

Type E — Maintenance instructions  
Applicable to serial numbers 52000 and above.

This bulletin is also applicable to product serial numbers beginning with the prefix CP57.



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## Safety for life



Eaton meets or exceeds all applicable industry standards relating to product safety in its Cooper Power™ series products. 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 *MN280058EN* covers the maintenance instructions for the Type E hydraulically controlled, single-phase, oil interrupting recloser. The manual includes a general description of the recloser and its operating principles and instructions for periodic inspection, testing, and shop repairs. 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 can they provide directions for meeting every possible contingency during installation, operation, or maintenance. For additional information, contact your Eaton representative.

#### Acceptance and initial inspection

This product is completely assembled, tested, and inspected at the factory. It is carefully calibrated, adjusted and in good condition when accepted by the carrier for shipment.

Upon receipt, inspect the carton for signs of damage. Unpack the control 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 storing the recloser for any length of time

#### Description

A Type E hydraulically controlled, oil-interrupting recloser (Figure 1) is a self-contained device that senses and interrupts fault currents on a single phase of a distribution line. The recloser automatically recloses and, if the fault is temporary, restores service. If the fault is permanent, the recloser locks open after one, two, three or four operations, depending upon its setting. Automatic resetting of this device enables it to distinguish between permanent and temporary faults. Thus, if a fault is temporary, the recloser resets and is then ready for a complete sequence should another fault occur.

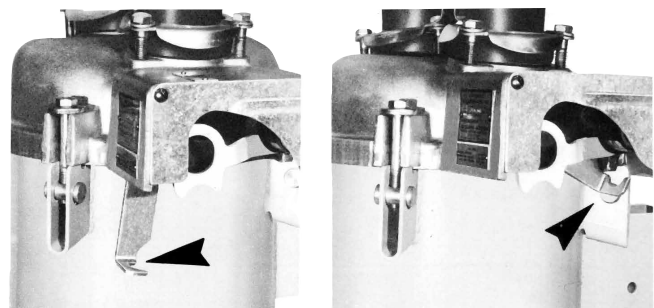
Operating sequences of the recloser can be all fast, all delayed, or a combination of fast followed by delayed operations. Furthermore, any one of three delay curves can be used to assure coordination with other reclosers or protective devices. On coordinated systems, fast recloser operations are used to clear temporary fault currents before branch-line fuses are damaged. Subsequent delayed

openings allow time for fault currents to be cleared by branch-line fuses. Outages caused by permanent faults are thereby confined to shorter sections of line.

Tripping is initiated by a series-connected coil. Current-carrying and interrupting capacities vary with the operating coil's rating, which is selected to meet circuit requirements. A non-reclosing feature (Figure 2), standard on all Eaton's Cooper Power series reclosers, is set with a hookstick-operated lever for one operation to lockout without removing the recloser from service.



**Figure 1. Type E single-phase, hydraulically controlled oil circuit recloser**



**Figure 2. The non-reclosing feature is set with a handle under the sleet hood (see arrow). When the handle is down (left), the recloser will trip on overcurrent and lock out without re-closing. When the handle is up (right), the recloser will operate according to its internally set program**

## Specifications and ratings

**Table 1. Specifications**

Nominal operating voltage (rms kV)	24.9
Maximum design voltage (rms kV)	27
Impulse withstand (BIL), 1.2 X 50 $\mu$ sec wave (crest kV)	150
60-Hz withstanding (rms kV) Dry, one minute	60
Wet, ten seconds	50
Reclosing time (see)	2
Bushing creepage distance (in.)	13-5/8

**Table 2. Interrupting ratings**

Trip-Coil continuous current (amps)	Minimum-Trip current (amps)	Interrupting current (rms sym amps)
5	10	300
10	20	600
15	30	900
25	50	1500
35	70	2100
50	100	2500
70	140	2500
100	200	2500

**Table 3. Duty cycles**

% Interrupting rating	Maximum circuit X/R Ratio	Number unit operations	Total unit operations
15-20	3	32	
45-55	5	24	68
90-100	12	12	

## General maintenance information

Type E reclosers are usually applied to increase service continuity, reduce operating costs, and increase revenue. The E's high load and interrupting ratings make it suitable for use in important substations. The Type E can perform at peak efficiency and provide reliable circuit protection if adequate maintenance is performed. Maintenance is relatively easy and inexpensive when compared with the savings achieved by the use of reclosers.

## Oil condition

Oil provides the internal insulation barrier between phases and from phase to ground. It must be replaced before it deteriorates below a safe dielectric level. Replace the oil if its dielectric strength falls below 22 kV. Always filter new oil before using, even 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. Keep aeration to a minimum during filtering to prevent moisture in the air from condensing in the oil and lowering its dielectric strength.

## Maintenance intervals

Frequency of maintenance depends upon local climactic conditions and the interrupting duty imposed on the recloser. Eaton recommends the unit be completely inspected, cleaned, and filled with new oil every 3 years or the duty cycle whichever comes first. If the Type E recloser operates through a duty cycle in less than one year, periodic maintenance should be performed at that time. Table 3 contains the NEMA standard duty cycle for reclosers.

## Oil dielectric strength

Although the Type E recloser can go through the complete duty cycle without requiring an oil change, more frequent oil changes will be required if the majority of fault currents are near the maximum interrupting rating. Oil that has become contaminated with carbon and sludge, or has a dielectric strength of 22 kV or lower, should be replaced. Use only oil that meets the requirements for Cooper Power series switchgear. Refer to *Reference Data TD280022EN*.

Used oil must be treated before reusing. Filtering may remove absorbed and free water and other contaminants, raising the dielectric strength to acceptable levels. However, filtering does not always remove water-absorbing contaminants, and the dielectric strength 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 these reclosers conforms to ASTM Standard D3487, Type I; its property limits are shown in *Reference Data TD280022EN Oil Specifications and Tests*.

## Periodic inspection and maintenance

Each periodic check should include at least the following steps:

1. Bypass and remove recloser from service.  
Replace with a temporary fuse or spare recloser.
2. Inspect external components.
  - A. Check for broken bushings, paint scratches, or other mechanical damage.

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- B. The counter reading should be noted and entered in the recloser record.
  - C. Move the manual operating lever up and down to see if the counter is functioning properly. Leave the recloser in the open position.
3. Remove mechanism from tank.

Loosen four bolts that secure the tank to the head casting, and loosen the gasket seal between tank and head casting. The gasket seal can be broken by carefully prying apart the head and tank. Hoist the mechanism out of the tank; allow oil to drain.

4. Clean all internal components.
- A. Remove all traces of carbon by wiping with a clean, lint-free cloth.
  - B. Flush mechanism with clean, dry transformer oil.

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**⚠ CAUTION**

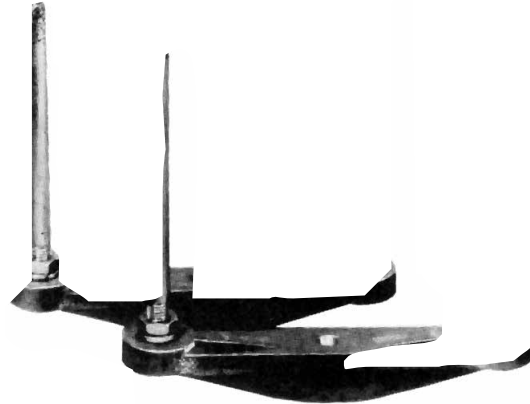
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**Never use volatile solutions, detergents, or water-soluble cleaners**

5. Inspect moving contacts.

Arcing tips of the moving contacts can experience a limited erosion before replacement is necessary. Contacts should be replaced before erosion of the load-current-transfer surfaces impairs their effectiveness.

If moving contacts appear to have further useful life, inspection of the arc interrupter chamber and stationary contacts can be omitted. These components are designed to last at least as long as the moving contacts.



**Figure 3. Moving contact assembly.**  
**Background: After severe duty. Foreground: New**

6. Inspect interrupter and exhaust port.

If the stationary contacts or fiber plates are badly eroded or burned, the complete stationary tube assemblies should be replaced. In addition, the stationary tube assemblies should be replaced any time the moving contacts are replaced. See the "Arc-Interrupting Assembly" section of this manual for disassembly instructions.

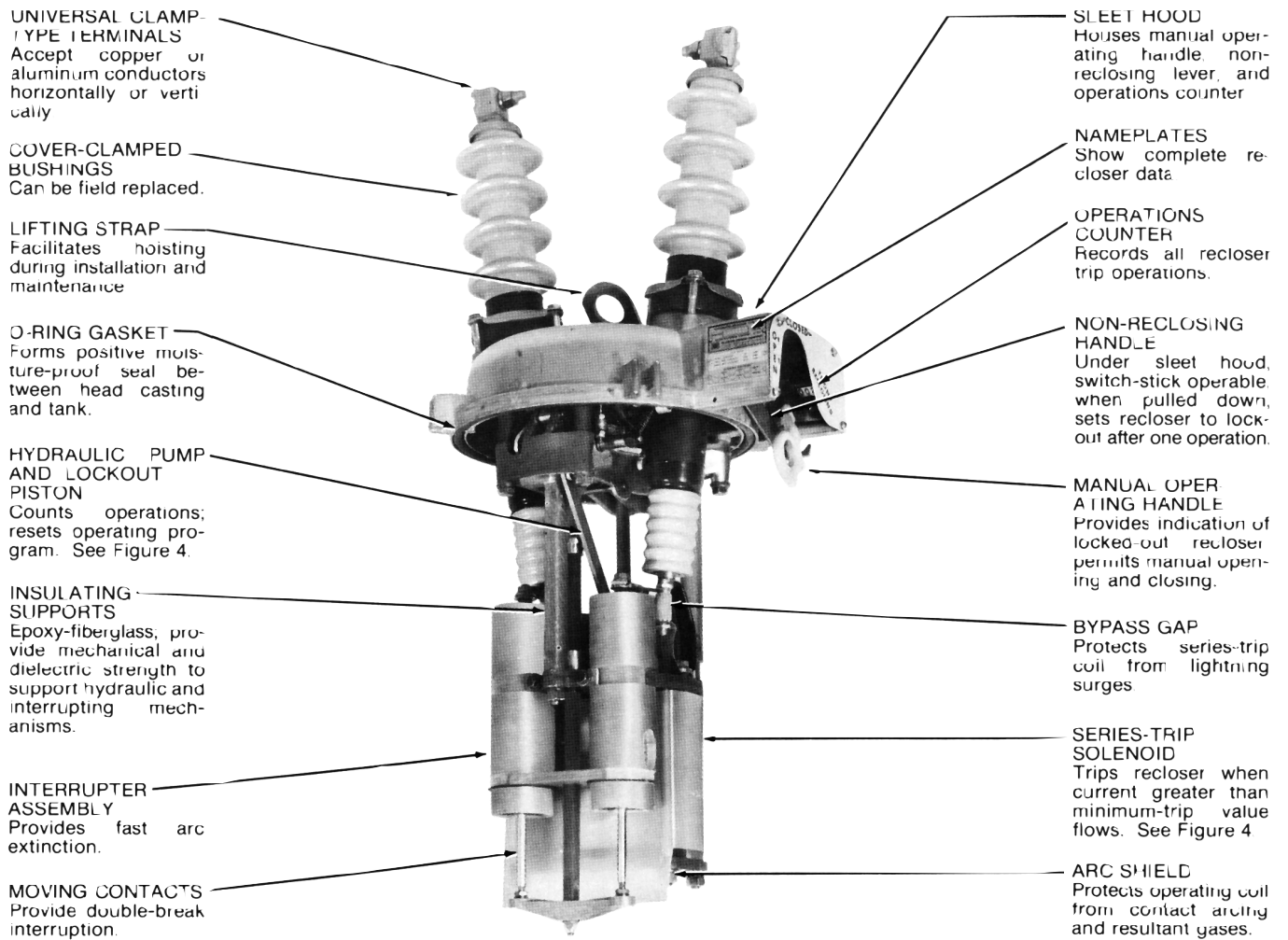


Figure 4. Untanked view of type 4E recloser

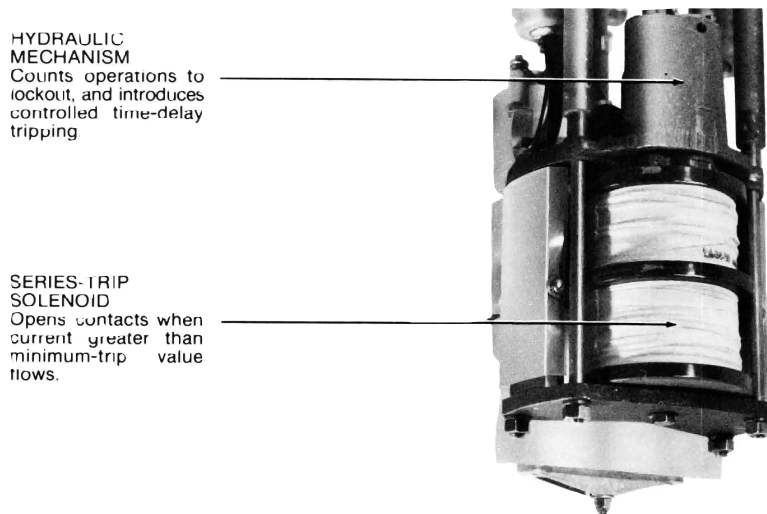
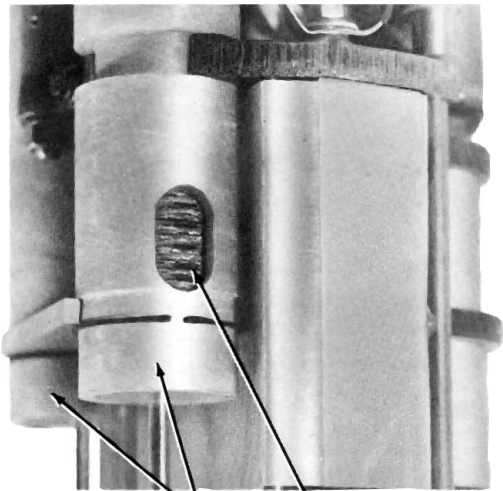


Figure 5. Hydraulic mechanism and series-trip solenoid



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STATIONARY CONTACTS

FIBER PLATES

**Figure 6. Inspecting stationary contacts and arc-interrupting chambers**

7. Check the dielectric strength of the insulating oil.
  - A. The dielectric strength should not be less than 22 kV when tested with a 0.1-in. gap in accordance with methods specified in ASTM D117.
  - B. Low dielectric strength usually indicates the presence of water or carbon deposits.
8. Remove old oil.

If oil must be replaced, drain the tank and clean out all sludge or carbon deposits.
9. Inspect tank liners.

Note that two liners are employed. The inner liner is fibrous and readily absorbs any moisture present. Soft or spongy areas indicate water has been absorbed. Replace the liner if these areas are present. The outer liner need areas are present. The outer liner need not be replaced unless it is cracked.

Rinse the tank with clean oil, and wipe out all carbon traces with a clean lint-free cloth.
10. Fill tank with oil.

Use only new transformer oil with dielectric strength of at least 30 kV as measured across a standard 0.1-in. gap in accordance with methods illustrated in ASTM Publication D117.

Fill the tank to the correct level with oil (8.4 gallons), indicated by a line on the fiber liner.
11. Check head gasket.

Clean and examine the head gasket. Replace if it is cracked, checked, cut, or otherwise damaged, or if it has been permanently deformed.
12. Replace cover and mechanism in tank.
  - A. Wipe clean the O-ring type gasket the gasket recess in the recloser cover, and the tank gasket seal.
  - B. Position the four head bolts and tighten alternately (torque head bolts to 25-40 ft-lb). The cover can be rotated in steps of 90 degrees with respect to the tank and its mountings.

Operate the unit manually about eight times to be sure no air remains in the hydraulic mechanism.
13. Test mechanical operation.

An easy, effective test can be performed as follows:

  - A. Move the operating lever to the CLOSED position and wait 4 minutes.
  - B. Move the operating lever to the OPEN position and listen for opening of the main contacts. Then quickly move the lever back to the CLOSED position.
  - C. Continue opening and closing the recloser manually until lockout is achieved. This can be determined by listening for unlatching of the lockout mechanism and also by noting that recloser mechanism will not latch when the lever is moved to the CLOSED position.

This test can be used to determine the number of operations to lockout. The number of fast and delayed operations can be noted also. Fast operations can be identified because the main contacts will open almost instantaneously when the operating lever is moved to the OPEN position. When delayed operations occur, a short time elapses between operation of the lever and opening of the contacts.
14. Direct-current testing.

Use the following procedure to prove the recloser is in good operating condition.

  - A. Move the operating lever to the CLOSED position and wait 4 minutes.
  - B. Connect a storage battery across recloser terminals. Count the operations to lockout. If the correct number of operations did not occur, wait five minutes and repeat the test. Air in the hydraulic system can cause incorrect operation. Refer to Tables 4 and 5 for the number of 6- or 12-volt batteries to use for testing Type E reclosers.

**Table 4. 6-Volt battery requirements for tripping**

Recloser rating (amps)	Batteries required (Parallel)	Cable size (AWG)
5	**	
10	**	
15	2	Short lengths of no. 6 or larger
25	2	
35	2	
70	2	
100	2	

\*Fully charges and in good condition.  
 \*\*Can not be tested in this method.

**Table 5. 12-Volt battery requirements for tripping**

Recloser rating (amps)	Batteries required (Paralleled)	Cable size (AWG)
5	**	
10	**	
15	**	Short lengths of no. 6 or larger
25	4	
35	4	
50	4	
70	4	
100	4	

\*Fully charges and in good condition.  
 \*\*Can not be tested in this method.

## Shop maintenance

When shop maintenance or repairs are to be performed, remove the four bolts that secure the tank and head casting. Trip the recloser and lift the mechanism out of the oil and allow to drain. Operations described in this section should be performed in the cleanest conditions possible.

**Note:** Maintenance work—except for bushing replacement—will be simplified if the work bench (table or stand) is arranged so the mechanism can be inverted (bushings down). Many of the following figures show the recloser in this inverted position.

## Arc-interrupting assembly

When erosion has spread close to the load-current transfer surfaces of the moving contacts, the entire arc-interrupting assembly should be removed and replaced.

Follow these procedures to perform this work:

1. Remove self-locking nut and washer from end of contact rod (Figure 7). Then drive out the roll pin that aligns the moving contact yoke. Lift off the moving contacts.
2. Remove the bronze capscrew, lockwasher and flat washer (right-hand tube only), from the end of each contact tube; remove the leads to each contact tube.
3. Remove the retaining-snap rings that secure the contact tubes to the moving contact rod guide (Figure 8).
4. Remove the capscrews, lockwashers and flat washers to release the contact tube wedges (Figure 9).
5. Grasp both contact tubes near the free ends and pull apart enough to release the tubes from the solenoid frame (Figure 10). Remove the fiber moving contact rod guide.
6. If further maintenance is to be performed, do not reassemble the interrupting assembly yet. When reassembling, reverse the procedures listed in the preceding steps 1 through 6.

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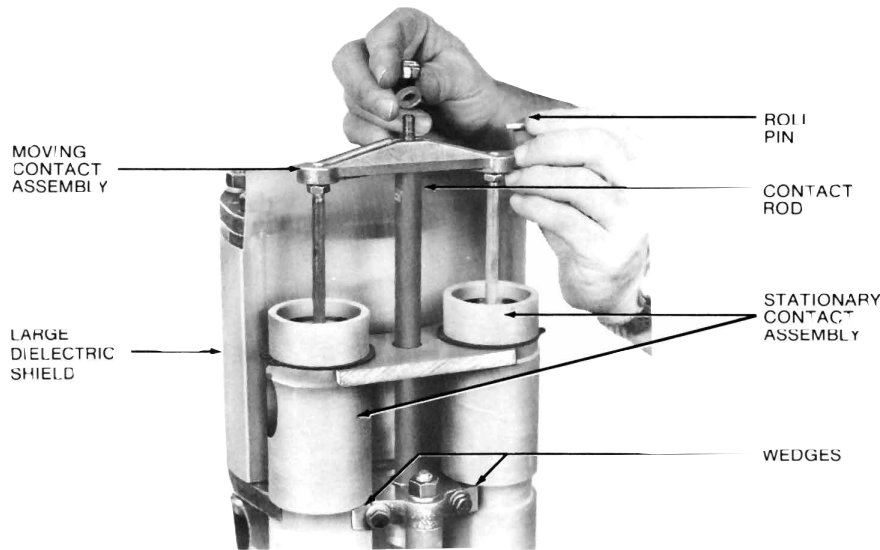


Figure 7. Removing contact yoke assembly

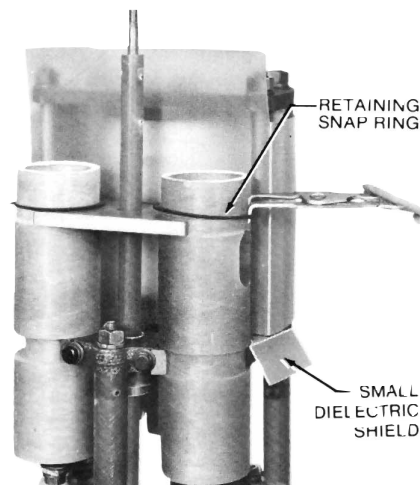


Figure 8. Removing retaining-snap rings

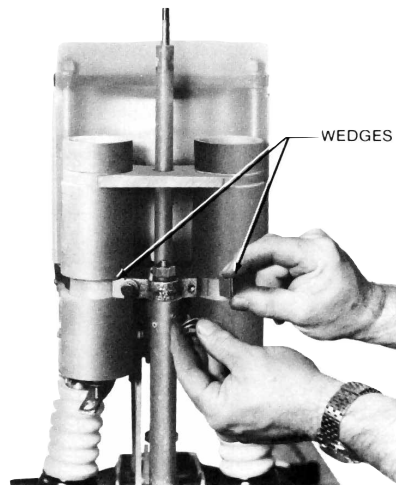


Figure 9. Removing contact tube wedges

MOVING CONTACT ROD GUIDE

Figure 10. Removing contact tubes

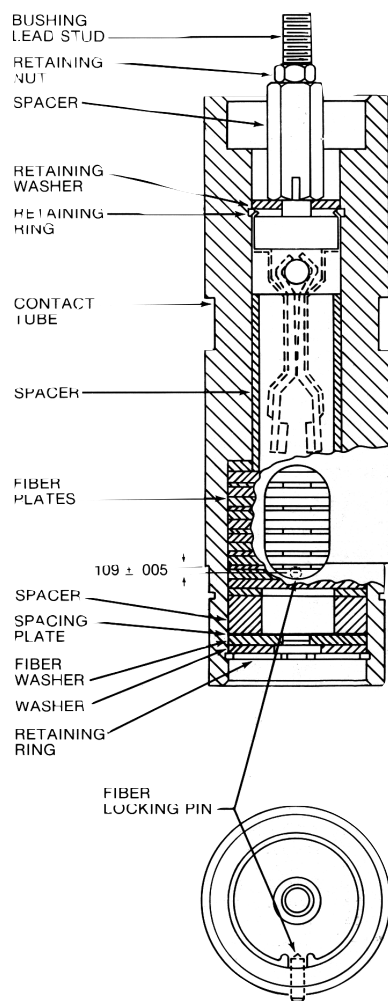
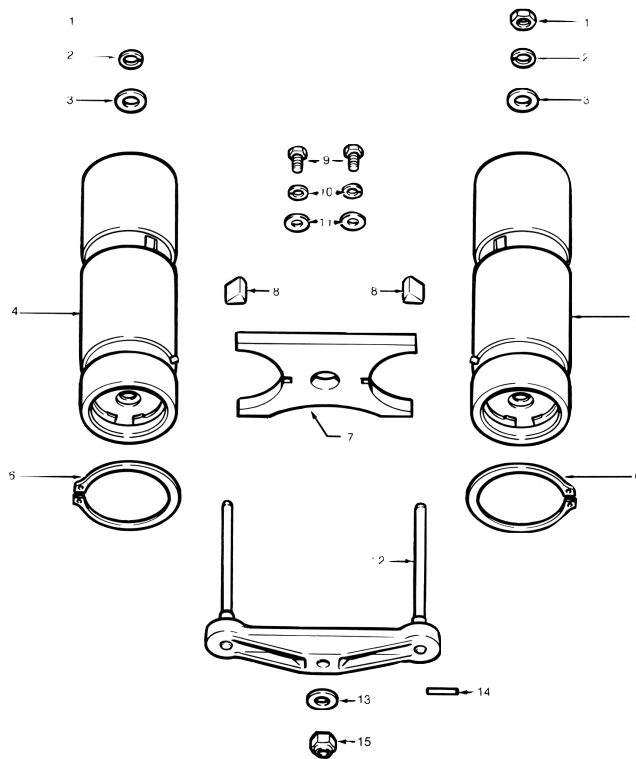


Figure 11. Cross-sectional view of contact tube



**Figure 12. Arc-interrupting assembly parts. See table 6 for parts identification**

**Table 6. Parts list for arc-interrupting assembly (Figure 12)**

Item no.	Catalog no.	Description	No. Used
1	K880725324037A	3/8in.-24 brass- jam nut	2
2	K90033003700A	3/8in. bronze lockwasher	2
3	K900525039087A	3/8in. brass- flat washer	2
4	KA170 E1	Stationary contact assembly - - left- hand	1
5	KA170 E2	Stationary contact assembly- - right hand	1
6	KP2013A46	Retaining ring	2
7	KP313 E	Moving contact rod guide	1
8	KP44L	Contact wedge	2
9	K730101125050A	1/4in-20NC2 X 1/2in. steel-hex screw	2
10	K900801025000A	1/4 in. steel lockwasher	2
11	K900201025000A	1 /4in. steel - flat washer	2
12	KA181 E	Moving contact assembly	1
13	K900201043000A	7/16in. steel - flat washer	1
14	K970801125081 C	Roll pin - - 1/8in. X 13/16in.	1
15	KP2020A4	Self- locking nut - - 5/16 in -24UNC2	1

**Series-trip solenoid disassembly**

If the series-trip coil has been damaged in any way or if the recloser is to be changed to a new rating, the series-trip coil can be replaced. New coils, gaskets, and data plates are shipped in sealed boxes.

Coils should not be exposed to air any longer than necessary because moisture from the air may be absorbed. When a good coil is replaced, it should be stored in the same container in which the new one was shipped.

Observe the following procedure for disassembly of a series-trip solenoid:

1. If the arc-interrupting assembly has not been removed previously, observe procedure outlined in the "Arc-Interrupting Assembly" section.
2. Disconnect coil leads. The long coil lead is disconnected while removing the arc-interrupting assemblies. The short coil lead is disconnected from the solenoid frame by removing the capscrew, flatwasher, lockwasher and hex nut (Figure 13).
3. Using a 3/4-in. box wrench, remove four hexnuts that secure the solenoid bridge plate. Lift this plate off as shown in Figure 14. Note that a red cushion washer is attached to the plate.
4. Lift off the lower gasket,coil end upper gasket.
5. Remove the hex cap screw that secures the lockwasher, bushing lead, and bypass gap to the frame.

One solenoid frame shoe will also be released. See Figure 15.

6. If necessary to remove the large dielectric shield, first unscrew the solenoid tie bolts from the closing solenoid side of the shield. Then remove the brass machine screws, flat washers, and lockwashers that secure the shield to the solenoid frame (Figure 16). The small dielectric shield is removed by sliding it off the solenoid tie bolt on the contact tube side of the solenoid frame (Figure 16).

**Series-trip solenoid reassembly**

If further maintenance is to be performed, do not reassemble the solenoid yet. When the solenoid is to be reassembled, observe the following steps:

1. If the small and/or large dielectric shields were removed, reinstall by reversing steps 6 in the "Series-Trip Solenoid Disassembly Section."
2. Position solenoid frame shoe. Place a lockwasher on the 3/8- X 1-1/4-in. steel capscrew and secure one bushing lead and the bypass gap to the solenoid frame. This capscrew threads into the solenoid frame shoe.
3. Place a new upper gasket on the flanged end of the trip coil. Reposition the coil and new lower gasket; secure the bridge plate.
4. Secure short coil lead to the solenoid frame by means of the 3/8- X 1-1/2-in. steel hex cap screw, flat-washer, lockwasher and hex nut
5. Replace arc-interrupting structure and long-coil lead as described in the "Arc-Interrupting Assembly" section of this manual.

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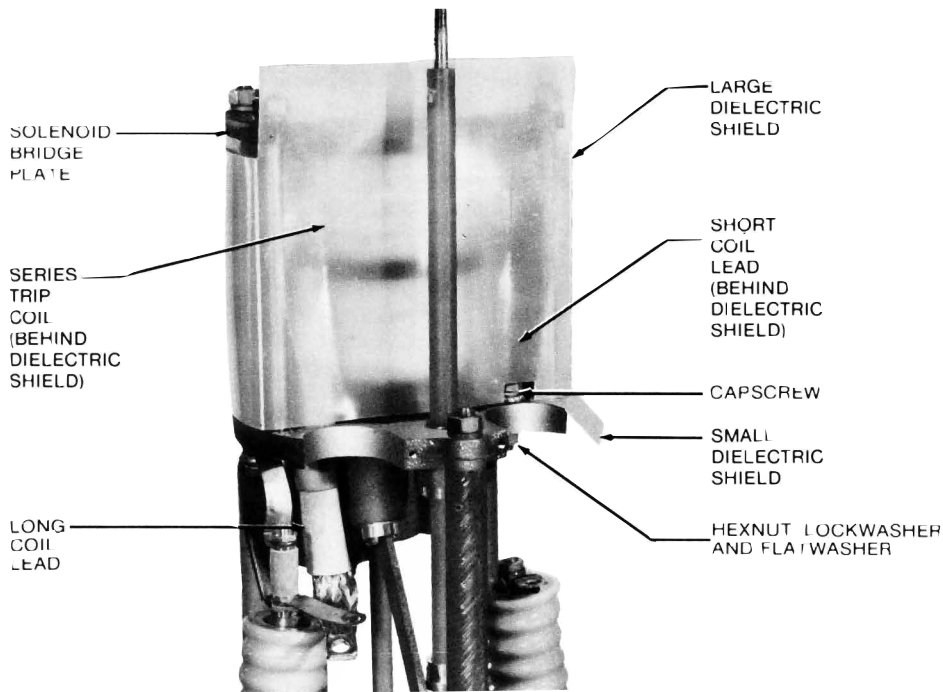


Figure 13. Series-trip solenoid assembly

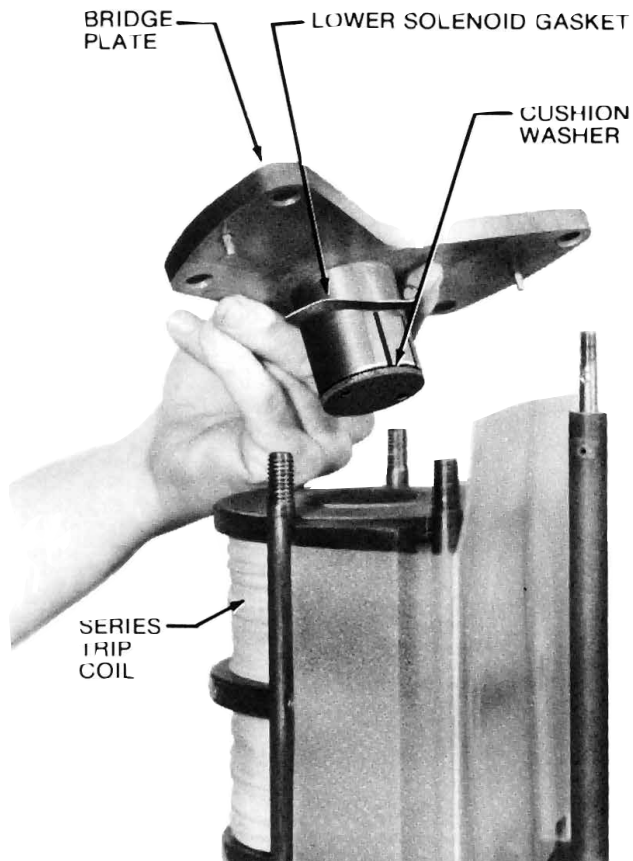


Figure 14. Bridge plate removal

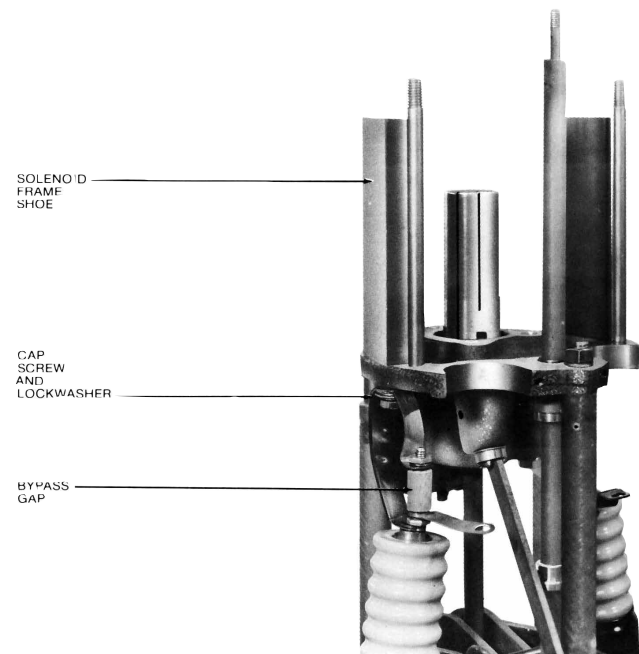


Figure 15. Releasing bushing lead and bypass gap



Figure 16. Removing large dielectric shield

Table 7. Parts list for series-trip assembly (Figure 17)

Item no.	Catalog no.	Description	No. used
1	KA60L-1	Coil bypass gap assembly	1
2	K73010113712SY	Steel hex cap screw - 3/8in. - 16NC2 X 1-1/4 in.	1
3	K900801037000Y	Steel Kantlink lockwasher - 3/8in. X 0.141 in. X 0.94in.	2
4	K730101137150A	Steel hexcapscrew-3/8in.- 16NC2 X1-1/2in.	1
5	K900830037000A	Bronze lockwasher, 3/8in.	2
6	K880201116037A	Steel hex nut- 3/8in.- 16NC2	1
7	KP2090A6	Solenoid gasket, upper	1
8	KA67L	Coil Assembly (Show coil rating by suffix Example: KA67L100 = 100-amp coil)	1
9	KP2090A28	Solenoid gasket, lower	1
10	KA85L	Plunger stop assembly	1
11	KP10L	Bridge Plate	1
12	KP3017A49	Sleeve, long coil lead (outer)	1
13	KP2104A4	Sleeve, long coil lead (inner)	1
14	KP3106	Large dielectric shield	1
15	K721525125050A	1/4in.-20X1/2in.brass machine screw	2
16	K900830025000A	1/4in. bronze lockwasher	2
17	K900525026068A	1/4in. brass flat washer	2
18	KP312E1	Small dielectric shield	1

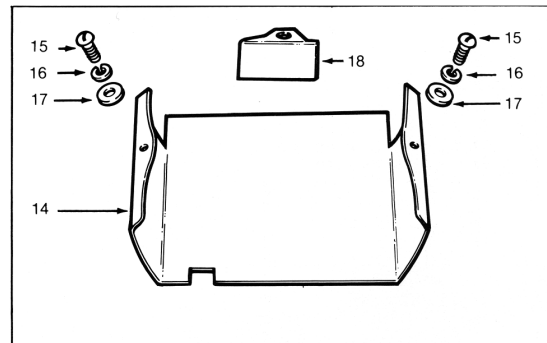
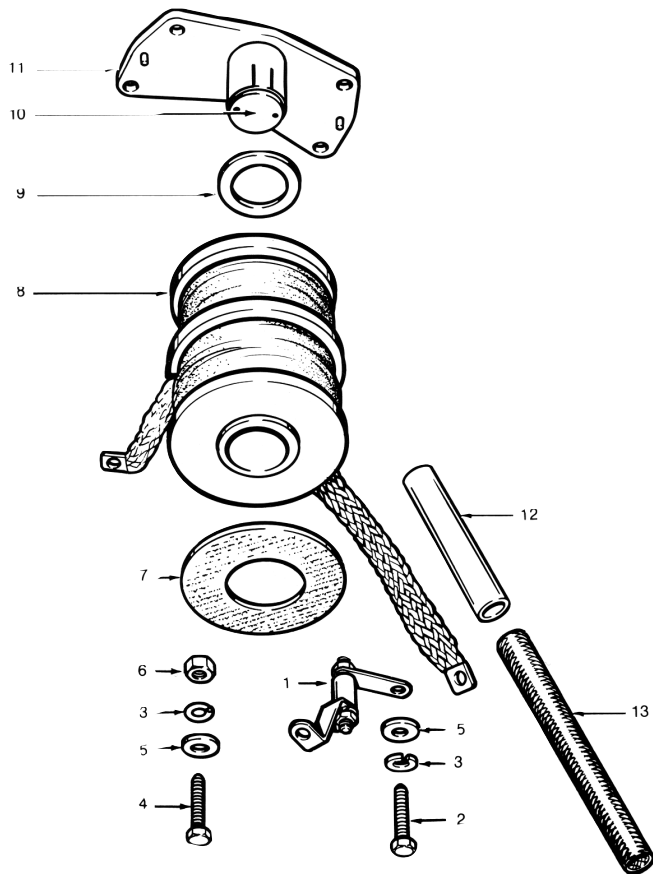


Figure 17. Parts for series-trip solenoid assembly. See table 7 for parts identification

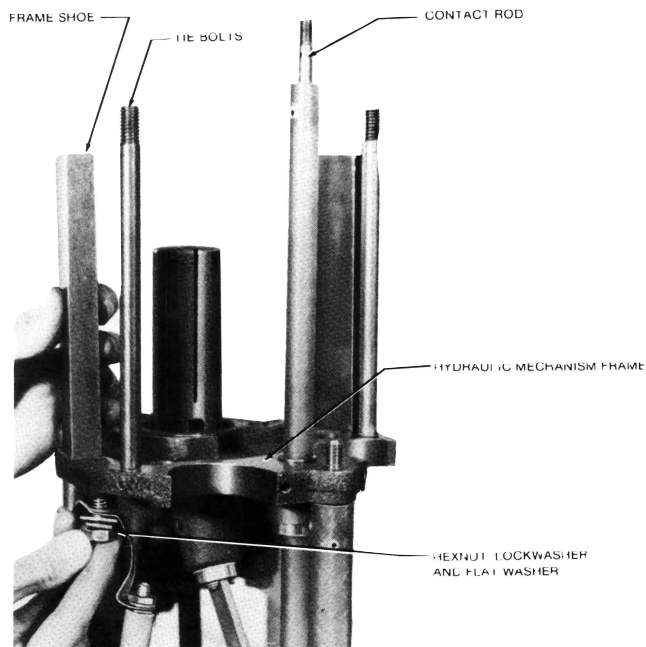
## Type E — Maintenance instructions

### Hydraulic mechanism

This mechanism should require no maintenance, but components may be changed to provide different operation sequences. Furthermore, removal of this mechanism may be required to gain access to the head operating mechanism.

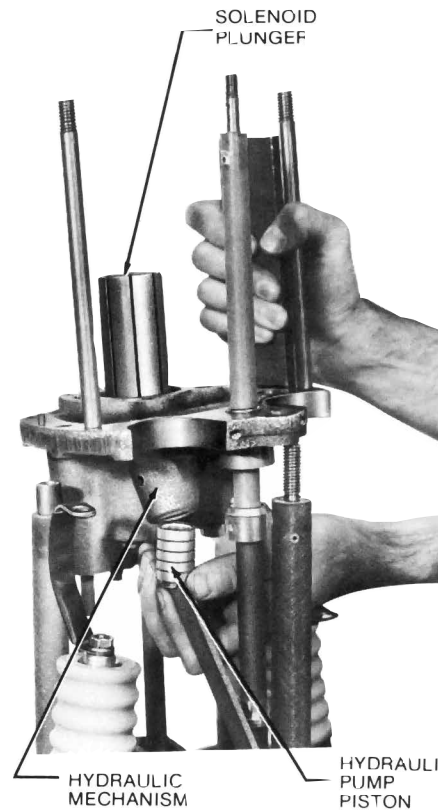
Observe the following steps:

1. Remove hexnut, lockwasher and flatwasher from the frame shoe at the hydraulic frame and then remove tie bolts (Figure 18).

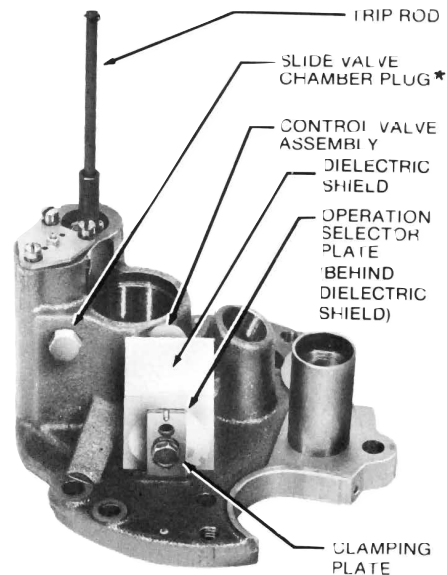


**Figure 18. Dismantling hydraulic mechanism**

2. Grasp the solenoid plunger and pump piston link with one hand and carefully lift off the frame with the other hand as illustrated in Figure 19.
3. With a 1/2-in. wrench, remove the capscrew that secures the operation selector plate, orifice plate, and gasket. See Figure 20.

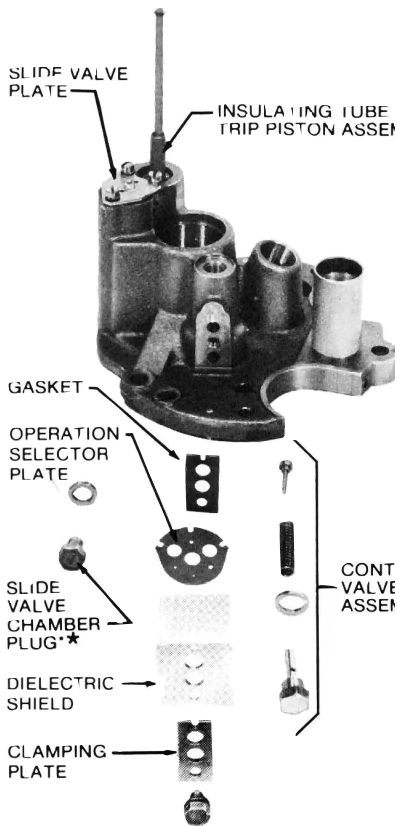


**Figure 19. Removing hydraulic mechanism**



**Figure 20. View of hydraulic mechanism**  
\*Used only on solenoid frame assembly KA179E3

4. Using a 5/8-in. wrench, remove the control valve assembly. Tip the frame so the valve element falls out.
5. Remove the slide valve chamber plug and gasket by means of a 5/8-in. wrench. Parts removed in steps 3, 4 and 5 are shown in Figure 21.
6. Remove the slide valve plate and gasket by releasing three screws. Tip the frame so the valve will slide out.
7. With a wire hook, pull the ball check valve seat out enough to expose the spring and insert a thin plate to release the spring. A steel ball will be released. Lift out the trip piston. Figure 23 shows parts removed in Steps 6 and 7.

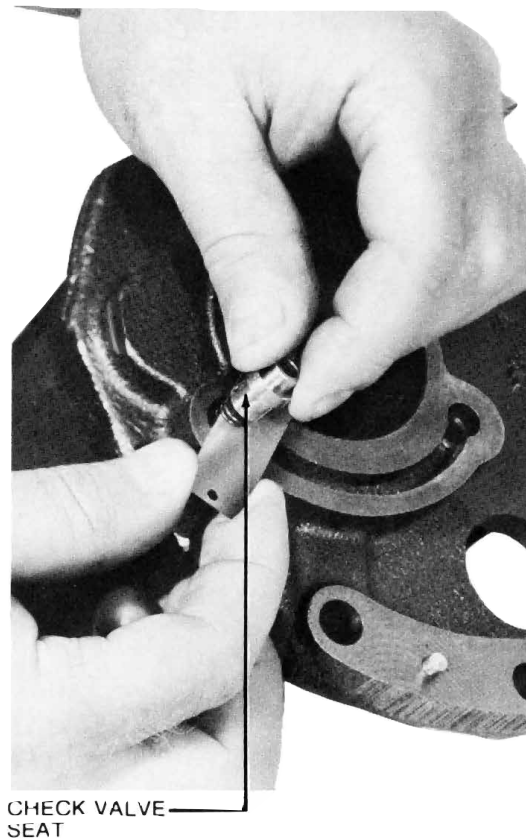


**Figure 21. Hydraulic mechanism partially assembled**  
 \*Used only on solenoid frame assembly KA179E3

8. The pump piston can be removed if necessary by turning the outer shell off the piston body. Then push out the pin that connects the body to the insulated link. See Figure 24.

If further maintenance is to be performed, do not replace the hydraulic mechanism yet. When ready for reassembly, observe the following steps:

1. Refer to Table 9 for components to be used for a particular operating sequence.
2. Insert the trip piston in its cylinder. Pull the spring out as shown in Figure 25 and insert a thin plate to hold it. Secure the ball and check valve seat to the spring by inserting the pin, but be sure the small steel ball is also retained by the pin.

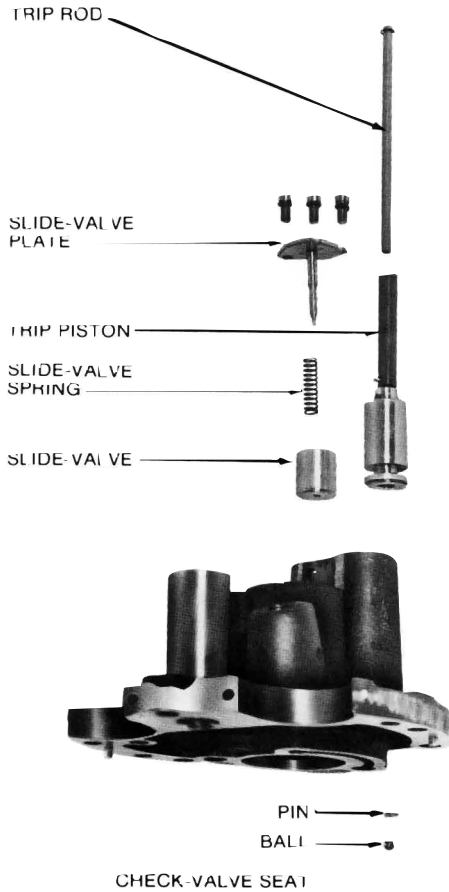


**Figure 22. Removing check valve seat**

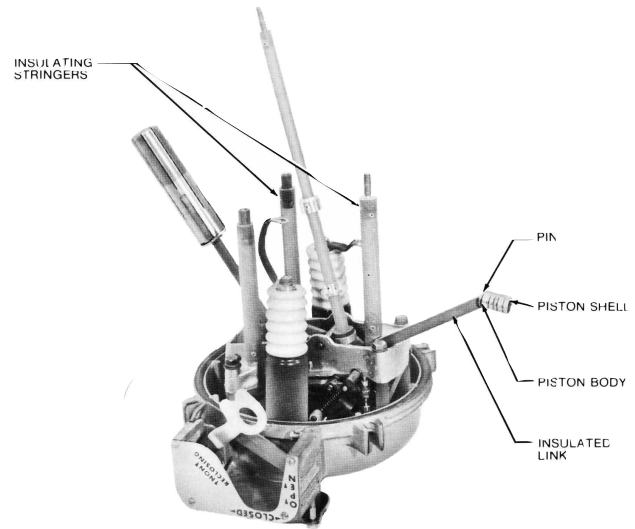


## Type E — Maintenance instructions

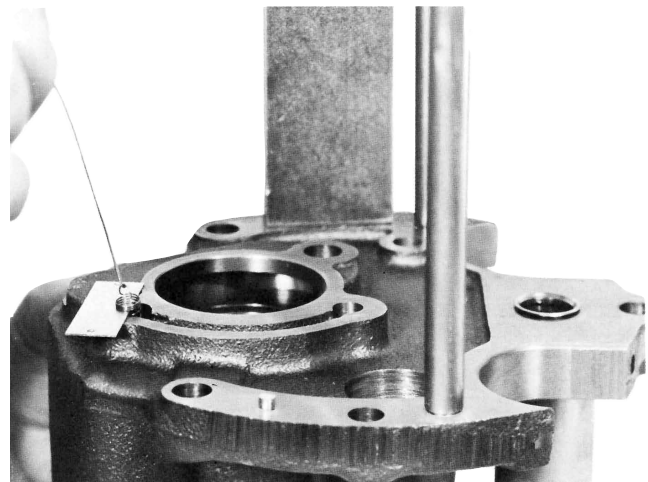
3. Replace the slide valve, slide-valve spring, and slide-valve plate and gasket assembly. Next, replace the slide-valve chamber plug and the operation selector assembly. Use a new gasket KA2011 A1 with the slide valve chamber plug.
4. Pin the pump piston body to the insulated link and screw on the outershell. When sequence adjustments have been made (Page 14), stake the shell to the body by means of a small prick punch.



**Figure 23. Removing slide valve, check valve and trip valve**



**Figure 24. Removing stringers and pump piston**



**Figure 25. Pulling out trip piston spring**

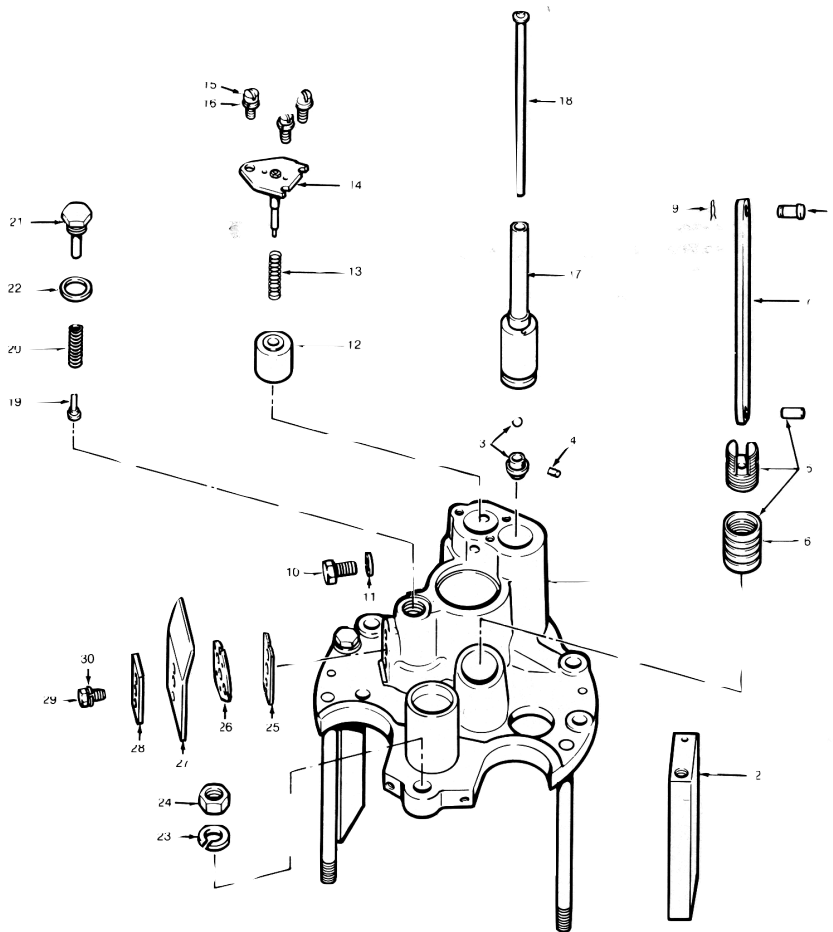


Figure 26. Hydraulic mechanism parts. See table 8 for parts identification

Table 8. Parts list for hydraulic mechanism (see Figure 26)

Item no.	Catalog no.	Description	No. used
1	KA179E I	Solenoid frame assembly	1
2	KP311E2	Frame shoe	2
3	KP155H	Ball check valve seat and 1/4-in.-steel ball	1
4	KP3051A3	Pin	1
5	KA2S H	Pump piston assembly	1
6	KP151 H	Pump piston shell only	1
7	KP112 L	Pump piston link	1
8	KP85L	Pivot pin- includes item 9	1
9	KP2018A2	Spring clip No.1137 0.035in.	1
10	KP119 L	Slide valve chamber plug C*	1
11	KA2011 A1	Type A gasket- 1/2- X 11/1 6- X5/64in.	1
12	KP104 L	Slide valve	1
	KA155 L	Slide valve	1
		} See Tables 9 and 10	
13	KP213 L	Slide valve spring	1
14	KA64 L	Slide valve stop assembly	2
15	K721801125050A	Steel round-head screw- 1/4 in. - 20 NC2 X 1/2in.	3
16	K900801037000M	Lockwasher - 1/4 in.	3
17	KA94L1	Piston and rod guide assembly	} See Table 9
	KA94L2	Piston and rod guide assembly	
	KA94L3	Piston and rod guide assembly	
	KA94 L4	Piston and rod guide assembly	

Table 8 continued on page 15.

## Type E — Maintenance instructions

**Table 8. Parts list for hydraulic mechanism (see Figure 26) (continued)**

Item no.	Catalog no.	Description	No. used
18	KP108L900 KP197L900	Trip rod } Trip rod } See Table 9	1
19	KP193L	Control valve	1
20	KP113L	Control valve spring	1
21	KP118L	Control valve stop screw	1
22	KP3013A12	Steel lockwasher- 1/2 in. X 0.170 in. X .099 in.	1
23	K900801043000A	Steel lockwasher - 7/16 in. X 0.156 in. X 0.109 in.	1
24	K880201114043A	Hexhead steel nut- 7/16 in. - 14NC2	1
25	KP222L	Operations selector gasket	1
26	KP123L	Plate selector. standard	1
27	KP315E	Dielectric shield	1
28	KP223L	Plate. clamping	1
29	K730101131050A	Steel hex cap screw - 5/16 in. - 18NC2 X 1/2 in.	1
30	K900801031000D	Lockwasher- 5/16in X 0.125in. X 0.78in	1

\*Used only on solenoid frame assembly KA179E3

**Table 9. Part numbers used for various operating sequences (above serial no. 52000)**

Curve.	Timing	Trip piston	Trip rod	Slide valve	Spring, slide valve	Stop slide valve	Spacer
	3 delayed	KA94L-1	KP108L900	KP104L	KP213L	KA64L	KP332H
A	4 delayed	*	*	*	*	*	**
B	4 delayed***	*	*	KA155L	*	KP105L& KP106L	**
B	3 delayed* * *	*	*	*	*	*	KP233L
B	2 delayed	*	*	KP104L	*	KA64L	KP332H
B	3 fast, 1 delayed	KA94L-3	*	*	*	*	**
B	2 fast, 2 delayed	KA94L-1	*	*	*	*	**
B	2 fast, 1 delayed	KA94L-4	*	*	*	*	**
B	1 fast, 3 delayed	KA94L-2	KP197L900	*	*	*	**
B	1 fast, 2 delayed	KA94L-1	KP108L900	*	*	*	KP233L
B	1 fast, 1 delayed	KA94L-4	*	*	*	*	*
C	4 delayed***	KA94L-1	*	KA1155L	*	KP105L & KP106L	**
C	3 delayed* * *	*	*	*	*	*	KP233L
C	2 delayed	*	*	KP104L	*	KA64L	KP332H
C	2 fast, 2 delayed	*	*	*	*	*	**
C	2 fast, 1 delayed	KA94L-4	*	*	*	*	**
C	1 fast, 3 delayed	KA94L-2	KP197L900	*	*	*	**
C	1 fast, 2 delayed	KA94L-1	KP1108L900	*	*	*	KP233L
C	1 fast, 1 delayed	KA94L-4	*	*	*	*	*
D	4 delayed***	KA94L-1	*	KA155L	*	KP105L & KP106L	**
D	3 delayed* * *	*	*	*	*	*	KP233L
D	2 delayed	*	*	KP104L	*	KA64L	KP332H
D	2 fast, 2 delayed	*	*	KP104L	*	*	**
D	2 fast, 1 delayed	KA94L4	*	*	*	*	**
D	1 fast, 3 delayed	KA94L-2	KP197L900	*	*	*	**
D	1 fast, 2 delayed	KA94L-1	KP108L900	*	*	*	KP233L
D	1 fast, 1 delayed	KA94L-4	*	*	*	*	*
E	2 fast, 2 delayed"	KA94L-1	*	*	KP194L	*	**
E	1 fast. 3 delayed"	KA94L-2	*	*	*	*	**
E	1 fast, 2 delayed"	KA94L-1	*	*	*	*	*
F	3 fast 1 delayedit	KA94L-3	*	*	KP213L	*	**
F	2 fast 2 delayed	KA94L-1	*	*	*	*	**
F	2 fast, 1 delayed	KA94L-4	*	*	*	*	**
F	1 fast, 3 delayed	KA94L-2	KP197L900	*	*	*	**
F	1 fast, 2 delayed	KA94L-1	KP108L900	*	*	*	KP233L

\*Same catalog no. as above

\*\*Not used in this sequence.

\*\*\*Slide-valve spring omitted. All others use KP213L slide-valve spring.

†Uses KP226L control valve plate. All others use KP123L.

††Uses KA123L control valve plate. All others have none.

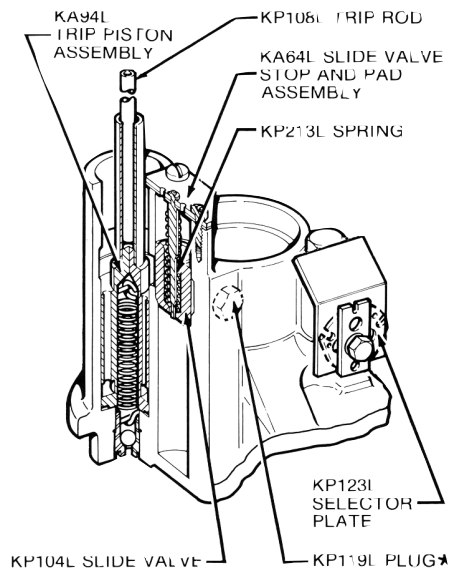
Note: In order to have all fast-trip operations, a solenoid frame assembly must be ordered.

### Changing time-current settings

Time-current curves for the Type E recloser indicate minimum-trip and the interrupting capacity range plotted to an average clearing time for each opening of the recloser contacts. Recloser curves are labeled to represent their relative speed of opening with A being fast, B delayed, C extra delayed, D steep delayed, E an intermediate delayed, and F a slightly less delayed curve than B curve. To provide all operations on the A curve, a special solenoid frame assembly must be ordered (KA179E3). To select operations on the B, C, or D curves, merely loosen the capscrew and clamping plate and reindex the orifice selector plate to the desired delayed curve. For all operations on the E curve, the KP123L selector plate is removed and a KP226L plate is inserted and indexed in its place. F curve operation requires the removal of the fast shot blocking plug KP119L (on units with special solenoid frame assembly KA179E3) and the addition of a KA123L control valve. Selector plate setting for this F curve is indexed at B.

### Changing operating sequence

Specified combinations of hydraulic parts as in Table 9 permit the recloser to operate along one curve (single timing) or with a combination of two curves (dual timing). When set for dual timing, the recloser operates first on a fast curve and then on a slower curve. After a selected number of operations, the recloser locks out. Figures 27 to 30 illustrate the location of the various parts used for changing the operating sequence to lockout.



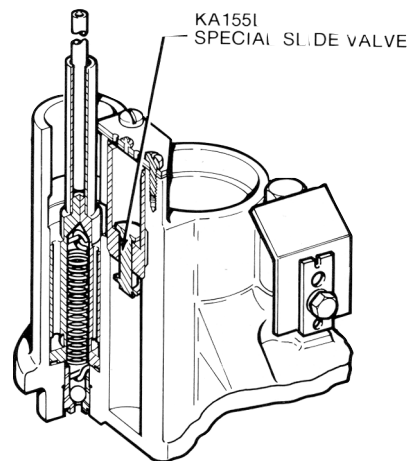
**Figure 27. Parts for most commonly used sequence, two fast and two delayed**  
**\*Only on units with solenoid frame KA179E3**

### Sequence adjustments

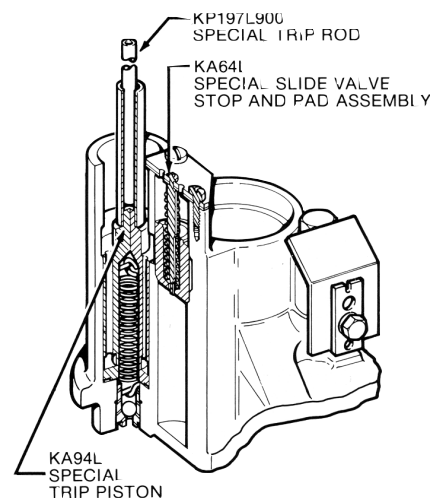
After any change or servicing of the hydraulic mechanism, make sure to remove any air that may have been entrapped, by operating the yellow control handle manually seven

or eight times. All changes should also be verified with the testing procedures that are explained in the "Periodic Inspection and Maintenance" section. It may also be necessary to adjust the hydraulic pump piston shell to enable pumping action to lockout in the following manner.

1. Lower the unit into the oil enough to cover the hydraulic system. Operate the recloser manually several times to dispel any air in the hydraulic system.
2. Close the recloser, wait 4 minutes, and rapidly trip and close the recloser three times. Then observe the position of the trip rod. This rod should just be touching the adjustable lockout level in the head mechanism.
3. If the trip rod is not correctly positioned, turn the pump piston shell to cause it to pump more or less oil as required. Turning the shell off the body tends to increase travel of the trip rod, whereas turning the shell into the body decreases trip-rod travel.



**Figure 28. Installation of special slide valve used for delayed-only operations. No slide-valve spring is used**



**Figure 29. Special parts used for one fast and three delayed sequence**

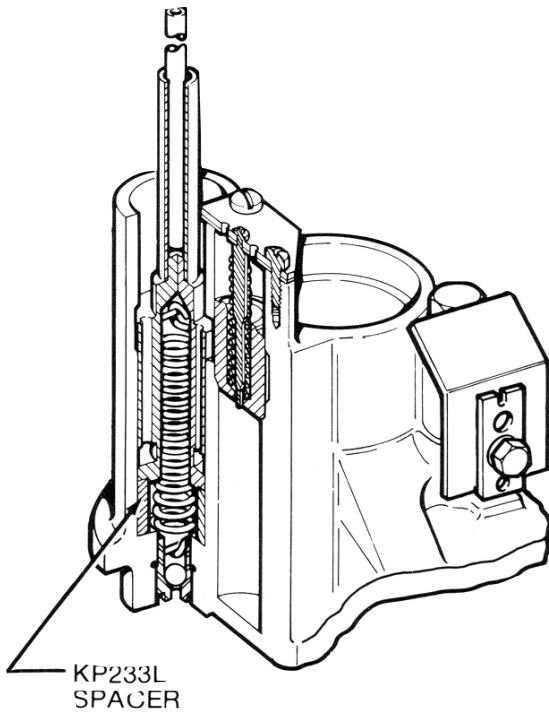


Figure 30. Location of spacer under trip piston

### Bushings

Maintenance of bushings is ordinarily limited to an occasional cleaning. If, however, a bushing is cracked or chipped, replace as follows:

**Note:** The recloser must be untanked to replace the bushings.

### Disassembly

1. If not done previously, remove the lead straps from bottom of each bushing by removing nut, lockwasher, and flatwasher.
2. Remove the three bolts that secure the bushing clamps and lift the bushings out of the head casting (Figure 31).

If further maintenance is to be performed, do not replace the bushings yet.

### Reassembly

1. Position the new bushing gaskets on the head mechanism.
2. Place the bushing clamping gaskets around the bushings.
3. Carefully insert bushings into head casting so that the flat part of the lower terminal faces away from the center of the recloser mechanism.
4. Replace the bushing clamps and bolt into place.
5. Secure the lead straps to the bushings by reinstalling the flatwasher, lockwasher and nut.

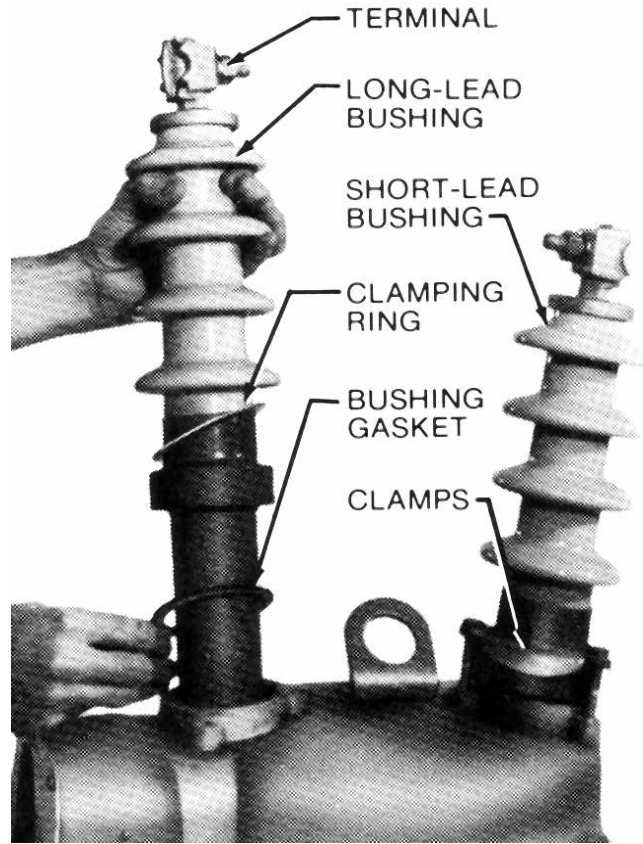


Figure 31. Lifting a bushing assembly

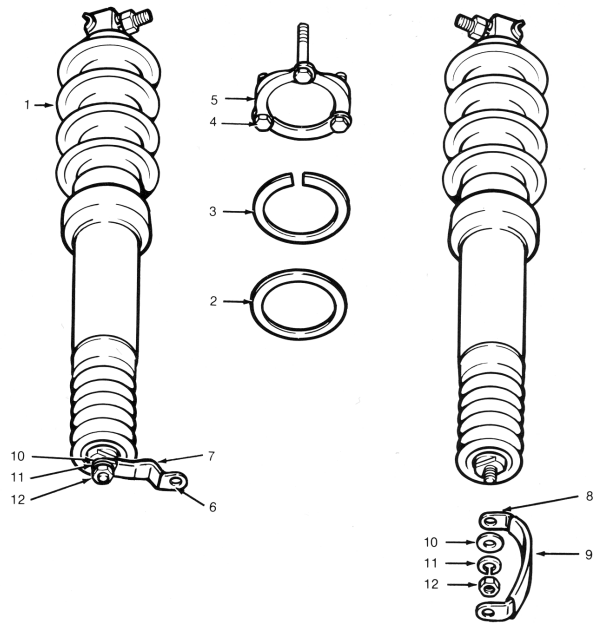


Figure 32. Bushing parts. See table 10 for parts identification

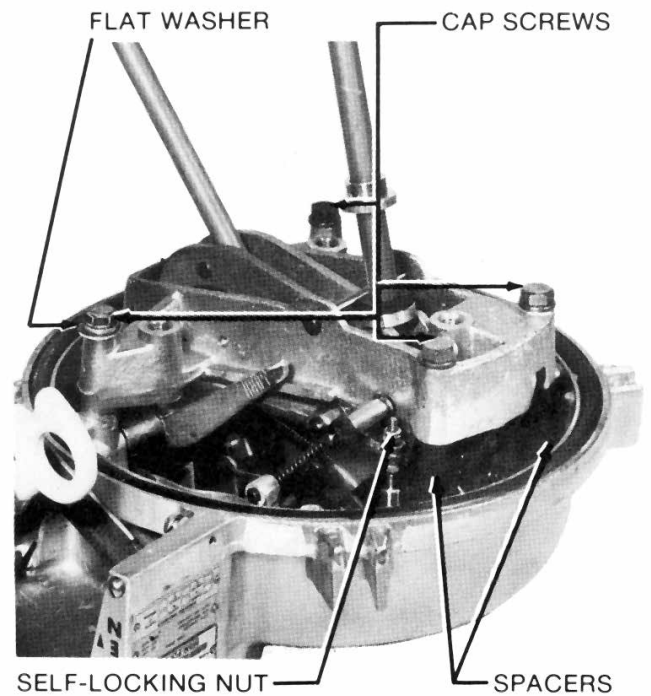
**Table 10. Parts list for bushings (see Figure 32)**

Item No.	Catalog No.	Description	No. used
1	KA160E23	Bushing assembly	2
2	KP2090A29	Bushing gasket, lower	2
3	KP121 L	Bushing clamping gasket	2
4	K730115137200A	Stainless steel hex cap screw - 3/8 in. - 16 NC2 X 2in.	6
5	KP41 L	Galvanized bushing clamp segment	6
6	KP3251A20	Bushing lead	1
7	KP2106A33	Tubing	1
8	KP3256A1	Bushing lead	1
9	KP2106A75	Tubing	1
10	K900525039087A	3/8 in. brass flatwasher	2
11	K900830037000A	3/8 in. bronze lockwasher	2
12	K880725321 037A	3/8 in. - 24UNF - 2 B brass hex nut	2

**Head mechanism**

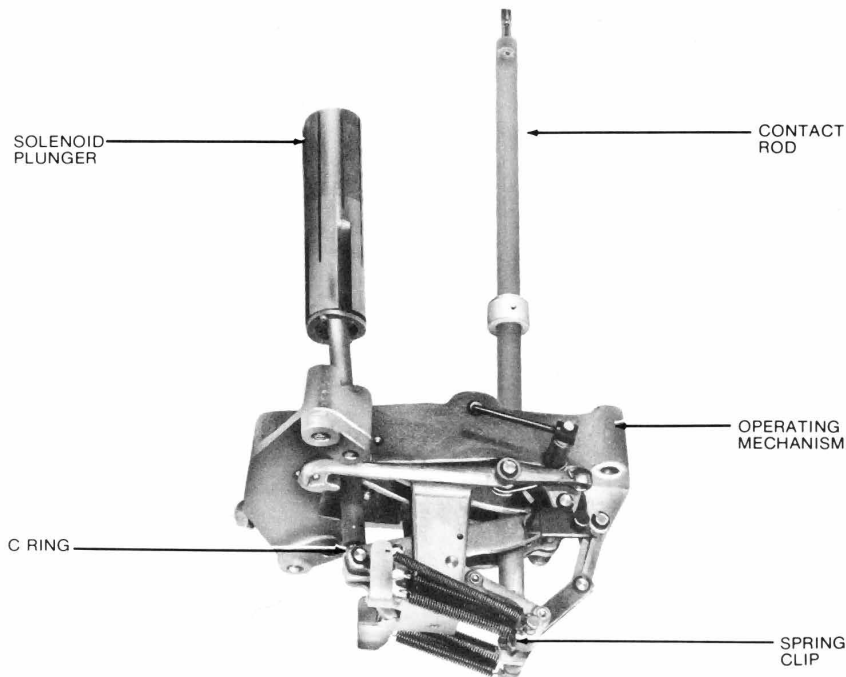
Disassembly of the head mechanism should rarely be required. Should this be necessary for any reason, follow these steps:

1. Move operating lever to the OPEN position.
2. Figure 33 shows a head assembly as it appears after the arc-interrupting structure, series-trip solenoid, hydraulic mechanism, insulating stringers and bushings have been removed. Remove self-locking nut and four hexcap screws indicated in Figure 33. Note use of flat washer under cap screw nearest the operating lever. Also note that two pipe spacers will be released.
3. Lift the operating mechanism assembly to expose the pivot point. Remove the C ring and pull out the pin. Lift out the entire mechanism.
4. Remove C ring (Figure34) and pull pin that secures the solenoid plunger to the operating mechanism. Then pull off spring clip and remove pin that secures the contact rod. The trip rod is removed by removing the E-ring on the head casting side of the rod (Figure 20).
5. Figure 35 shows the head assembly as it appears after the operating mechanism has been removed. Unhook lockout spring and operating lever spring.
6. Remove sleet hood cover and counter. Then drive out a pin (not shown) in the lockout lever.

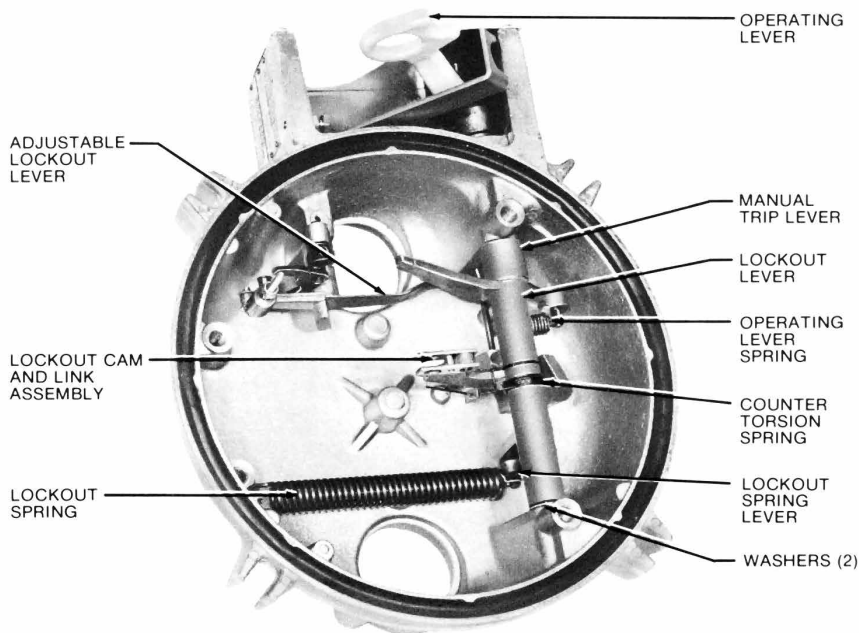


**Figure 33. Head operating mechanism**

## Type E — Maintenance instructions



**Figure 34. Releasing plunger and contact rod**



**Figure 35. View of head mechanism**

7. Pull the operating lever and remove manual trip lever. Then lift out the lockout cam and link assembly, and lockout lever. See Figure 36.
  8. Drive out the rollpin that secures the counter lever assembly to the counter shaft as illustrated in Figure 37. Pullout the shaft. Note the flat washer that separates the counter lever assembly and a post in the head casting.
  9. Slip off the adjustable lockout lever (Figure 38).
- All major components have been removed at this point, with the exception of the non-reclosing accessory. Description of removal of this device is omitted because such procedure should never be necessary.

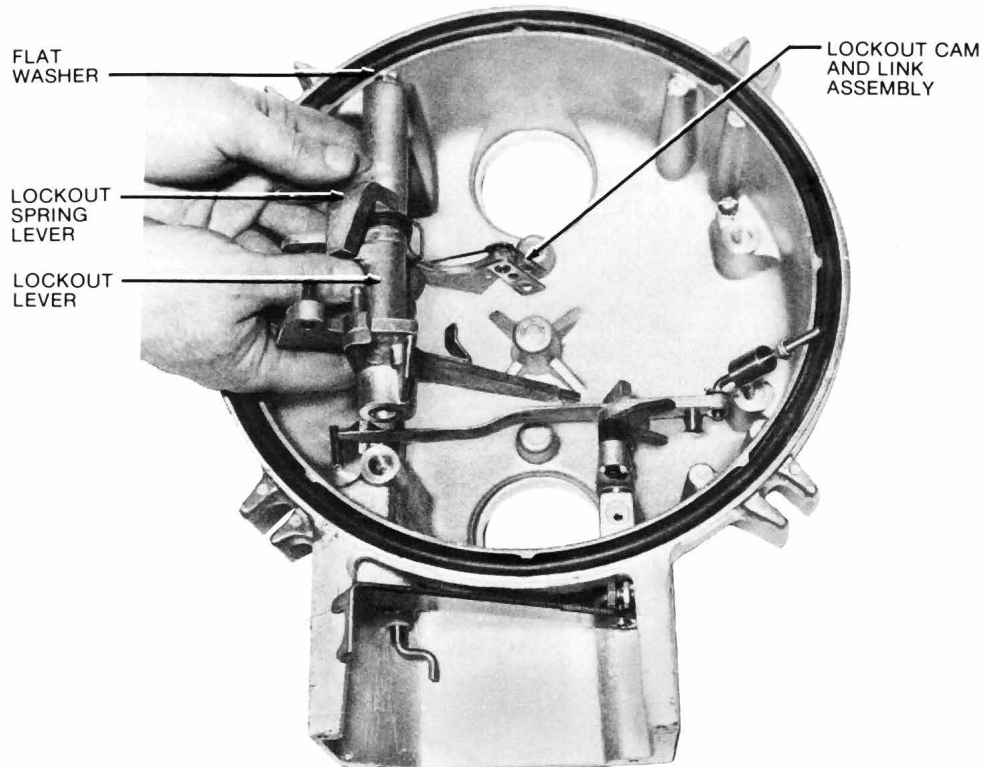


Figure 36. Head mechanism parts being removed

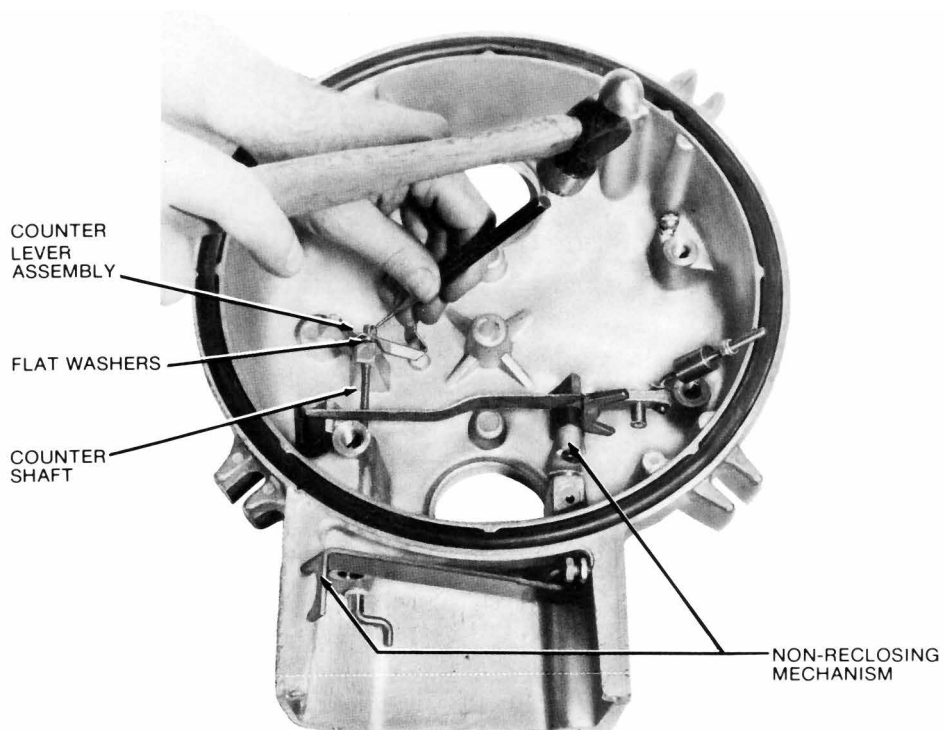


Figure 37. Driving out pins in counter shaft



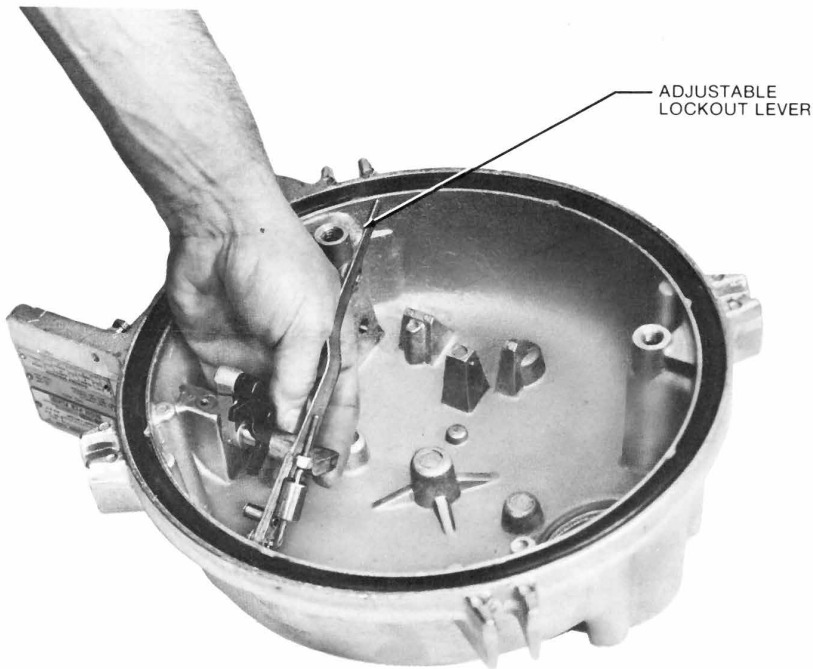
## Type E — Maintenance instructions

Reassembly of the head mechanism can in general be accomplished by reversing the foregoing procedure. Some helpful precautions are noted below.

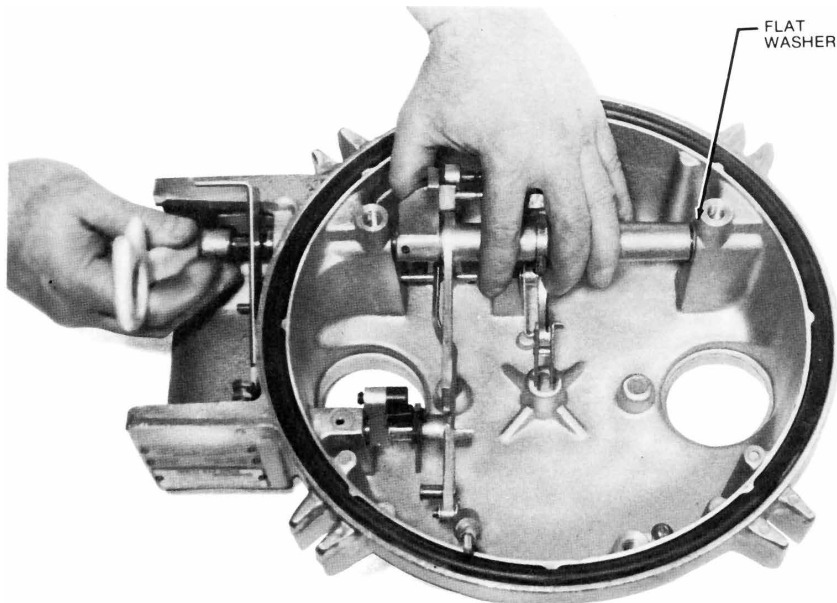
1. Install counter parts first.
2. Next, position adjustable lockout lever (Figure 38).
3. Slide lockout spring lever, counter spring, lockout cam and link assembly, and lockout lever onto their shaft.

Note that the hollow shaft end must point toward the sleet hood. Position this assembly. Be sure to include the flatwasher on the end of the shaft. See Figure 39.

4. Now position the manual trip lever and insert the operating lever. Pin the lockout lever to the operating lever.
5. Connect the solenoid plunger and contact rod to the operating mechanism. Bolt the operating mechanism in the position shown in Figure 33.



**Figure 38. Lifting out adjustable trip lever**



**Figure 39. Reassembling head mechanism**

6. Connect adjustable lockout lever to the operating mechanism by replacing the self-locking nut removed in the "Head Mechanism" section, Step 2.
7. Check adjustment of the lockout mechanism as follows:
  - A. Grasp the insulating tube portion of the trip piston assembly (Figure 23), and lift it until the trip piston contacts the slide valve stop. Make a light scribe mark on the insulating tube 1/4 in. above the slide valve stop.
  - B. Release the trip piston tube and move the operating lever to the CLOSED position.
  - C. Hold the operating lever with one hand to prevent the recloser from opening out of oil. Then slowly raise the insulating tube of the trip piston assembly. Recloser should trip just as the light mark made in step A moves even with the top of the slide valve stop.
  - D. If tripping does not occur as described in Step C, adjust self-locking nuts shown in Figure 40 to achieve correct operation. Note that the mechanism cannot operate properly if the nuts are tight against the operating mechanism lever. Always back off either nut one-half turn before testing.

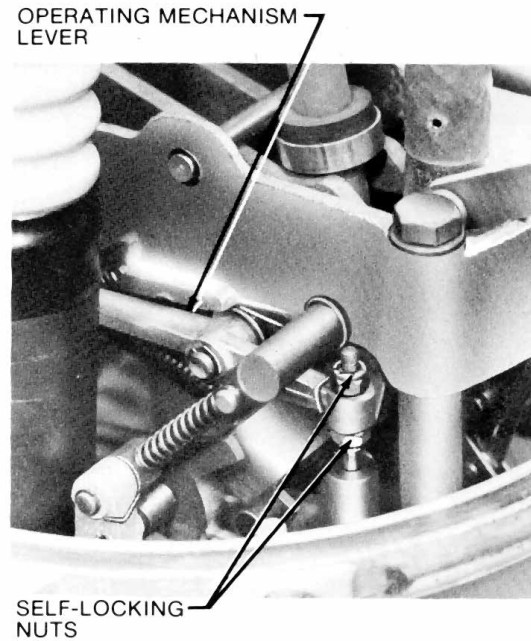


Figure 40. Adjustable lockout lever setting

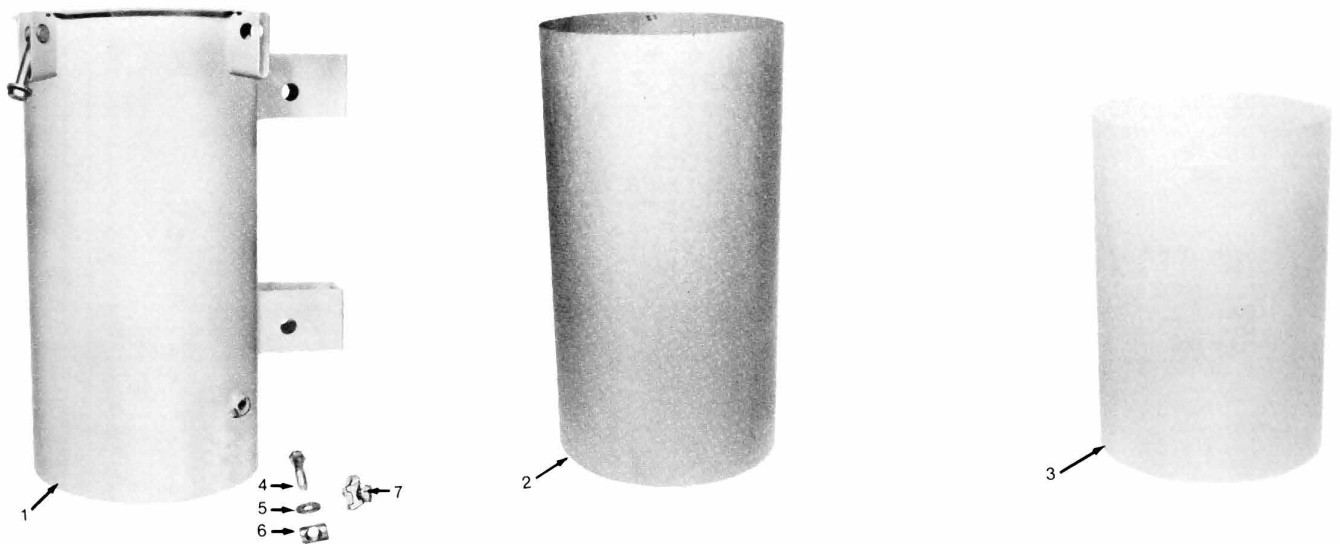
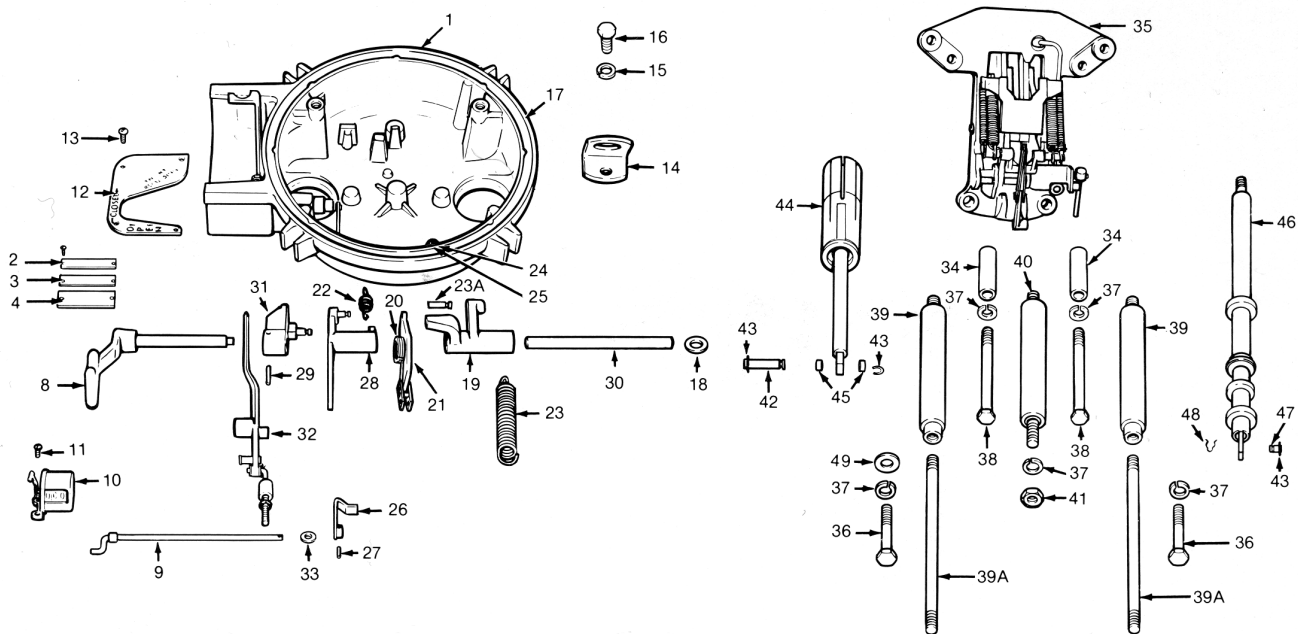


Figure 41. Parts for tank and liner. See Table 11 for parts identification

## Type E — Maintenance instructions

**Table 11. Parts list for tank and liner (see Figure 41)**

Item No.	Catalog No.	Description	No. used
1	KA145L2	Tank assembly	1
2	KP277E	Tankwall insulation	1
3	KP191L	Liner	1
4	K730101150350Q	Electro zinc-plated steel hex cap screw-1/2in.-13NC2 X3-1/4in.	4
5	KP2028A23	Galvanized steel washer- 17/32- X 1-1/8-in. X1/8in.	4
6	KP86 L	Galvanized combination steel nut and pin	4
7	KA227H	Ground clamp	2



**Figure 42. Parts for head assembly. See table 12 for parts identification**

**Table 12. Parts list for head assembly (Figure 42)**

Item no.	Catalog no.	Description	No. used
1	KP344L-2	Head Casting	1
2	KP282E900	Name plate and mounting screws	1
3	KP2119A13	Coil data plate, add continuous rating and screws	1
4	KP1371R	Operating data plate, add sequence and screws	1
5	KP3106A12	Bushing in cover, counter shaft*	1
6	KP269L	Bushing in cover, operating handle*	1
7	K970901500000	Open-type retaining ring*	1
8	KA92L	Operating lever, includes shaft assembly (KA5L)	1
9	KP258 L	Counter shaft assembly	1
10	KA28COIS	Counter kit	1
11	K751501106062A	Round-head self-tapping screw No.4 X5/16in.	2
12	KP292 L	Sleet hood cover plate	1
13	K781515112050A	Steel round-head phillips self-tapping screw— No.12 X1/2in.	4
14	KP764 H	Lifting lug replacement kit	1
15	K900801050000Z	Lockwasher	1
16	K730101150100C	Standard hex capscrew 1/2in.- 13UNC2 X1 in.	1

**Table 12. Parts list for head assembly (Figure 42) (continued)**

Item no.	Catalog no.	Description	No. used
17	KP2103-A4	O-ring head gasket	1
18	K900101051087C	Flat washer- zinc plated	1
19	KP14L	Lockout spring lever	1
20	KP158L	Counter torsion spring	1
21	KA27L	Lockout cam and link assembly	1
22	KP27H	operating lever spring	1
23	KP99L	Lockout spring	1
23A	KP73L	Lockout spring anchor pin	1
24	K721501125062C	Zinc plated round head screw -1/4in.-20UNCA2AX5/8in.	1
25	K881001120025C	Zinc plated hexnut-1/4in.-20UNC2B	1
26	KA118L	Counter lever assembly	1
27	KP2001 A2	Stainless steel groove pin - 3/32 in. X 1/2 in., Type 2	1
28	KA17L	Lockout lever assembly	1
29	KP2001 A13	Stainless steel groove pin -1/8 in.X1-1/4 in.,Type1	1
30	KP77L	Operating shaft	1
31	KA5L	Manual trip lever assembly, part of item 8 (KA92L)	1
32	KA72 L	Trip lever assembly	1
33	KP3006A7	Spacer, counter shaft	1
34	KP33 L	Operating mechanism frame spacer	2
35	KA37L	Operating mechanism assembly	1
36	K730101143250A	Steel hex cap screw -7/16 in.-14NC2X2-1/2 in.	2
37	K900801043000A	Steel lockwasher - 7/16 in. - X 0.156in. X 0.109 in.	5
38	K730101143550A	Steel hex cap screw -7/16 in.-14NC2X5-1/2 in.	2
39	KA10L	Insulating stringer, long	2
39A	KP3149A33	Solenoid tie bolt	2
40	KA122 L	Insulating stringer, short	1
41	K880201114043A	Steel hex nut - 7/16 in. - 14 NC2	5
42	KP3125A4	Pivot pin	2
43	K970901312000M	Retaining Ring	5
44	KA28L	Solenoid plunger assembly	1
45	KP3007A162	Spacer	2
46	KA1 78 E	Contact rod assembly	1
47	KP3125A1	Pivot pin	1
48	KP2018A1	Spring clip, no.1090 narrow, 0.041 dia. wire	1
49	K900201043000A	Standard light steel flat washer 7/16 in. X59/64 in. X 0.080 in. (see Figure 35)*	1

\*not shown

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