Types V4L and V4E single-phase maintenance instructions

Powering Business Worldwide

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Contents

Safety for life

Eaton's Cooper Power series products meet or exceed all applicable industry standards relating to product safety. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Eaton employees involved in product design, manufacture, marketing, and service.

We strongly urge that you always follow all locally approved safety procedures and safety instructions when working around high voltage lines and equipment, and support our "Safety For Life" mission.

Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as arc flash clothing, safety glasses, face shield, hard hat, rubber gloves, clampstick, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage only.

Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

DANGER

Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment. G103.3

WARNING

Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling or maintenance can result in death, severe personal injury, and equipment damage. G101.0

WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury and equipment damage. G102.1

WARNING

Power distribution and transmission equipment must be properly selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install or maintain power distribution and transmission equipment can result in death, severe personal injury, and equipment damage. G122.3

Product information

Introduction

Service Information MN280055EN covers the periodic inspection, routine maintenance instructions, testing, component replacements, and adjustments for Types V4L and V4E hydraulically controlled, single-phase, vacuum interrupting reclosers. Service parts lists, keyed to exploded-view drawings of the unit, along with ordering information, are included in the manual.

Read this manual first

Read and understand the contents of this manual and follow all locally approved procedures and safety practices before installing or operating this equipment.

Additional information

These instructions cannot cover all details or variations in the equipment, procedures, or process described nor provide directions for meeting every possible contingency during installation, operation, or maintenance. For additional information, contact your Eaton representative.

Acceptance and initial inspection

Each recloser is completely assembled, tested, and inspected at the factory. It is in good condition when accepted by the carrier for shipment. Upon receipt, inspect the shipping container for signs of damage. Unpack the recloser and inspect it thoroughly for damage incurred during shipment. If damage is discovered, file a claim with the carrier immediately.

Handling and storage

Be careful during handling and storage of the recloser to minimize the possibility of damage. If the recloser is to be stored for any length of time prior to installation, provide a clean, dry storage area.

Standards

Eaton's Cooper Power series reclosers are designed and tested in accordance with the following standards: ANSI/IEEE C37.60-1981 and IEEE Std C37.85™-1989 standards and ANSI Guide C37.61-1973.

Quality standards

ISO 9001 Certified Quality Management System.

Maintenance

Frequency of maintenance

Because reclosers are applied under widely varying operating and climatic conditions, periodic inspection and routine maintenance are best determined by the user, based on actual operating experience. Routine maintenance should be performed at a minimum of fifteen years.

To assure proper and trouble-free operation, reclosers must be maintained when they have operated the equivalent of twice the rated duty cycle, refer to Table 5.

In the absence of specific operating experience, routine maintenance should be performed on Types V4L and V4E vacuum reclosers at a minimum of fifteen (15) years.

⚠ CAUTION

This equipment requires routine inspection and maintenance to ensure proper operation. If it is not maintained, it can fail to operate properly. Improper operation can cause equipment damage and possible personal injury. G105.1

Periodic inspection and maintenance

Each periodic inspection of the recloser should include at least the following steps. Use all locally approved safety and operating procedures. Bypass recloser to perform Step 1D.

1. Check the following external components:
   A. Check for damages to arresters, arrester brackets, by-pass switches, and high voltage connections.
   B. Check for broken bushings, flashover damage, significant signs of rust at the head or tank, oil residue/leaks, other mechanical damage. Replace or repair if necessary.
   C. Record counter reading in recloser record log.
   D. Open and close the manual operating handle (counter advances on the trip/open operation) to test operation of counter. Replace counter if necessary.
2. Return the unit to service.

Routine maintenance

Preparation

⚠ CAUTION

Equipment damage. Recloser must be open (yellow operating handle, under sleethood, down) before untanking. Tripping the mechanism out of oil will cause excessive mechanical shock to the operating mechanism, which will cause accelerated wear and/or damage to the mechanism. T202.0

1. Remove mechanism from tank. Loosen four bolts that secure tank to head casting, and loosen gasket seal between tank and head casting. Gasket seal can be broken by carefully prying head and tank apart.
2. Hoist mechanism out of tank; allow oil to drain off of mechanism.
3. Inspect and clean all internal components, as required.

⚠ CAUTION

Dielectric failure, equipment damage. Never use volatile solutions, detergents, or water-soluble cleaners when cleaning the interior of this equipment. These cleaners will contaminate the insulating oil, reducing its dielectric strength. Operation with contaminated insulating oil can result in internal flashovers that will cause equipment damage and possible personal injury. T201.2

Bushings and bushing gaskets

4. Clean the bushing thoroughly and examine carefully for cracks, or other damage, while the recloser is untanked for servicing. Cracked or damaged bushings must be replaced. Refer to bushing changeout section.
5. Disconnect appropriate bushing lead, see Figures 2 and 3.
6. Remove three hex-head cap screws and bushing clamps that secure bushing to head casting. Lift bushing assembly from head.
7. Install new lower bushing gasket.
8. Position aluminum clamping ring so split will be centered between two clamping bolts.
9. Replace bushing clamps and tighten cap screws evenly, a little at a time, to 6-10 lbs-ft (8-13 Nm).
10. Reconnect bushing lead and tighten.
11. Upper terminal gaskets should not need replacing. Do not attempt to disassemble the V4E oil-filled bushings.
12. Remove old oil, drain tank and dispose of according to local regulations. Wipe tank walls and bottom with clean lint free cloth. Low dielectric strength usually indicates presence of water or carbon deposit.
13. Install new inner tank liners.

Note: Two liners are used. The inner liner is fibrous and readily absorbs any moisture present. Soft or spongy areas indicates that water has been absorbed.

14. Fill tank with new, clean transformer oil:
    A. Use oil with dielectric strength of at least 30 kV, as measured across a standard 0.1 inch (2.54 mm) gap in accordance with methods illustrated in ASTM Publication D117.

B. 9.5 gallons (35.9 liters) of oil will fill tank to correct level as indicated by line on fiber liner (4 inches from rim of tank).

New oil should be filtered before use, even if it was obtained from an approved source. Passing oil through a blotter press will remove free water and solid contaminants such as rust, dirt, and lint. Keep aeration to a minimum during filtering to prevent moisture from condensing in oil. Moisture will lower the dielectric strength of transformer oil.

15. Install new O-ring head gasket into head casting groove.
16. Replace cover and mechanism in tank:
    A. Wipe O-ring type head gasket and tank gasket seat clean of any oil residue.
    B. Position head so manual operation handle is above handle warning decal, tighten bolts alternately (tighten bolts to 25-40 ft-lb (34-54 Nm) torque).
    C. Operate manually until recloser reaches lockout; to be sure no air remains in hydraulic mechanism.
17. Test mechanical operation. An easy, effective test can be performed as follows:
    A. Move the operating lever to CLOSED position and wait a minimum of 6-7 minutes to allow the trip piston to fully reset.
    B. Move operating lever to OPEN position and listen for opening of the main contacts. Then quickly move lever back to CLOSED position to hear for contacts to close. There will be a short delay for the main plunger to return to the up position.
    C. Continue opening and closing manually until lockout is achieved (recloser mechanism will no longer latch when the lever is moved to the CLOSED position).
    D. If the recloser fails to operate to lockout, or if it appears to mis-operate in any way, additional disassembly and testing will be required to identify the source of the malfunction. Refer to the **Advanced Maintenance** section of this manual.
18. Perform an Insulation Level Withstand Test, see procedure following in Testing section of this manual.

Routine maintenance testing

See **Testing** section for tests recommended to determine that the recloser is operating properly. For a more detailed explanation of testing procedures, refer to *Reference Data R280-90-2, Low Voltage AC Testing of Hydraulic Recloser*.

Specifications and ratings

The recloser will interrupt fault currents only when applied within its specific ratings. Consult the following ratings and compare to system characteristics at point of application prior to installation.

Table 1. Voltage ratings

	V4L	V4E
Maximum design voltage (kV)	15.5	27.0
Nominal operating voltage (kV)	2.4-14.4	2.4-24.9
Basic insulation level (BIL) (kV)	110	150
60 Hertz withstand voltage (kV)		
Dry, one minute	50	60
Wet, ten seconds	45	50
Max RIV @ 1.0 MHz		
V4L - 9.41 kV, V4E - 23.0 kV (µV)	100	100

Table 2. Mechanical life

Open-Close, no load, operations (minimum)	2500

Table 3. Current ratings

	V4L	V4E
Continuous current rating (amps)	280	280
Cable charging current (amps)	10	25
Magnetizing current (amps)	9.8	9.8

Table 4. Interrupting ratings, V4L and V4E*

Nominal ratings (Amps)	Minimum trip (Amps)	Maximum RMS symmetrical (Amps)
15	30	900
25	50	1500
35	70	2100
50	100	3000
70	140	4200
100	200	6000
140	280	6000
170	340	6000
200	400	6000
280	560	6000

*Interrupting ratings are based on a maximum X/R of 15.

Table 5. Full-life duty V4L and V4E

Percent of maximum circuit interrupting rating	Maximum X/R ratio	Number of unit operations
15-20	3	88
45-55	7	112
90-100	15	32
	Total	232

Note: IEEE® defines duty cycle as "half-life" vacuum interrupters. Full-life duty is two (2) times the "half-life" definition for vacuum interrupting reclosers.

Table 6. Mechanical specifications

Operating temperature (°C)	
Minimum	-30
Maximum	+40
Closing mechanism	Spring operated
Opening mechanism	Solenoid spring operated
Contact gap (approximate) (inches)	0.5
Close contact travel Time (mS)	15.0
Contact open time, manual operation (mS)	15.0
Nominal reclosing time (oil @25 °C) (Sec)	2
Resetting time per operation (oil @25 °C) (Sec)	60
Allowable contact erosion (inches)	0.0625

Testing

Following are several tests that can be performed to determine if a recloser is operating properly. For a more detailed explanation of testing procedures, refer to *Reference Data R280-90-2, Low Voltage AC Testing of Hydraulic Recloser.*

Minimum-trip-current test

To perform the minimum-trip-current test:

1. Connect a low-voltage variable-current source to the recloser terminals as shown in Figure 1.

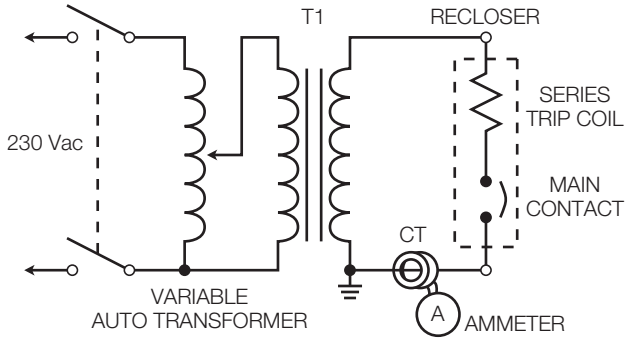

Figure 1. Test-circuit diagram

Note: Ratio and kVA rating of transformer T1 will depend upon size of recloser trip coil. Short time rating of T1 must be sufficient to accommodate load of trip solenoid.

2. Close the recloser by moving the yellow operating handle to CLOSE. Wait at least three minutes to make sure the trip piston is completely reset.
3. Slowly raise the variable-autotransformer voltage from zero, note the current needed to trip the recloser.

Note: As the trip-solenoid plunger moves downward, into the trip-coil, coil impedance will increase; the increased coil impedance will cause current flow to decrease. The maximum current reading, the peak observed just before current begins to decrease, is the minimum-trip current.

Insulation level withstand tests

High-potential withstand tests provide information on the dielectric condition of the recloser. Perform the high-pot test in a suitable test cage at 75% of the rated low frequency withstand voltage (V4L 37.5 kV ac-rms, V4E 45 kV ac-rms). Table 1 shows the dry, one minute, 60 Hz withstand voltage rating for each recloser. Test reclosers at the applicable voltage for 60 seconds in each of the following configurations:

⚠ CAUTION

Radiation. 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 can be emitted. See *Service Information S280-90-1, Vacuum Interrupter Withstand Test Voltage Ratings Information*, for further information. G109.2

⚠ CAUTION

Equipment damage. Never operate a vacuum recloser with a dc test source. The vacuum interrupters will be severely damaged if a dc arc interruption is attempted. T229.1

TEST 1: Proceed as follows:

1. Manually close main contacts.
2. Ground recloser tank and head.
3. Apply test voltage to one bushing.

TEST 2: Proceed as follows:

1. Open main contacts.
2. Ground recloser tank, head, and one bushing.
3. Apply test voltage to opposite bushing.
4. Reverse connections and apply test voltage.

FAILURE MODES: The recloser has failed the test if any one of the following occurs:

1. Breaker opens on high potential tester.
2. External arcing is seen (from bushing terminal to head or terminal to terminal).
3. A sharp "*popping*" noise is heard (indicating an internal failure).

TEST RESULTS: The high potential withstand tests provide information on the dielectric condition of the recloser and the integrity of the vacuum interrupter.

1. If the recloser fails the closed-contact test (Test 1), the cause may be a diminished electrical clearance, low oil dielectric strength, or failed insulation. Inspect the recloser to identify and correct the problem. Repeat the test.
2. Failure in either open contact test may be caused by a deterioration of the vacuum interrupter. Replace interrupter assembly and repeat test.

Contact operation test

The following test is meant to verify that the recloser contacts/mechanism are operating properly. With recloser tanked:

1. Manually operate recloser to lockout.
2. Slowly raise operating handle to the closed position. Operate at a uniform rate which will allow the handle to swing through its complete arc in a period of approximately 5 to 15 seconds.
3. As soon as the contacts close restrain the downward movement of the handle. Slowly allow handle to return to the open position. Again movement should take approximately 5 to 15 seconds, contact should open.

Contacts should freely close and open while the mechanism is being slowly operated. If contacts fail to freely open or close, inspect recloser and repair or replace parts as required to achieve proper operation.

Advanced 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). No special tools are required for any of the repair procedures.

Bushings

Bushing maintenance generally consists of cleaning the bushings thoroughly and examining carefully for cracks, or other damage, while the recloser is untanked for servicing. Cracked or damaged bushings must be replaced.

The bushings used on the Type V4E recloser are oil filled and must be replaced as an assembly, recloser untanking is required to replace these bushings.

The bushings used on the Type V4L recloser can be replaced with the recloser either tanked or untanked. The following standards should be used as a guide:

- If a bushing porcelain was damaged while the recloser was in service, or while in storage, the recloser should be untanked to replace the porcelain. Water or other contaminants may have entered the tank (check the tank liner and test the condition of the oil), the bushing lead could be damaged (either mechanical damage or from flashover), or pieces of porcelain may have fallen into in the tank.
- If a bushing porcelain is chipped during installation or handling, and it is obvious that no other damage has been done, it is not necessary to untank the recloser to replace the porcelain.

Replacing bushing assembly

1. Untank recloser and disconnect appropriate bushing lead, see Figure 2.
2. Remove three hex-head cap screws and bushing clamps that secure bushing to head casting. Lift bushing assembly from head, discard bushing gasket.
3. Twist aluminum clamping ring and remove from old bushing assembly. If ring is in good condition it may be reused. If ring is damaged, it must be replaced.

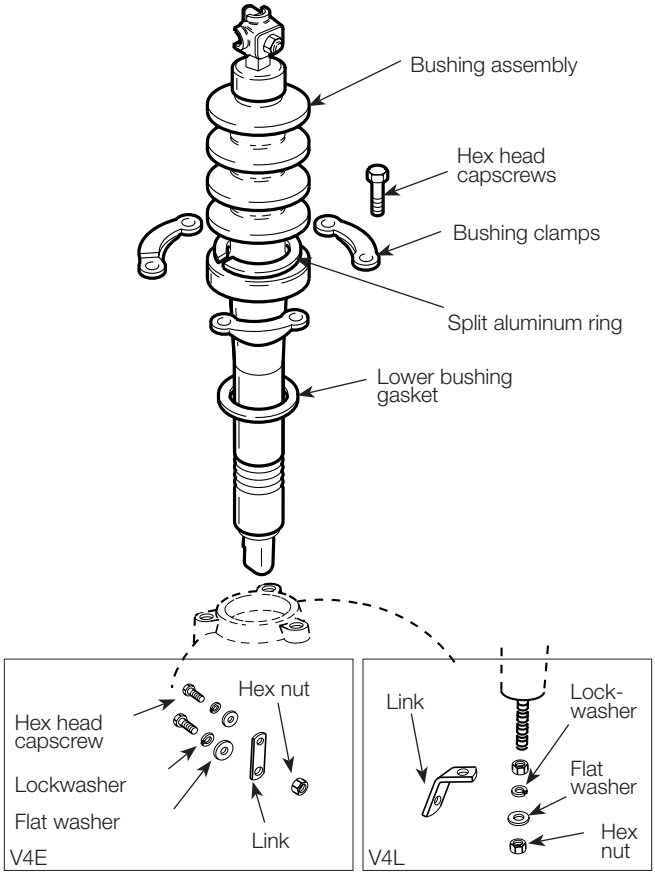

Figure 2. Bushing replacement

⚠ CAUTION

Bushing damage. The split aluminum ring must be replaced if damaged. The clamping ring cushions and distributes the pressure between the bushing flange and the bushing. If bushing clamps are assembled without a new clamping ring, the bushing may be damaged when clamp hardware is tightened. T234.1

4. Install new bushing assembly. Position a new bushing gasket between bushing flange and head casting.
5. Position aluminum clamping ring, so split will be centered between two clamping bolts.
6. Replace bushing clamps and tighten cap screws evenly, a little at a time, to 6-10 lbs-ft (8-13 Nm).

⚠ CAUTION

Dielectric failure, bushing damage. To prevent gasket leaks or bushing damage, clamping force must be applied gradually and equally in rotation to each bolt. If the clamping force is not evenly applied, seal leakage can result, compromising the dielectric capabilities of the recloser and can cause possible personal injury. Unequal clamping force can cause bushing breakage. T235.2

7. Reconnect bushing lead and tank recloser.

Bushing porcelain replacement, recloser tanked, Type V4L only

1. Unscrew bushing terminal, discard terminal gasket, see Figure 3.
2. Remove three hex-head cap screws and bushing clamps that secure bushing porcelain to head casting. Lift bushing porcelain from head, discard bushing gasket.
3. Twist aluminum clamping ring and remove from old bushing porcelain. If ring is in good condition, it may be reused. If ring is damaged it must be replaced.

⚠ CAUTION

Bushing damage. The split aluminum ring must be replaced if damaged. The clamping ring cushions and distributes the pressure between the bushing flange and the bushing. If bushing clamps are assembled without a new clamping ring, the bushing may be damaged when clamp hardware is tightened. T234.1

4. Install new bushing porcelain. Position a new bushing gasket between bushing flange and head casting. Turn porcelain until locking key (roll pin through bushing lead) is properly seated.
5. Position aluminum clamping ring, so split will be centered between two clamping bolts.
6. Replace bushing clamps and tighten cap screws evenly, a little at a time, to 6-10 lbs-ft (8-13 Nm).

⚠ CAUTION

Dielectric failure, bushing damage. To prevent gasket leaks or bushing damage, clamping force must be applied gradually and equally in rotation to each bolt. If the clamping force is not evenly applied, seal leakage can result, compromising the dielectric capabilities of the recloser and can cause possible personal injury. Unequal clamping force can cause bushing breakage. T235.2

7. Install new terminal gasket.
8. Apply a very small amount of petroleum jelly to the knurled inside surface of the bushing terminal. Screw terminal onto lead and tighten to 20-25 lbs-ft (27-34 Nm).

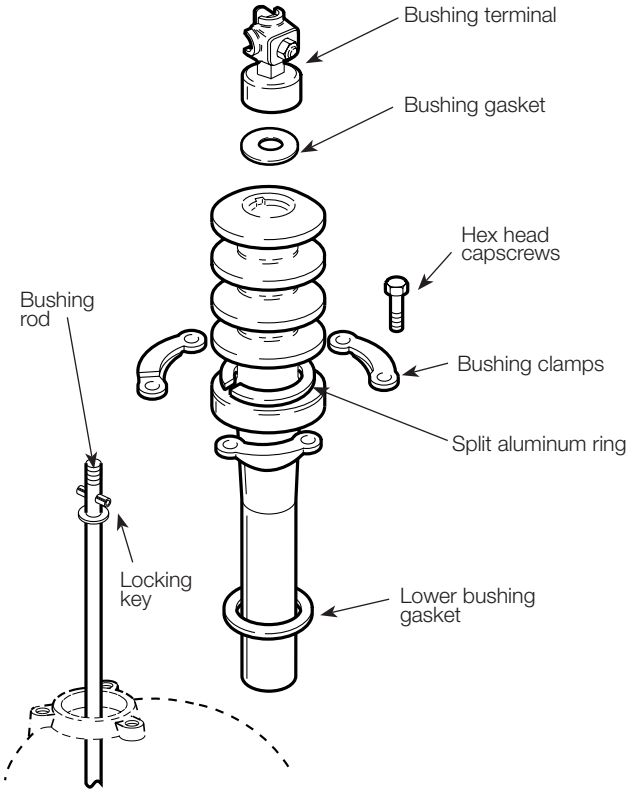

Figure 3. Bushing porcelain replacement

Vacuum Interrupter

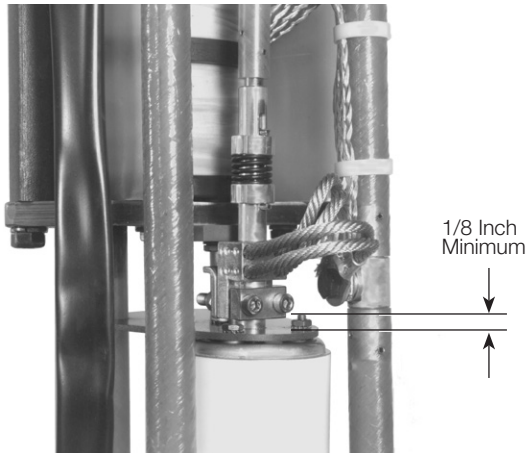

Figure 4. Measuring vacuum interrupter contact wear

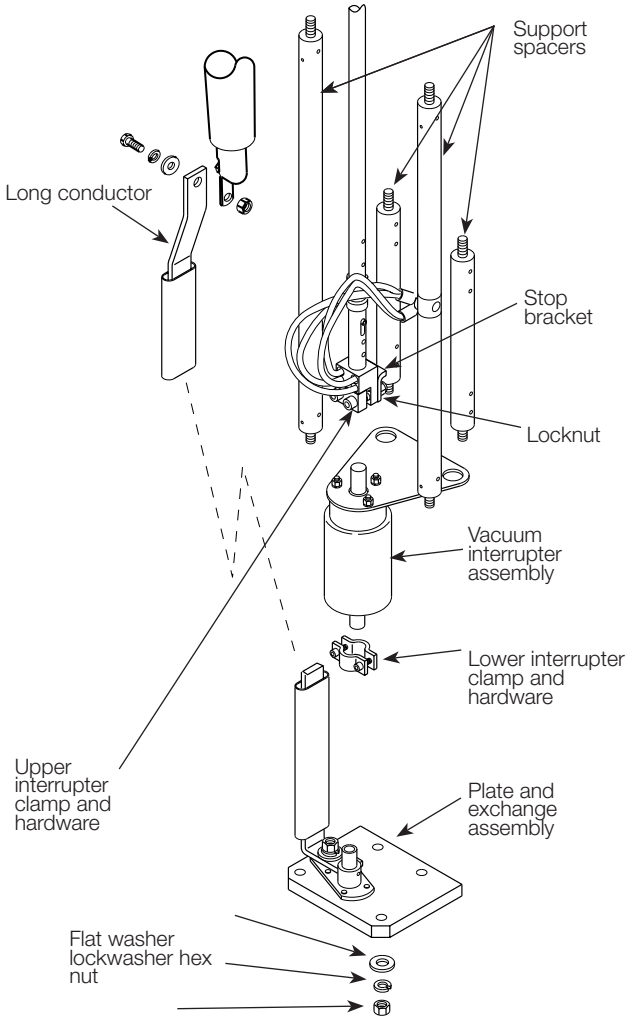

Figure 5. Interrupter replacement

The vacuum interrupter must be replaced when:

- It loses its vacuum, as evidenced by a failure during the low-frequency dielectric withstand test across the open contact; or.
- The interrupter contacts have eroded beyond their useful life, as evidenced by travel of the moving contact rod. See Figure 4.

To replace vacuum interrupter, refer to Figure 5 and proceed as follows:

1. Trip recloser open by pulling down the manual operation handle.
2. Untank recloser.
3. Remove hardware that secures long conductor, at bushing end.
4. Loosen upper interrupter clamp hardware. As the clamp is loosened, atmospheric pressure, acting on the bellows, will cause the moving contact rod to move into the interrupter.
5. Remove hardware that secures plate and exchange assembly to the four support spacers.
6. Loosen lower interrupter clamp and pull interrupter from plate and exchange assembly. It may be necessary to spread clamp fingers with a thin screwdriver to free interrupter.
7. Carefully push new interrupter (stationary contact rod) into lower clamp. Loosely install clamp hardware.

Note: Stationary contact rod must bottom on rollpin in plate and exchange assembly.

8. Place plate and exchange assembly, with interrupter, into position. Carefully align moving contact rod with upper clamp as assembly is being installed.
9. Install hardware to secure plate and exchange assembly to support spacers.

⚠ CAUTION

Equipment damage. Do not twist or apply radial pressure to the vacuum interrupter movable contact rod. Excessive twisting or pressure on the contact rod will damage the interrupter bellows, which can cause equipment failure. T211.0

10. Close recloser.

Note: Moving contact rod must bottom in upper interrupter clamp assembly.

11. Position lower clamp, so force will be applied to the center of each clamp finger, see Figure 6. Tighten upper and lower clamp hardware to 75 lbs-in (8.5 Nm).

12. Push contact stop bracket up as high as it will go. Hold upper interrupter clamp hardware, to prevent movement, while locknuts are tightened to secure contact stop bracket.

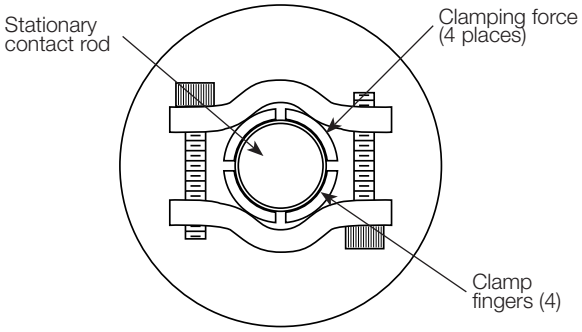

Figure 6. Positioning of lower interrupter clamp

13. Check contact rod assembly adjustment, refer to ADJUSTMENTS Section, following in this manual.
14. Reattach hardware to secure long conductor.
15. Retank recloser.
16. Test recloser. Manually operate recloser to verify proper operation. Perform an Insulation Level Withstand Test.

Series-trip coil

If the series-trip coil has been damaged or if the recloser is to be changed to a new rating, the series-trip coil must be replaced. Observe the following procedure for replacement, refer to Figure 7.

1. Trip recloser open by pulling down the manual operation handle.
2. Untank recloser.
3. Remove hardware that secures long conductor, at the bushing end.
4. Loosen upper vacuum interrupter clamp hardware, to free interrupter.
5. Remove hardware that secures plate and exchange assembly to the four support spacers. Carefully remove the interrupter, and the plate and exchange assembly.
6. Disconnect coil leads from support spacer and bushing.
7. Remove six hex nuts that secure solenoid bridge plate, remove bridge plate.
8. Remove lower gasket, coil, and upper gasket.
9. Install new series-trip coil, installing with new upper and lower gaskets.
10. Install solenoid bridge plate assembly, secure with hardware removed.
11. Place plate and exchange assembly, with interrupter, into position. Carefully align moving contact rod with upper clamp as assembly is being installed.

⚠ CAUTION

Equipment damage. Do not twist or apply radial pressure to the vacuum interrupter movable contact rod. Excessive twisting or pressure on the contact rod will damage the interrupter bellows, which can cause equipment failure. T211.0

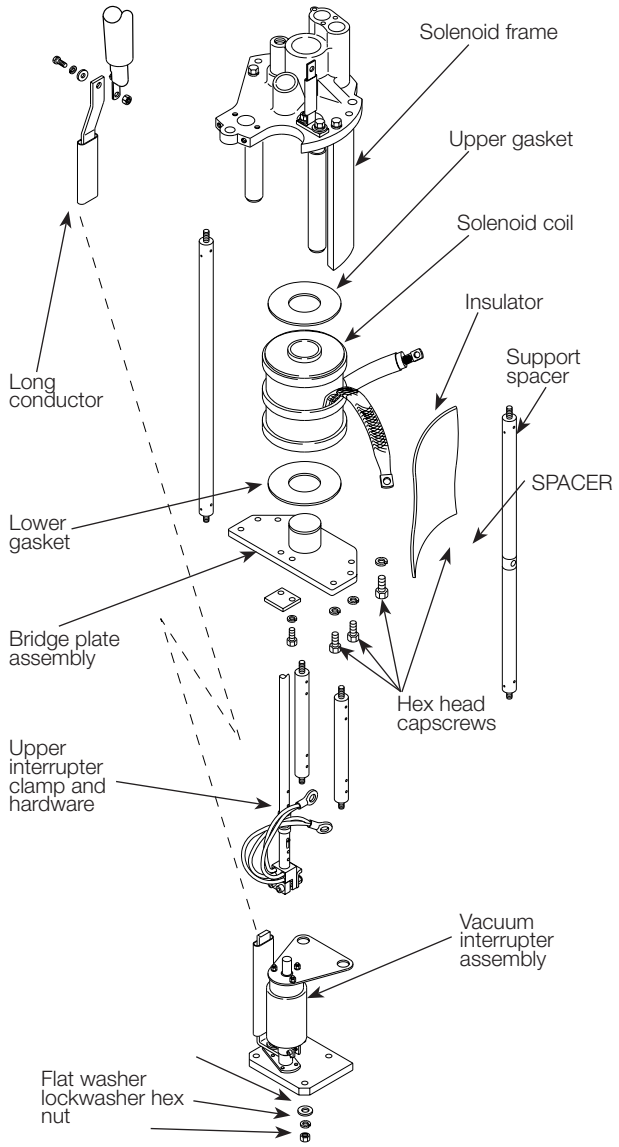

Figure 7. Series-trip solenoid replacement

12. Install hardware to secure plate and exchange assembly to support spacers.
13. Manually close recloser.

Note: Moving contact rod must bottom in upper interrupter clamp assembly.

14. Tighten interrupter clamp hardware to 75 lbs-in (8.5 Nm).
15. Push contact stop bracket up as high as it will go. Hold upper interrupter clamp hardware, to prevent movement, while locknuts are tightened to secure contact stop bracket.
16. Check contact rod assembly adjustment, refer to **Adjustments** section, following in this manual.
17. Connect coil lead, interrupter leads, and coil gap assembly lead at support spacer, secure leads to support spacer with wire ties. Connect upper coil lead at bushing.
18. Reattach hardware to secure long conductor at bushing.
19. Tank recloser.
20. Test recloser. Manually operate recloser to verify proper operation. Perform an Insulation Level Withstand and a Minimum Trip Current test to verify proper operation.

Solenoid frame and hydraulic mechanism

Disassembly

Normally, the components of the hydraulic timing and counting mechanism will require little or no maintenance. To disassemble the mechanism for cleaning, inspection, and possible parts replacement, proceed as follows:

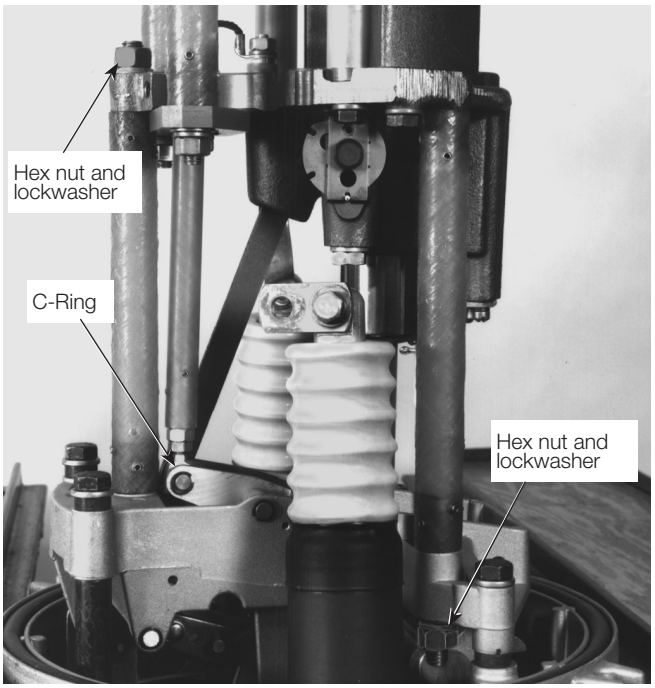

Figure 8. Removing solenoid frame from mechanism

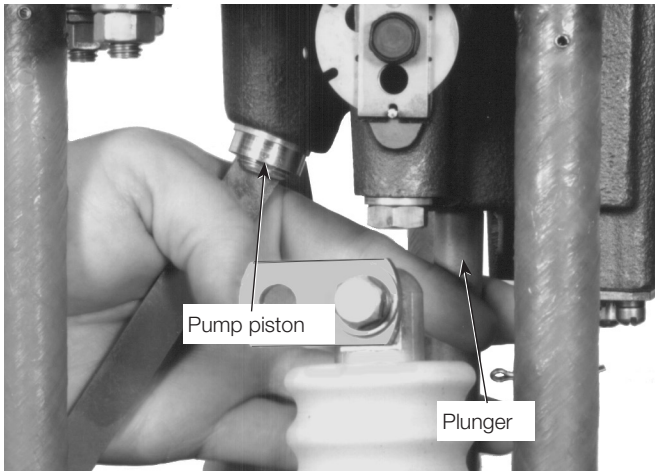

Figure 9. Solenoid frame removal

1. Remove interrupter and solenoid coil assemblies, refer to preceding instructions.
2. Remove three hex nuts and lockwashers which attach solenoid frame to support stringer and mechanism frame, see Figure 8. Remove C-ring that secures contact rod to operating linkage. Carefully remove solenoid frame assembly.

⚠ CAUTION

Equipment damage. Carefully support the plunger and pump piston when removing or installing the solenoid frame assembly. If either the plunger or the pump piston are nicked or damaged, the recloser can misoperate or fail to operate. T209.1

3. Remove slide valve and spring by removing three screws and lockwashers, attaching trip-piston stop and slide-valve stop and gasket to solenoid frame.
4. Remove timing plate and gasket from solenoid frame.
5. To remove trip piston assembly, see Figure 10:
   A. Using a wire hook, raise check-valve ball seat out of underside of casting to expose tension spring, which is part of trip-piston assembly.

⚠ CAUTION

Equipment damage. Do not over stretch the trip piston return spring when removing the piston assembly. Over stretching the spring can affect the sequence of operation and reset times. T210.0

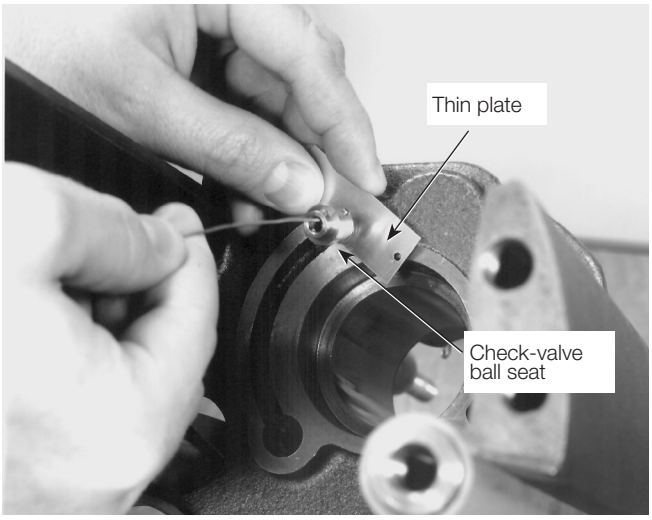

Figure 10. Trip piston removal

B. Insert a thin metal plate through spring to release tension on ball-seat pin.

C. Remove ball-seat pin to disengage spring and free ball seat.

Note: The steel ball inside the seat is free to drop out. Handle carefully to prevent nicking or scratching.

D. Remove plate from spring and remove trip piston assembly.

The disassembled hydraulic-mechanism components are shown in Parts List Section of this manual Figure 29.

Thoroughly clean all parts and carefully inspect for nicks, scratches,or other damage. Include pump piston and plunger in inspection. Replace parts as necessary.

Assembly

1. Reinstall control-valve assembly, timing plate and gasket. Make sure that the small notch in the timing-plate and the hole in the gasket are positioned over the indexing pin. Check that the plate is indexed to the proper timing curve (check data plate on sleet hood for proper timing curve).
2. Replace trip-piston assembly:

   A. Install trip piston into its cylinder.

Note: If operating sequence of recloser is to be changed, make changes to trip-piston assembly before installing. See Timing Mechanism Section, in this manual.

B. Using a wire hook, pull spring through bottom of trip piston cylinder and hold with a thin metal plate.

⚠ CAUTION

Equipment damage. Do not over stretch the trip piston return spring when removing the piston assembly. Over stretching the spring can affect the sequence of operation and reset times. T210.0

C. Reinstall O-ring gasket on ball seat, replace check-valve ball and pin the assembly to the spring, see Figure 11.

D. Remove plate and seat check valve in place.

3. Insert slide valve and slide-valve spring into its cylinder, secure with slide-valve stop and trip-piston stop assembly, use hardware removed.
4. Test the check valve in the base of the pump piston.

   A. Holding the piston upside down, fill it with clean transformer oil.

   B. If check valve does not hold, clean it thoroughly and repeat step A.

   C. If check valve still does not hold, replace the entire pump-piston assembly.

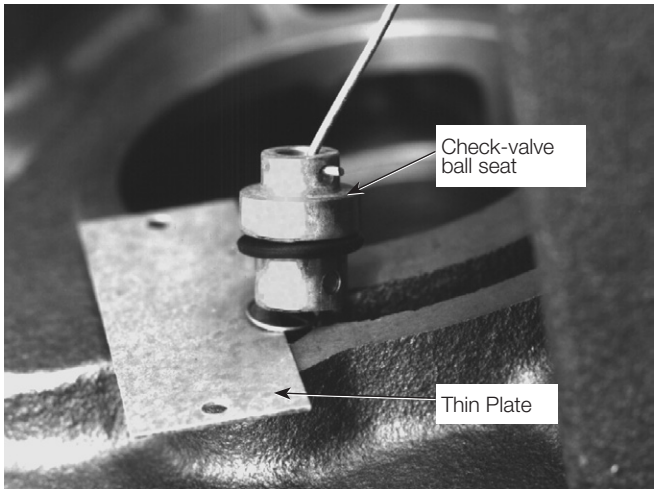

Figure 11. Check valve installation

5. To replace pump-piston assembly:
   A. Note position of pump-piston shell with respect to pump-link assembly.
   B. Unscrew shell far enough to expose piston pin.
   C. Push pin out and discard pump piston.
   D. Install new piston and adjust the pump-piston shell to its approximate original position.

Note: After re-assembling the recloser must be tested; refer to TESTING Section, preceding in this manual.

Head assembly

Disassembly

Disassembly of head mechanism should normally not be required. Should it become necessary, follow these steps:

1. Trip recloser open by pulling down the manual operating handle.

Note: Figure 12 shows head assembly as it will appear after vacuum interrupting structure, series-trip solenoid, hydraulic mechanism, and insulating stringers have been removed. Bushing removal is required for further head tear down.

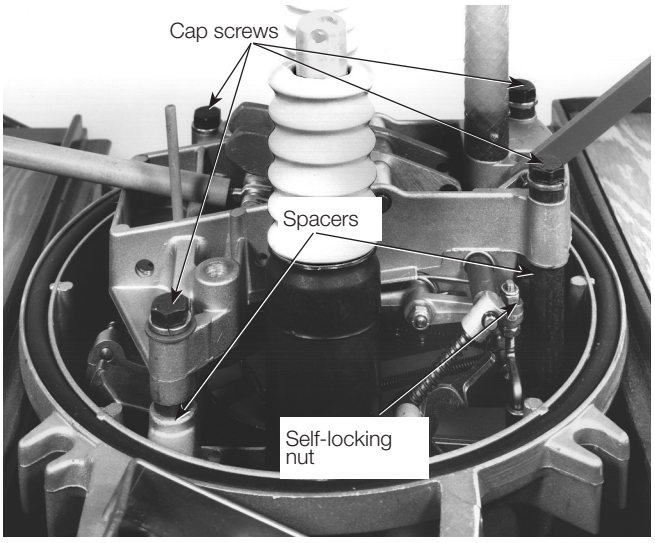

Figure 12. Head operating mechanism

2. Remove self-locking nut and four hex cap screws shown in Figure 12. Note locations of washers and spacers.
3. Lift operating mechanism assembly enough to expose pivot point, see Figure 13. Remove C-ring and pin to free operating mechanism.

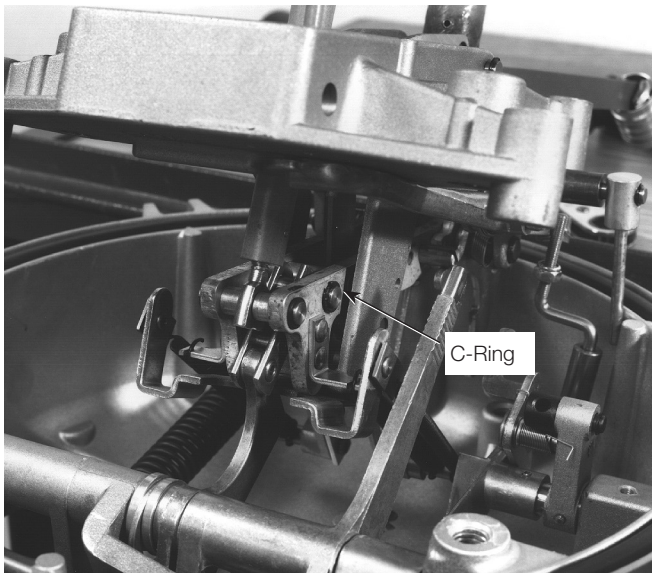

Figure 13. Removal of operating mechanism

4. Carefully unhook lockout spring, operating lever spring and counter spring, see Figure 14.

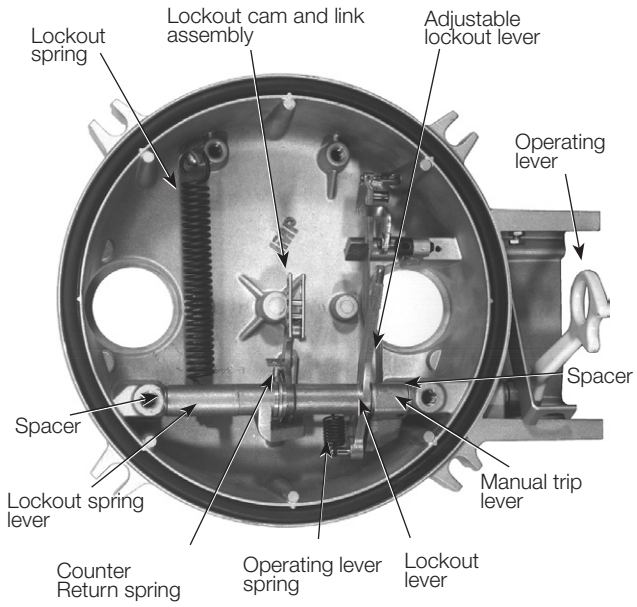

Figure 14. View of head mechanism

5. Remove sleet hood cover and counter.
6. Drive out rollpin that secures lockout lever, see Figure 15.

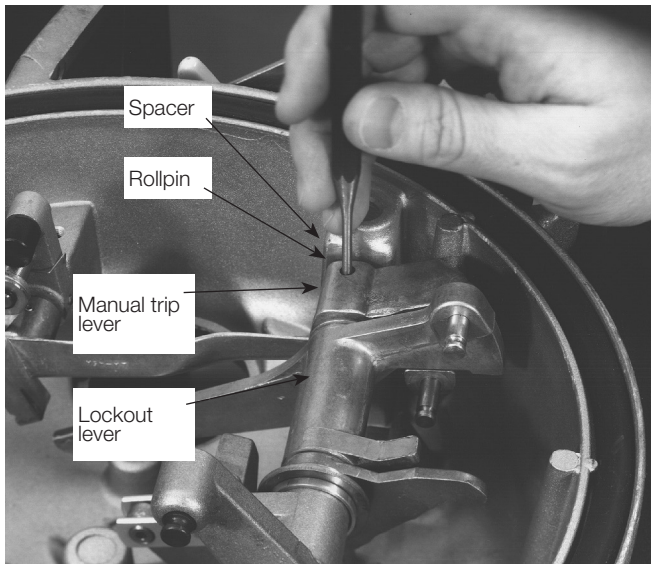

Figure 15. Removal of rollpin, lockout lever removal

7. Pull operating lever from assembly and lift out lockout spring lever, spring guide and spacers, lockout cam and link assembly, and lockout spring lever, see Figure 16.

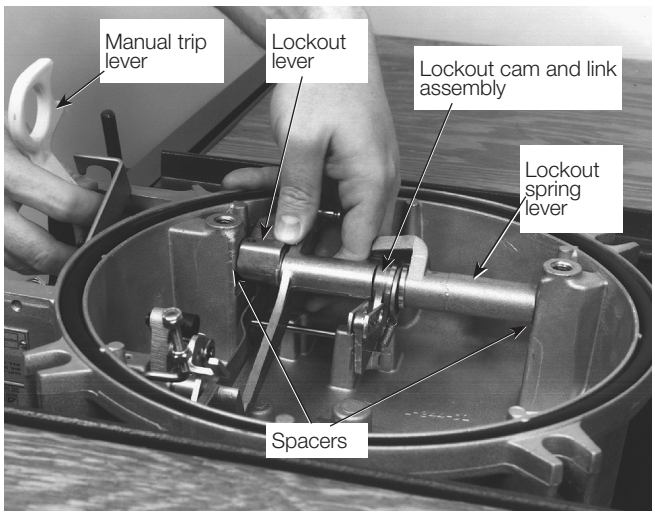

Figure 16. Head mechanism parts being removed

8. Drive out roll pin that secures counter lever assembly to counter shaft, see Figure 17. Remove shaft. Note location of flat washer that separates counter lever assembly and head casting post.

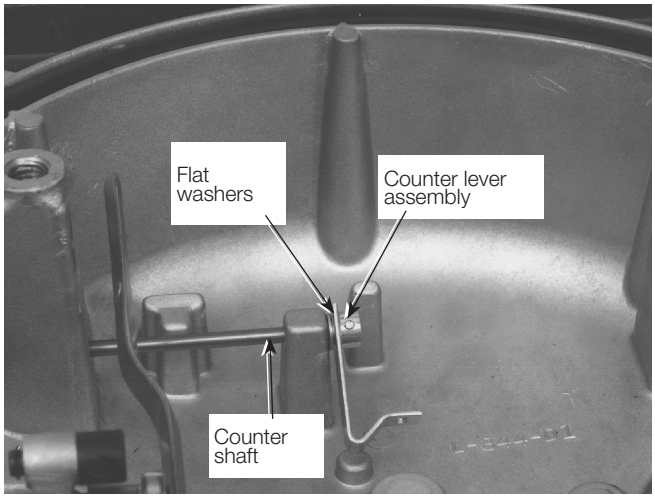

Figure 17. Driving out pins in counter shaft

9. Drive out rollpin and slip off adjustable lockout lever; drive out pin and slide off non-reclosing mechanism, see Figure 18.

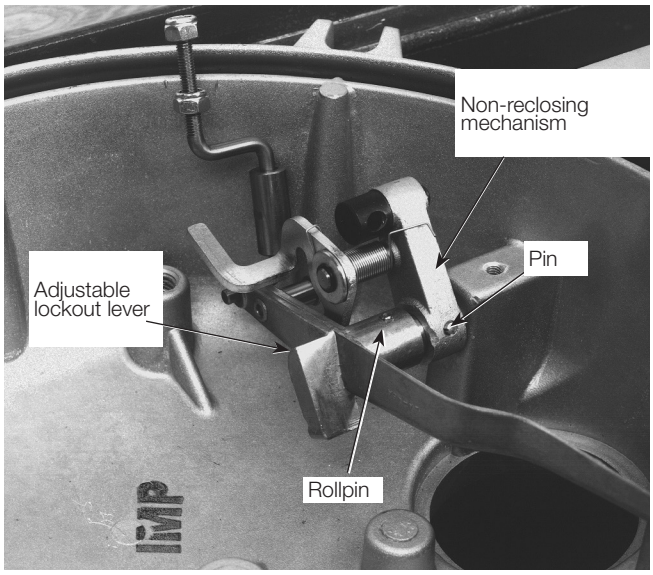

Figure 18. Lifting out adjustable lever

Assembly

Reassembly of the head mechanism assembly can, in general, be accomplished by reversing the disassembly procedure.

1. Install counter parts first, carefully secure with rollpin, see Figure 17.
2. Slide non-reclosing mechanism into position and secure with pin; slide adjustable lockout lever into position and secure with rollpin, see Figure 18.
3. Place lockout spring lever, spring guide and spacers, lockout cam and link assembly, and lockout spring lever onto their shaft. Note that the hollow shaft end must point toward the sleet hood. Position this assembly. Be sure to include flat washers at end of shaft, see Figure 19.

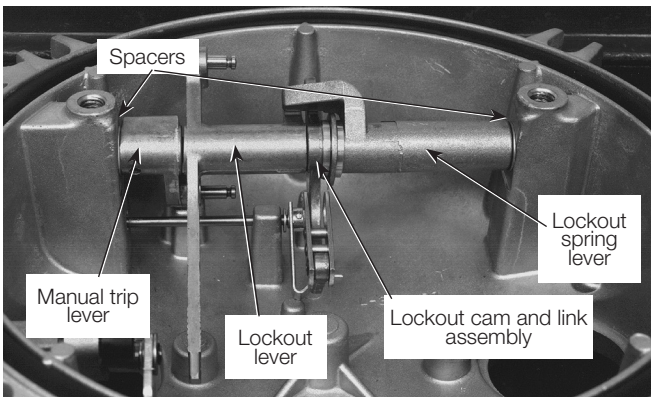

Figure 19. Reassembling head mechanism

4. Position manual trip lever and insert operating lever. Secure with rollpin, see Figure 15.
5. Place operating mechanism into position, install pin and secure with C-ring, see Figure 13.
6. Slide adjustable lockout lever into position through operating mechanism lever. Install spacers and capscrews to secure operating mechanism to head mechanism, see Figure 12.
7. Install self-locking nut onto adjustable lockout lever. Check lockout mechanism adjustment (adjustment is to made after entire mechanism, solenoid and interrupter have been reassembled:
   A. Manually close recloser and hold operating up with one hand.
   B. Grasp trip piston assembly and lift until recloser trips. Observe rollpin that secures trip piston to trip piston adjuster assembly. Note location of rollpin, relative to trip adjuster stop, as recloser trips to lockout:
      - If trip piston is in F-PRI position recloser should trip to lockout when rollpin is about even with bottom of trip adjuster stop.
      - If trip piston is in F-ALT position recloser should trip to lockout when rollpin is about even with top of trip adjuster stop.
   C. Adjust self-locking nuts (see Figure 20) as required to achieve correct tripping operation.

Note: Be sure to maintain free play between trip transfer lever and self-locking nuts. Ideally, loosen one nut one-half turn, to maintain proper free play, any time assembly becomes tight.

⚠ WARNING

Equipment mis-operation. The two self-locking nuts must not be adjusted tightly against trip transfer lever. If nuts are tight, movement of trip transfer lever will be prevented; as a result, recloser may fail to lockout. Failure to lock out can cause death, severe personal injury, and equipment damage. T237.1

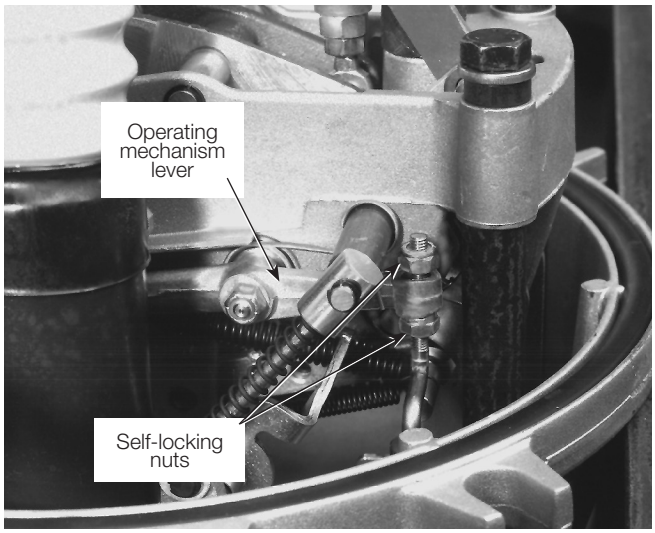

Figure 20. Adjusting lockout lever setting

Adjustments

Timing mechanism and operating sequence

Operating sequence and timing are governed by the hydraulic system, which utilizes insulating oil as the operating medium. Operating sequence and timing can be changed with the mechanism disassembled, during maintenance, or by untanking to gain access to the points of adjustment.

Timing

Provision is made for selecting a retarded B characteristic, a retarded C characteristic or an extra retarded D characteristic. Timing characteristics are selected by indexing the timing plate to the appropriate hole (see Figure 21).

Note: After making timing changes the mechanical operation must be checked to verify that the recloser is operating per specifications, and to assure that the sequence and timing are correct.

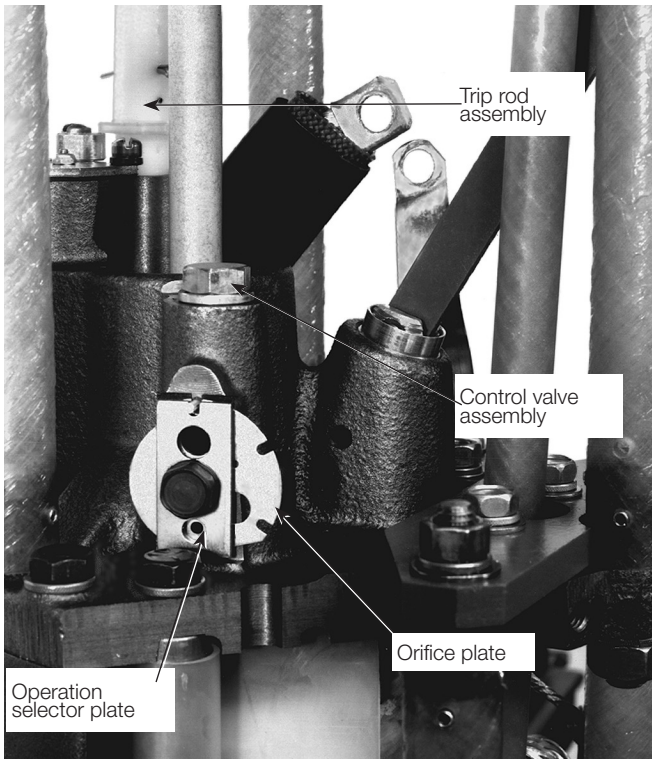

Figure 21. Indexing of timing plate

Operating sequence

Type V4E and V4L reclosers are designed so that they may be easily reconfigured for different operating sequences, or number of operations to lockout.

1. To change operating sequence the trip piston is repositioned to the desired number of fast trip operations, refer to Figure 22.

Note: There are two different trip pistons used in these reclosers; the KA23L1 piston provides either one or two fast operations (F-PRI two fast operations, F-ALT one fast operation), the KA23L3 piston provides either two or three fast operations (F-PRI three fast operations, F-ALT two fast operations).

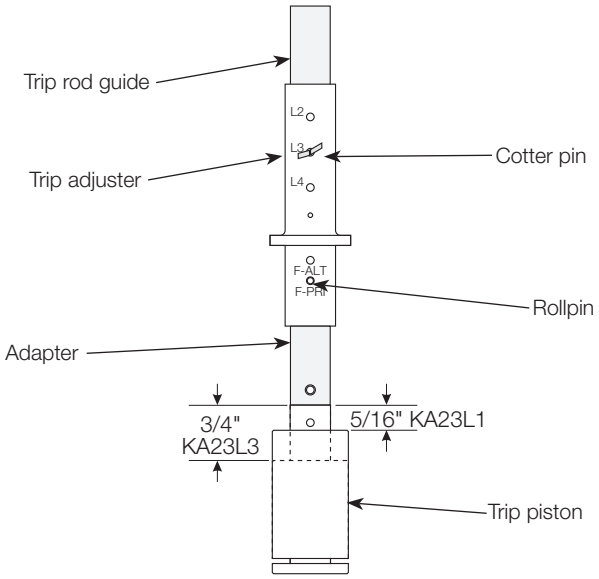

Figure 22. Adjustments for sequence and number of operations to lockout

A. Pull trip rod up until top of piston is exposed. Place a small fiber wedge between trip piston and valve stop plate, to hold trip piston extended.

B. Carefully drive rollpin through trip adjuster assembly. The trip adjuster should be backed by a solid metal object while the rollpin is being driven (in or out).

C. Reposition trip piston assembly for required operating sequence.

D. Secure trip piston with rollpin.

Note: Retarded timing characteristic for all four operations requires a special slide valve, which is equipped with a timing orifice.

2. The number of operations to lockout is selected by positioning trip rod to the appropriate hole in trip adjuster; secure assembly with cotter pin. Two, three or four operations to lockout can be selected.

Mechanical operation

After parts have been replaced, or after the operating sequence has been changed, it is necessary to verify and fine-tune the operation of the recloser. This fine-tuning procedure requires a suitable tester to apply the required test currents. The fine-tuning procedure begins with adjustment of the pump piston shell (to produce the proper number of fast operations), and concludes with adjustment of the trip linkage (to produce the proper number of operations to lockout).

Pump piston adjustment

If the recloser fails to perform the correct number of fast operations, it will be necessary to adjust the position of the pump piston shell, on the pump piston.

- Turning the pump piston shell off the piston, to increase the effective length of the piston, will cause the ports in the cylinder wall to be covered earlier during the downward stroke of the pump; as a result more oil will be pushed into the trip piston cylinder and the trip piston will raise more (reducing the number of fast operations).
- Turning the pump piston shell onto the pump piston, to decrease the effective length of the piston, will cause the ports to remain open longer during the downward stroke of the pump; as a result less oil will be pushed into trip piston cylinder and the trip piston will raise less (increasing the number of fast operations).

Adjustment of the pump piston shell is a trial-and-error procedure that must be done with a suitable tester. Refer to *Reference R280-90-2 Low Voltage A-C Testing of Hydraulic Reclosers* for additional information. The tester should be adjusted to provide a minimum of four-times the continuous current coil rating of the recloser being tested. Use the following test procedure to perform the piston shell adjustment:

Note: Prior to performing this adjustment procedure it will be necessary to drill out the stake punch that secures the pump piston shell to the pump piston, see Figure 23. As an initial starting guide: When the recloser is adjusted for a "B" timing curve approximately 1/4 of the pump cylinder ports should be covered by the piston shell, when set for a "C" curve approximately 1/2 of the ports should be covered, and when set for a "D" curve approximately 3/8 of the ports should be covered.

1. Move the yellow manual operating handle to the CLOSED position and wait at least three minutes for trip piston to fully reset.
2. Operate tester (per manufacturer's directions) to apply the required current through the recloser. Note the sequence and number of operations.

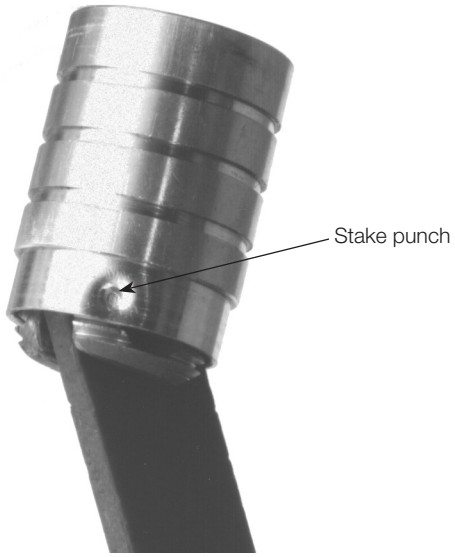

Figure 23. Drilling out stake punch in pump piston shell

Note: During fast operations recloser contact will open almost immediately after test current is applied. During delayed operations a noticeable delay will be observed before the recloser operates. When lockout occurs the yellow manual operation handle will drop down. The trip times recorded for <u>all</u> fast operations should be almost identical.

3. The number of fast and delayed operations should match the data plate specifications. If the sequence does not match, check to see if recloser is correctly configured. If configuration is correct, the problem may be either a mis-adjusted pump piston or an oil leak.

Note: If the recloser operates too many, of too few, times to lockout it will be necessary to adjust the trip linkage to achieve the correct number of operations to lockout. It may be necessary to readjust the piston shell and trip linkage several times to obtain proper sequence and time characteristics.

A. Inspect upper coil gasket and replace if damaged or worn. Repeat test.

B. If recloser is performing too many fast operations, turn piston shell counterclockwise a little (off the pump piston) see Figure 24. Repeat test.

C. If recloser is performing too few fast operations, turn piston shell clockwise a little (onto the pump piston) see Figure 24. Repeat test.

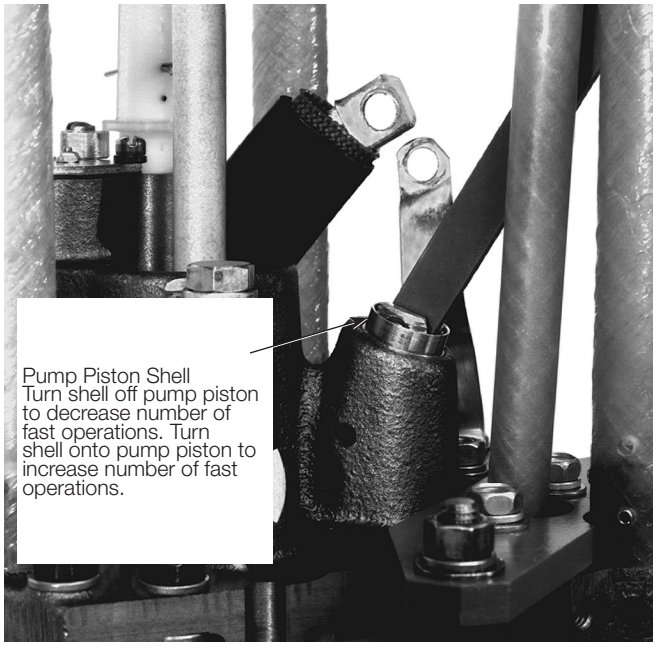

Figure 24. Pump piston shell adjustment

D. Continue to test and adjust the pump piston shell until the proper number of fast trip operations are being performed, then stake piston shell to prevent movement.

Note: If adjustment of the pump piston shell will not provide proper operation, the piston shell may be worn, replace shell and repeat test and adjustment procedure.

Trip linkage adjustment

After the pump piston has been adjusted to perform the correct number of fast operations, the trip linkage must be adjusted so the recloser will operate the correct number of times to lockout.

Adjustment of the trip linkage is a trial-and-error procedure that must be done with a suitable tester. The tester should be adjusted to provide a minimum of four-times the continuous current coil rating of the recloser being tested. Use the following test procedure to perform the trip linkage adjustment (refer to *Reference R280-90-2 Low Voltage AC Testing of Hydraulic Reclosers* for additional information):

1. Move the yellow manual operating handle to the CLOSED position and wait at least three minutes for trip piston to fully reset.
2. Operate tester (per manufacturer's directions) to apply the required current through the recloser. Note the number of operations to lockout.
3. The number of operations should match the data plate specifications. If the number of operations does not match, check to see if the recloser is correctly configured. If configuration is correct, adjust trip linkage.
   A. If recloser is performing too many operations, turn self-locking nuts off the trip linkage (counterclockwise) a little, see Figure 25. Repeat test.
   B. If recloser is performing too few operations, turn self-locking nuts onto the trip linkage (clockwise) a little (onto the pump piston) see Figure 25. Repeat test.

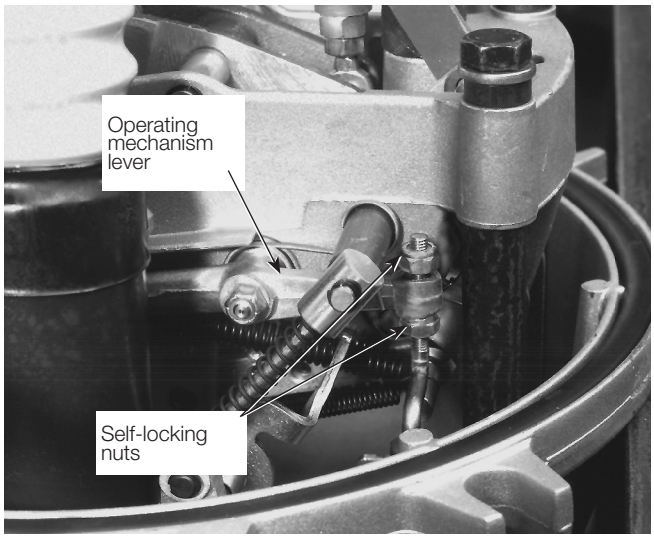

Figure 25. Trip linkage adjustment

Note: Be sure to maintain free play between the trip transfer lever and the two self-locking nuts. Ideally loosen one nut one-half turn, to maintain proper free play, any time the assembly becomes tight.

⚠ WARNING

Equipment misoperation. The two self-locking nuts must not be adjusted tightly against trip transfer lever. If nuts are tight, movement of trip transfer lever will be prevented; as a result, recloser may fail to lockout. Failure to lock out can cause death, severe personal injury, and equipment damage. T237.1

Contact rod assembly adjustments

With the contacts open, the contact rod should be at or within 1/32 inch of the overtravel stop. With the contacts closed, the length of the compressed compression spring should not exceed 19/32 inch. Adjust contact rod and stop bracket to achieve proper measurements, see Figure 26:

Overtravel stop adjustment

1. Remove leads from spacer assembly.
2. Loosen upper interrupter clamp to free moving contact rod.
3. Loosen jam nut that secures contact rod assembly. Rotate rod assembly to obtain proper measurement. Secure jam nut.
4. Close recloser.

Note: Moving contact rod must bottom in upper interrupter clamp assembly.

5. Tighten upper clamp hardware to 75 lbs-in (8.5 Nm).
6. Push contact stop bracket up as high as it will go. Hold upper interrupter clamp hardware, to prevent movement, while locknuts are tightened to secure contact stop bracket.
7. Secure leads to spacer assembly.

Compression spring adjustment: If the length of the compressed compression spring exceeds 19/32 inch, the contact rod assembly will have to be adjusted to provide more spring compression, and/or the contact stop bracket will have to be adjusted to obtain the proper dimension. The adjustment may require a trial and error compromise between the overtravel adjustment and compression spring adjustment. It may be necessary to adjust both the contact rod and overtravel stop bracket.

1. Remove leads from spacer assembly.
2. Loosen upper interrupter clamp to free moving contact rod.
3. Loosen jam nut that secures contact rod assembly. Rotate rod assembly to obtain proper spring compression, manually close recloser to check compression, open recloser to adjust rod assembly. When proper compression is obtained secure jam nut.
4. Close recloser.

Note: Moving contact rod must bottom in upper interrupter clamp assembly.

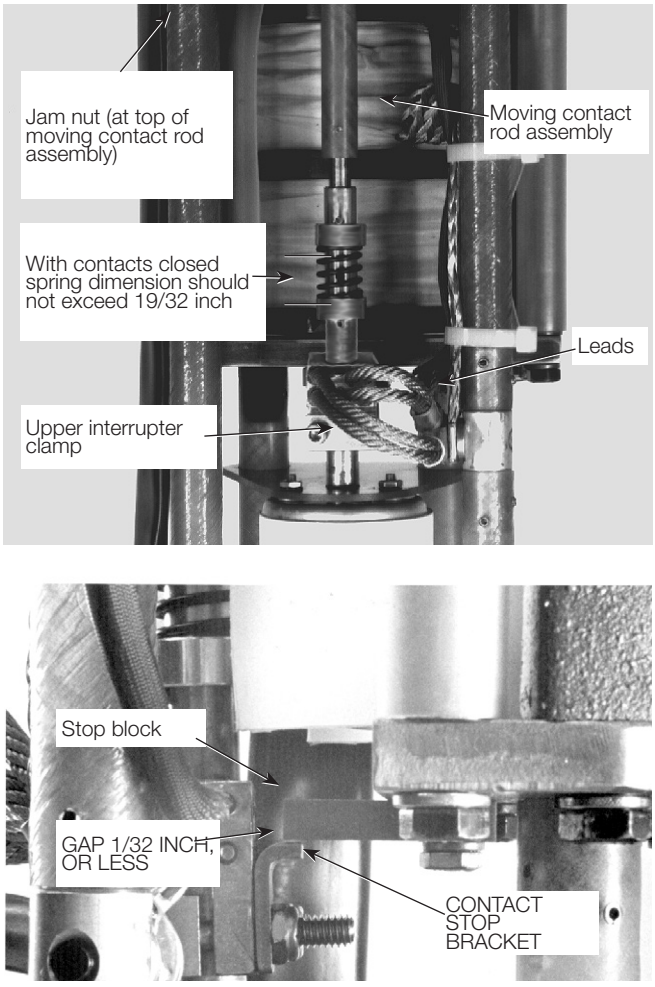

Figure 26. Overtravel stop adjustment

5. Tighten upper clamp hardware to 75 lbs-in (8.5 Nm).
6. Push contact stop bracket up as high as it will go. Hold upper interrupter clamp hardware, to prevent movement, while locknuts are tightened to secure contact stop bracket. Recheck overtravel adjustment.
7. Secure leads to spacer assembly.

Maintenance information

⚠ CAUTION

This equipment requires routine inspection and maintenance to ensure proper operation. If it is not maintained, it may fail to operate properly. Improper operation can cause equipment damage and possible personal injury. G105.1

⚠ CAUTION

This equipment relies on dielectric fluid to provide electrical insulation between components. The dielectric strength of the fluid must be checked on a regular basis, as part of the routine maintenance inspection, to ensure that it is at or above minimum dielectric requirements. Use of this equipment with dielectric fluid that does not meet minimum requirements can result in internal flashovers that will damage the equipment and can cause personal injury. G107.3

Instructional video programs

Two video maintenance training programs; KSPV1A General Maintenance and Inspection Procedures for Eaton's Cooper Power series Reclosers and KSPV2A, Mechanical Operation, Service and Testing for Eaton's Cooper Power series Single-Phase Reclosers; are also available as supplemental training aids for maintenance personnel. These video programs, developed for use in the factory training classes, are to be used in conjunction with existing service literature. For additional information, contact your Eaton representative.

Factory authorized service centers

Factory authorized service centers are located throughout the continental United States to provide maintenance, repair, and testing services for Eaton's Cooper Power series reclosers. For further information, contact your Eaton representative.

Factory maintenance classes

The factory Service Department offers recloser maintenance training classes. These classes, taught by experienced service technicians, are held at the factory's in-house training facility. These courses provide training and factory recommended procedures for the routine maintenance, troubleshooting, repair and testing of Eaton's Cooper Power series reclosers. It is recommended that all personnel who service and maintain our switchgear, attend the appropriate classes. For additional information, contact your Eaton representative.

Service parts lists

The service parts and hardware listed and illustrated include only those parts and assemblies usually furnished for repair or involved in the maintenance procedures described in this manual. Further breakdown of listed assemblies is not recommended.

Dimensions of all common hardware parts have been carefully checked so that they may be locally acquired. The suffix letter of the 14 character catalog number for common hardware parts codes the plating of the part:

A - No plating; raw material

H - Silver

M - Black oxide

Q - Cadmium + zinc + chromate

Y - Zinc + chromate

Z - Electro zinc + bronze irridite

A hardware kit, Catalog No. KA849R1, contains an assortment of roll pins, cotter pins, retaining rings, stop nuts, etc.—common hardware parts used in Eaton's Cooper Power series reclosers that may not be readily locally available.

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

Replacement parts kits for Eaton's Cooper Power series reclosers are available through the factory Service Department. Only factory-authorized parts are to be used. To order replacement parts, refer to Parts *Guide S260-01 through S280-01* for catalog numbers. Contact your Eaton representative for additional information and ordering procedures.

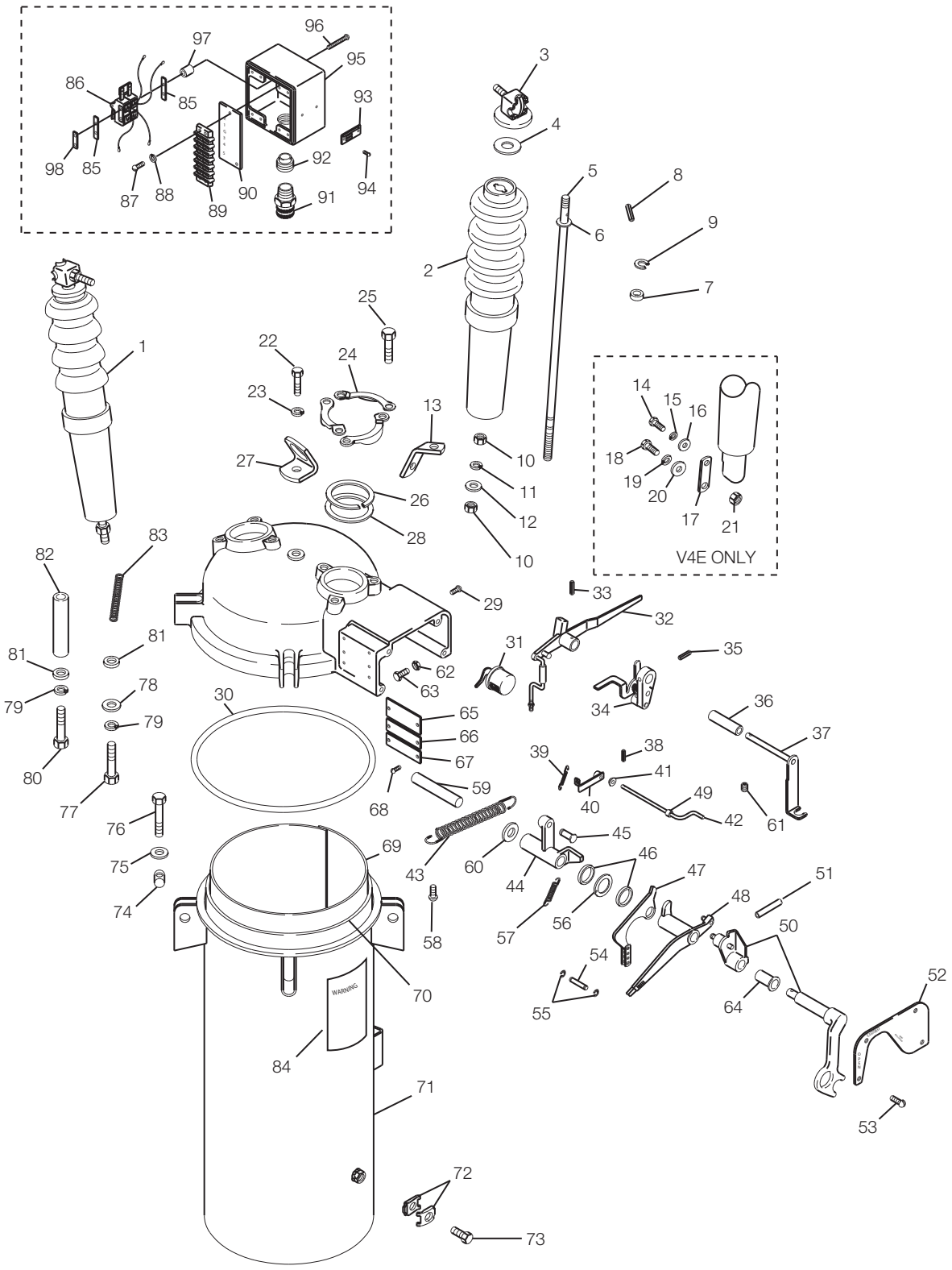

Figure 27. Head and tank

Head and tank (Figure 27)

Item no.	Description	Catalog number	Qty. per assy.
1	Bushing assy.		
	V4E	KA160E3	2
	V4L (includes items 2 thru 9)	KA160E24	2
	V4L 17" creepage (includes items 2 thru 9)	KA160E25	2
	V4L 125 kV BIL	KA147L	2
2	Bushing ceramic		
	Std creepage	KP1L	1
	17" creepage	KP320L	1
3	Terminal	KA143L900	1
4	Terminal gasket	KP2090A57	1
5	Bushing rod	KP158GN3-3	1
6	Washer	KP3013A6	1
7	Washer	KP2090A102	1
8	Roll pin	K970801125075C	1
9	C-ring	K970901500000M	3
10	Hex nut, 1/2-13 UNC-2B	K880225113050H	4
11	Lockwasher, 1/2	K900830050000A	2
12	Washer, flat, 1/2	KP2028A3	2
13	Terminal adapter-V4L only	KP1021V4L	2
14	Screw, hex hd, 5/16-18 UNC-2A x 1	K730133131100A	2
15	Lockwasher, 5/16	K900830031000A	2
16	Washer, plain	K900525033075A	2
17	Terminal adapter	KP1011V4E	1
18	Screw, hex hd, 3/8-16 UNC-2A x 1	K730133137100A	1
19	Lockwasher, 3/8	K900830037000A	1
20	Washer, flat, 3/8	K900525039087H	1
21	Hex nut, 3/8-16 UNC-2B	K880233116037A	1
22	Screw, hex hd, 1/2-13-13 UNC-2A x 1	K730115150100A	1
23	Lockwasher, 1/2	K900815050000A	2
24	Bushing clamp	KP117H6	6
25	Screw, hex hd, 3/8-16 UNC-2A x 2	K730115137200A	6
26	Bushing clamp gasket	KP121L	2
27	Lifting lug	KP473H1	1
28	Lower bushing gasket	KP2090A29	2
29	Screw, rd hd, #6-32 UNC-2A x 5/8	K751515106062A	2
30	Gasket	KP2103A4	1
31	Counter assy.	KA28CO14S	1
32	Trip lever assy.	KA137E4-2	1
33	Roll pin	K970801125075C	1
34	Cam & lever assy.	KA135E4	1
35	Groove pin	KP2001A13	1
36	Sleeve	KP243L2	1
37	One shot lever assy.	KA71L	1
38	Groove pin	KP2001A2	1
39	Counter spring	KP385L	1
40	Counter lever assy.	KA118L	1
41	Bushing	KP3106A12	1
42	Counter shaft	KP258L	1
43	Lockout spring	KP1062E4	1
44	Lockout spring lever	KP14L	1
45	Lockout spring anchor pin	KP73L	1
46	Spacer	KP3017A60	2
47	Lockout cam & link assy.	KA125E4	1
48	Lockout lever assy.	KA17L	1

Item no.	Description	Catalog number	Qty. per assy.
49	Spacer	KP3006A7	1
50	Handle & trip lever assy. (includes item 51)	KA92L	1
51	Spiral Pin	KP2027A15	1
52	Sleet hood	KP292L	1
53	Screw, shake proof, type 23, #12-24 x 1/2	K781515112050A	4
54	Groove pin	KP3125A4	1
55	Retaining ring	K970901312000M	2
56	Spring guide	KP386L	1
57	Operating handle spring	KP27H	1
58	Screw, rd hd, 1/4-20 UNC-2 x 5/8	K721501125062Z	1
59	Operating shaft	KP77L	1
60	Washer, flat	K900101051087K	AR
61	Screw, set	KP2023A6	1
62	Palnut, 1/4-20 UNC-2B	K881101120025Z	2
63	Screw, rd hd, 1/4-20 UNC-2A x 3/4	K730115125075A	1
64	Bushing	KP269L	1
65	Name plate		
	V4L	KP1030V4L	1
	V4E	KP1012V4E	1
66	Coil data plate	KP2119A19	1
67	Operating data plate	KP1371R	1
68	Screw, rd hd, type F #2-56 NC-2A x 3/16	K751515102018A	6
69	Liner assy.	KA141E4	1
70	Tank wall insulation	KP1082E4	1
71	Tank assy.	KA145L3	1
72	Ground clamp assy.	KP227H900	1
73	Screw, hex hd, 1/2-13 UNC-2A x 1	K730115150100A	1
74	Combination nut & pin	KP307L	4
75	Washer	KP2028A19	4
76	Screw, hex hd, 1/2-13 UNC-2A x 3-1/4	K730115150325A	4
77	Screw, hex hd, 7/16-14 NC-2A x 2-1/4	K730101143225A	2
78	Washer, flat, 7/16	K900201043000A	2
79	Lockwasher, 7/16	K900801043000Z	4
80	Screw, hex hd, 7/16-14 UNC-2A x 6	K730101143600A	2
81	Spacer	KP3012A11	4
82	Spacer	KP3021A12	2
83	Compression spring	K246L	1
84	Label	KP1001SI	1
85	Barrier	KP155E	2
86	Switch assy.	KA169E	1
87	Screw, rd hd, #6-32 UNC-2A x 1/2	K721525106050A	2
88	Lockwasher, #6	K900830006000A	2
89	Terminal strip	KP2101A7	1
90	Marker strip	KP239E	1
91	Sealing grip	KP2014A1	1
92	Reducer	KP2043A4	1
93	Rating plate	KP172GR2	1
94	Screw, rd hd, #2 x 3/16	K751515102018A	2
95	Switch housing assy.	KA118E	1
96	Screw, rd hd, #6-32 UNC-2A x 2-1/4	K721501106225Z	2
97	Spacer	KP3007A32	2
98	Plate	KP149E	1

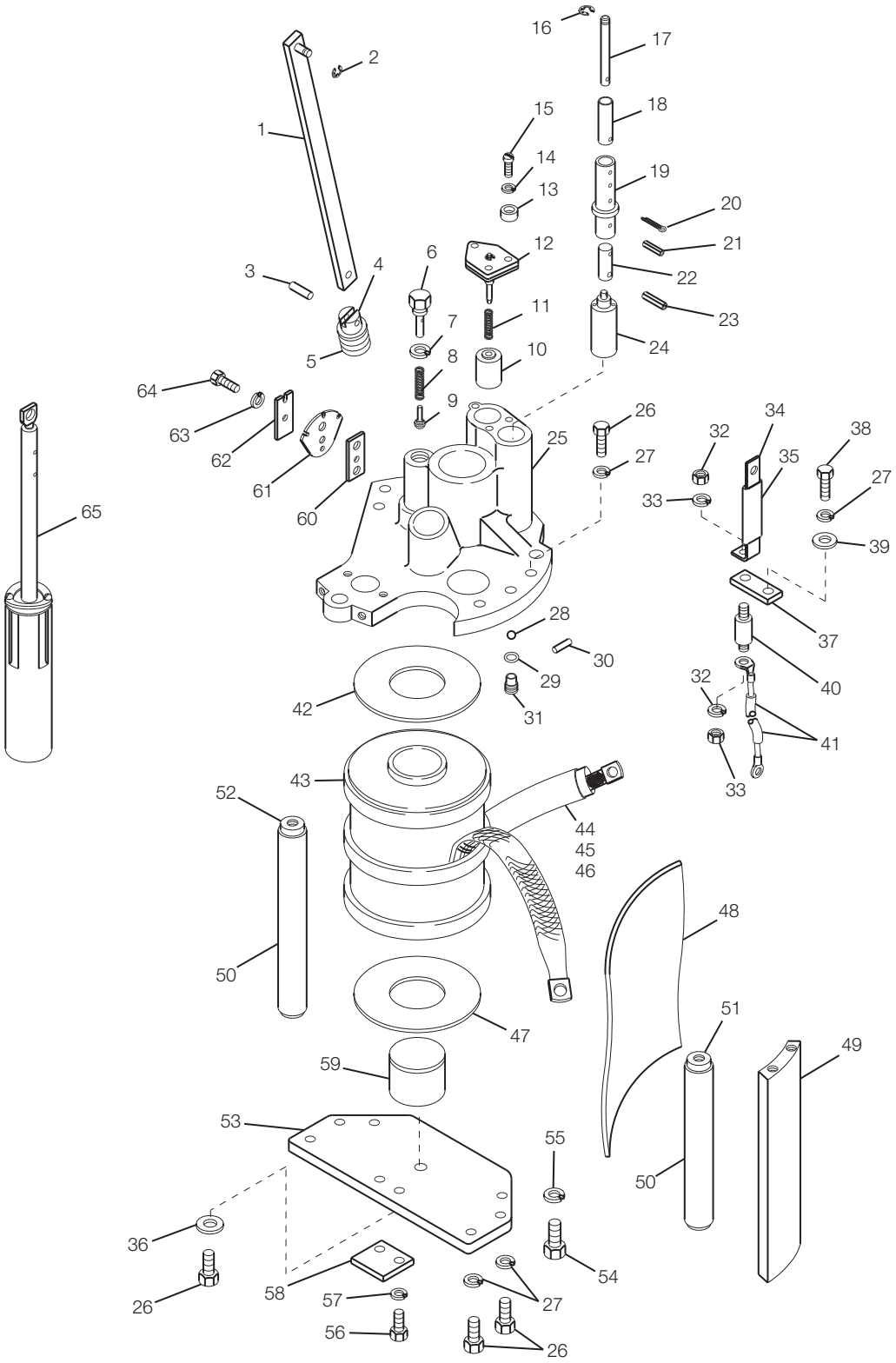

Figure 28. Solenoid frame assembly

Solenoid frame assembly (Figure 28)

Item no.	Description	Catalog number	Qty. per assy.
1	Pump piston link assy.	KA176L	1
2	Spring clip	KP2018A2	1
3	Pin	KP3055A1	1
4	Pump piston assy.	KA25H	1
5	Pump piston shell	KP151H	1
6	Control valve stop assy.	KA178L	1
7	Spacer	KP3013A6	1
8	Control valve spring	KP113L	1
	E-curve applications	KP194L	1
9	Control valve	KP193L	1
10	Slide valve	KP104L	1
11	Slide valve spring	KP213L	1
12	Slide valve assy.	KA64L	1
13	Trip adjuster stop	KP391L	1
14	Collar washer	KP2030A1	3
15	Screw	KP376L	3
16	Retaining ring	K971001187000A	1
17	Trip rod	KP387L	1
18	Trip rod guide	KP388L	1
19	Trip adjuster	KP389L	1
20	Cotter pin	K970525093100A	1
21	Roll pin	K970815062062A	1
22	Adapter	K390L	1
23	Roll pin	K970815093050A	1
24	Trip piston assy.		
	1 or 2 fast operations	KA23L1	1
	2 or 3 fast operations	KA23L3	1
25	Solenoid frame assy.		
26	Screw, hex hd cap, 3/8- 16 UNC-2A x 1-1/4	K730101137125A	8
27	Lockwasher, 3/8	K900801037000A	8
	Ball, seat & pin assy. kit (items 28 thru 31)	KA710H1	
28	Ball	KP2025A2	1
29	O-ring	KP2000A3	1
30	Pin	KP3051A3	1
31	Ball seat	KP155H2	1
32	Hex nut, 5/16-18 UNC-2B	K880201118031Y	2
33	Lockwasher, 5/16	K900801031000Z	2

Item no.	Description	Catalog number	Qty. per assy.
34	Lead	KP3251A4	1
35	Insulating tubing	KP2106A75	1
36	Gasket	KP2011A7	1
37	Coil gap support	KP1022V4L	1
38	Screw, hex hd cap, 3/8-16 UNC-2A x 1-1/2	K730101137150A	1
39	Washer, flat, 3/8	K900201037000A	1
40	Coil gap assy.	KA116GS	1
41	Lead assy.	KA113V4L	1
42	Coil gasket, upper	KP2090A6	1
43	Solenoid coil assy.		
	(15, 25, 35, 50, 70, 100, 140, 170, 200, 280 amp)	KA700V4L___	1
44	Extruded P.V.C. 7/8 ID	KP2106A51	1
45	Extruded P.V.C. 1" ID	KP2106A52	1
46	Glass sleeving	KP2104A23	1
47	Coil gasket, lower	KP2090A28	1
48	Insulating shield	KP1013E4	2
49	Solenoid frame shoe	KP1057E4-2	2
50	Insulating tubing	KP3230A30	2
51	Solenoid support, short	KP1056 E4	1
52	Solenoid support, long	KP1017V4L	1
53	Bridge plate	KP1003V4L	1
54	Screw, hex hd cap, 7/16-14 UNC-2A x 1-1/4	K730101143125A	2
55	Lockwasher, 7/16	K900801043000A	2
56	Screw, hex hd cap, 1/4-20 UNC-2A x 3/4	K730101125075A	2
57	Lockwasher, 1/4	K900801025000A	2
58	Stop block	KP1029V4L	1
59	Plunger stop assy.	KA122E4	1
60	Control valve gasket	KP222L	1
61	Control valve plate	KP123L	1
	E-curve applications	KP226L	1
62	Clamping plate	KP223L	1
63	Lockwasher, 1/2	K900801050000A	1
64	Screw, hex hd cap, 5/16-18 UNC-2A x 1/2	K830101131050A	1
65	Solenoid plunger assy.	KA121E4	1

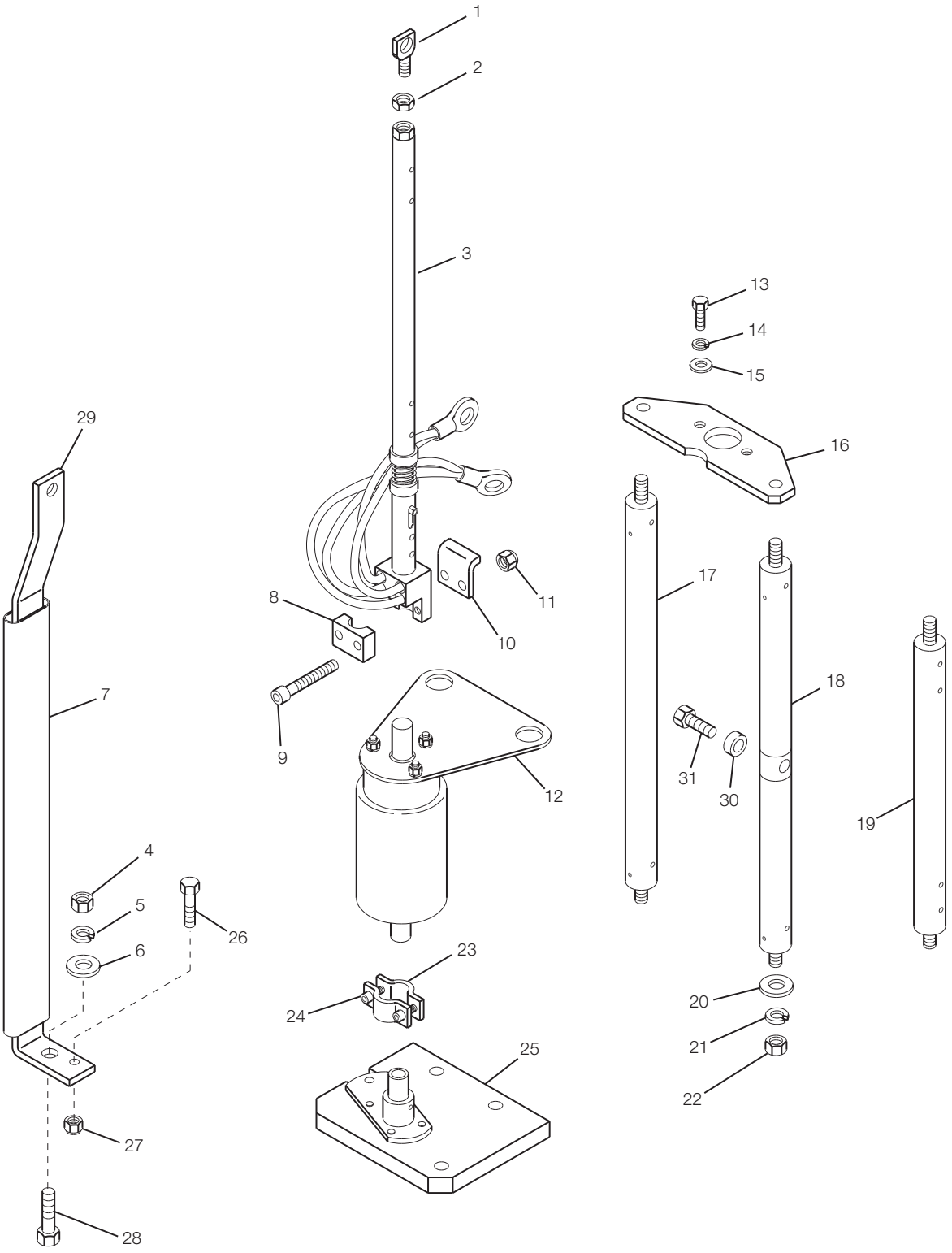

Figure 29. Interrupter assembly

Interrupter assembly (Figure 29)

Item no.	Description	Catalog number	Qty. per assy.
	Contact rod and spring assy. (includes items 1 thru 7)	KA109V4L	1
1	Rod extension	KP102L	1
2	Hex nut, 1/4-20 UNC-2	K880202120025A	1
3	Contact rod assy.	KA108V4L	1
4	Hex nut, 3/8-16 UNC-2B	K880225116037A	1
5	Lockwasher, 3/8	K900830037000A	1
6	Washer, flat, 3/8	K900525039087A	1
7	Extruded P.V.C. tubing	KP2106A62	1
8	Clamp	KRK1141F2	1
9	Screw, socket hd, 1/4-20 UNC-2A x 1-1/2	KP2036A35	2
10	Stop bracket	KP1034V4L	1
11	Elastic stop nut	KP2020A16	2
12	Vacuum interrupter assy.	KA119V4L	1
13	Screw, hex hd cap, 5/16-18 UNC-2A x 1	K730101131100A	2
14	Lockwasher, 5/16	K900801031000A	2
15	Washer, flat, 5/16	K900201031000A	2
16	Support plate	KP1008V4L	1
17	Spacer assy., long	KA116V4L	1
18	Spacer assy., long	KA122V4L	1
19	Spacer assy., short	KA115V4L	2
20	Washer, flat, 3/8	K900201037000A	6
21	Lockwasher, 3/8	K900801037000A	6
22	Hex nut, 3/8-16 UNC-2B	K880201116037A	6
23	Clamp	KP1036VS	2
24	Screw, socket hd, 1/4-20 UNC-2A x 5/8	KP2036A5	2
25	Plate & exchange assy.	KA111V4L	1
26	Screw, hex hd cap, #10-24 UNC - 2A x 1	K722401110100A	1
27	Elastic stop nut, #10-24 UNC - 2B	KP2020A13	
28	Screw, hex hd cap, 3/8-16 UNC - 2A x 7/8	K730125137087A	1
29	Conductor	KP1014V4L	1
30	Spacer	KP3013A38	1
31	Screw, hex hd cap, 3/8-16 UNC-2A x 1-1/4	K730101137125A	1

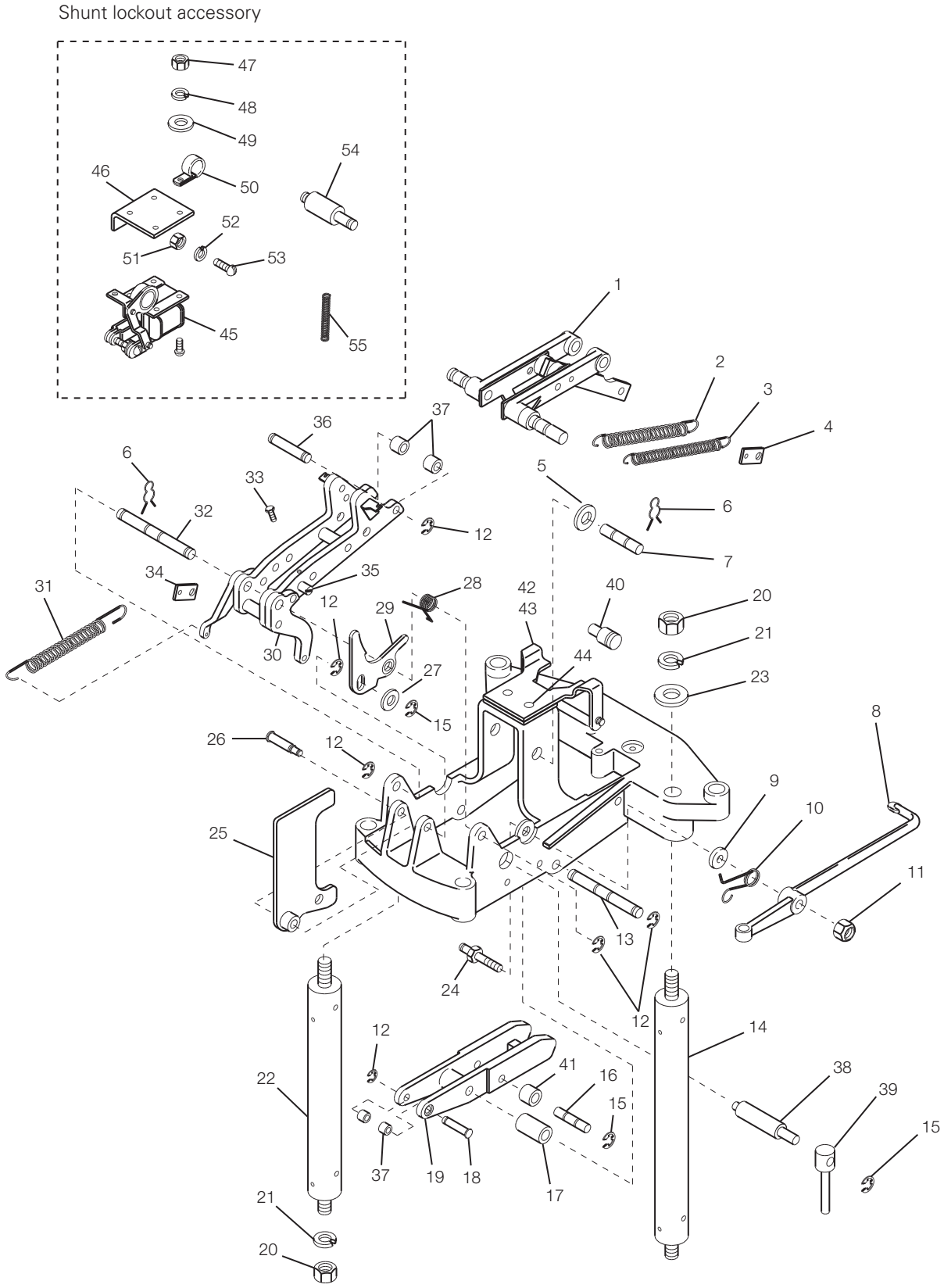

Figure 30. Operating mechanism

Operating mechanism (Figure 30)

Item no.	Description	Catalog number	Qty. per assy.
1	Straight line motion lever assy.	KA105V4L	1
2	Auxiliary closing spring	KP97L	2
3	Closing spring	KP1107E4	2
4	Spring anchor	KP1108E4	2
5	Washer, light, 5/16	K900101032056Z	AR
6	Spring clip	KP2018A1	4
7	Pivot pin	KP80L	1
8	Trip transfer lever	KP43L	1
9	Spacer	KP1023E4	1
10	Trip lever spring	KP242L	1
11	Elastic stop nut	KP2020A1	1
12	Retaining ring, 5/16	K970901312000M	7
13	Groove pin	KP3125A16	1
14	Stringer assy.	KA111E4	2
15	Retaining ring, 1/4	K970901250000M	4
16	Groove pin	KP3124A79	1
17	Spacer	KP3009A210	2
18	Groove shoulder pin	KP3129A9	1
19	Contact knockout lever	KP1010V4L2	1
20	Hex nut, 7/16-14 UNC-2B	K880201114043A	3
21	Lockwasher, 7/16	K900801043000A	3
22	Stringer assy.	KA10L	1
23	Washer, flat, 7/16	K900201043000A	2
24	Pivot Pin	KP1020E4	1
25	Plate and bushing assy.	KA107V4L	1
26	Shaft	KP1027V4L	1
27	Washer	K900525026056A	1
28	Torsion spring	KP1028V4L	1
29	Latch & bushing assy.	KA114V4L	1
30	Plunger lever assy.	KA1294E	1

Item no.	Description	Catalog number	Qty. per assy.
31	Counterbalance spring	KP98L	1
32	Shaft	KP84L	1
33	Screw, hex hd, #6-32 UNC-2A	K722415106031A	1
34	Spring anchor	KP1035V4L	1
35	Cam	KP1064E4	1
36	Groove pin	KP3125A4	1
37	Spacer	KP3007A162	4
38	Shoulder pin	KP248L	1
39	Spring guide	KP1072E4	1
40	Anchor pin	KP75L	1
41	Spacer	KP3009A133	2
42	Closing spring anchor assy.	KA119E4	1
43	Gasket	KP174L	1
44	Rivet	K930801018040C	2
45	Solenoid assy	KA192E	1
46	Bracket	KP322E	1
47	Hex nut, #6-32 UNC-2B	K881015132006A	4
48	Lockwasher, #6	K900815006000A	4
49	Washer, flat, #6	K900215006000A	4
50	Wire clip	KP2006A8	1
51	Hex nut, #10-24 UNC-2B	K881015124010A	1
52	Lockwasher, #10	K900815010000A	2
53	Screw, rd hd #10-24 UNC-2A x 1/2	K721515110050A	2
54	Shoulder pin	KP329E	1
55	Trip lever spring	KP333E	1

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