen into the tank (check bottom of tank and recloser mechanism for porcelain pieces).

Replacing the bushing porcelain with the recloser tanked—Refer to Figure 13 and proceed as follows:

1. Unscrew the bushing terminal and discard the terminal gasket.
2. Remove the bushing clamps; lift the porcelain out of the head casting; remove and discard the lower bushing gasket.
3. Transfer the split aluminum clamping ring from the old to the new porcelain. Replace the ring if it is damaged.

   NOTE: The split aluminum clamping ring cushions and distributes the pressure between the porcelain and the bushing clamps. Do not omit.
4. Using a new lower bushing gasket, install the new porcelain over the bushing lead and into the head. Make sure the locking pin in the top of the lead is seated at the top of the porcelain.
5. Install a new upper terminal gasket and reassemble the terminal to the bushing.

   NOTE: Apply a very small amount of petroleum jelly to the inside face of the terminal (knurled surface only) before reassembling to the bushing.
6. Position the split aluminum clamping ring with the split centered between two clamping bolts.

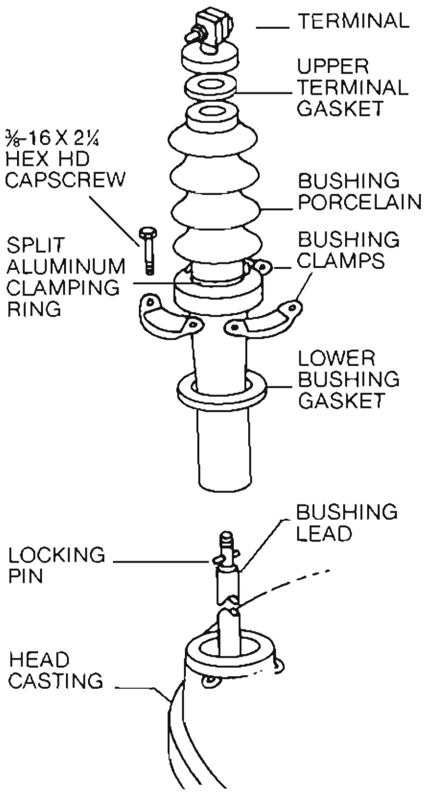


Figure 13.
Bushing assembly.

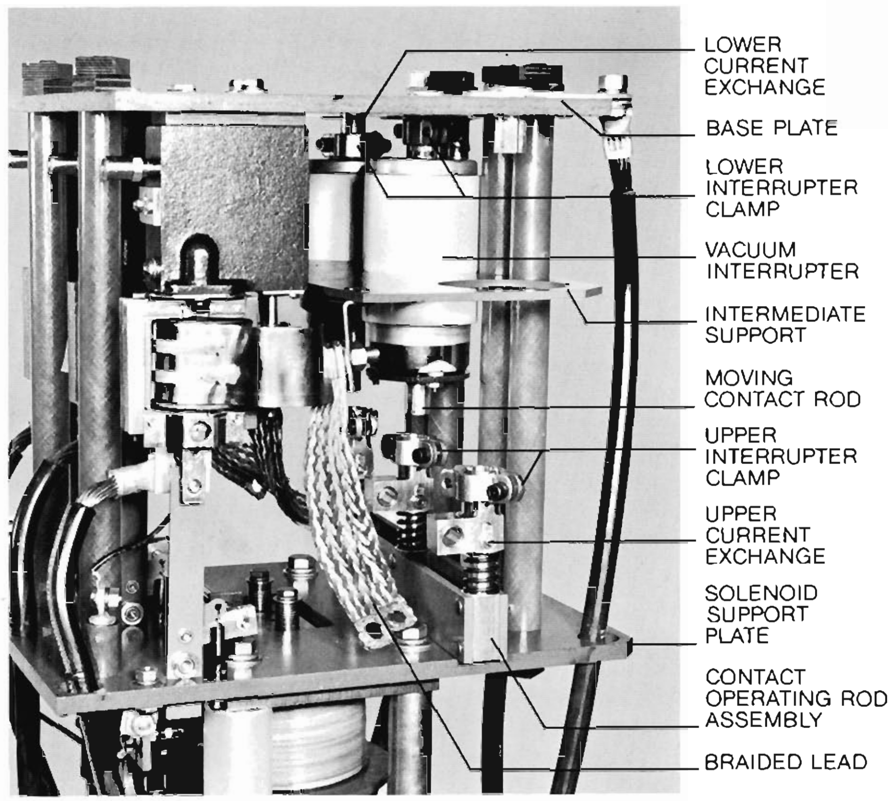


Figure 14.
Vacuum interrupter removal (recloser in inverted position).

7. Reassemble the bushing clamps and tighten the bolts evenly a little at a time to a torque of 14-20 N-m (10-15 ft-lbs).

NOTE: Clamping forces must be applied gradually and equally, in rotation, to each bolt. This results in an evenly distributed gasket sealing pressure.

Replacing the bushing with the recloser untanked—

1. Disconnect the appropriate bushing lead.
   A. *400 Amp Recloser*—disconnect the flexible multiple-strap (item 11, Figure 34) at the end of the bushing rod extending from the bottom of the bushing.
   B. *280 Amp Recloser*—the bushing leads extend out of the bottom of the bushings down to the bottom of the recloser mechanism. The shorter leads are connected to the series-trip coil; the longer leads to the bottom of the vacuum interrupter.

   NOTE: It will be necessary to straighten the bent connector lug at the end of the lead to remove the attaching capscrew and enable the lead to pass through the hole in the solenoid support plate.
2. Remove the three hex head capscrews and bushing clamps that secure the bushing to the head casting and lift out the entire bushing assembly up through the head.
3. Remove and discard the lower bushing gasket.
4. Twist off the split aluminum clamping ring from the old bushing. If it is in good condition, install it on the new bushing porcelain. If the ring is damaged, a new clamping ring must be installed.

   NOTE: The clamping ring cushions and distributes the pressure between the porcelain and the clamps and must not be omitted.
5. The complete bushing assembly can be replaced or new porcelain only can be installed. If new porcelain only is to be installed, proceed as follows:
   A. Unscrew the bushing terminal and withdraw the lead or rod from the bottom of the porcelain.
   B. Remove and discard the terminal gasket.
   C. Insert the lead or rod assembly all the way into the new porcelain until the locking pin on the lead is seated in the porcelain.
   D. Reassemble the bushing terminal to the lead using a new terminal gasket.

   NOTE: Apply a very small amount of petroleum jelly to the inside face of the terminal (knurled surface only) before reassembling to the bushing.
6. Reinstall the bushing assembly (new or reworked) into the head using a new gasket between the bushing and head casting. Position the bushing with the stud-end of the terminal pointing outward.
7. Position the split aluminum clamping ring with the split centered between two clamping bolts.
8. Reassemble the bushing clamps and tighten the bolts evenly a little at a time to a torque of 14-20 N-m (10-15 ft-lbs).

   NOTE: Clamping forces must be applied gradually and equally in rotation to each bolt. This results in an evenly distributed gasket sealing pressure.
9. Reconnect the bushing leads or rods.

Vacuum Interrupters

Vacuum interrupters must be replaced:

- When they lose their vacuum, as evidenced by failure during the high-potential dielectric withstand test across open contacts;
- When the interrupter contact has eroded beyond its useful life, as evidenced by the position of the scribe mark on the moving contact rod; or
- When the interrupters have completed their mechanical life of 1000 operations.

To replace the interrupters, refer to Figure 14, and proceed as follows:

1. Make sure the unit is open—yellow handle under the sleet hood is down.
2. Loosen and remove the upper interrupter clamp. As this clamp is loosened the contact rod will move upward into the interrupter due to atmospheric pressure acting upon the bellows. This action can be verified by observing the scribe mark on the moving contact rod of the interrupter. It will move upward from just above the upper clamp to above (or below) the fiber rod-guide.

   NOTE: If the contact rod does not move, it may have lost its vacuum, or it may be sticking in the clamping fingers of the current exchange on the contact operating rod assembly. Use a screw driver to gently spread the clamping fingers to free the contact rod.
3. Disconnect the contact operating rod assembly.
   A. Disconnect the braided lead from each of the three current exchanges on the contact operating rod assembly by removing the attaching hardware.
   B. Disconnect the upper end of the contact operating rod by removing the C-ring and pin which attaches the rod to the operating mechanism lever, Figure 15.
   C. The assembly will drop down off the interrupter moving contact rods and rest on the solenoid support plate as shown in Figure 14.

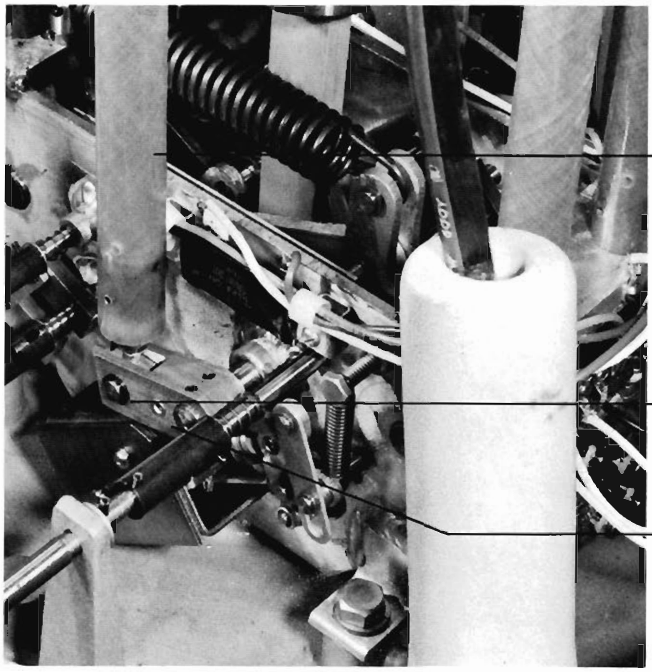


Figure 15.
Remove C-ring and pin to disconnect contact operating rod from operating mechanism.

4. Loosen and remove the lower interrupter clamps and remove the interrupter.
5. Install new vacuum interrupters.

   NOTE: For easier assembly, install the center interrupter first, then two outside interrupters.
   A. Loosely assemble the lower interrupter clamps to the lower current exchange on the base plate.
   B. Insert the stationary contact rod of the interrupter into lower current exchange and finger-tighten the clamps to hold the interrupter in place.
6. Loosely assemble the upper interrupter clamps to the current exchanges on the contact operating rod assembly.
7. Carefully raise the rod assembly onto the interrupter contact rods, making sure the rods are fully seated.
8. Reconnect the upper end of the contact operating rod to the mechanism, Figure 15.
9. Slowly close the recloser with the two-handle manual closing tool (Figure 12).
10. Orient the upper and lower clamp so that clamping force is applied to the center of the contact finger. Then rotate the interrupter so that one of the hex nuts on the top of the interrupter is centered beneath the gap between the clamping elements on one side (Figure 16).
11. Coat the threads of the clamps and attaching screws with transformer oil and tighten the two screws evenly to maintain equal gaps on either side. Torque the screws to 8.5 N-m (75 in.-lbs).

    NOTE: Clamps must be tight to prevent the interrupter contact rods from slipping in their current exchanges.
12. Manually trip and close the recloser several times to check interrupter operation.

    NOTE: Contact movement may be checked by observing the movement of the scribe mark on the contact rod. On closing the mark will travel 9.5 mm (3/8 in.).

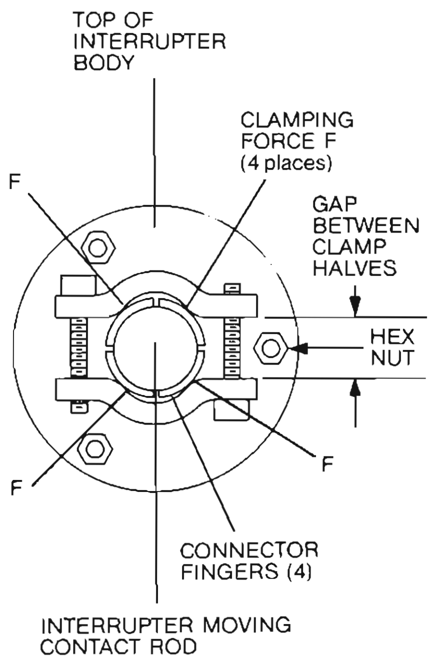


Figure 16.
Orientation of interrupter and clamp.

Trip Solenoid and Sequencing Assembly

To replace the series-trip coil refer to Figure 17 and proceed as follows:

1. Unhook the bias springs from all three plunger links (on the two outboard assemblies).
2. Disconnect the bushing lead and fuse lead from the series-trip coil by removing the attached hardware.
3. Remove the attaching hardware which secures the other end of the coil and the braided leads to the bracket on the intermediate support plate.
4. Loosen the attaching hardware for the assembly on the base plate, and while holding the assembly, complete the removal of the screws.
5. While holding both the assembly housing and the plunger link (Figure 18), remove the entire assembly from the recloser.
6. To replace the series trip coil, disassemble the trip solenoid in the order shown in Figure 19.

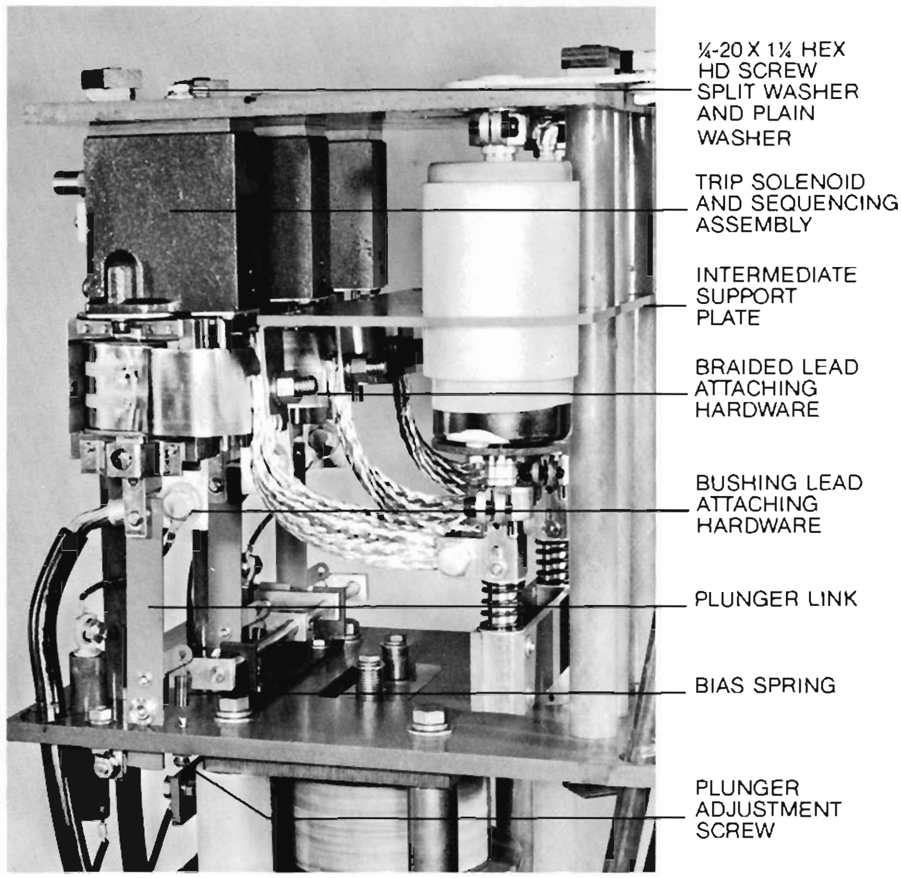


Figure 17.
Attaching hardware for trip solenoid and sequencing assembly.

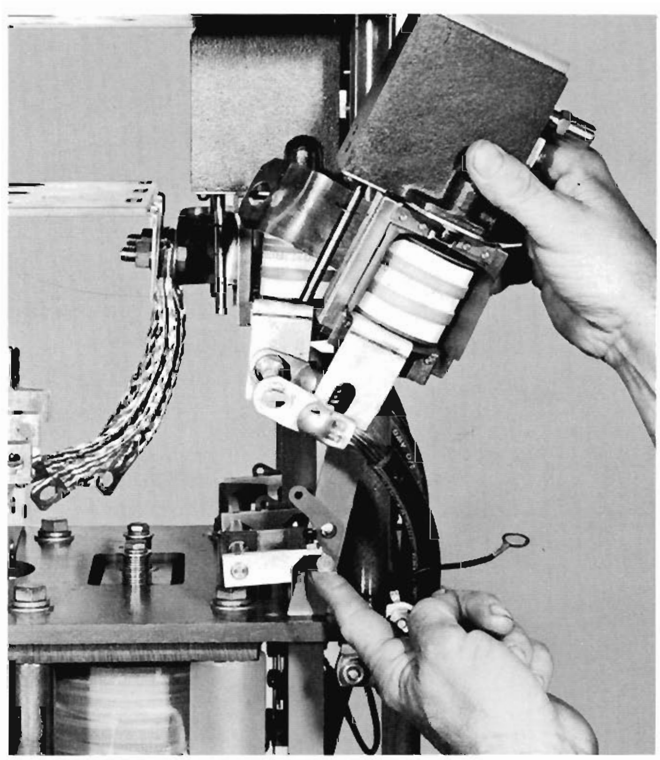


Figure 18.
Removing trip solenoid and sequencing assembly.

Normally the components of the time delay and sequencing assembly will require little or no maintenance. If, however, erratic timing or sequencing performance is suspected the following procedure may be used to clean and inspect the unit.

Important: Each unit is individually calibrated to operate within specified limits. Perform the following maintenance procedure on one unit at a time to avoid intermixing parts.

1. To disassemble the mechanism follow the order shown in Figure 20.

   NOTE: The plunger piston and plunger spring are held in place with the ¼-20 X ½ RHMS in the side of the mechanism housing. Hold the piston and carefully release the spring while backing out the screw.
2. Thoroughly clean all parts and flush with clean transformer oil. Carefully inspect all parts and housing solenoid bores for nicks, scratches, or excessive wear.
3. Because each assembly is individually calibrated, individual parts replacement is not recommended. Replace the entire unit if damage is evident.
4. Reassemble the unit in the reverse order of disassembly.
5. Timing can be changed from the original factory-set and calibrated curve to the other available curve by changing the position of the orifice plate. The "right-side-up" letter is the curve in use.

   However, since the orifice plate and high-current control valve are tailored to the specific assemblies, time-current testing is strongly recommended to assure that desired results have been achieved.

   NOTE: There is a timing mechanism on each phase. Any change or testing must be performed identically on all three phases.
6. Complete the reassembly of the trip solenoid via the reverse order of disassembly and install the unit into the recloser.
7. Reconnect the series-trip coil to the bushing lead and the braided lead.

   NOTE: Refer to the exploded view parts (Figure 36A) for the required attaching hardware and the order of assembly.
8. Finally, reassemble the bias spring with the open end of the loop to the outside to prevent the end of the loop from cutting into the aluminum trip arm.

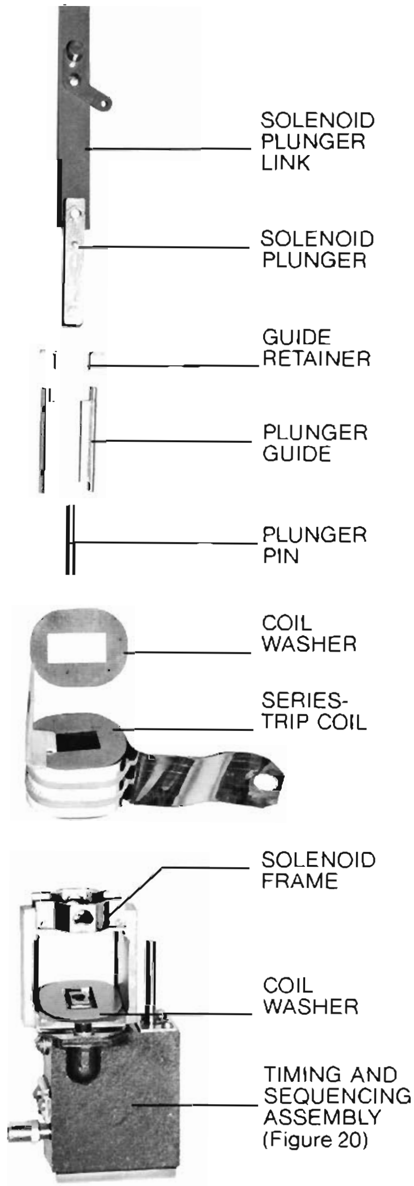


Figure 19.
Trip-solenoid parts.

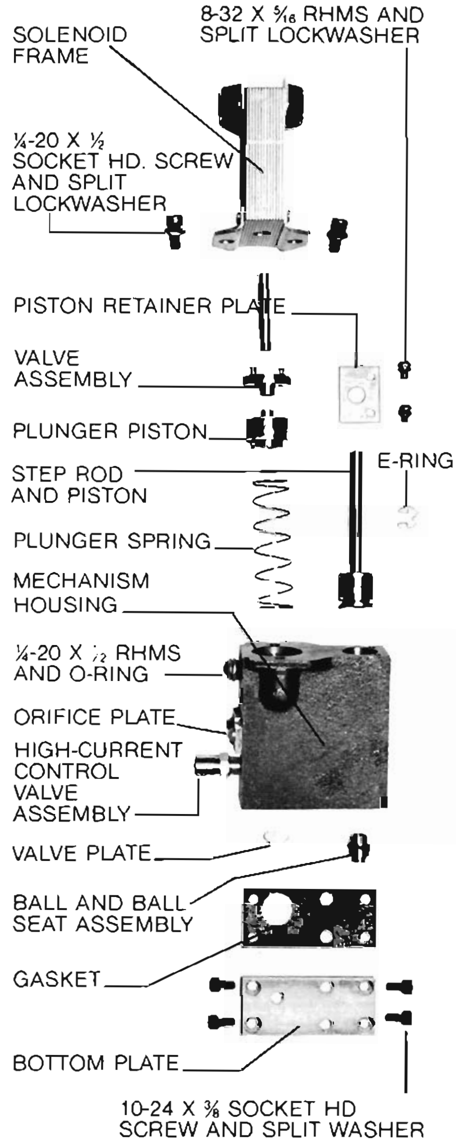


Figure 20.
Time delay and sequencing assembly parts.

Closing Coil

To replace the closing coil refer to Figure 21 and proceed as follows:

1. Disconnect the six bushing leads at the base plate and series-trip coil.
2. Disconnect the trip shaft (item 43, Figure 36A) from the trip arm assembly (42) by removing the C-ring (35), pin (44), and spacer (45).
3. Remove the trip arm assembly (item 42, Figure 36A) by removing the attaching hex nuts and lockwashers.
4. Disconnect the upper end of the contact operating rod (Figure 15) by removing the C-ring and pin (items 71 and 72, Figure 36B).
5. Disconnect the two fuses at the closing coil contactor; remove and discard the fuses (new fuses are included in the closing coil replacement kit).

   NOTE: Contactor parts are attached with the same hardware used to attach the fuse and coil leads. Be careful not to lose parts when disconnecting. Loosely reattach the hardware to retain the contactor parts.

6. Disconnect the two coil leads at the contactor. The NOTE in step 5 also applies.
7. Remove the four hex head bolts (item 54, Figure 36B), lockwashers (55), and flat washers (56) that attach the solenoid support plate (52) to the solenoid frame stringers (57).
8. The complete lower portion of the mechanism can then be lifted-off the assembly.
9. Remove the bridge plate assembly (53) to gain access to the coil.
10. Remove and discard the gasket (84) and coil (85).
11. Install the new coil and new gasket, and reassemble in the reverse order of disassembly.

NOTE: Fuse and coil connections to the contactor are shown in Figure 22.

Removal of Mechanism From Head

To gain access to components mounted under the head, removal of the entire operating mechanism may be required. Proceed as follows:

1. Disconnect the six bushing leads at the base plate and the series-trip coil.
2. If the unit is equipped with the Ground Fault Trip Accessory, disconnect the CT wiring harness at the accessory circuit board, Figure 23.

NOTE: Identify the removed leads for proper reconnection.

3. Uncouple the shafts of the two operating handles and indicator under the sleet hood by locking the couplings in the disconnected position as shown in Figure 24.
4. Close the recloser to gain access to the attaching bolt located under the main shaft (Figure 24A) and remove bolt.

NOTE: Because of close clearances, the bushing at this location may have to be removed. A swivel-type socket wrench is required to remove this bolt.

5. Trip open the recloser and remove the remaining three attaching bolts.
6. Attach an eyebolt through the hole in the center of the base plate, straighten the bushing leads so they will pass through the holes in the solenoid support plate, and lift out the entire mechanism.

Reassemble the mechanism and head in the reverse order of disassembly.

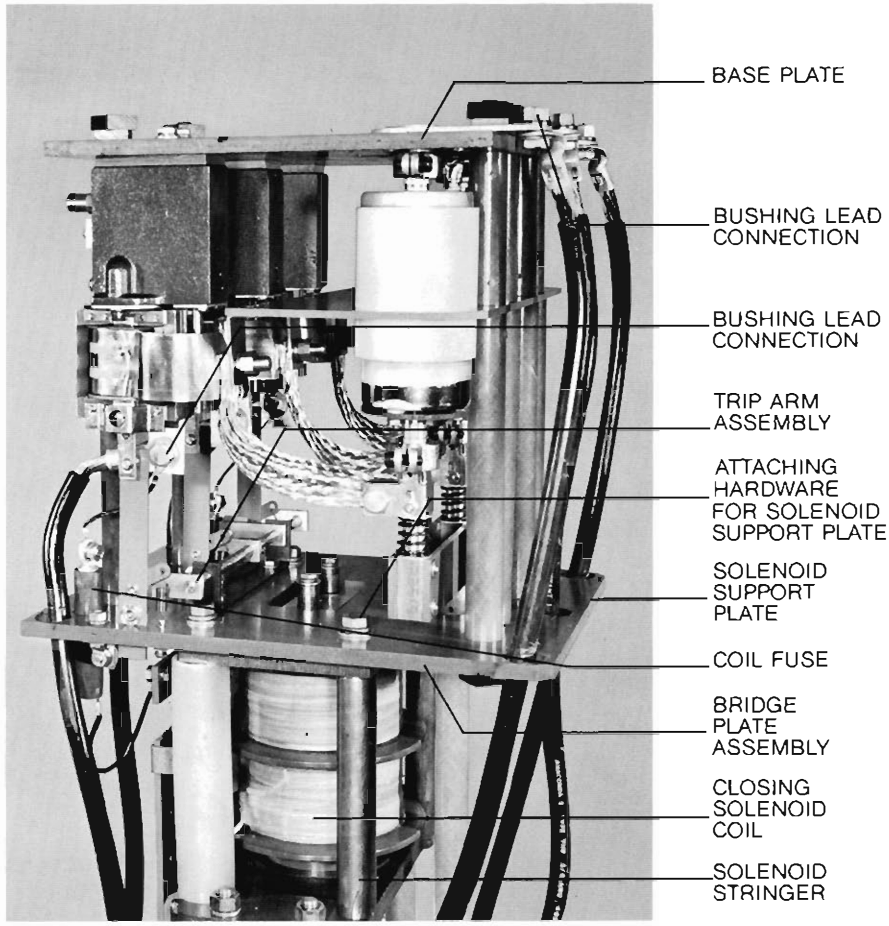


Figure 21.
Parts associated with replacement of closing solenoid coil.

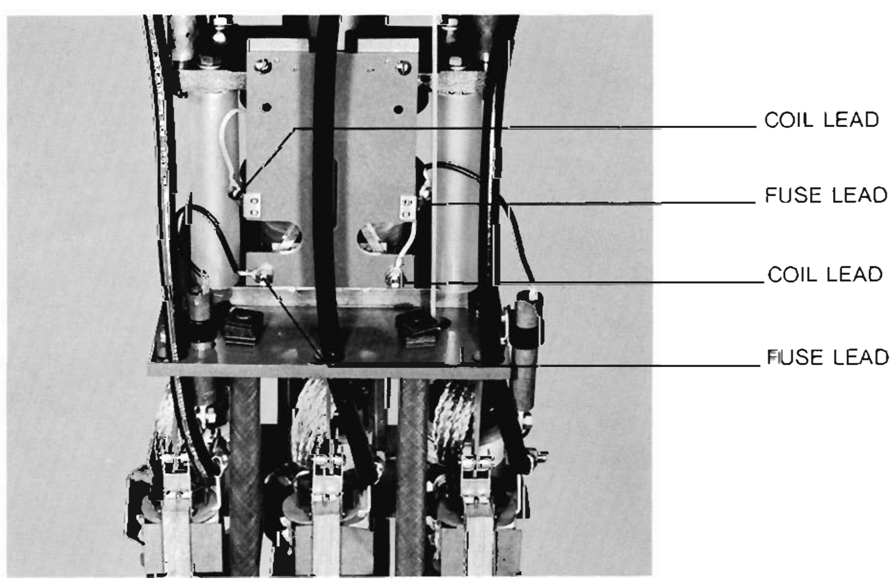


Figure 22.
Connects to closing solenoid contactor.

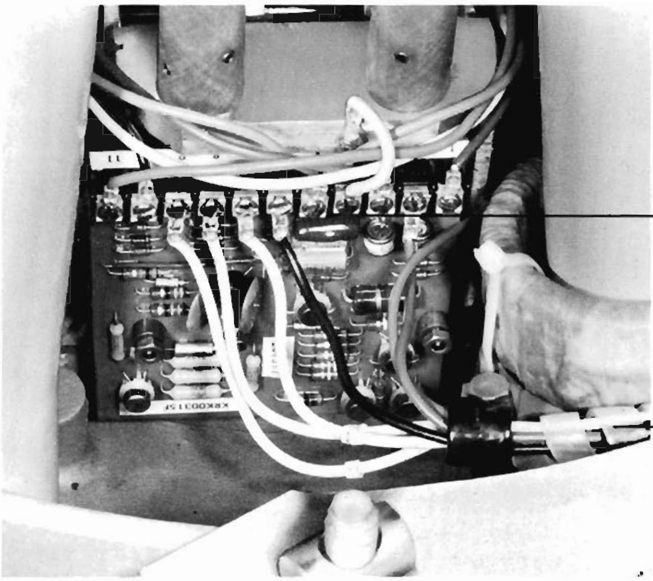


Figure 23.
C.T. wiring harness leads are connected to terminal strip on Ground Trip Accessory circuit board.

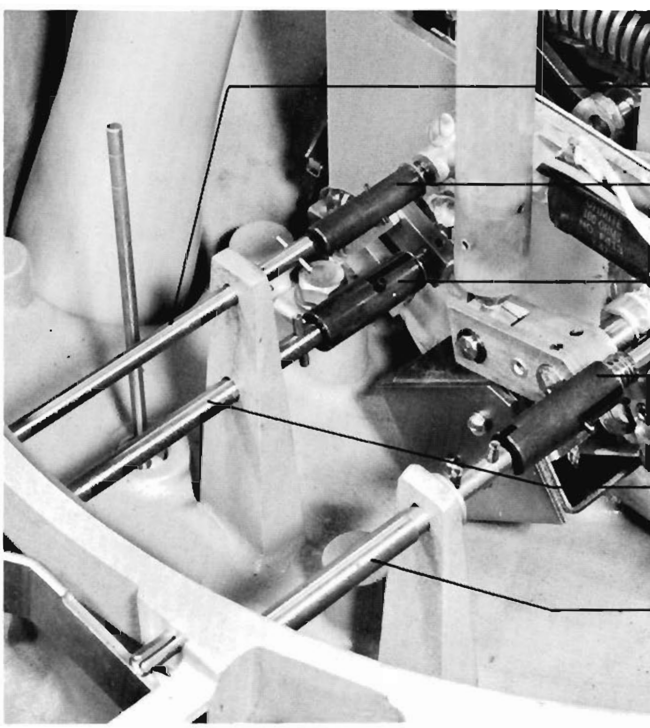


Figure 24.
External operating shafts uncoupled from mechanism.

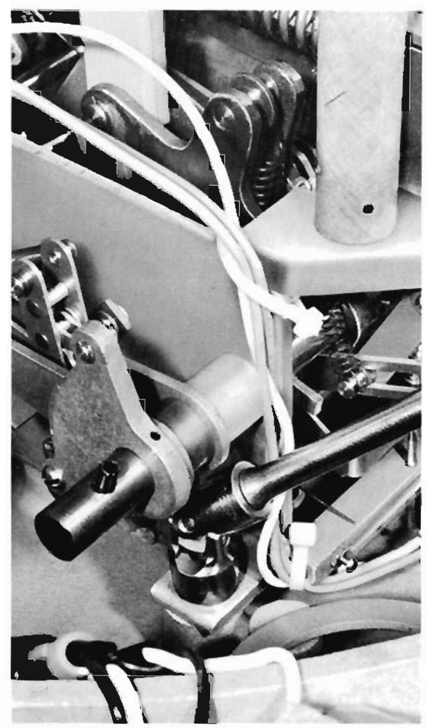


Figure 24A.
Removing mechanism mounting bolts from head.

ADJUSTMENTS

Adjustments described in this section may be required when the recloser has been disassembled or when new parts are installed.

Trip Adjustment

With the socket head screw (A) approximately flush with the trip lever and the mechanism in the closed position, hold down the plunger link and turn the screw until mechanism trips (Figure 25). Now, turn the screw an additional two full turns and lock screw in place with the hex nut. Repeat the procedure on the other two phases.

Minimum Trip Adjustment

The minimum trip current can be raised or lowered to fall within tolerance limits by adjusting the tension on the plunger link spring (Figure 25). Lengthening the spring increases the minimum trip current. Adjust the length of the spring with the spring adjustment screw (B) and lock with the hex nut.

Operations to Lockout

With the mechanism closed, adjust screw A for a clearance of approximately 0.76 mm (0.03 in.) between the panel and the ratchet rod (Figure 26). If actual number of operations to lockout does not agree with the setting use screw B to adjust. Backing out screw B increases the number of operations to lockout and vice versa.

GROUND (EARTH) FAULT TRIPPING ACCESSORY

The electronically controlled Ground Fault Trip Accessory provides the Type KF recloser with the capability of detecting and operating on ground faults as low as five amps.

Description

The accessory is self-contained and requires no external power to operate. Operating power is obtained from the line by three current transformers mounted on the source-side bushings under the head casting. A second set of three transformers, mounted in tandem and connected in parallel, sense zero sequence (ground) currents.

Additional components of the accessory include: a solid-state electronic control circuit board, an electromagnetic tripper, a terminal strip for

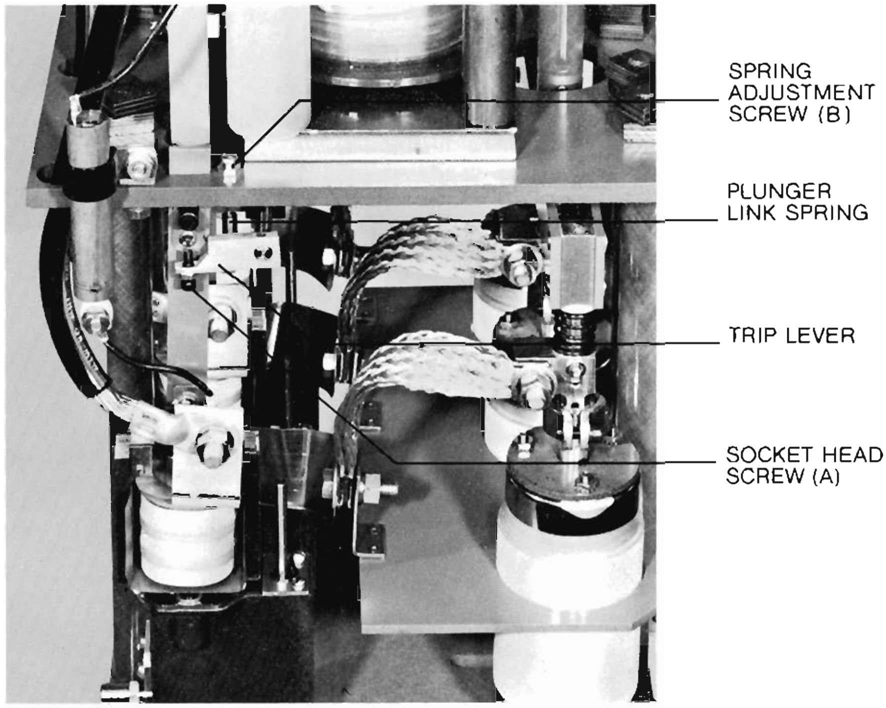


Figure 25.
Trip and minimum trip adjustment.

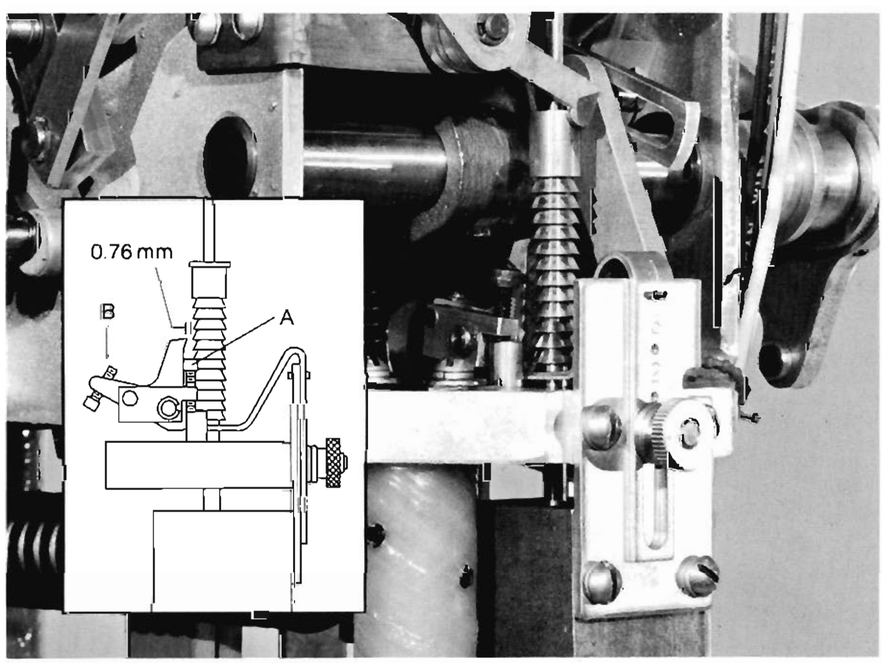


Figure 26.
Operations to lockout adjustments.

attaching the minimum trip and timing resistors, and a cam-operated dual timing switch (if dual timing is provided) (Figures 27 and 28). A connection diagram for the accessory is shown in Figure 29.

Ground fault sensing and tripping operations are independent of the recloser's phase-fault operation. However, recloser operations to lockout are counted by a common integrating mechanism, so that the operations to lockout can be all phase, all ground, or a combination of the two.

The ground current level at which the recloser will trip is determined by the minimum trip resistor (Figure 29A). Ground trip levels available are: 5, 10, 20, 35, 50, 70, 100, 140, 200, 280, 400 amps. This minimum ground trip setting is independent of the minimum phase trip setting.

Ground-trip clearing time is also independent of the phase-trip clearing time and is determined by the timing resistor(s) (Figure 29A). The Ground Fault Tripping Accessory is provided with either a single clearing time sequence for all operations to lockout, or dual timing, wherein a fast clearing time preceeding a slower clearing time sequence to lockout can be programmed. The number of operations at the initial faster clearing time is set on a selector cam which is operated by the ratcheted trip rod of the lockout integrator (Figure 28).

With the trip rod down (reset) the roller on the switch arm rests in the cam detent. If set for one fast ground trip operation (as shown in Figure 28), the first recloser operation rotates the cam counterclockwise and actuates the switch which shifts timing resistors. One, two, or three fast ground trip operations (as determined by the first timing resistor) can be set on the cam. The balance of the trip operations to lockout will be at the slower clearing time (second timing resistor). Reset of the trip rod piston in the lockout integrator also resets the ground trip timing selector cam.

Clearing times available are: 0.1, 0.2, 0.5, 1.0, 2.0, 3.0, 5.0, 10, and 15 seconds. Figure 30 illustrates typical ground trip clearing times. The upper curve (9) is the 15 second and the lower curve (1) is the 0.1 second clearing characteristic. The complete set of clearing curves is published in McGraw-Edison Reference Data Bulletin 73004.

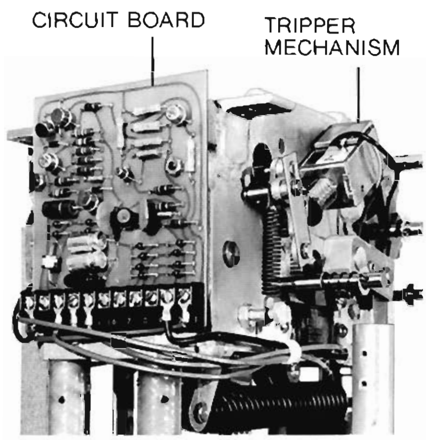


Figure 27.
Ground (Earth) Fault Tripping Accessory components mounted on recloser mechanism frame.

As drawn, the definite-time curves are for all minimum trip current levels and clearing times are read directly. Shifting of the curve is not required. That portion of the curve extending to the left of the programmed minimum trip level is simply ignored.

An externally operable, manual switch to disable ground fault tripping can also be provided. Operable from below with a hookstick, the switch handle is located on the side of the recloser head opposite the sleet hood (Figure 31).

The switch handle is housed under its own sleet hood. When pulled down to disable ground trip, the handle remains down and must be manually returned to reactivate the ground trip function. Disabling is accomplished by short-circuiting the current transformer secondaries.

Operation

When the zero sequence (ground) current exceeds the selected minimum trip level and remains above that level through the selected time period, a trip signal is generated in the electronic circuitry of the accessory. This signal electronically transfers a stored capacitor charge to the electromechanical tripper mechanism. Movement of the spring-loaded plunger on the tripper, released by the transferred charge, trips a latch holding the recloser opening springs and the recloser opens in the same manner as for phase faults.

When the recloser trips, the tripper plunger is immediately reset which in turn charges the plunger spring. After the recloser contacts reclose, the electronic circuits recharge preparing the accessory for its next operation as current again flows through the recloser. A minimum of five amps current flow will provide sufficient power to operate the electronic control and keep the trip storage capacitors charged.

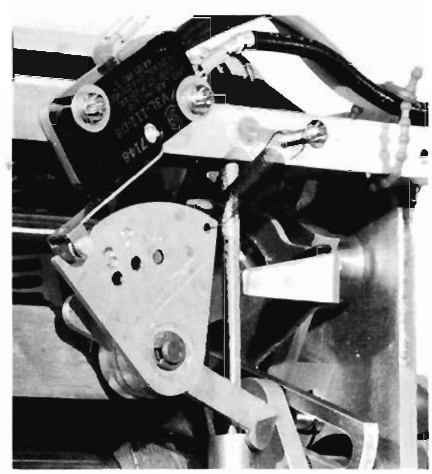


Figure 28.
Dual timing mechanism for Ground Fault Tripping Accessory.

Test Procedure

The Ground Trip Accessory can be tested by manually closing the recloser with the closing tool and electrically tripping with a low-voltage a-c source.

A suggested test circuit is shown in Figure 32. The following equipment is required for the recommended test setup:

1. Variable autotransformer (T1): 240 vac, 20 amps.
2. Low voltage transformer (T2): Same as for phase-trip testing on page 11.
3. Ammeter: Full scale deflection should be at least twice the minimum trip current.

Connect leads X and W on low-voltage transformer T2 to one pair of bushing terminals (1 and 2, 3 and 4, 5 and 6) and proceed as follows:

1. Move the ground-trip disabling switch to its closed (up) position.
2. Move the yellow manual operating handle to its closed position and manually close the recloser.

NOTE: For single timing ground trip operation, dual timing switch and second timing resistor are eliminated and terminals 5 and 8 on TB1 are jumpered.

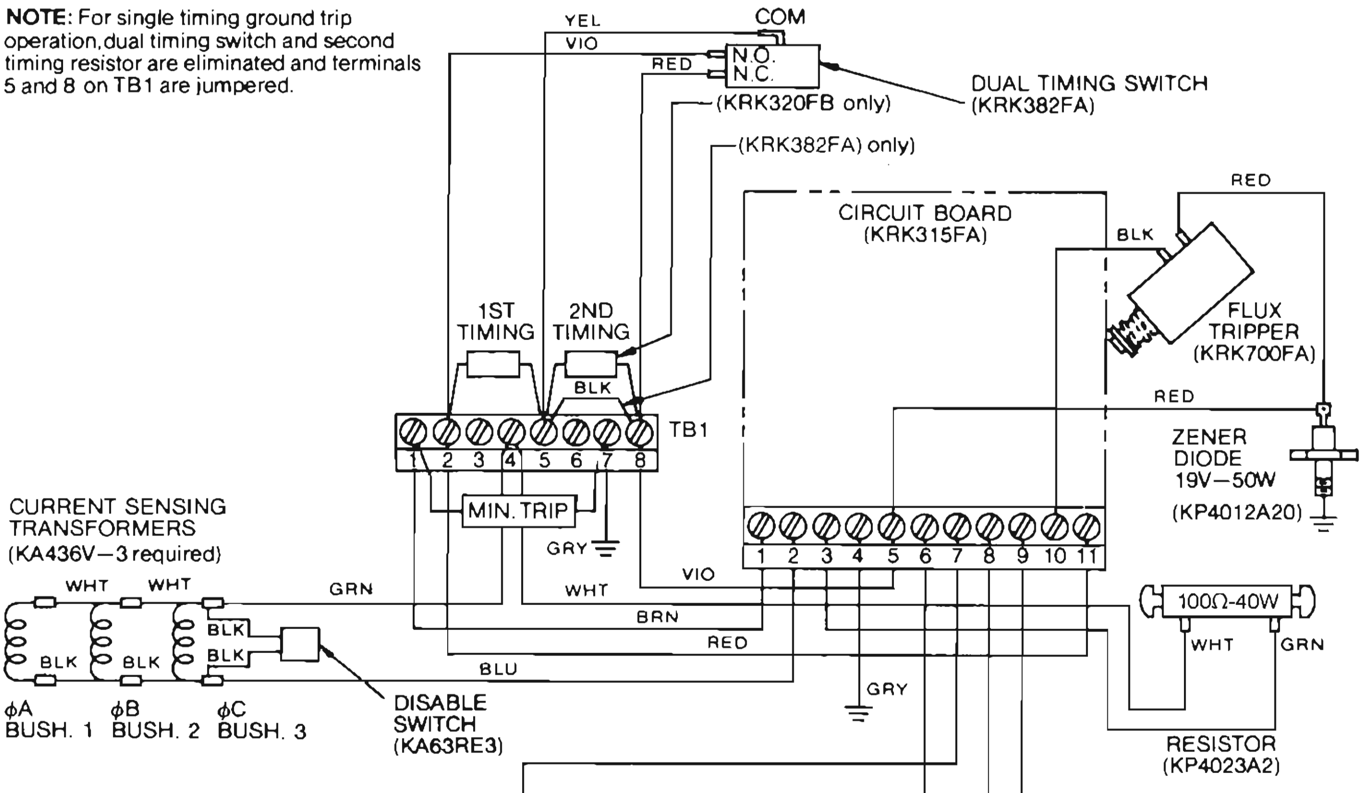
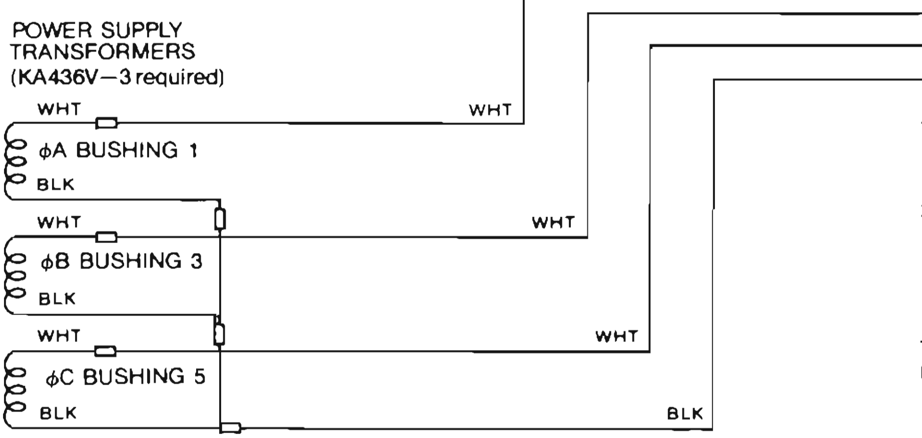



Figure 29.
Connection diagram—
KRK320FA (single timing) and KRK320FB (dual timing) Ground Fault Sensing Accessory.

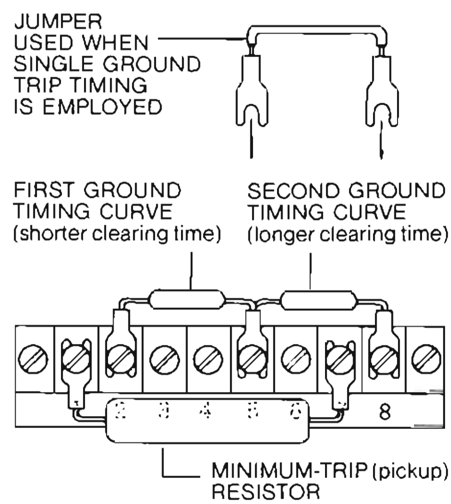


Figure 29A.
Ground trip programming components.

3. Energize the Variac and slowly raise the voltage from zero, noting the ammeter reading when the recloser trips. The operating tolerances for each minimum trip rating are shown in Table 4.

Table 4.
Operating Tolerances of Ground Minimum Trip Resistors

Resistor Rating (amps)	Trip Tolerance Limits (amps) Min	Max
5	4.0	5.5
10	8.5	10.5
20	17.5	21.0
35	31.5	38.5
50	45	55
70	63	77
100	90	110
140	126	154
200	180	220
280	252	302
400	360	440

Fast-Trip, Slow-Trip Sequence

When the Ground Trip Dual Timing Accessory is furnished, its sequence can be checked as follows:

1. With ground trip disabling handle and yellow handle up, manually close the recloser.
2. Set the Variac high enough to cause ground trip, but not so high as to have current in excess of the phase minimum-trip level.

   NOTE: Test current should be sufficiently above the ground minimum-trip level so that line fluctuations will not cause it to fall below the ground minimum-trip level for more than one cycle, as this causes the timing period to start over.
3. Energize the low-voltage transformer T2. The recloser should trip.
4. Immediately after hearing the two clicks (as described under TEST PROCEDURE—Manual Closing), close the recloser manually for the next trip operations.

When employing manual closing in the ground trip operations-counting tests, always close and trip the recloser

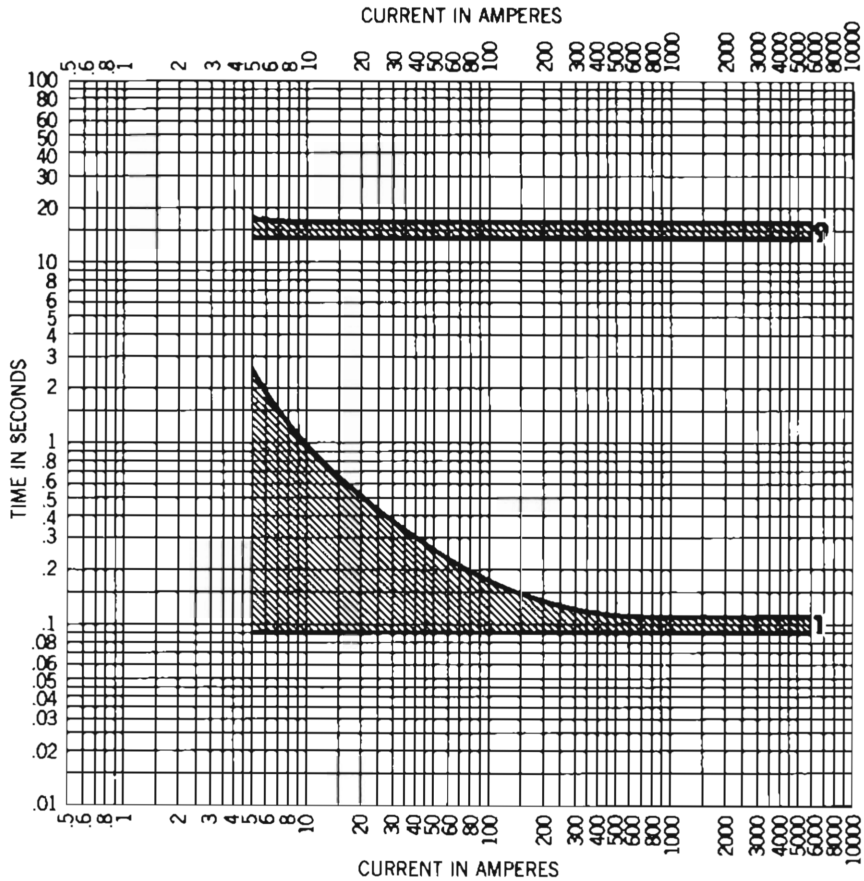


Figure 30.
Typical time-current characteristics for ground (earth) fault tripping. Fastest (9) and slowest (1) characteristics are illustrated.

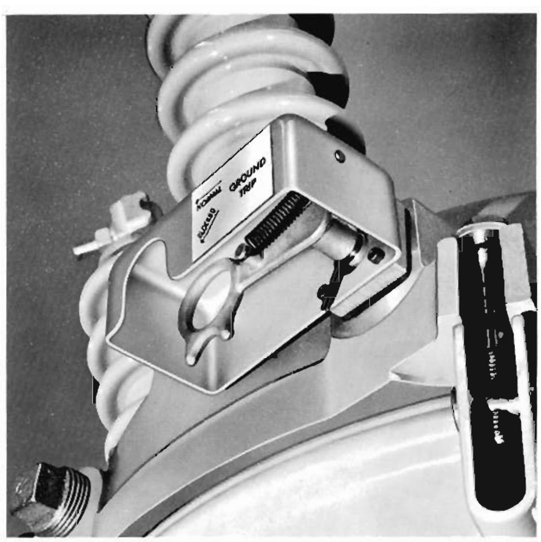


Figure 31.
Ground trip disabling switch.

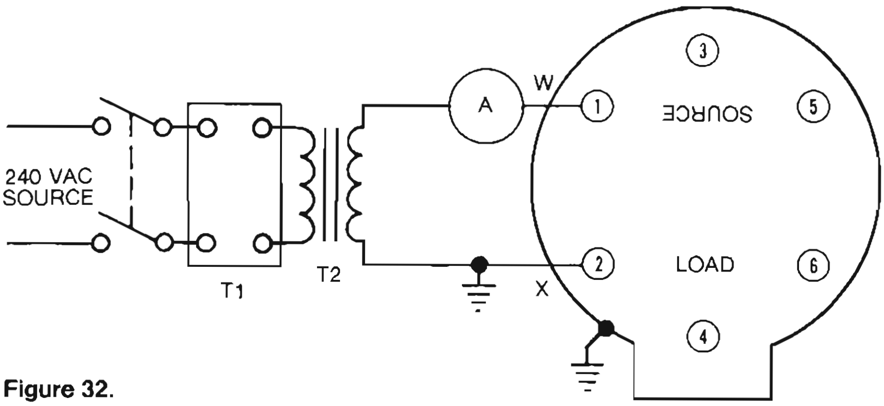


Figure 32.
Suggested test circuit for testing Ground Fault Trip Accessory.

without appreciable delay. Otherwise, extra ground trip operations may occur due to partial resetting of the lockout piston.

5. Observe the number of fast ground trip operations, the number of slower ground trip operations, and the number of ground trip operations to lockout. When lockout is reached, the yellow manual operating handle will drop down and the manual closing mechanism will become inoperative.

Troubleshooting

If the recloser fails to operate properly during ground trip testing the following procedure may be used to troubleshoot the accessory.

1. Using the untanking procedure on page 9, remove the head and mechanism assembly from the tank to gain access to the accessory circuit board.
2. Verify that the proper minimum trip and timing resistors are being used.
3. Verify that all connections are correct and intact. See connection diagram, Figure 29.
4. Connect the low-voltage a-c test circuit, Figure 32, to phase A of the recloser.
5. Manually close the recloser, energize the test circuit and adjust T1 for a five amp test current.
6. Measure d-c voltage from terminal 10 of the circuit board to ground. Voltmeter should read + 18 vdc.
7. Repeat steps 4, 5, and 6 for phases B and C.
8. If +18 vdc is not present, the power supply current transformers are open or shorted.
   A. Deenergize the test circuit and measure resistance of the CT as follows:
      Phase A-Terminals
      6 to 8 . . . . 12 ohms.
      Phase B-Terminals
      6 to 9 . . . . 12 ohms.
      Phase C-Terminals
      6 to 7 . . . . 12 ohms.
      Terminal 6 to ground . . . infinity.
   B. Check all CT wiring for shorts, grounds, and evidence of physical damage and repair; or replace damaged CT's as necessary.
9. Connect a d-c voltmeter between terminal 1 and ground and raise the test current to the minimum trip level value. The voltmeter should read + 4.5 vdc.
10. Repeat step 9 for other two phases.
11. If + 4.5 vdc is not present the sensing current transformers are open or shorted.
    A. Check that the ground disable switch is in the up position.
    B. Measure resistance of sensing transformers. An ohmmeter connected between terminal 2 and the green lead terminal of the 100 ohm, 40 watt resistor should read four ohms.
    C. Check all CT wiring for shorts, grounds, and evidence of physical damage and repair; or replace damaged CT as necessary.
12. When the test current exceeds the minimum trip level the accessory will start timing. At the end of the timing period, the + 18 vdc measured at terminal 10 will drop to zero rapidly and the recloser should trip open.
13. If the voltage at terminal 10 drops to zero and keeps cycling between 18 vdc and zero, the tripper assembly is receiving a signal but the recloser is not tripping open.
    A. Check that the flux shift tripper has operated. Tripper plunger should be up tight against its trip lever.
    B. Replace tripper if faulty.
    C. Check tripping mechanism for sticking by manually operating the trip lever. Realign as necessary.
14. If voltage does not drop to zero, the circuit board is faulty and should be replaced.

SERVICE PARTS LIST

Service parts listed and illustrated include only those parts and assemblies usually furnished for repair. Further breakdown of listed assemblies is not recommended. Because of the ease, faster receipt, and greater economy of local acquisition, the wiring, wire-end terminals, and connectors have not been included in this parts listing. All common hardware parts dimensions have been carefully checked so they also may be obtained locally.

To assure correct receipt of any parts order, always include recloser type and serial number. Because of McGraw-Edison's continuous improvement policy, there may be instances where parts ordered may not look exactly the same as parts furnished; however they will be completely interchangeable without any rework of the recloser.

All parts carry the same warranty as any whole item of switchgear, i.e., against failure due to defects in material or workmanship within 15 months from date of readiness for delivery.

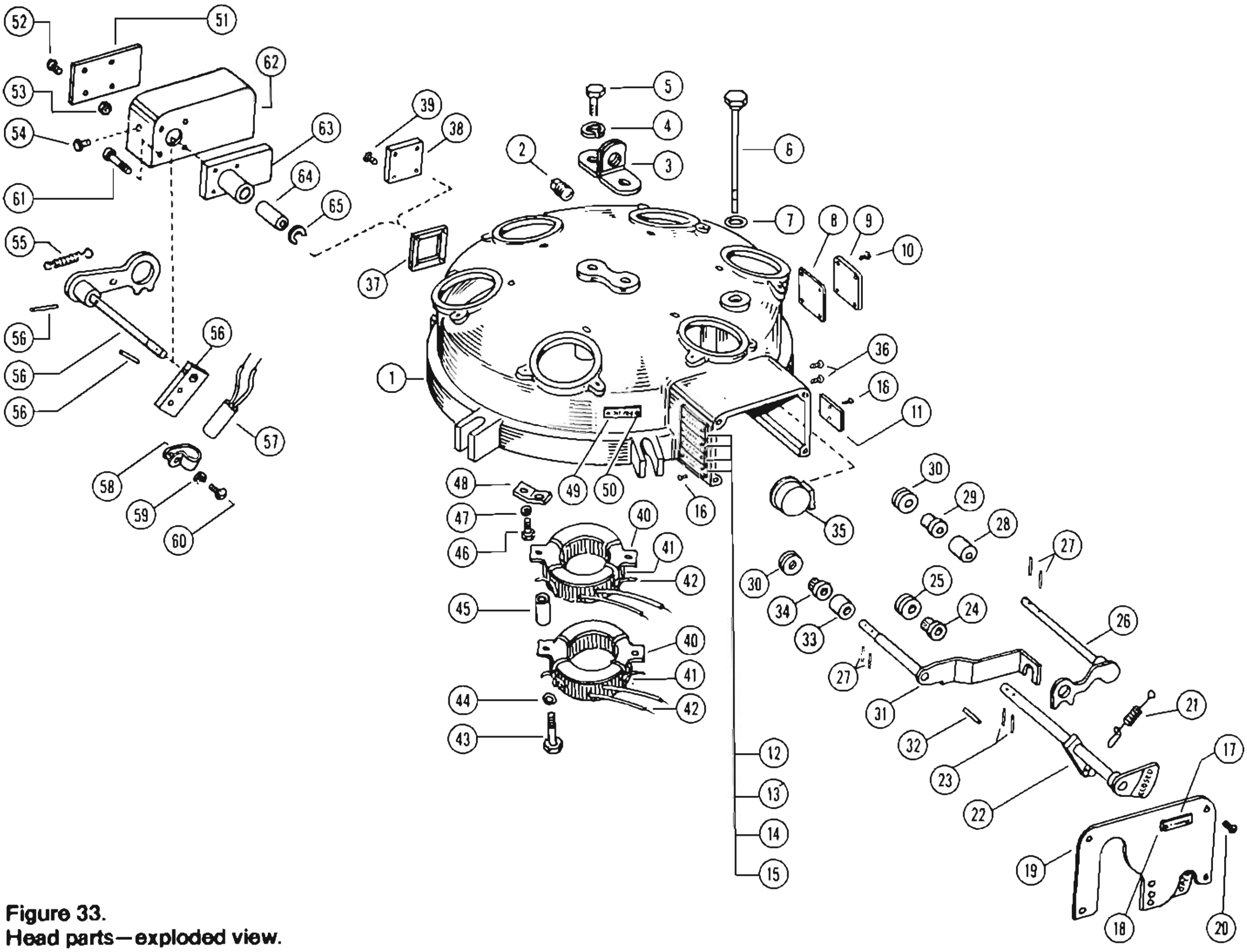


Figure 33.
Head parts—exploded view.

Head Parts (Figure 33)

Item No.	Description	Catalog Number	Quan. Req'd.
1	Head casting	KRK101F2	1
2	Pipe plug, manual closing tool port	KP2007A4	1
3	Lifting lug	KRK388F1	2
4	Lockwasher, med, 5/8, stl	KP1124	2
5	Capscrew, hex hd, 5/8—11 x 1 1/2, stl	KP1297	2
6	Oil-level dipstick	KA363R	1
7	O-ring gasket	KP2000A9	1
8	Gasket, accessory wiring port	KRK406F1	1
9	Cover plate, accessory wiring port	KRK407F1	1
10	Machine screw, rd hd, 8—32 x 3/8, sst	KP687	4
11	Identification plate, non-reclosing	KP390R	1
12	Data plate, recloser ratings 280 amp recloser 400 amp recloser	 KRK281F1 KRK281F2	 1 1
13	Data plate, closing coil voltage; add correct suffix number; 1 = 2.4 kv, 2 = 4.16—4.8 kv, 6 = 6 kv, 7 = 11 kv, 4 = 12.0—13.2 kv, 16 = 13.2 kv, 5 = 14.4 kv (item 13 included in closing coil kit, 85, Figure 36).	KP567R_	
14	Data plate, current rating, add continuous current rating of series-trip coil as suffix number (item 14 included in series-trip solenoid coil kit, 33, Figure 36).	KRK282F_	1
15	Data plate, operating sequence	KP1371R	1
16	Self-tapping screw, rd hd, No. 2 x 3/16, sst	KP687	10
17	Data plate, 50 cycle	KP1576R	1
18	Self-tapping screw, rd hd, No. 4 x 3/16, sst	KP21	2
19	Cover plate	KRK127FA	1
20	Self-tapping screw, rd hd, No. 12 x 1/2, sst	KP1252	4
21	Counter spring	KP310F1	1
22	Indicator lever assembly	KRK121FA	1
23	Roll pin, 3/32 x 5/8, sst	KP1309	2
24	Bushing	KP3107A5	1
25	Flatwasher, 1/2 AN lt, stl	KP1138	2
26	Manual operating (yellow) handle	KRK120FA	1
27	Roll pin, 1/8 x 3/4, sst	KP1304	4
28	Spacer	KP3010A7	1
29	Bushing	KP3107A1	1
30	Flatwasher, 5/16 AN lt, stl	KP1114	4
31	Non-reclosing lever assembly	KRK125FA	1
32	Lever-stop pin, 1/4 x 7/8, sst	KP1310	1
33	Spacer	KP3013A38	1
34	Bushing	KP3107A4	1
35	Counter assembly	KA28006	1
36	Self-tapping screw, rd hd, 6—32 x 3/4, sst	KP1264	2
37	Gasket	KP1541	1
38	Cover plate	KRK312F1	1
39	Machine screw, rd hd, 6—32 x 3/8, sst	KP1176 KP1176	4 4
	THE FOLLOWING PARTS ARE APPLICABLE TO THE GROUND TRIP ACCESSORY (Figure 37.)		
40	CT support plate	KP145RE	6
41	Bushing current transformer	KA43GV	6
42	Cable tie (secures CT to support plate)	KP965	24
43	Capscrew, hex hd, 1/4—20 x 2 1/2, stl	KP1058	6
44	Flatwasher, 1/4 SAE, stl	KP1113	6
45	Spacer	KP3009A88	6
46	Capscrew, hex hd, 5/16—18 x 3/4, stl	KP1277	6
47	Lockwasher, med, 5/16, stl	KP356	6
48	CT support strap	KRK133F1	6
49	Data plate, ground trip sequence	KP1776R	1
50	Self-tapping screw, rd hd, No. 4 x 3/16, sst	KP21	2
	THE FOLLOWING PARTS ARE APPLICABLE TO THE GROUND TRIP DISABLING SWITCH ACCESSORY KRK333FA		
51	Data plate, handle position	KRK521F1	1
52	Machine screw, rd hd, 6—32 x 1/4, sst	KP636	4
53	Hex nut, 6—32, sst	KP288	4
54	Spring retainer	KP1005R	1
55	Spring	KRK350F1	1
56	Switch handle	KRK334FA	1
57	Switch	KA63RE3	1
58	Switch retaining clip	KP200644	2
59	Flatwasher, lt, No. 6, brass	KP992	2
60	Thread-cutting screw, rd hd, 6—32 x 1/2, stl	KP1257	2
61	Cap screw, socket hd, 6—32 x 3/4, stl	KP2036A18	4
62	Switch handle cover	KRK340F1	1
63	Bushing-spacer assembly	KRK338FA	1
64	Spacer	KP3009A87	1
65	Retaining ring, Type C, WA-518	KP79	1

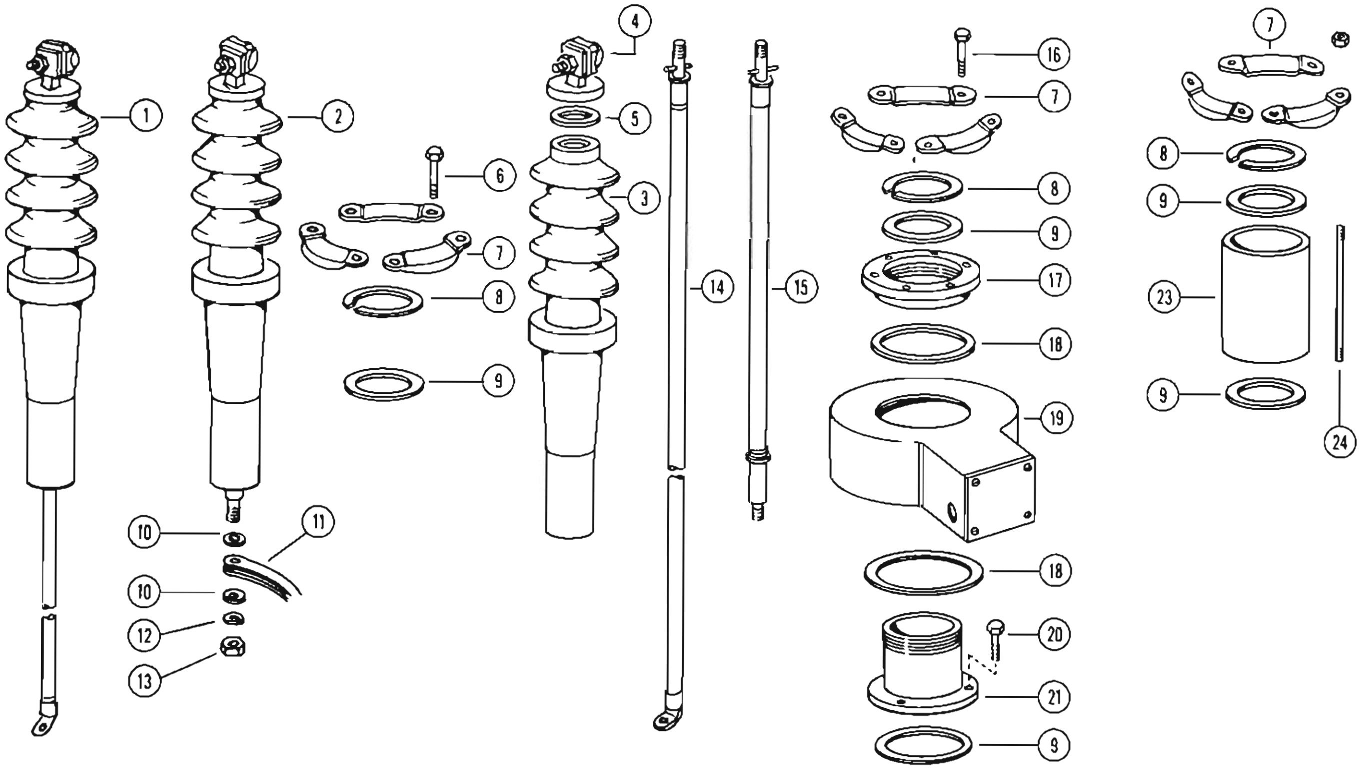


Figure 34.
Bushing parts—exploded view.

Bushing Parts (Figure 34)

Item No.	Description	Catalog Number	Quan. Req'd.
1	Bushing assemblies for 280 amp recloser:		
	Standard creepage, long lead	KA17R46	6
	Standard creepage, short lead	KA717R47	6
	Standard creepage, accy BCT, long lead	KA717R48	6
	Standard creepage, accy BCT, short lead	KA717R49	6
	17-inch creepage, long lead	KA717R50	6
	17-inch creepage, short lead	KA717R51	6
	17-inch creepage, accy BCT, long lead	KA717R52	6
	17-inch creepage, accy BCT, short lead	KA717R53	6
	Bushing assemblies for 400 amp recloser:		
	Standard creepage	KA717R1	6
	Standard creepage for accy BCT	KA717R2	6
	17-inch creepage	KA717R3	6
	17-inch creepage for accy BCT	KA717R4	6
3	Bushing ceramic:		
	Standard creepage	KP1110R	1
	Standard creepage for accy BCT	KP171W	1
	17-inch creepage	KP1578R	1
	17-inch creepage for accy BCT	KP186W	1
4	Bushing terminal	KA143L	1
5	Terminal gasket	KP2090A57	1
6	Capscrew, hex hd, ⅜—16 x 2¼, stl	KP1291	3
7	Bushing clamp	KP1109R	3
8	Bushing clamp ring	KP1111R	1
9	Bushing gasket	KP2090A66	1
10	Lower terminal washer (400 amp recloser)	KP2028A3	1
11	Connecting straps (400 amp recloser)	KP3250A17	4
12	Lockwasher, med, ½—00, bronze	KP542	1

Item No.	Description	Catalog Number	Quan. Req'd.
13	Hex jam nut, ½—20, brass	KP584	1
14	Bushing lead assembly for 280 amp recloser:		
	Std and 17" creepage, long lead	KA716R35	1
	Std and 17" creepage, short lead	KA716R36	1
	Std and 17" creepage, accy BCT, long lead	KA716R37	1
	Std and 17" creepage, accy BCT, short lead	KA716R38	1
15	Bushing lead assembly for 400 amp recloser:		
	Std and 17" creepage	KA716R7	1
	Std and 17" creepage, accy BCT	KA716R11	1
16	Capscrew, hex hd, ⅜—16 x 2, stl, BCT accy	KP1287	3
17	Clamping sleeve, BCT accy	KP170W	1
18	Flange gasket, BCT accy	KP2090A73	2
19	Replacement current transformer, BCT accy	KA159W	1
20	Capscrew, hex hd, ⅜—16 x 1¼, stl, BCT accy	KP1372	3
21	Securing sleeve, BCT accy	KP169W	1
22	Hex nut, ⅜—16, stl, BCT accy	KP1215	3
23	Bushing height spacer, BCT accy	KP275W	1
24	Securing stud, BCT accy	KP3149A40	3

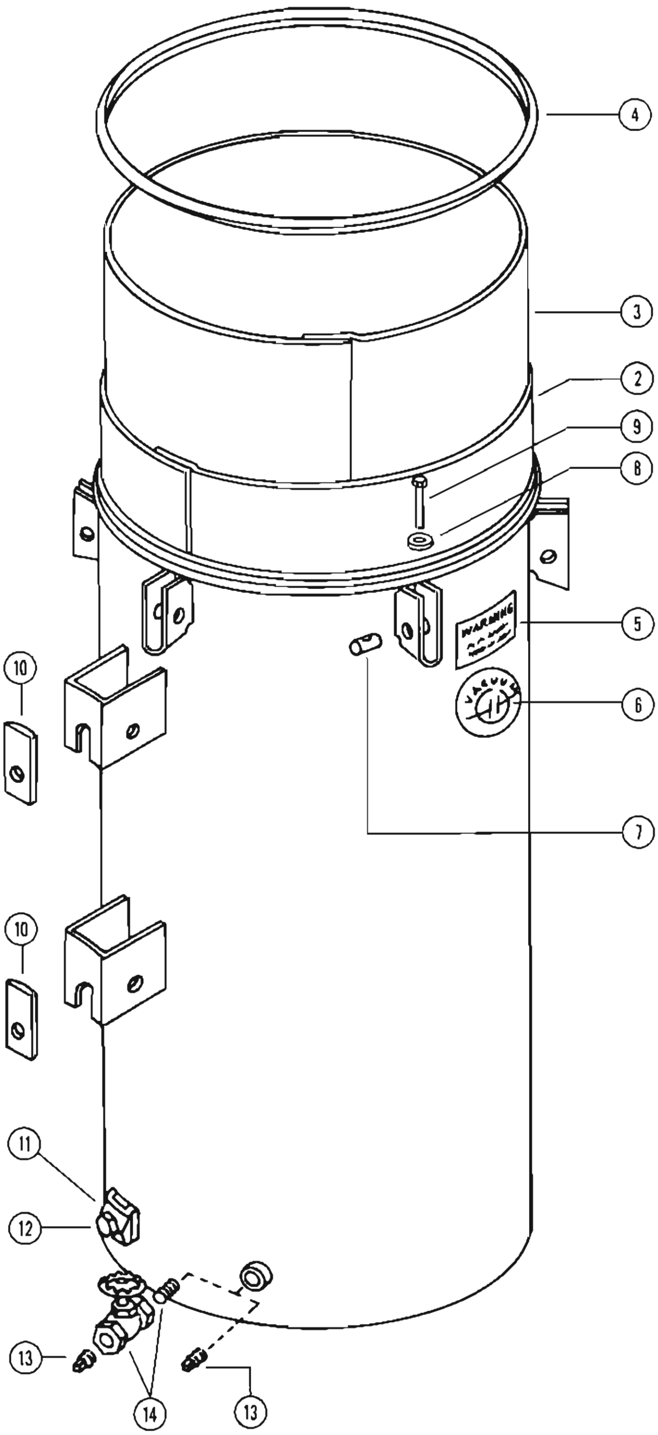


Figure 35.
Tank parts—exploded view.

Tank Parts (Figure 35)

Item No.	Description	Catalog Number	Quan. Req'd.
1	Tank	KRK116FA	1
2	Tank wall insulation	KRK341F1	1
3	Tank liner	KRK283F1	1
4	Head gasket	522077A8	1
5	Radiation warning label	KP1015VSR	1
6	Vacuum decal	KP1041V4H	1
7	Head-bolt retainer	KP86L	6
8	Head-bolt washer	KP2028A23	6
9	Capscrew, hex hd, ½—13 x 3½, stl	KP1289	6
10	Flat-surface mounting adapter plate	KP631D3	2
11	Ground connector	KA227H	1
12	Capscrew, hex hd, ½—13 x 1, stl	KP1282	1
13	Pipe plug, ½ sq hd	KP2007A3	1
14	Gate valve and close nipple accessory	KA809R	1

Recloser Operating Mechanism Parts (Figures 36A and 36B)

Item No.	Description	Catalog Number	Quan. Req'd.
1	Base plate	KRK250FA	1
2	Square nut, ½—13 fiber (Permali)	KP1211	24
3	Threaded fiber rod	KP1014TSC5	6
4	Vertical spacer (lower)	KP3222A38	4
5	Vertical spacer (upper)	KP3222A30	4
6	Vertical spacer (long)	KP3222A40	2
7	Interrupter clamp	KP1036VS	12
8	Interrupter clamp screw, socket head	KP2036A5	12
9	Vacuum interrupter	KRL162FB	3
10	Intermediate support plate	KRK261FA	1
11	Hex nut, ⅜—16, brass	KP599	15
12	Lockwasher, med, ⅜ bronze	KP326	21
13	Flatwasher, 24S, brass	KP823	24
14	Capscrew, hex hd, ⅜—16 x 1¼ brass	KP1300	3
15	Capscrew, hex hd, ⅜—16 x 1¾ brass	KP762	3

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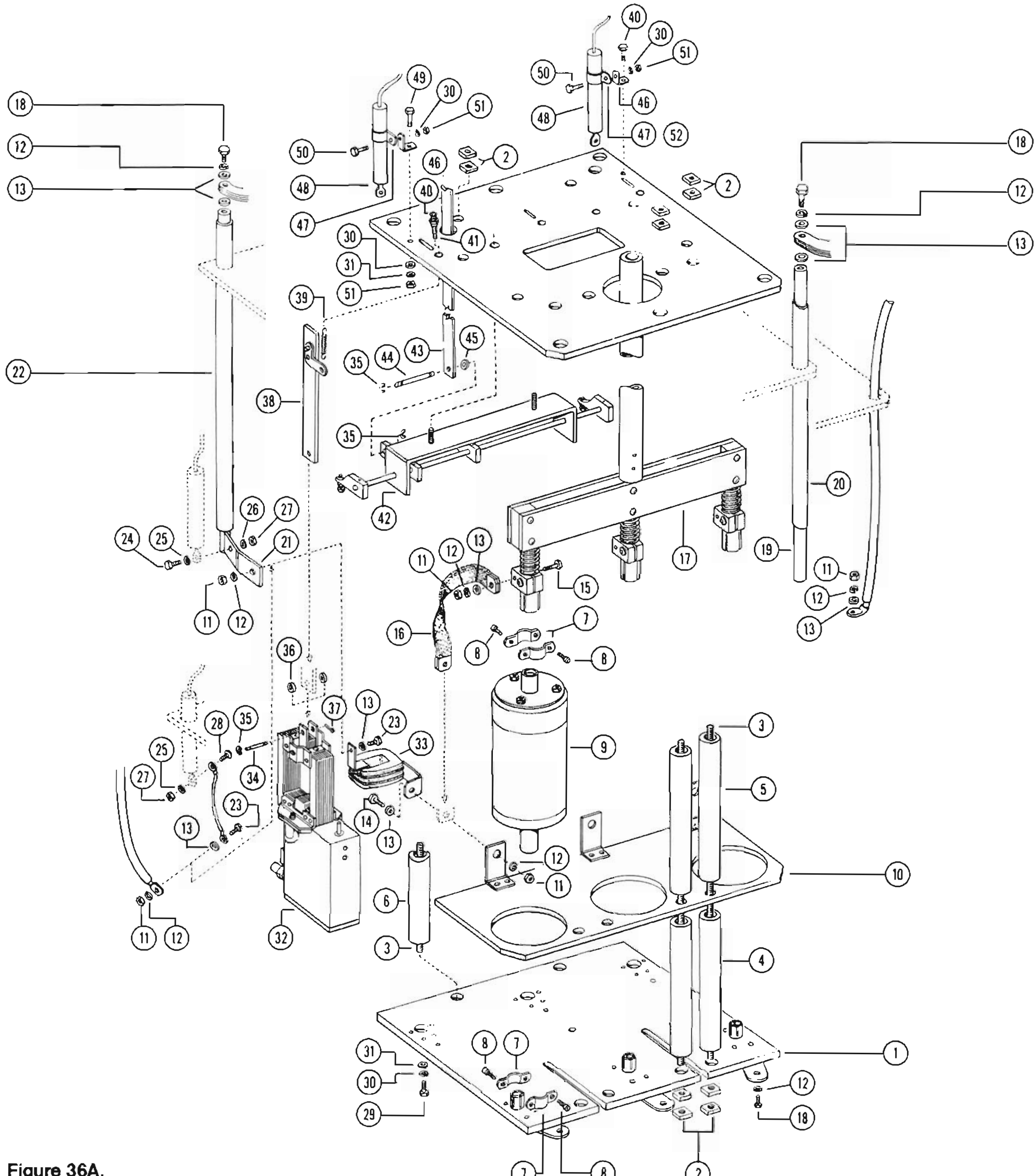

Figure 36A.
Operating mechanism, (lower portion)—exploded view.

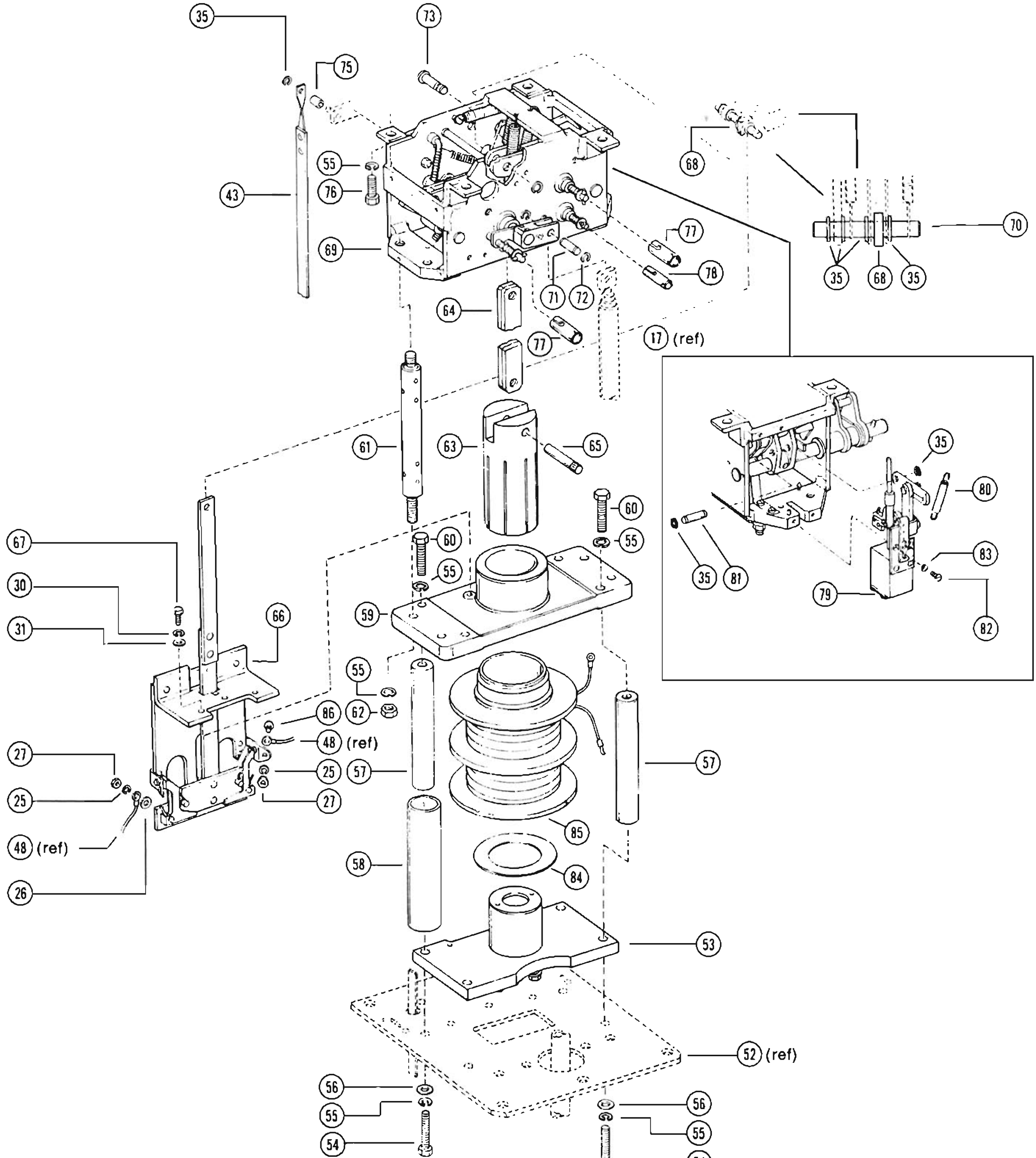

Figure 36B.
Operating mechanism, (upper portion)—exploded view.

Recloser Operating Mechanism Parts (continued) (Figures 36A and 36B)

Item No.	Description	Catalog Number	Quan. Req'd.
16	Braided lead	KRK276FA	6
17	Moving contact rod and clamp assembly	KRK263FA	1
18	Capscrew, hex hd, ⅜—16 x ¾ brass (400 amp recloser)	KP1296	9
19	Bushing connection rod (400 amp recloser)	KRK275F1	3
20	Connection rod insulator (400 amp recloser)	KP3230A17	3
21	Bushing connection rod and terminal (400 amp recloser)	KRK272FA	3
22	Connection rod insulator (400 amp recloser)	KP3013A69	3
23	Capscrew, hex hd, ⅜— 16 x 1 brass	KP1088	3
24	Capscrew, hex hd, ¼—20 x ¾ brass	KP1298	2
25	Lockwasher, med, ¼ bronze	KP347	2
26	Flatwasher, med, ¼ brass	KP818	2
27	Hex nut, ¼—20 brass	KP274	2
28	Machine screw, ¼—20 x ¼ brass	KP473	2
29	Capscrew, hex hd, ¼—20 x 1¼, stl	KP182	6
30	Lockwasher, med ¼ stl	KP337	10
31	Flatwasher, SAE med, ¼, stl	KP343	8
32	Time delay and sequencing mechanism (specify B or C curve and number of fast operations in the recloser operation sequence)	KRK215F	3
33	Series-trip solenoid, replacement kit. Add coil rating to catalog number. Includes coil and data plate (item 14, Figure 33).	KRK268F_	3
34	Single-groove pin	KP3114A1	3
35	Retaining ring, Type C, WA514	KP75	5
36	Spacer	KP3007A124	6
37	Cotter pin, ⅟₁₆ x ¼ brass	KP312	3
38	Solenoid plunger link	KRK343FA	3
39	Plunger link spring	KRK372F1	3
40	Plunger adjustment screw	KRK374F1	3
41	Adjustment screw locking nut	KRK378F1	3
42	Trip arm assembly	KRK245FA	1
43	Trip shaft	KRK240FA	1
44	Double groove pin	KP3124A57	1
45	Spacer	KP3009A9	1
46	Fuse mounting clip (280 amp recloser)	KRK399F1	2
47	Fuse retainer (280 amp recloser)	KP2009A14	2
48	Closing coil fuse assembly add suffix number to indicate voltage rating. 1—2.4 kv (black color band), 2—4.16-4.8, and 6 kv (yellow color band), 3—11 through 14.4 kv (red color band), (item 48 included in closing coil kit, 85)	KA259R_	2
49	Capscrew, hex hd, ¼—20 x 1 stl (280 amp recloser)	KP1299	2
50	Capscrew, hex hd, ¼—20 x ½ stl (280 amp recloser)	KP1367	2
51	Hex nut, ¼—20 stl (280 amp recloser)	KP570	4
52	Solenoid support plate	KRK271F1	1
53	Bridge plate assembly	KRK258FA	1
54	Capscrew, hex hd, 7/16— 14 x 2, stl	KP1350	4
55	Lockwasher, med, 7/16, stl	KP1137	16
56	Flatwasher, SAE med, 7/16, stl	KP354	4
57	Stringer	KP712D	4
58	Stringer insulating tube	KP3230A29	2
59	Solenoid frame	KRK257F1	1
60	Capscrew, hex hd, 7/16— 14 x 1¾, stl	KP187	4
61	Insulating spacer	KA106D	4
62	Hex nut, 7/16— 14, stl	KP271	4
63	Solenoid plunger	KFK256F1	1
64	Plunger link	KP521D	2
65	Plunger pin	KRK353F1	1
66	Closing solenoid contactor	KA97D3	1
67	Capscrew, hex hd, ¼—20 x ¾ stl	KP735	3
68	Shield	KP599D	1
69	Mechanism assembly (phase trip)	KRK134FA	1
70	Six-groove pin	KP1306R	1
71	Double groove pin (contact oper shaft)	KP3125A27	1
72	Retaining ring, Type C, WA516	KP76	2
73	Grooved shoulder pin (solenoid plunger links)	KP3192A5	1
74	Retaining ring, Type C,WA518	KP79	1
75	Spacer (trip shaft)	KP3007A20	1
76	Capscrew, hex hd, 7/16— 14 x ⅞ stl	KP1295	4
77	Coupling, mechanism to operating lever	KP1177R	2
78	Coupling, mechanism to operating lever	KP1056R	1
79	Operations-to-lockout count mechanism	KRK135FA	1
80	Return spring	KP1093CE	1
81	Double groove pin	KP3124A17	1
82	Machine screw, flat hd, 8—32 x ⅜, stl	KP1178	2
83	Lockwasher, No. 8 ext tooth, countersunk	KP8111	2
84	Lower solenoid gasket	KP579D	1
85	Closing coil kit, (includes coil, lower coil gasket, 84, two fuse assemblies, 48, and data plate, 13, Figure 33).		
	For 50 hertz operation:		
	6.0 kv	KRK369FH	1
	11.0 kv	KRK369FJ	1
	13.2 kv	KRK369FK	1
	14.4 kv	KRK369FL	1
	For 60 hertz operation:		
	2.4 kv	KRK369FA	1
	4.6-4.8 kv	KRK369FB	1
	12.0-13.2 kv	KRK369FF	1
	14.4 kv	KRK369FG	1
86	Machine screw, rd hd, ¼—20 x ½, brass	KP173	2

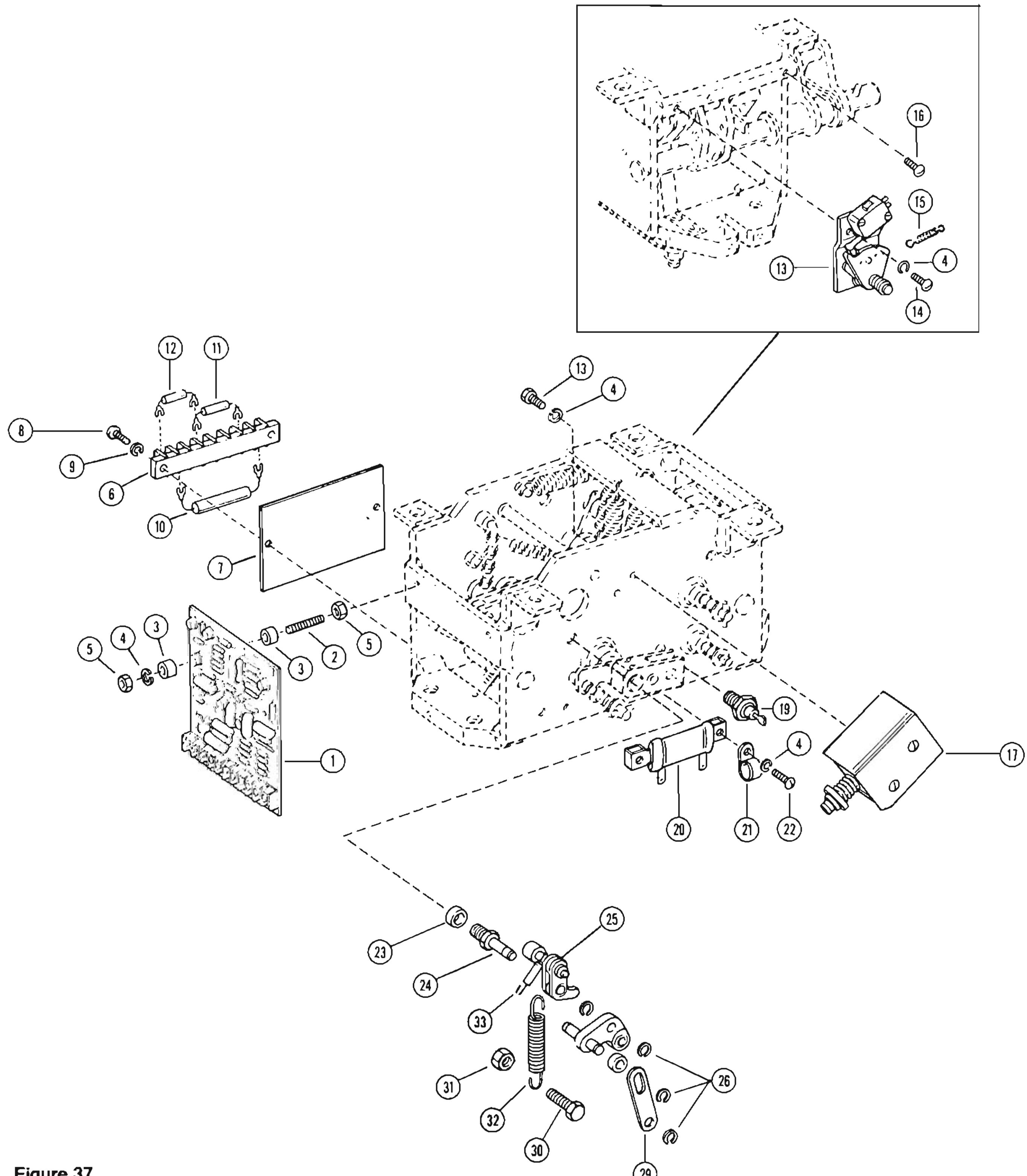

Figure 37.
Ground Fault Trip Accessory.

Ground Trip Accessory Parts (Figure 37)

Note: Sensing current transformers, ground trip disable switch and their associated hardware are listed in the HEAD PARTS section (Figure 33, item 40 through 65).

Item No.	Description	Catalog Number	Quan. Req'd.
1	Circuit board assembly	KRK315FA	1
2	Set screw, hex hd, 8—32 x 1, stl	KP406	2
3	Mounting spacer	KP3007A71	4
4	Lockwasher, med, No. 8 stl	KP1118	8
5	Hex nut, 8—32, stl	KP1200	4
6	Terminal block	KP2101A41	1
7	Terminal market card	KRK528F1	1
8	Machine screw, rd hd, 6—32 x 1, stl	KP1195	2
9	Lockwasher, med, No. 6, stl	KP1129	2
10	Ground minimum trip (pickup) resistor. Add trip rating to catalog number.	KRK317F_	1
11	First timing characteristic resistor. Add characteristic number to catalog number	KRK316F_	1
12	Second timing characteristic resistor. Add characteristic number to catalog number. (omit if single timing ground trip is used.)	KRK316F_	1
13	Dual timing switch assembly (omit if single timing ground trip is used.)	KRK382FA	1
14	Machine screw, rd hd, 8—32 x ⅜, stl	KP1194	2
15	Spring (omit if single timing ground trip is used.)	KRK331F1	1
16	Machine screw, rd hd, 8—32 x ⅝, stl	KP1170	1
17	Flux tripper assembly	KRK700FA	1
18	Machine screw, hex hd, 8—32 x ⅝, stl	KP1442	2
19	Zener diode (IN3378R)	KP4012A30	1
20	Resistor, 100—2, 40 w	KP4023A21	1
21	Wire support clips	KP2006A1	2
22	Machine screw, rd hd, 8 32 x ¾, stl	KP1196	2
23	Spacer	KP3007A75	1
24	Anchor pin	KRK304F1	1
25	Push link and pin assembly	KRK301FA	1
26	Retaining rings, WA-514	KP75	4
27	Lever and pin assembly	KRK297FA	1
28	Spacer	KP3007A64	1
29	Link	KRK305F1	1
30	Capscrew, hex hd, ¼—20 x 1, stl	KP1294	1
31	Hex nut, ¼—20, stl	KP1213	1
32	Spring	KRK524F1	1
33	Spring	KRK319F1	1

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