Types H, 4H, and V4H maintenance instructions

Type H 50 Amp reclosers - Applicable to serial numbers above 246404 or beginning with CP57.

Type 4H 100 Amp reclosers - Applicable to serial numbers above 69275 or beginning with CP57.

Type V4H 200 Amp reclosers - Applicable to serial numbers above 7542 or beginning with CP57.

Powering Business Worldwide

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Contents

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY I

SAFETY FOR LIFE III

SAFETY INFORMATION III

Safety instructions iii

PRODUCT INFORMATION 1

Introduction 1

Read this manual first 1

Additional information 1

ANSI standards 1

Quality standards 1

General description 1

RATINGS AND SPECIFICATIONS 2

RECLOSER OPERATION 3

First operation 3

Second operation 3

Third operation 4

Fourth operation 4

ROUTINE MAINTENANCE 5

Periodic maintenance check 5

Oil condition check 7

Vacuum interrupter check 7

Vacuum integrity 7

TESTING 8

Mechanical operation test 8

Minimum-trip-current test 8

Insulation level withstand tests 9

Timing characteristics test 9

SHOP MAINTENANCE PROCEDURES 10

Bushings 10

Contact-box assembly, type 4H recloser 11

Solenoid coil 13

Solenoid frame and hydraulic mechanism 14

Timing mechanism and operating sequence 17

Head assembly 18

SERVICE PARTS LIST 21

Bushing and tank assemblies (Figure 30) 21

Head assemblies (Figure 31) 23

Solenoid and interrupter assemblies (Figure 32) 25

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 flash clothing, safety glasses, face shield, hard hat, rubber gloves, 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 may 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 *MN280052EN* covers the maintenance instructions for Types H, 4H, and V4H hydraulically controlled single-phase reclosers. This includes their general description, operating principles, and instructions for periodic inspection, testing, troubleshooting, and shop repairs. Service parts lists keyed to exploded-view drawings of the equipment are included at the back of 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.

ANSI standards

Eaton's Cooper Power series reclosers are designed and tested in accordance with the following ANSI standards: C37.60 and 37.85 and ANSI Guide C37.61.

Quality standards

ISO 9001 Certified Quality Management System.

General description

The Types H, 4H (oil interrupting), and V4H (vacuum interrupting) reclosers are self-contained devices that sense and interrupt single-phase fault current on a distribution circuit. If the fault is temporary, the recloser automatically recloses to restore service. If the fault is permanent, the recloser will lock out after one, two, or three attempts to restore service, depending on its setting. Once locked out, the recloser must be manually reset to restore service.

Operating sequences of the recloser can be all fast, all slow, or a combination of fast operations followed by slow operations. Fast operations (no intentional delay in interrupting the circuit) are used to clear temporary faults before branch-line fuses are damaged. Slow operations (delay inversely proportional to the magnitude of the fault) are used to allow fault current to flow long enough to be cleared by branch-line fuses. Subsequent reclose restores service to the unfaulted portion of the circuit and confines outages to shorter sections of the line.

Ratings and specifications

Table 1. Voltage ratings

Nominal system voltage, kV RMS	14.4
Rated maximum voltage, kV RMS	
Type H	15.0
Types 4H and V4H	15.5
Rated impulse withstand voltage (BIL), kV crest	
Type H	95
Types 4H and V4H	110
60 Hz withstand, kV rms	
Dry, 60 seconds	
Type H	35
Types 4H and V4H	50
Wet, 10 seconds	
Type H	30
Type 4H and V4H	40
Reclosing time, seconds	
Type H recloser	1
Type 4H recloser	1-1/2
Type V4H recloser	1-1/2
Bushing creepage distance, mm (in)	
Type H	264 (10.25)
Type 4H and V4H	276 (10.75)

Table 2. Current ratings

Recloser	Trip coil ratings continuous (A)	Minimum trip ratings (A)	Interrupting ratings (RMS symmetrical amps) 2.4 through 14.4 kV		
Type H 50 A max	5	10		125	
	10	20		250	
	15	30		375	
	25	50		625	
	35	70		875	
	50	100		1250	
			4.8 kV	8.32 kV	14.4 kV
Type 4H 100 A max	5	10	200	200	200
	10	20	400	400	400
	15	30	600	600	600
	25	50	1000	1000	1000
	35	70	1400	1400	1400
	50	100	2000	2000	2000
	70	140	2800	2500	2000
	100	240	3000	2500	2000
Type V4H 200 A max	5	10	200	200	200
	10	20	400	400	400
	15	30	600	600	600
	25	50	1000	1000	1000
	35	70	1400	1400	1400
	50	100	2000	2000	2000
	70	140	3000	2500	2000
	100	200	3000	2500	2000
	140	280	3000	2500	2000
	200	400	3000	2500	2000

Table 3. Duty cycle

Type	% Interrupting rating	Maximum circuit X/R ratio	Number unit operations	Total unit operations
H	15-20	2	40	100
	45-55	4	40	
	90-100	8	20	
	15-20	2	32	
4H	45-55	5	24	68
	90-100	10	12	
	15-20	2	128	
V4H	45-55	5	96	272
	90-100	10	48	

Recloser operation

Electrical operation of the recloser is initiated by the trip solenoid. The trip-solenoid coil is connected in series with the distribution circuit and protected from transient surges by a bypass gap. When the current through the coil approaches twice the continuous current rating of the coil, the increased magnetic field pulls the solenoid plunger down into the coil. As the plunger moves downward, it trips open the recloser contacts to interrupt the fault. The coil de-energizes, the plunger returns, and the contacts reclose to restore service. Up to a maximum of four such operations can be provided before the recloser locks out. It must then be manually reset before it can be put back in service.

The operating sequence of the Types H, 4H, and V4H reclosers is governed by a hydraulic system that utilizes the surrounding insulating oil in timing and counting operations. For a normal sequence of two fast operations followed by two slow operations, the hydraulic counting and timing system functions as follows.

First operation

As the plunger is drawn down by the solenoid coil, the lower end trips the contact assembly to open the contacts. At the same time, the plunger displaces the oil in the plunger cylinder. The displaced oil raises the slide valve and escapes through a port above the trip piston (see Figure 2).

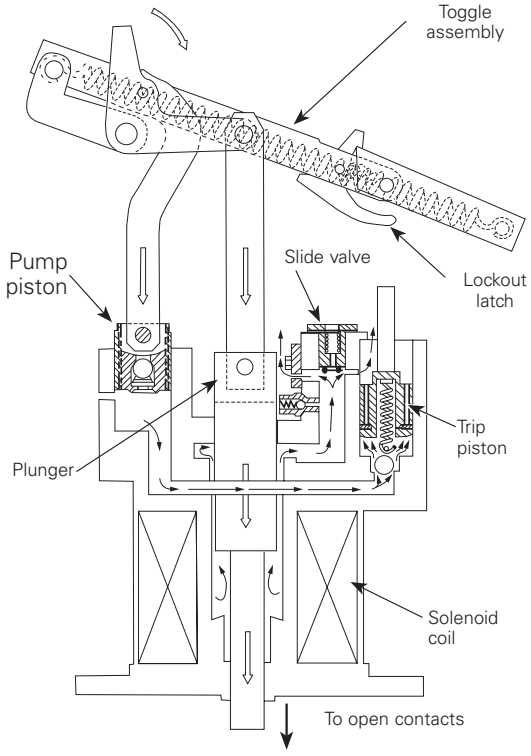


Figure 1. Magnetic force of coil pulls plunger down

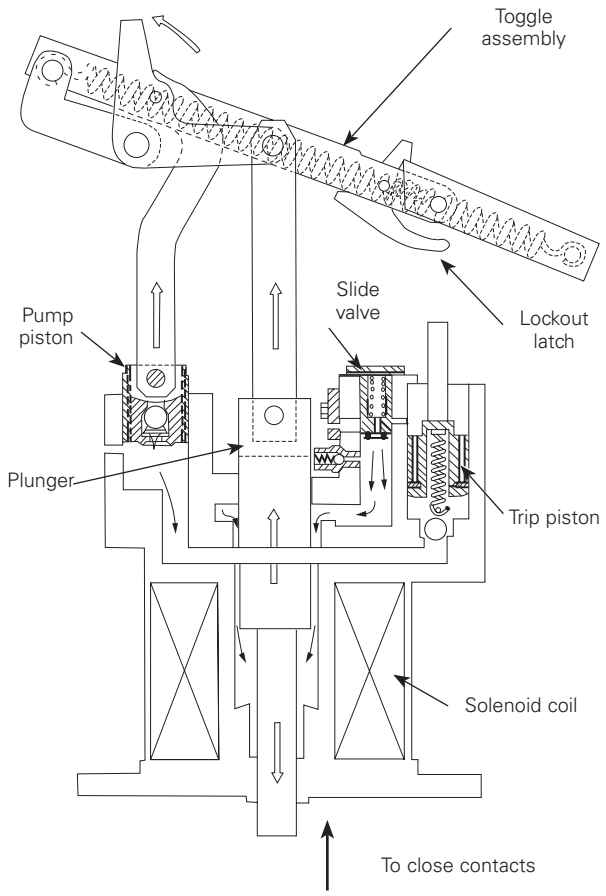


Figure 2. Plunger returns to normal position

The pump piston, connected to the plunger by a lever arrangement, also moves downward and forces a charge of oil under the trip piston. This charge displaces the trip piston a measured amount. A ball-check valve retains the charge in the trip piston. The quantity of oil in the charge can be regulated by changing the effective length of the pump piston.

Opening the contacts breaks the circuit and de-energizes the solenoid coil. Contact operating springs force the plunger back to its normal position and close the contact assembly. As the plunger moves upward (see Figure 3), oil is drawn back into the plunger cylinder, causing the slide valve to move down and block the port to the trip piston cylinder. Thereafter, oil flows slowly through the small port in the slide valve. This slow oil flow retards the return of the plunger to its normal position, causing a delay of 1 (Type H) or 1-1/2 (Type 4H or V4H) seconds before the contacts close.

Second operation

If the fault still exists after the contacts close, the recloser recycles. This second operation is similar to the first, except the second charge of oil from the pump raises the trip piston high enough to block the escape port in the slide-valve cylinder.

Third operation

If the fault still exists after the contacts close the second time, the recloser again recycles. During this third operation (see Figure 4), travel of the plunger down into the coil is impeded by the oil. Oil displaced by the plunger raises the slide valve, but it cannot flow out through the blocked escape port. The oil must flow around the plunger and through the orifice in the timing plate. Slowing the downward movement of the plunger causes a delay in opening the contacts to produce the retarded trip operation.

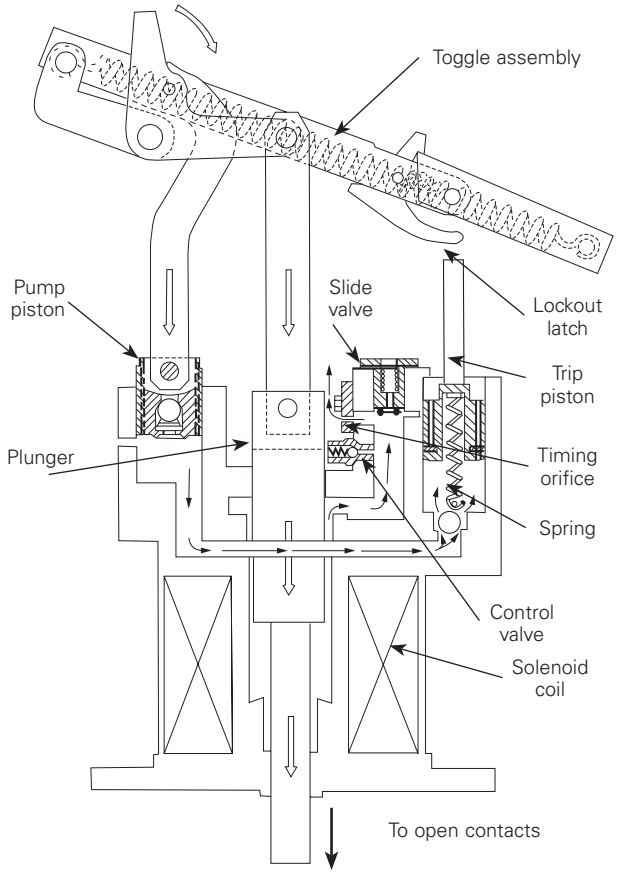


Figure 3. Magnetic force pulls plunger down for third operation, which is retarded by blocked escape port

If the fault current is high, enough pressure will be developed by the plunger to open the spring-loaded control valve in the trip-piston cylinder and provide an additional escape port for the oil. This produces the inverse time–current characteristic of the retarded trip operation.

As the plunger moves downward, a third charge of oil is forced under the trip piston, raising it another measured amount in its cylinder.

Fourth operation

If the fault is still present after the third reclosure, the recloser performs a fourth operation. The fourth operation is a retarded trip operation similar to the third. However, the fourth charge of oil produced by the pump raises the trip piston the remaining distance required to trip the lockout latch (see Figure 5). This latch releases the toggle that holds open the contacts until the toggle is manually reset by operating the yellow operating handle on the recloser.

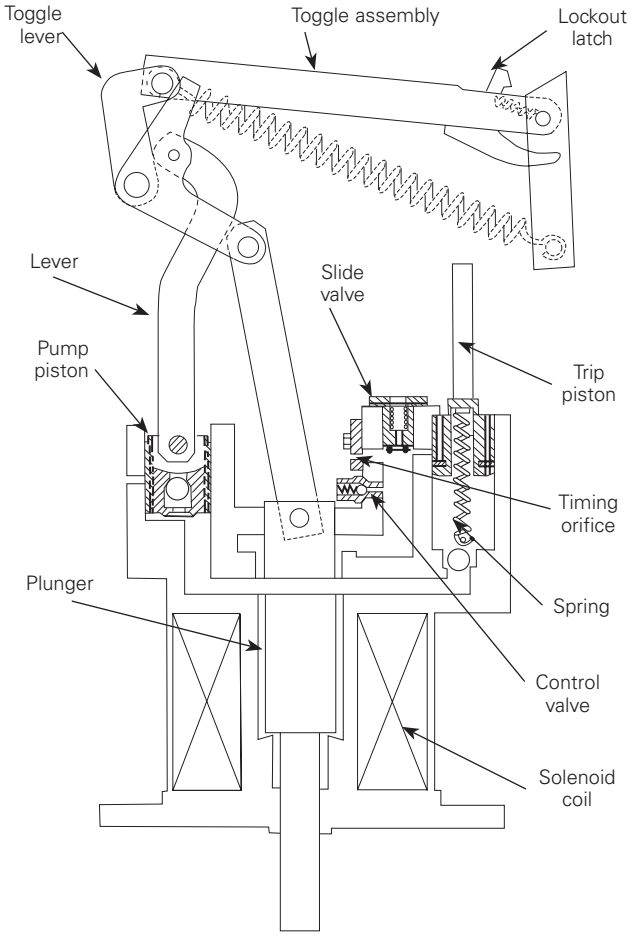


Figure 4. Fourth operation causes lockout as trip piston strikes lockout latch

During lockout, the trip piston, aided by its spring, settles to the bottom of its cylinder. The recloser is ready to perform another operating sequence as soon as the contacts are manually closed.

If a temporary fault clears before lockout, all mechanical operations cease after the contacts have closed on the first successful reclosure. The trip piston settles to the bottom of its cylinder, and the recloser is ready to start another operating sequence when a fault again occurs. Settling of the trip piston enables the recloser to "forget" that a temporary fault occurred. Settling time is approximately one minute per operation at a 25°C (77° F) ambient oil temperature.

Routine maintenance

Periodic maintenance check

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

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

The frequency of maintenance depends upon local climatic and operating conditions; maintenance intervals are best determined by the user, based on actual operating experience. To assure proper and t rouble-free operation, reclosers must be maintained when they have operated the equivalent of a rated duty cycle. Initially, a maintenance check should be made after three years of service or the completion of a standard duty cycle, whichever occurs first. Refer to Table 3 in the **Ratings and Specifications** section of this manual.

Note: ANSI C37.61, "Guide for the Application, Operation, and Maintenance of Automatic Circuit Reclosers," gives a procedure for converting the rated standard duty cycle into an equivalent duty cycle based on the actual operating duty of the recloser.

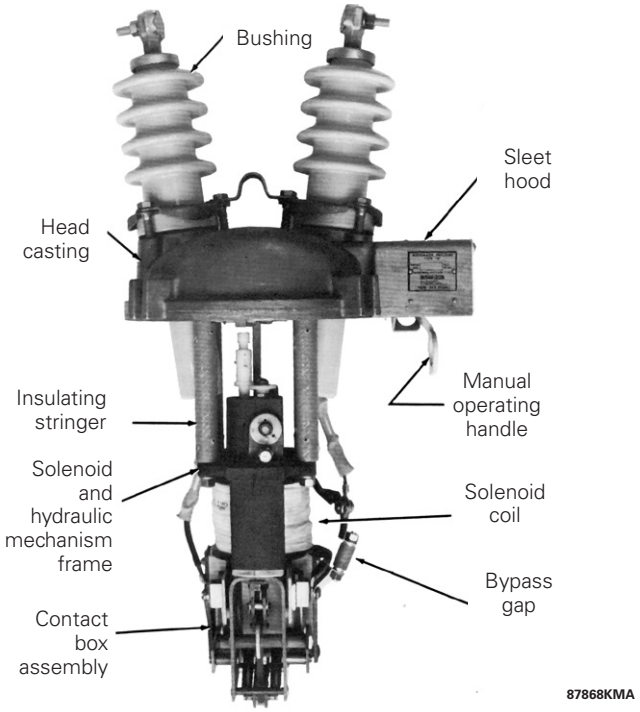


Figure 5. Identification of major assemblies, Type H Recloser

Maintenance procedure

Each periodic maintenance check should include at least the following steps (see Figure 6):

1. Bypass and remove the recloser from service. To remove from service, close the bypass switch and open the disconnect switches. See Figure 7.

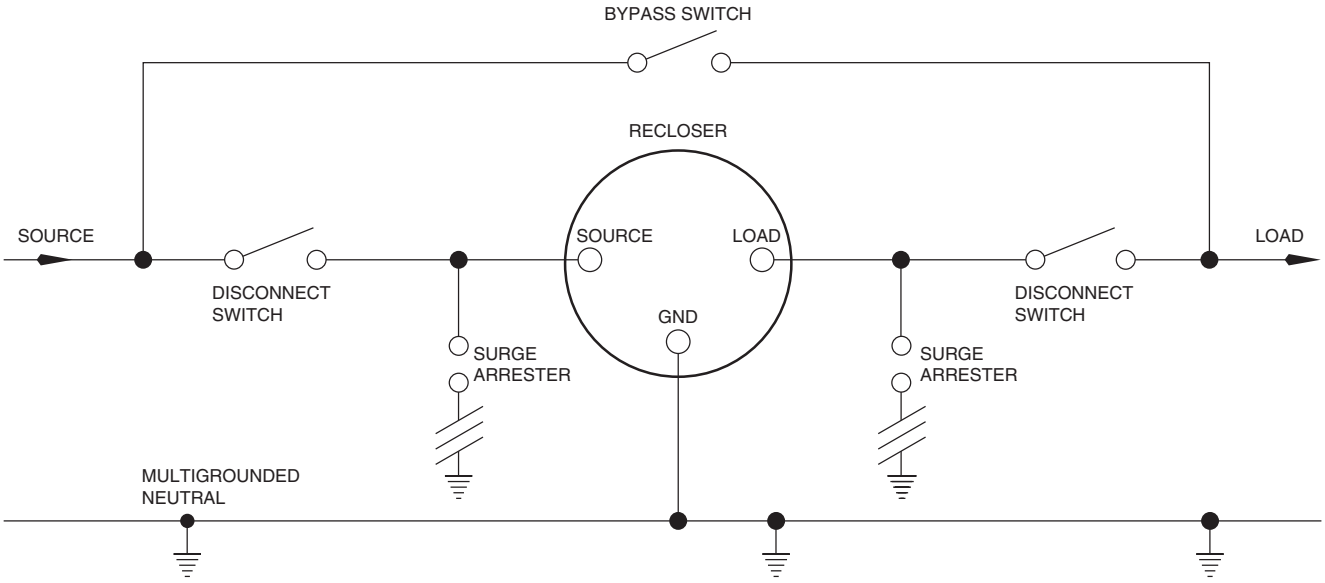


Figure 6. Connection diagram

2. Thoroughly clean exterior.
3. Inspect external components.
   A. Check for broken or cracked bushings. Replace as necessary. (See the **Shop Maintenance Procedures** section of this manual.)
   B. Check for paint scratches and other mechanical damage. Repair or replace as required.
   C. Note counter reading and enter into the record log.
4. Perform an insulation level withstand test to check the insulation level of the recloser. See the **Insulation Level Withstand Tests** section of this manual.

⚠ CAUTION

Equipment damage. Recloser must be open (yellow operating handle, under sleet hood, 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

5. Manually operate yellow handle until lockout is reached to verify that recloser is working properly. Leave the recloser in the open position.
6. Loosen bolts that secure head casting and remove mechanism from tank. (The gasket seal can be broken by carefully prying apart the head and tank.) Allow oil to drain off the mechanism.

⚠ 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

7. 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.
8. Remove bushings, clean, and inspect.
9. Replace all external seals and gaskets.
10. Inspect mechanism for cracks, carbon tracking, flashovers, or other damage. Repair or replace as required.
11. Inspect contacts and interrupting structures.

    For H and 4H recloser:

    A. Slight pitting and discoloration can be dressed with polishing-grade sandpaper.
    B. Replace moving contacts and interrupting structures if they are severely eroded.

    For V4H recloser:

    See the **Vacuum Interrupter Check** section of this manual.

12. Inspect tank liners. Soft or spongy areas indicate that water has been absorbed. Replace liners if this condition exists. Locate the seam of the tank liner opposite the pole-mounting bracket, see Figure 8.

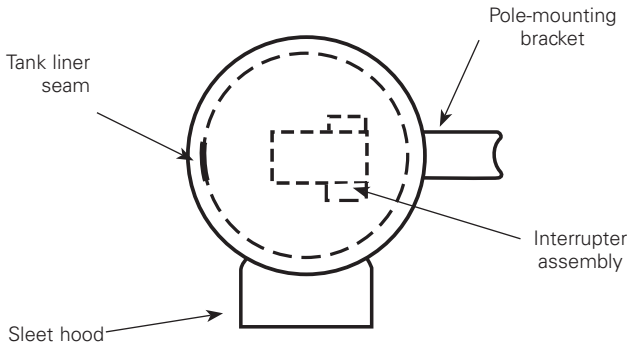


Figure 7. Orientation of tank liner

13. Check the dielectric strength of the insulating oil.
    A. The dielectric strength should not be less than 22 kV when tested with a 2.5 mm (0.1 in.) gap in accordance with methods specified in ASTM D117.
    B. Low dielectric strength usually indicates presence of water or carbon deposits.
14. If oil must be replaced, drain the tank and clean out all sludge or carbon deposits.
15. With the mechanism removed, fill the tank with clean insulating oil to level marked on tank liner. Capacity is approximately four gallons for Type H or five gallons for Types 4H and V4H. Use only new or like-new reconditioned insulating oil that conforms to the specifications in Reference Data *TD280022EN: Reclosers, Sectionalizers, Switches: Oil Specifications and Tests.*
16. Examine head gasket. Replace the o-ring gasket if it has taken a permanent set.
17. Replace the mechanism in the tank.
    A. Replace the head bolts and torque to 15–22 N•m (11–16 ft•lb). Clamping forces must be applied gradually and equally, in rotation, to each bolt. This results in evenly distributed gasket sealing pressure.
    B. Operate the recloser manually approximately eight times to expel all air from the hydraulic system.
    C. See the **Testing** section of this manual; check for proper operation before returning recloser to service.

Oil condition check

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

Oil plays an important role in the proper functioning of the recloser. It provides the internal insulation barrier from phase to ground, it acts as the timing and counting medium, and, in the H and 4H reclosers, it acts as an arc quencher. For effective recloser operation, the oil must be replaced before it deteriorates below a safe level. Oil that has been contaminated with carbon sludge or has a dielectric strength of less than 22 kV should be replaced.

New oil should always be filtered before using, 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. When filtering the oil, aeration should be kept to a minimum to prevent moisture in the air from condensing in the oil and lowering its dielectric strength.

Used oil must be treated before reusing. Filtering may remove absorbed and free water and other contaminants to raise the dielectric strength to acceptable levels. However, filtering does not always remove water-absorbing contaminants and the dielectric strength of the oil may fall rapidly after being returned to service. Therefore, the recloser should be filled with new oil or oil that has been restored to like-new condition.

Vacuum interrupter check

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

Vacuum integrity

The following procedure may be used to check the vacuum integrity of the interrupter.

1. With the unit installed in its oil-filled tank, pull down the yellow operating handle to make sure the recloser is open.
2. Perform a high-potential test across the bushings of the open recloser at 37.5 kVac RMS.
3. The interrupter should withstand the specified test voltage for one minute.
4. Replace any interrupter failing to meet this test.

Contact erosion

With the mechanism removed from its tank and the recloser closed (yellow operating handle up), measure the distance (see Figure 9) bet ween the interrupter bracket and the larger diameter of the stepped shaft. If dimension is less than 21 mm (13/16 in.), the interrupter must be replaced.

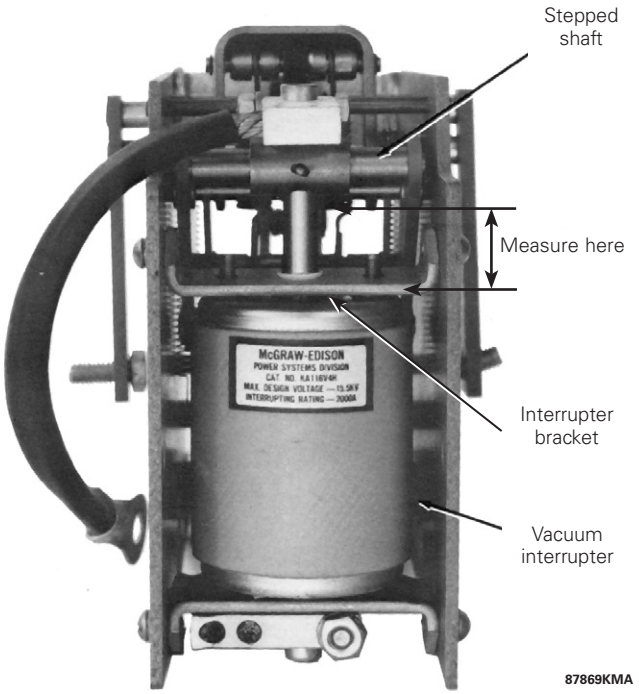


Figure 8. Measurement of contact erosion, type V4H

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 Reclosers.

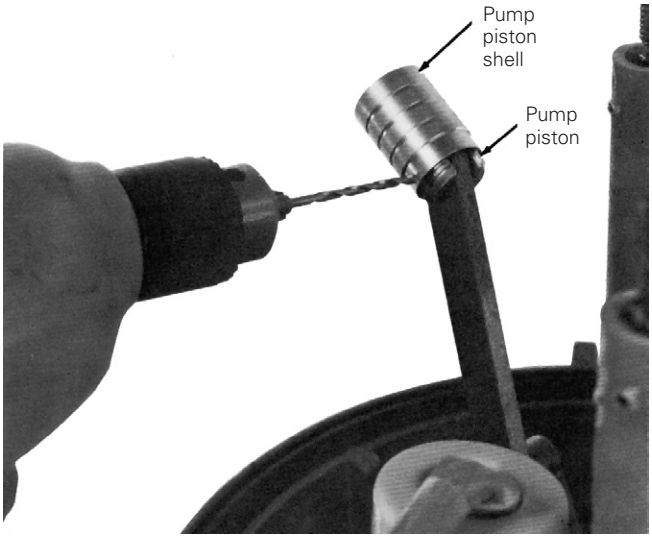
Mechanical operation test

To check the number of operations to lockout and the number of fast and delayed operations, the following mechanical operation test can be performed. Perform this test using a suitable tester.

1. Move the yellow manual operating handle to the CLOSED position and wait at least six minutes to be sure the trip piston is fully reset.
2. Move the operating handle to the OPEN position and listen for the opening of the main contact. Move the handle to the CLOSED position and repeat this cycling until lockout occurs.
3. When lockout occurs, the yellow manual operation handle will not latch in the CLOSED position.

Note: During fast operations, the contacts open immediately after the handle is moved to the OPEN position. on delayed openings, a noticeable slowing of handle movement can be observed until contacts open.

4. The number of fast and delayed operations should match the data plate specifications. If the sequence does not match, check to see if the recloser is correctly configured. If the configuration is correct, the problem may be either a misadjusted pump piston or an oil leak. Inspect the upper coil gasket and replace it if damaged or worn. Repeat the test.
5. If the sequence is still not correct, the pump piston needs to be adjusted or replaced. To adjust, the recloser will have to be disassembled to remove the solenoid frame. Drill out the stake punch in the pump piston shell (Figure 10).



87870KMA

Figure 9. Drilling out stake punch in pump piston shell

   A. If the recloser is performing too many operations to lockout, turn the piston shell counterclockwise a little off the pump piston (Figure 11).

   B. If the recloser is performing too few operations to lockout, turn the piston shell clockwise a little, onto the pump piston (Figure 11).

Assemble the recloser. Continue to test and adjust the pump piston shell until the proper sequence is performed. Then stake the piston to prevent it from moving.

6. If adjustments to the pump piston do not provide the proper sequence, the pump piston shell may be worn. Replace the shell and repeat the test and adjustment procedures.

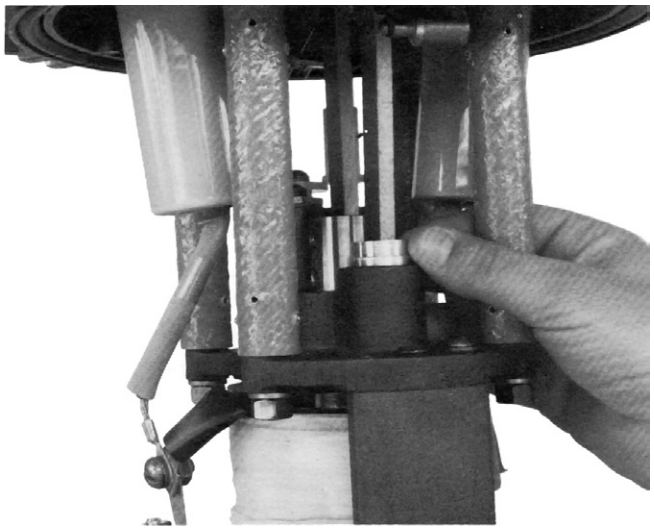


Figure 10. Pump piston shell adjustment 87871KMA

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 12.

   A. Ratio and kVA size of the transformer (T1) will depend upon the size of the recloser trip coil.

   A. Table 4 shows the test voltage and kVA requirements for all ratings of the recloser.

2. Close the recloser by moving the yellow operating handle to CLOSE. Wait at least six minutes to make sure the trip piston is completely reset.
3. Slowly raise the variable-autotransformer voltage from zero. As the trip-solenoid plunger starts to move, the trip coil impedance will rise, causing a decrease in current flow. The maximum current reading taken just before the current begins to decrease is the minimum pickup value.

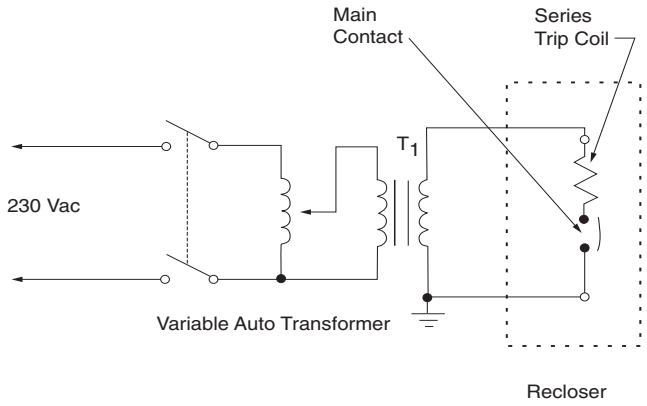


Figure 11. Test circuit diagram

Insulation level withstand tests

⚠ 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

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

Test 1:

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

Test 2:

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

Test results: These high-potential withstand tests provide information on the dielectric condition of the recloser and the integrity of the interrupter.

A. 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.

B. Recloser failure in either open contact test may be caused by a deterioration of the interrupter. Replace the interrupter assembly and repeat the test.

Timing characteristics test

⚠ 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

Timing characteristics should be compared to the published time–current curves for the coil and recloser being tested. Timing characteristics should be within 10% (time or current, whichever is greater) of the published curves.

Note: Refer to the instructions supplied with the tester for additional specific test procedures.

Table 4 shows test voltage and kVA requirements. As the solenoid plunger is drawn into the series trip coil, the impedance of the coil rises sharply. To avoid inaccurate times while testing timing characteristics, the power source must provide four times (4x) the continuous current rating of series trip coil/recloser being tested.

Table 4. Recloser test circuit power requirements for minimum-trip-current test

Recloser	Current coil	Coil x_L (4 X coil rating)	(Plunger up)	Series R (Ohms)	Voltage† required	Test kVA‡ (Short time)
H,4H,	5	20	7.48	37.4	750	15
V4H	10	40	1.88	9.4	376	15.1
	15	60	.814	4.06	244	14.6
	25	100	.297	1.49	149	14.9
	35	140	.158	.79	111	15.6
	50	200	.073	.365	73	14.6
	70	280	.039	.195	55	15.4
	100	400	.020	.100	40	16.0
V4H	140	560	.011	.055	30.8	17.2
	200	800	.005	.025	20	16.0

†Voltage calculations simplified. Found by multiplying current by added series resistance. Coil impedance, source impedance, and test lead resistance neglected, so actual voltage required is greater.

‡Test kVA shown found by multiplying current by voltage. Since voltage is actually somewhat greater, kVA is also greater. Test intervals are short so transformer rating can be smaller if short-time rating equals values shown in table.

If the times fall outside the published range, the problem may be a misadjusted pump piston, an oil leak, or worn parts.

1. If all the delayed times are too short, inspect the solenoid coil and seals. Replace any worn or damaged parts.
2. If one delayed time is too short or one fast time is too long, the pump piston may need adjustment. Refer to the Mechanical Operation Test section of this manual for the proper adjustment procedures.

Note: Adjustments made to the pump piston to effect timing will also effect the sequence of operation.

If proper timing cannot be achieved through adjustment of the pump piston, the problem may be either worn parts or improper configuration. Double check the timing adjustment or replace components, as required, and repeat the test.

Shop maintenance procedures

The operations described in this section should be performed under the cleanest conditions possible. The repair work, except for bushing replacement, will be simplified if the work bench is arranged so the mechanism can be inverted (bushings down). No special tools are required for any of the repair procedures.

Bushings

⚠ 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

⚠ 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

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

A bushing can be replaced with the recloser either tanked or untanked. The following criteria should be used as a guide:

A. If the bushing has been damaged in service or while in storage, the recloser should be untanked. 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 be in the tank.

B. If the bushing porcelain is accidentally chipped during installation or maintenance and it is obvious that no other damage has been done, it is not necessary to untank the recloser to replace the bushing porcelain.

Replacing bushing assembly with the recloser untanked

⚠ CAUTION

Equipment damage. Recloser must be open (yellow operating handle, under sleet hood, 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. Untank the recloser and disconnect the appropriate bushing lead.
   A. The long lead is disconnected at the arc-interrupting structure.
   B. The short lead is disconnected at the solenoid coil.
2. Remove the three hex-head capscrews and the bushing clamps securing the bushing to the head casting, and lift the entire bushing assembly up through the head. Discard the gasket between the bushing and the head casting.
3. Twist the aluminum clamping ring and remove it from the old bushing porcelain. If the ring is in good condition, install it on the new bushing porcelain. If the old ring is damaged, a new clamping ring must be installed. The clamping ring cushions the pressure between the bushing and the bushing clamps and should not be omitted.
4. Replace the bushing assembly. Use a new gasket between the bushing flange and the head casting.
5. Position the aluminum clamping ring with the split in the ring centered between two clamping bolts.
6. Replace the bushing clamps and tighten the capscrews evenly, a little at a time. Clamping torque should not exceed 8–14 N•m (6–10 ft•lb).
7. Reconnect the bushing lead.

Replacing bushing porcelain with the recloser tanked

1. Unscrew the bushing terminal and discard the terminal gasket.
2. Remove the three hex-head capscrews and the bushing clamps, lift the porcelain from the head casting, and discard the old gasket.
3. Transfer the aluminum clamping ring from the old porcelain to the new porcelain. (Replace the ring if damaged.)
4. Install a new gasket between the porcelain and the head casting.
5. Tie a string to the lead, thread it through the bushing, and pull the lead through the porcelain as the porcelain is inserted into the head casting. Pull the lead until the locking key is seated.
6. Install a new terminal gasket and screw the terminal onto the lead.

Note: Apply a very small amount of petrolatum jelly to the knurled surface of the inside face of the terminal before assembly to the bushing rod.

7. Position the aluminum clamping ring with the split in the ring centered between two clamping bolts.
8. Replace the bushing clamps and tighten the capscrews evenly, a little at a time. Clamping torque should not exceed 14 N•m (10 ft•lb).
9. Tighten the bushing terminal to 27–34 N•m (20–25 ft•lb).

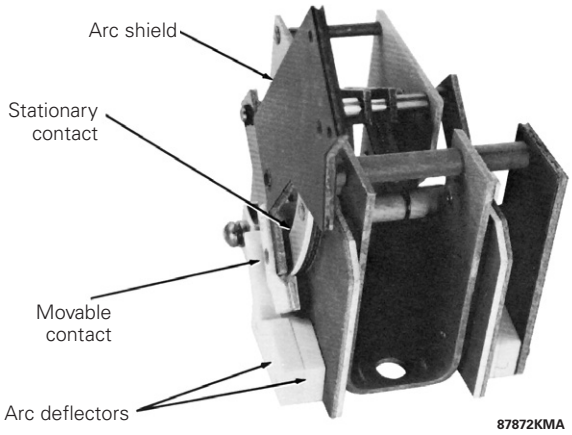


Figure 12. Type H contact-box assembly

Contact-box assembly, type H recloser

Fault current is interrupted in minimum time by the arc- interrupting structure. Circuit opening is provided by a double, spring-loaded, moving contact assembly, see Figure 13.

Inspect contact assembly and be sure contacts completely close.

To clean contacts

If contacts are rough and carbonized, clean as follows:

1. Disconnect two leads from arc-interrupting structure.
2. Remove two screws from arc shield, and swing shield upward.
3. Remove both arc deflectors.
4. Lift movable contact, and clean both contacts with crocus cloth.
5. Reassemble arc-interrupting structure by reversing steps 2 and 3.
6. Clean other set of contacts in same manner.

To replace contact-box assembly

If contacts are badly burned or do not close completely, arc-interrupting structure should be replaced. Proceed as follows:

1. Disconnect two leads from arc-interrupting structure.
2. Remove two hex nuts and washers holding interrupting structure in place.
3. Note position of interrupting structure with respect to pump piston. Lift off interrupting structure.

To install the contact-box assembly

Note: If further maintenance is to be performed at this time, do not reinstall arc-interrupting structure.

1. Lock in the operating mechanism by closing the yellow operating handle.
2. Install the contact-box assembly and secure with the two hex nuts and washers.
3. Reconnect the coil lead and bypass gap to one side of the interrupting structure.
4. Reconnect the long bushing lead to the other side of the structure.
5. Manually open and close the mechanism several times to check the operation of the arc-interrupter assembly.

Contact-box assembly, type 4H recloser

Fault current is interrupted by an oil-quenched arc-interrupting structure consisting of two interrupting chambers connected by a cross-blast tube. Circuit opening is accomplished by a double, spring-loaded, moving contact assembly arranged to provide two breaks in series. As the contacts open, gas pressure generated by the arc in the closed generating chamber forces cool oil against the arc in the vented exhaust chamber, rapidly deionizing the arc path and interrupting the current.

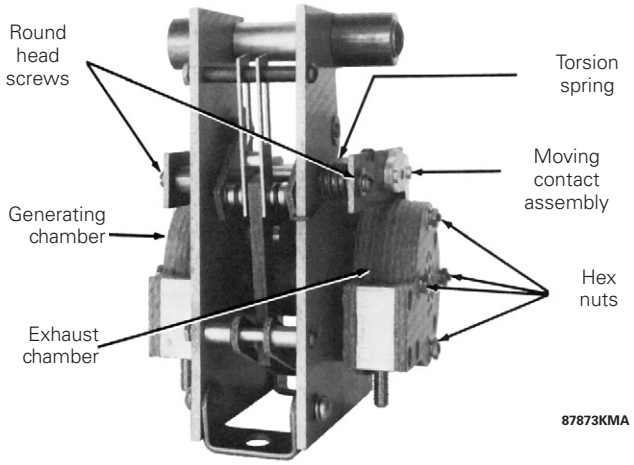


Figure 13. Type 4H contact-box assembly

If contacts are badly burned or do not close completely, both interrupting-chamber assemblies, the cross-blast tube, and the moving-contact assembly must be replaced. Proceed as follows (see Figure 14).

To remove the contact-box assembly

⚠ CAUTION

Equipment damage. Recloser must be open (yellow operating handle, under sleet hood, 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. The main contacts should be open to remove the contact box to prevent inadvertent operation.
   A. To open contacts while the mechanism is tanked, pull down the yellow operating handle.
   B. To open the contacts after the mechanism is untanked, securely hold the yellow operating handle in the closed position, trip the lock-out latch (see Figure 25), and then slowly release the yellow operating handle.

2. Disconnect the long bushing lead from one side of the interrupter structure.
3. Disconnect the coil lead and bypass gap from the other side of the interrupter structure.
4. Remove the two hex-head bolts that secure the arc- interrupting structure to the solenoid frame and remove the structure.
5. Holding the moving contacts open, loop a light cord to the contact spring at the end farthest from the cross-blast structure (see Figure 15) and unhook both springs. Do not stretch the springs any further than required for removal.

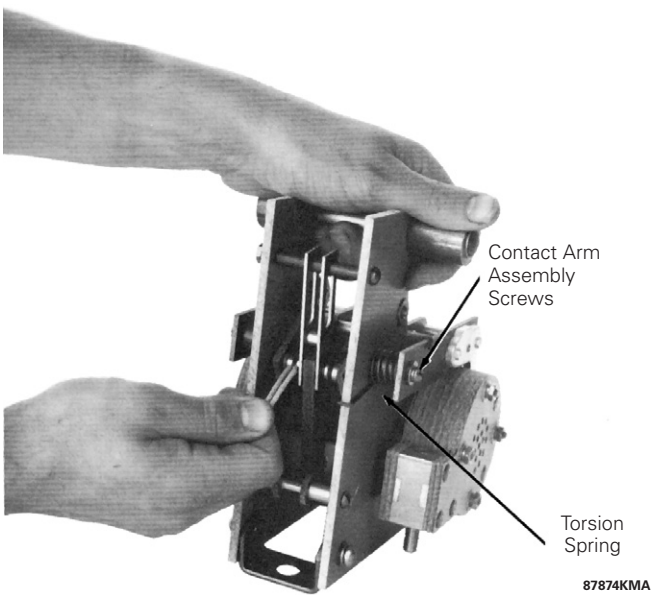


Figure 14. Releasing contact springs

6. Unhook the torsion spring and remove the two roundhead screws, lockwashers, flat washers, and pivot bearings to free the moving contact arm assembly. Remove the assembly.

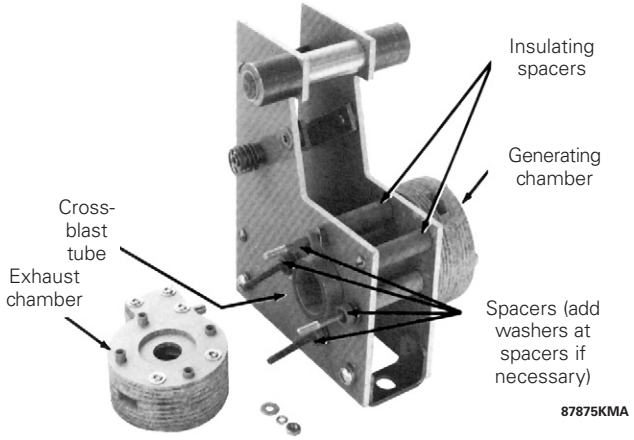


Figure 15. Partially assembled contact-box

7. Remove the four hex nuts, lockwashers, and flat washers that secure the exhaust and generating chambers to the contact-box assembly and remove both chambers by sliding them off the mounting bolts. Figure 16 shows the exhaust chamber removed from the contact-box assembly. Note the position of the insulating spacers.
8. Remove the cross-blast tube. Remove and save the fiber dowel before discarding the tube.

To reassemble the contact-box assembly

1. Assemble the fiber dowel to the new cross-blast tube and install the tube into the contact box. Make sure the dowel is secured in the notch on the side plate.
2. Assemble the interrupting chambers and the moving contact assembly by reversing Steps 5, 6, and 7 above.

Note: After reassembling the contact-box assembly, check for completely free entry of the moving contacts into the stationary-contact housing. Use No. 10 plain brass washers to adjust the position of the stationary-contact housing with respect to the moving contact (see Figure 14).

To install the contact-box assembly

Note: If further maintenance is to be performed, do not install the arc-interrupting structure.

1. Lock in the operating mechanism by closing the yellow operating handle.
2. Install the contact-box assembly and secure with the two hex-head bolts.
3. Reconnect the coil lead and bypass gap to the generating chamber.
4. Reconnect the long bushing lead to the exhaust chamber.
5. Manually open and close the mechanism several times to check the operation of the arc-interrupter assembly.

Vacuum contact-box assembly, type V4H recloser

Current is generally interrupted in less than 1/2 cycle by the vacuum interrupter. Circuit opening is accomplished by a spring-loaded contact assembly operating in a high-vacuum chamber.

When the vacuum interrupter is to be replaced because of contact wear, replace the entire contact-box assembly. If, however, replacement is required because of vacuum interrupter failure (physical damage, loss of vacuum), the vacuum interrupter only can be replaced. See Figure 17.

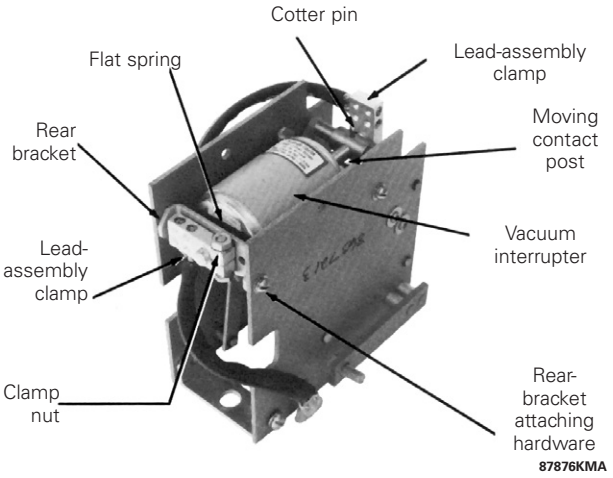


Figure 16. Type V4H vacuum contact-box assembly

To replace the entire vacuum contact-box assembly

CAUTION

Equipment damage. Recloser must be open (yellow operating handle, under sleet hood, 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. The main contacts should be open to remove the contact box to prevent inadvertent operation.
   A. To open contacts while the mechanism is tanked, pull down the yellow operating handle.
   B. To open the contacts after the mechanism is untanked, securely hold the yellow operating handle in the closed position, trip the lock-out latch (see Figure 25), and then slowly release the yellow operating handle.
2. Disconnect the long bushing lead from one side of the interrupter structure.
3. Disconnect the lower coil lead and bypass gap from the other side of the interrupter structure.
4. Remove the two hex-head bolts that secure the arc-interrupting frame and remove the structure.

To install the vacuum contact-box assembly

Note: If further maintenance is to be performed, do not reinstall the arc-interrupting structure.

1. Lock in the operating mechanism by closing the yellow operating handle.
2. Install the contact-box assembly and secure with the two hex-head bolts.
3. Reconnect the coil lead and bypass gap to one side of the interrupting structure.
4. Reconnect the long bushing lead to the other side of the structure.
5. Manually open and close the mechanism several times to check the operation of the arc-interrupter assembly.

To replace only the vacuum interrupter

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

1. Remove the lead assemblies from each end of the vacuum interrupter by loosening the clamping nuts and prying open the clamps.
2. Remove the cotter pin that attaches the movable-contact rod to the operating linkage.
3. Remove the rear bracket by removing the two attaching screws, lockwashers, and flat washers.
4. Remove the flat spring and withdraw the vacuum interrupter.
5. Install a new interrupter and reassemble the structure in the reverse order of disassembly.

Solenoid coil

Types H, 4H, and V4H reclosers are constructed so that solenoid coils of different ampere ratings are interchangeable.

To change a coil, proceed as follows:

1. Remove the arc-interrupting structure.
2. Disconnect the short bushing lead and coil-gap assembly from the upper coil lead.
3. Matchmark bridge plate and solenoid frame for proper position during reassembly.
4. Remove the coil shield (Type H only), bridge plate, lower solenoid gasket, and solenoid coil shown in Figure 18

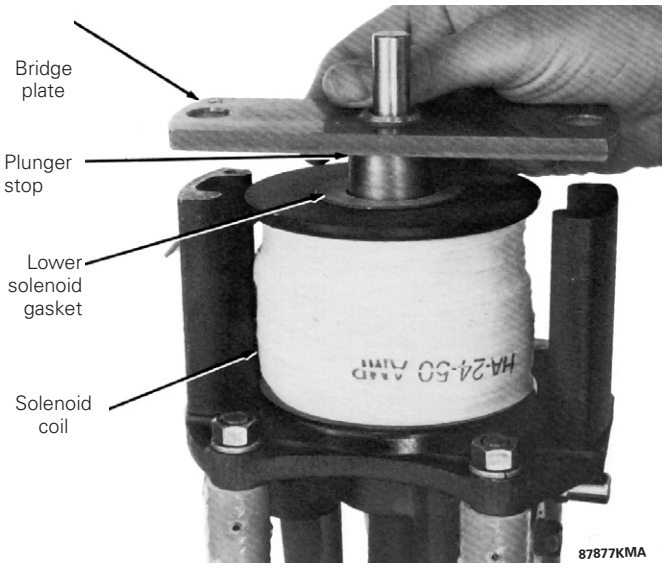


Figure 17. Removing bridge plate, lower solenoid gasket, and solenoid coil

Note: The bridge plate is drilled and pinned to the solenoid frame in a factory fixture for optimum plunger fit. To obtain the most reliable operation, do not intermix bridge plates, plungers, plunger stops, or any other parts between reclosers.

5. Remove upper solenoid gasket and impact washer shown in Figure 19.

Note: Whenever the solenoid coil is replaced or reinstalled, the upper and lower solenoid gaskets must be replaced to maintain proper timing characteristics.

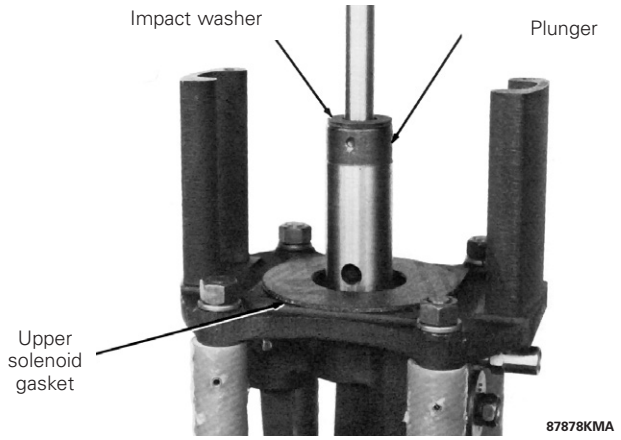


Figure 18. Removing upper solenoid gasket and impact washer

6. Install solenoid coil of desired rating by reversing the above procedure. Make sure that the coil is installed with its leads on the same side of the recloser as the sleet hood and with the short coil lead connected to the short bushing lead and the long coil lead connected to the contact box.

IMPORTANT

When reinstalling the coil bypass, install with air gap hole facing away from head casting. If it is installed upside down, it will fill with oil and be unable to protect the coil from high-voltage surges.

Solenoid frame and hydraulic mechanism

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 replacement, proceed as follows (see Figure 20):

⚠ 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

1. Remove the four hexnuts and lockwashers which attach the solenoid frame to the support stringers.

IMPORTANT

Raise the assembly slowly to withdraw the plunger and pump piston fron their cylinders. Be careful to keep them from falling and being damaged. See Figure 21.

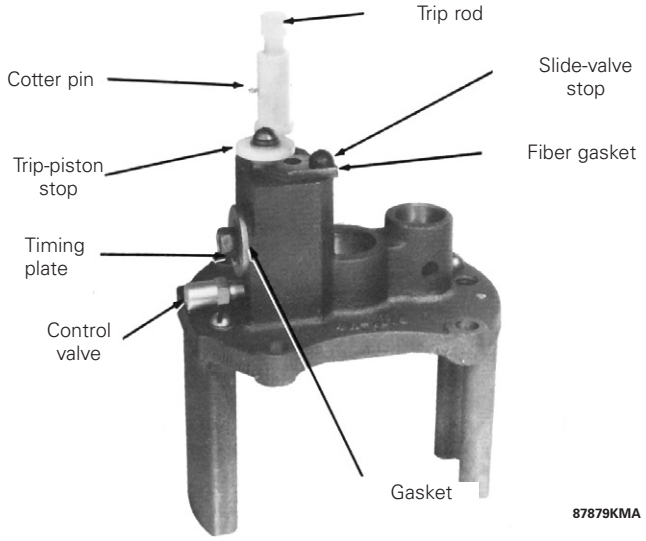


Figure 19. Solenoid frame and hydraulic mechanism

2. Remove the slide valve and spring by removing the two screws and lockwashers attaching the trip-piston stop and the slide-valve stop and gasket to the solenoid frame.

Note: Before disassembly, scribe a mark across the slide-valve stop and the adjacent solenoid frame to identify proper orientation during assembly.

3. Remove the timing plate, gasket, and the control-valve assembly from the solenoid frame.
4. If equipped, remove the solenoid plate and gasket by removing the four flat-head screws.

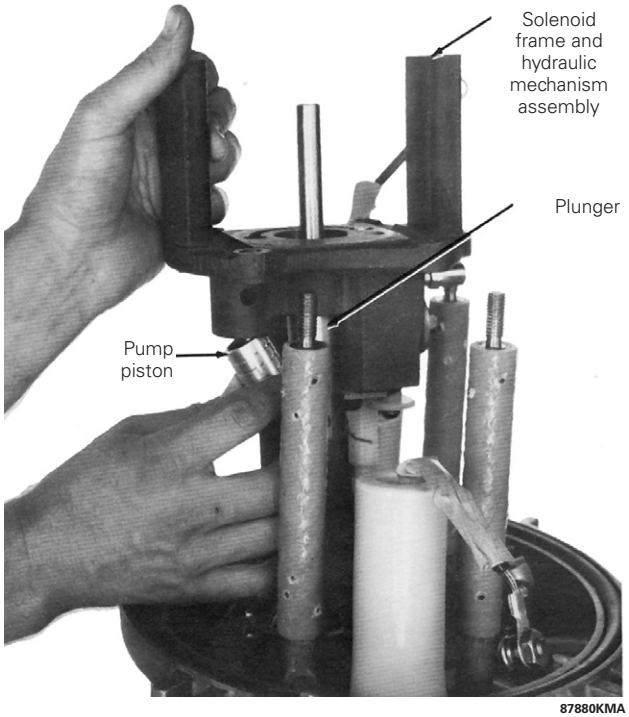


Figure 20. Removing solenoid frame and hydraulic mechanism

⚠ 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

5. To remove the trip piston assembly:
   A. Using a wire hook, raise the check-valve ball seat out of the underside of the casting to expose the tension spring which is part of the trip-piston assembly.
   B. Insert a thin metal plate through the spring to release the spring tension on the ball-seat pin as shown in Figure 22.
   C. Remove the ball-seat pin to disengage the spring and free the ball seat.

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

   D. Withdraw the thin plate from the spring and remove trip-piston assembly. Disassembled hydraulic-mechanism components are shown in Figure 23.

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

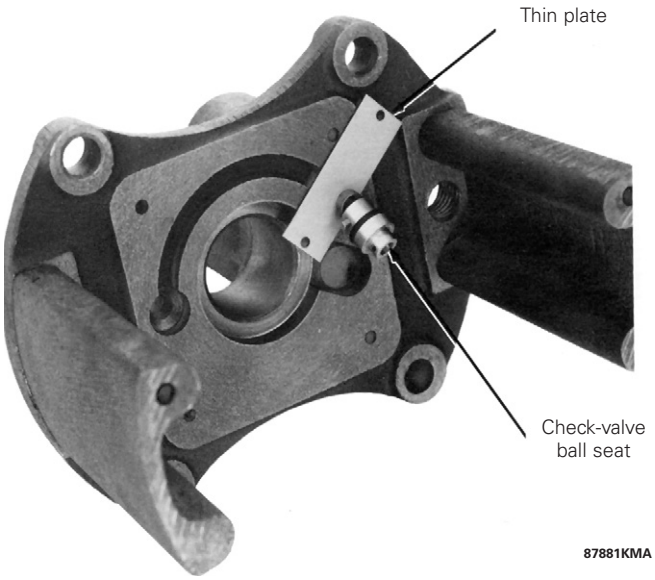


Figure 21. Releasing spring tension on check valve ball seat pin

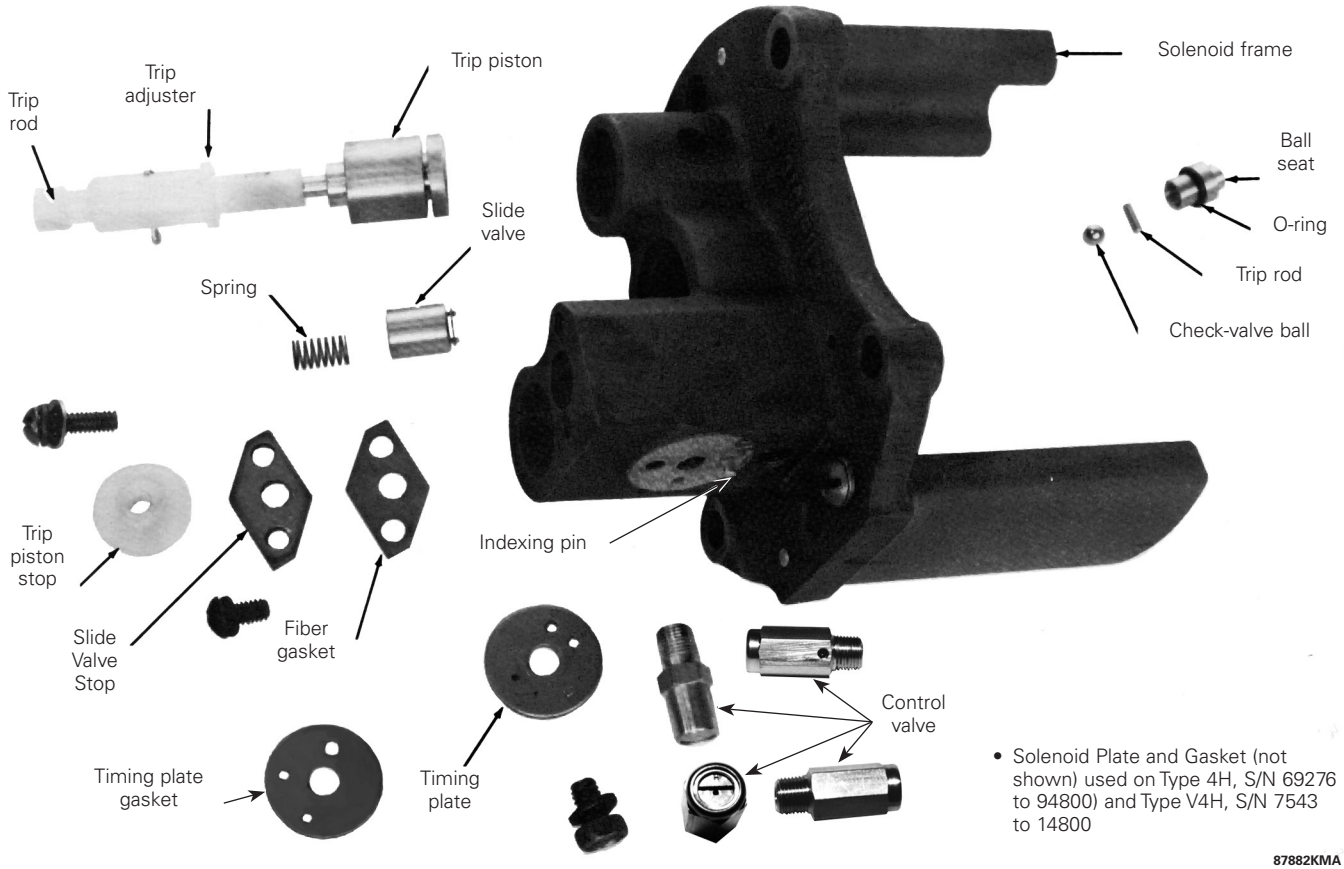


Figure 22. Disassembled solenoid frame and hydraulic mechanism

To reassemble the hydraulic mechanism

1. Reinstall the control-valve assembly and the timing plate and gasket. Make sure the small hole in the timing-plate gasket is positioned over the indexing pin and the large hole is positioned over the orifice in the casting. Check that the plate is indexed to the proper timing curve (check data plate on sleet hood for proper timing curves).

⚠ 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

2. Replace the trip-piston assembly:
   A. Install the trip piston into its cylinder.

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

   B. Using a wire hook, pull out spring through bottom of trip-piston cylinder and hold with a thin metal plate.
   C. Reinstall o-ring gasket on ball seat, replace check-valve ball, and pin the assembly to the spring (see Figure 22).
   D. Remove thin plate and seat check valve in place.
3. If equipped, reassemble solenoid plate and gasket to hold the ball-seat check valve in place. Reverse the solenoid plate gasket when reassembling.
4. Insert slide valve and slide-valve spring into its cylinder and secure the fiber-gasket, slide-valve stop, and trip-piston stop with the appropriate attaching hardware. Check scribe marks made during disassembly to properly orient the slide valve stop. Be sure holes in fiber gasket and slide-valve stop are aligned and centered over the slide-valve cylinder.

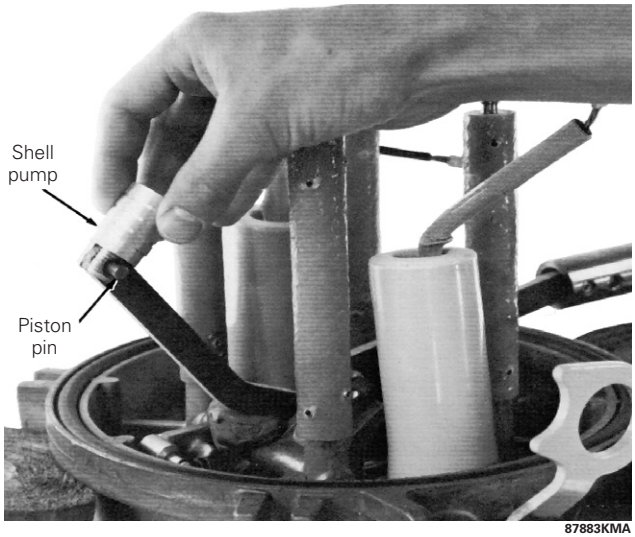


Figure 23. Removing pump-piston shell to expose steel pin

5. 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 the check valve does not hold, clean it thoroughly and repeat step A.
   C. If the check valve still does not hold, replace the entire pump-piston assembly.
6. To replace the pump-piston assembly (see Figure 24):
   A. Note position of pump-piston shell with respect to the pump-link assembly.
   B. Unscrew shell far enough to expose the piston pin.
   C. Push out pin and discard pump piston.
   D. Install new piston and replace the pump-piston shell in its original position.

Adjusting new pump pistons

After installing a new pump piston, it may be necessary to adjust the pump-piston shell to obtain the correct number of operations to lockout. Turning the pump-piston shell to increase the effective length of the piston will cause the port in the pump cylinder to be covered earlier in the downward stroke of the pump. The quantity of oil escaping through this port is reduced, and the amount of oil pumped to the trip-piston cylinder is increased. Turning the shell to decrease the effective length of the piston will cause the port to remain open during a greater part of the stroke. The quantity of oil escaping through the port is increased, and less oil is pumped into the trip-piston cylinder. Proper position of shell is determined as follows:

1. Attach solenoid frame to support stringers. Make sure plunger and pump piston are inserted in their respective cylinders.

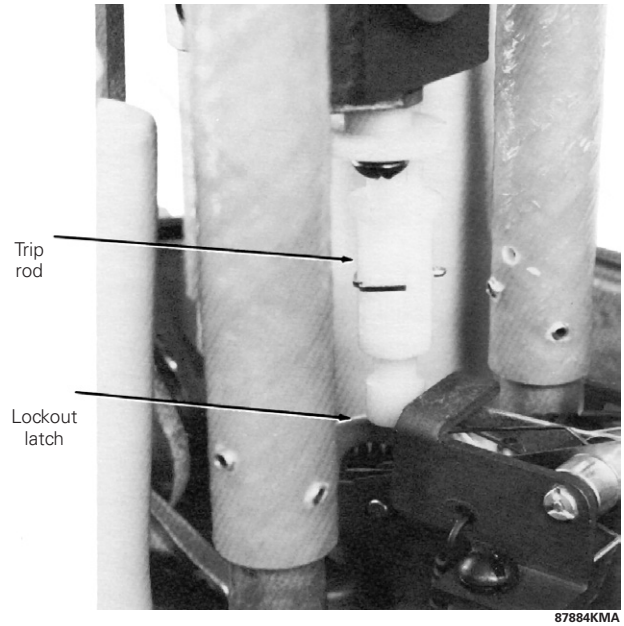


Figure 24. Trip rod touching lockout latch

2. Install solenoid-coil assembly; see the **Solenoid Coil** section of this manual.
3. Lower the mechanism into the oil until pump and trip pistons are completely covered.
4. Operate recloser manually. Close and trip mechanism a few times, using the manual operating handle, to remove the air trapped in the hydraulic system. Return operating handle to CLOSED position, and allow trip piston to reset fully.
5. Manually open and close recloser three times if it is set for four operations to lockout. Observe trip rod - end of trip rod should touch lockout latch as shown in Figure 25.
6. To lengthen the travel of the trip rod, increase the effective length of the piston by unscrewing the piston shell a slight amount. The trip-rod travel is shortened by screwing the shell farther onto the piston. Adjust in one-half turn increments and repeat step 5.
7. When adjustment is complete, stake pump-piston shell with a small punch.

Timing mechanism and operating sequence

The operating sequence and timing of Types H, 4H, and V4H reclosers is governed by the hydraulic system. The hydraulic system utilizes the surrounding insulating oil as an operating medium. The operating sequence and timing can be changed with the mechanism disassembled, during maintenance, or by untanking the recloser to gain access to the points of adjustment.

Timing

Provision is made for selecting an A characteristic, no intentional time delay, and a retarded B characteristic or an extra-retarded C characteristic. Choice of the B or C characteristic is made by indexing the timing plate to the appropriate hole (see Figure 26). Complete removal of the timing plate causes all operations of the recloser to have an A curve characteristic.

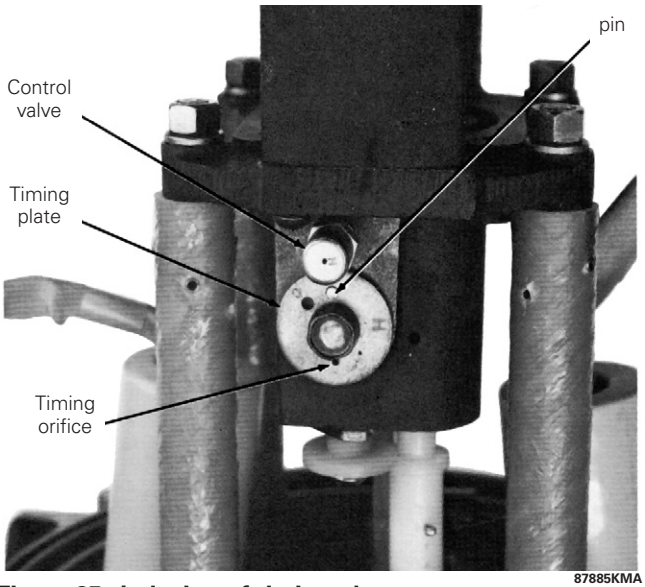


Figure 25. Indexing of timing plate

Operating sequence

Two, three, or four operations to lockout are selected by positioning the trip rod to the appropriate hole in the trip adjuster and securing with a cotter pin. Figure 27 shows a recloser set for two fast and two retarded operations. One operation to lockout is selected by pulling down the non-reclosing lever, located under the sleet hood, which is provided as part of the non-reclosing accessory.

Selection of one, two, or three fast operations is made by positioning the trip adjuster to the appropriate hole in the trip piston and securing with a roll pin (see Figure 27).

Note: To gain access to the adjustment for fast operations when the recloser mechanism is assembled, pull out the trip rod until the top of the trip piston is exposed. Use a small, fiber wedge between the trip-piston assembly and the valve-stop plate to hold the trip piston extended while making changes in the number of fast operations. The trip adjuster should be backed by a solid metal object when the roll pin is being driven in or out.

A retarded characteristic for all four operations requires a special spacer above the slide valve and a special slide valve equipped with a timing orifice.

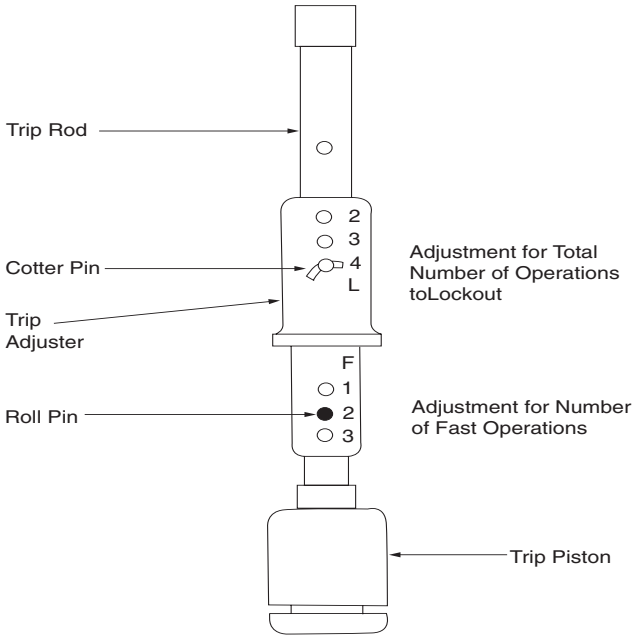


Figure 26. Adjustments for number of operations to lockout

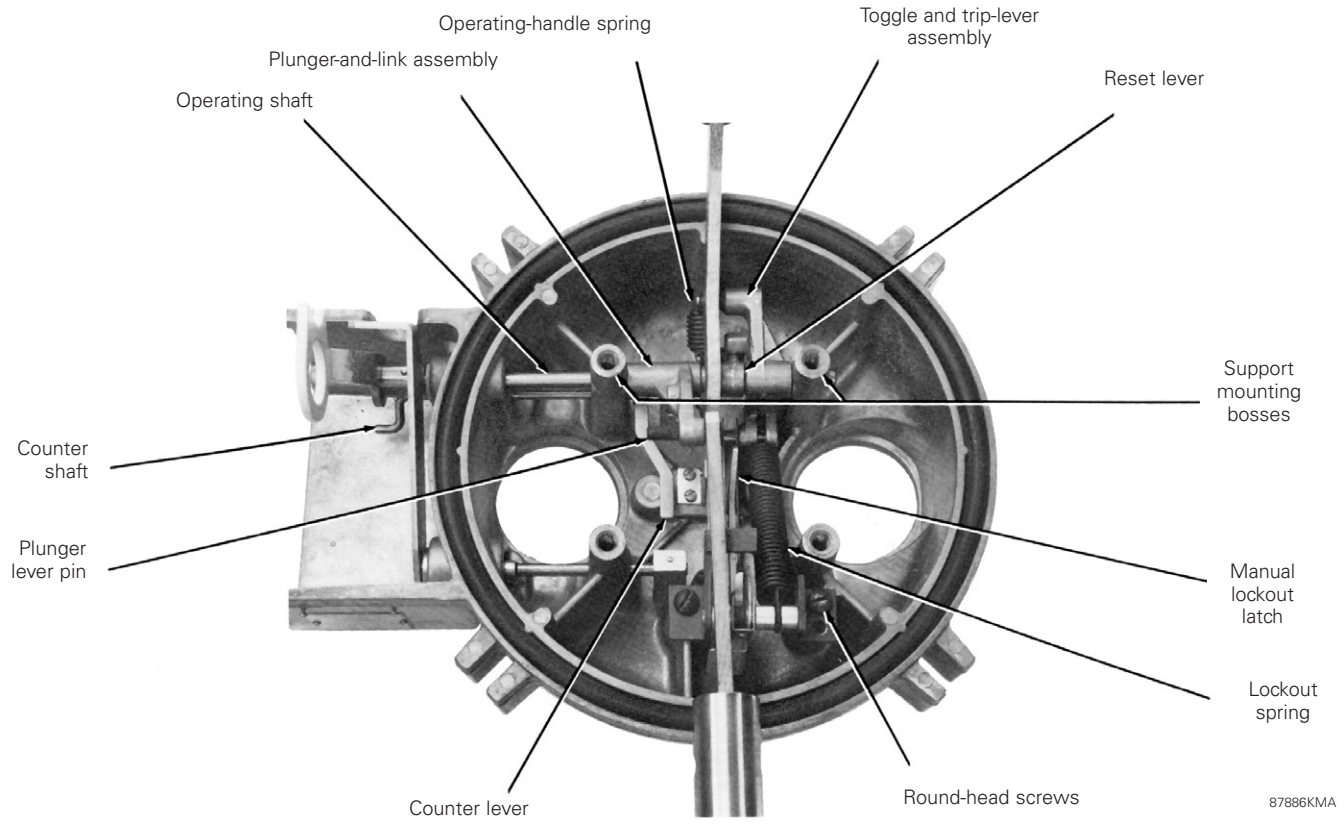


Figure 27. Head assembly (Type H shown)

Head assembly

Normally, no maintenance will be required on the head assembly. If the head mechanism is to be disassembled, see Figure 28 and proceed as follows:

1. Make sure yellow operating handle is in OPEN position, then unhook lockout spring.
2. Remove sleet hood cover. Remove counter assembly by unscrewing two round-head mounting screws.
3. Using a drift punch, drive out reset-lever groove pin. Use new groove pin for reassembly.
4. Remove operating-handle spring. Remove two round-head screws to free toggle-trip lever from head casting.
5. Grasp pump piston and plunger in one hand and pull out operating handle and shaft assembly. Lift plunger and link assembly, reset lever, and toggle-trip-lever assembly from head casting.

   Type 4H and V4H (S/N above 94800, 4H; above 14800, V4H) also are equipped with a torsion spring that engages with the toggle-trip-lever assembly. (For upgrade kits for 4H and V4H units with earlier serial numbers, see the Service Parts Lists, Head Assemblies section of this manual.)
6. To remove counter shaft and counter lever, drive out counter lever groove pin.
7. To reassemble head mechanism, first replace counter shaft, washer (if equipped), retaining ring, and counter lever.

Note: Use washer to maintain 1.6 mm (1/16 in.) clearance between retaining ring and head casting.

   Drive new groove pin into counter lever.

8. Slide operating-handle shaft through first support mounting boss.
9. Attach plunger and link assembly, making sure that plunger-lever pin extends over counter lever. Attach reset lever and toggle-trip lever (and torsion spring, if used) to shaft and push shaft through second support mounting boss. Secure toggle-trip lever to head casting with roundhead screws. Be sure reset lever is under toggle-trip-lever pin as shown in Figure 28.
10. Drive in new groove pin from same side of the reset lever from which the groove pin was driven out. Because groove pins are tapered, small end must enter reset lever and pins must be driven in from the large end.

11. Install counter with mounting screws and attach sleet hood cover.

Note: Each circuit interruption is recorded by the operation counter. When the counter shaft fails to raise the counter arm enough to register an operation, or if the counter stop is encountered before the unit closes, adjust as follows:

A. With the counter removed, loosen the screw holding the counter arm in place (Figure 29).

B. Move the counter arm slightly upward, if counter stop is encountered too soon, or slightly downward, if counter is failing to index and register a circuit interruption.

C. Retighten the screw and reinstall counter.

D. Check operation of the counter by slowly raising the closing handle. The counter should index (the ratchet should drop into the next groove position) before the recloser contacts close and the recloser contacts should close before the counter stop is encountered. (Hold the operating handle at the point where the recloser contacts just close. The counter arm should be able to travel another 2.4 mm ± 0.8 mm (3/32 in. ±1/32 in.) before the counter stop is hit.)

E. If necessary, repeat the above steps.

IMPORTANT

If the counter stop is hit before the recloser contacts are closed, the recloser may fail to close.

12. Attach operating-handle spring and lockout spring.

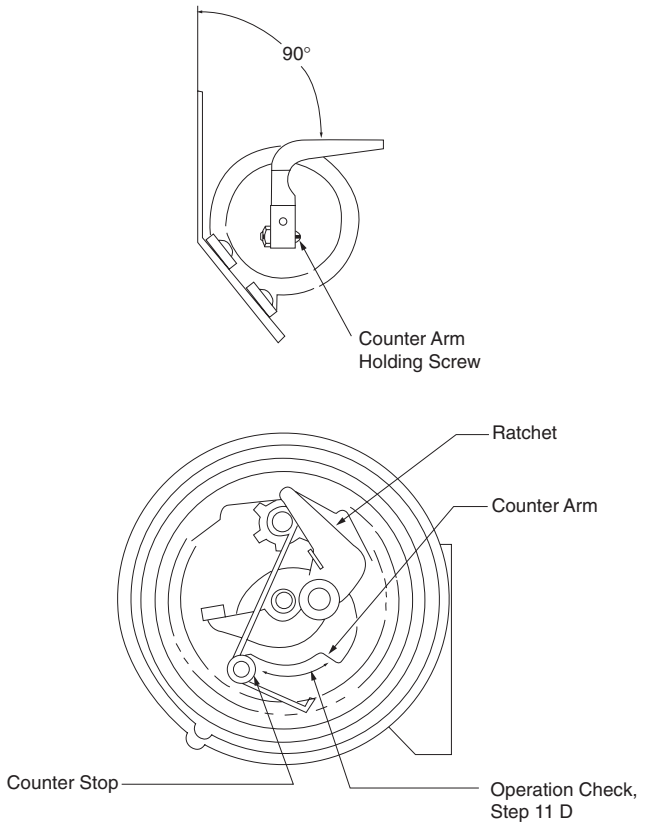


Figure 28. Operation counter arm

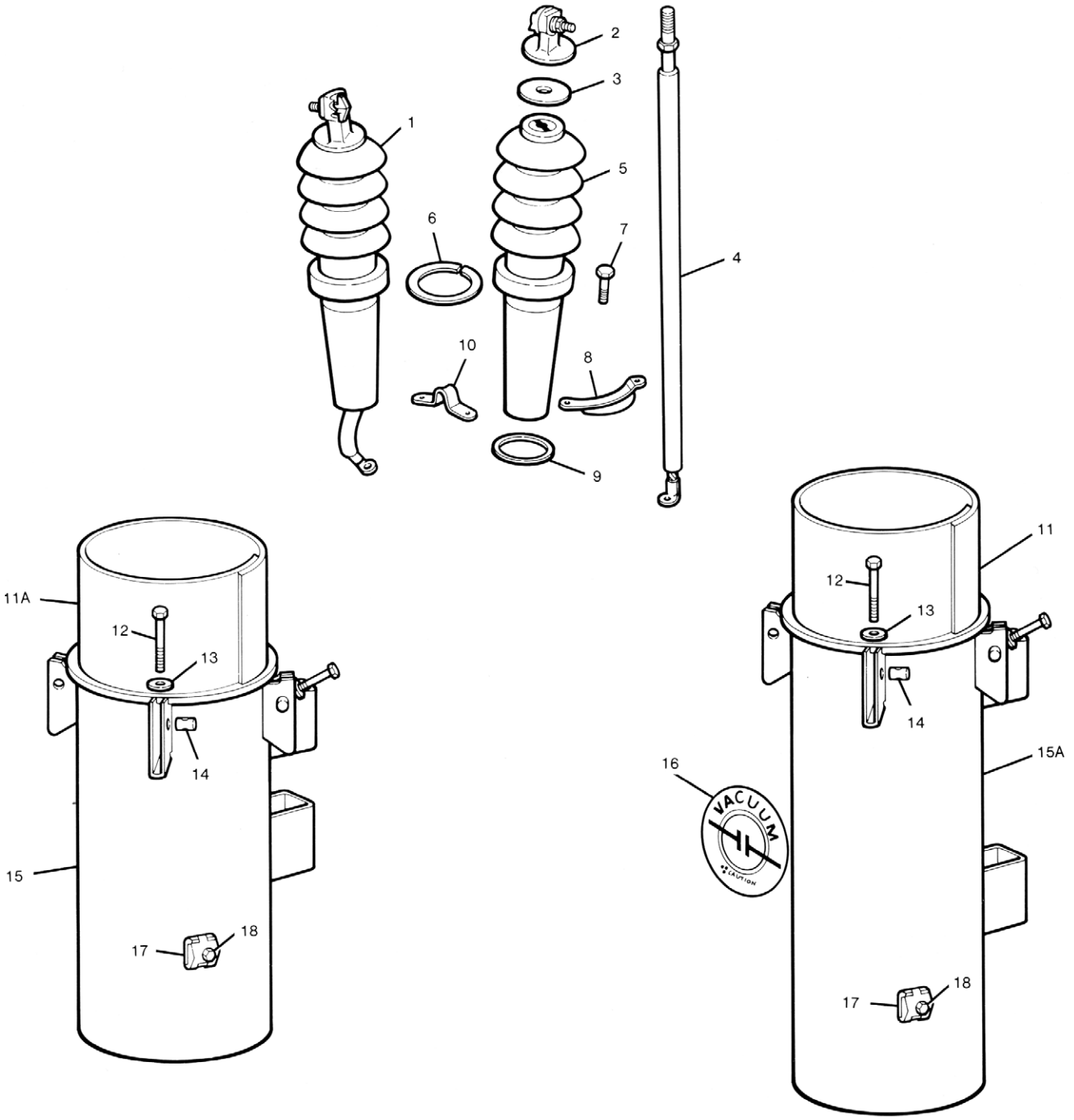


Figure 29. Bushing and tank assemblies

Service parts list

Bushing and tank assemblies (Figure 30)

Item no.	Description	Catalog number	Qty. per assy.
1	Bushing Assembly, Type H		
	Standard creepage, short lead	KA234H1	1
	Standard creepage, long lead	KA234H2	1
	17-in. extra-creepage, short lead	KA234H5	1
	17-in. extra-creepage, long lead	KA234H6	1
	Bushing Assembly, Type 4H, (includes items 2 through 5)		
	Standard creepage, short lead	KA234H41	1
	Standard creepage, long lead	KA234H42	1
	17-in. extra-creepage, short lead	KA234H45	1
	17-in. extra-creepage, long lead	KA234H46	1
	Bushing assembly, Type V4H, (includes items 2 through 5)		
	Standard creepage, short lead	KA234H47	1
	Standard creepage, long lead	KA234H48	1
	17-in. extra-creepage, short lead	KA234H49	1
	17-in. extra-creepage, long lead	KA234H50	1
2	Terminal assembly		
	Type H, standard	KA82H900	2
	Type H (17-in. creepage),		
	4H and V4H	KA143L900	2
3	Terminal gasket		
	Type H, standard	KP2090A25	2
	Types (17-in. creepage),		
	4H and V4H	KP2090A57	2
4	Short lead assembly, Type H	KA234H1	1
	Standard creepage bushing	KA233H1	1
	17-in. extra-creepage bushing	KA233H5	1
	Short lead assembly, Type 4H		
	Standard creepage bushing	KA233H41	1
	17-in. extra-creepage bushing	KA233H45	1
	Short lead assembly, Type V4H Standard creepage bushing	KA233H46	1
	17-in. extra-creepage bushing	KA233H47	1
	Long lead assembly, Type H	KA234H2	1
	Standard creepage bushing	KA233H2	1
	17-in. extra-creepage bushing	KA233H6	1
	Long lead assembly, Type 4H		
	Standard creepage bushing	KA233H42	1
	17-in. extra-creepage bushing	KA233H64	1
	Long lead assembly, Type V4H		
	Standard creepage bushing	KA233H44	1
	17-in. creepage bushing	KA233H48	1
5	Bushing ceramic		
	Type H		
	Standard creepage	KP328H	2
	17-in. extra-creepage	KP246VR	2
	Types 4H and V4H		
	Standard creepage	KP130VR	2
	17-in. extra-creepage	KP246VR	2
6	Bushing clamping ring	KP121L	2
7	Capscrew, hex hd, sst, 3/8-16x 1-5/8	K730115137162A	6
8	Bushing clamp	KP117H6	6
9	Bushing gasket	KP2090A29	2
10	Lifting strap, sst	KP464H	1
11	Tank liner, Type 4H and V4H	KP178H4	1
11A	Tank liner, Type H	KP341 H	1
12	Capscrew, hex hd, 3/8-16 x 3, stl	K730101137300Q	4
13	Flat washer	KP2028A34	4
14	Head bolt retainer	KP3061A4	4
15	Tank assembly, Type H	KA172H	1
15A	Tank assembly,		
	Types 4H and V4H	KA10H4	1
16	Decal, Type V4H	KP1041 V4H	1
17	Ground clamp	KA227H 900	1
18	Capscrew, hex, hd,		
	1/2-13x 1,stl	K730101150100Q	1

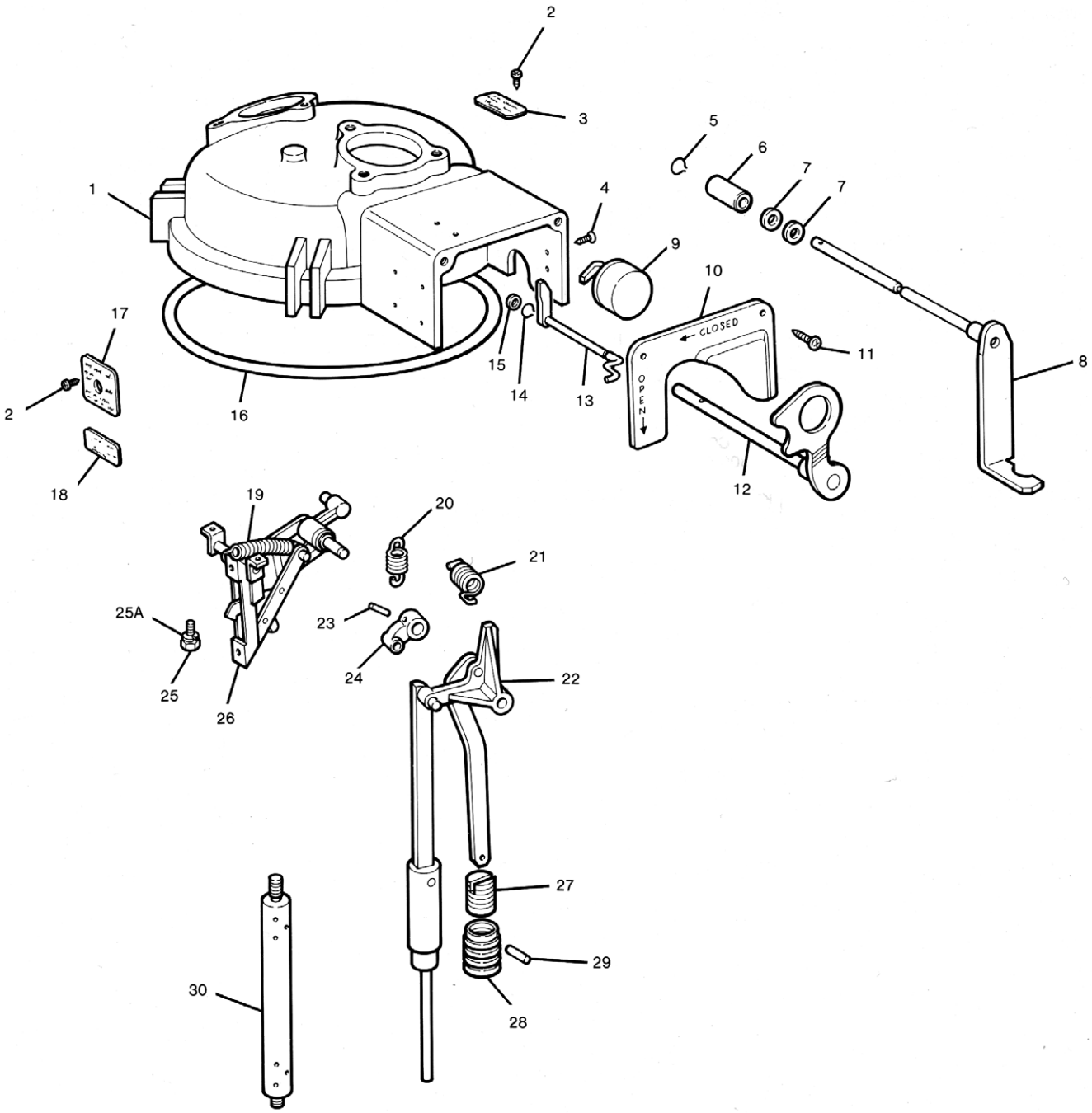


Figure 30. Head assemblies

Service parts list

Head assemblies (Figure 31)

Item no.	Description	Catalog number	Qty. per assy.
1	Replacement head casting assembly (Includes one shot lever, spacer, washer and retaining ring)	KA700H4S	1
2	Self-tapping screw, rd hd 2 x 3/16, sst	K751515102018A	6
3	Blank operating data plate	KP164H1	1
4	Self-tapping screw, type F, rd hd, 6-32 x 5/8, sst	K751515106062A	2
5	Retaining Ring, WA514, type C	K970901250000M	1
6	Spacer	KP3007A41	1
7	Flat washer, 1/4 an. brass	K900225026050A	2
8	One shot lever and shaft assembly	KA96H	1
9	Counter assembly	KA28C01S	1
10	Cover plate	KP309H	1
11	Self-tapping screw, type T, rd hd, No.12x 1/2,sst	K781515112050A	2
12	Operating handle	KA121 H	1
13	Counter lever and shaft assembly	KA186H	1
14	Retaining ring, type C, 3/16, WA510	K970915188000A	1
15	Flat washer,10S, brass	K900525020043A	2
16	Head gasket	KP2103A7	1
17	Nameplate		
	Type H	KDATA-1	1
	Type 4H	KDATA-1	1
	Type V4H	KDATA-1	1
18	Blank coil data plate	KP2122A900	1
19	Toggle tension spring	KP116H6	1
20	Operating handle spring Type H	KP27H	1
	Types 4H and V4H	KP95E	1
21	Torsion spring (Type 4H only above S/N 94800 and Type V4H only above S/N 14800, not used on Type H)	KP239H4	1
22	Plunger and link assembly Type H	KA63H3	1
	Types 4H and V4H	KA9H4	1
	Plunger return spring kit for 4H S/N 62966–94800 and V4H S/N 4491–14800	KA721H4-1	1
	(If plunger and/or plunger stops are worn or damaged, order)	KA721H4-2	1
	Plunger return spring kit for 4H S/N 25479–62965 and V4H S/N 100–4490	KA721H4-2	1
	Plunger return spring kit plus replacement plunger and solenoid frame assembly.	KA721H4-4	1
23	Groove pin, 1/8x5/8	KP2001A12	1
24	Reset lever assembly	KA11H2	1
25	Capscrew, hex hd, 1/4-20x1/2, stl		
	Type H (includes lockwasher)	K831501125050A	2
	Types 4H and V4H	K730101125050Q	2
25A	Split lockwasher, med, 1/4, stl Types 4H and V4H	K900801025000Z	2
26	Toggle and lever assembly	KA205H1	1
27	Pump piston replacement kit	KA725H	1
28	Pump piston shell	KP151H	1
29	Piston pin	KP3055A1	1
30	Insulating support assembly		
	Type H	KA17H1	4
	Types 4H and V4H	KA18H4-1	4

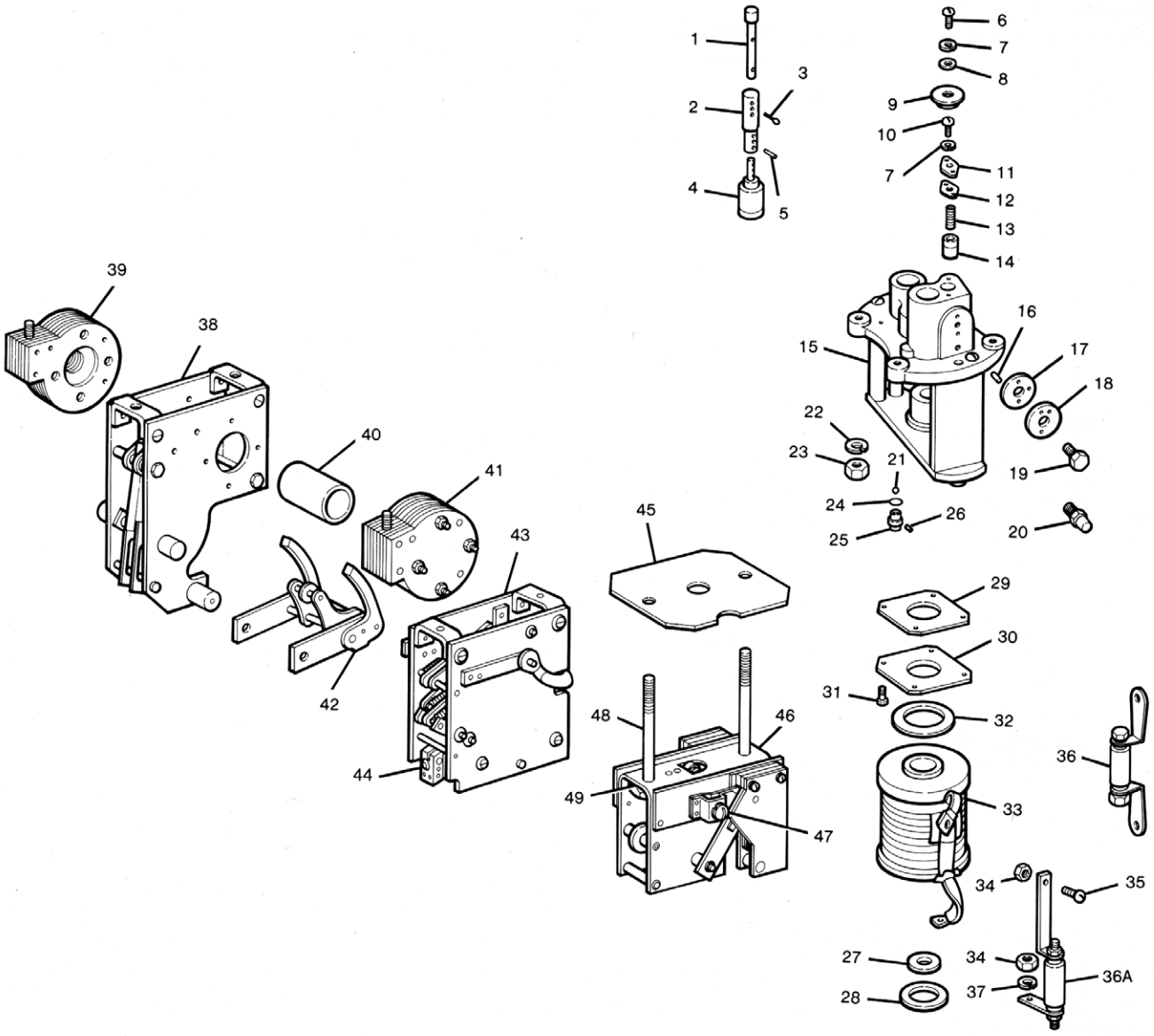


Figure 31. Solenoid and Interrupter Assemblies

Service parts list

Solenoid and interrupter assemblies (Figure 32)

Item no.	Description	Catalog number	Qty. per assy.
	Solenoid frame and hydraulic mechanism assembly (includes items 1 through 27) Type H	KA207HS	1
	Trip rod adjuster kit (includes items 1-3 & 9)		
	Type H	KA709H	1
	Type 4H and V4H	KA703H4	1
1	Trip rod		
	Type H	KP216H4-2	1
	Types 4H and V4H	KP216H4-1	1
2	Trip adjuster	KP215H4	1
3	Cotterpin,stl,1/16x 1	K970501062100A	1
4	Trip piston assembly	KA17H4	1
5	Roll pin,1/16 x 7/16, sst	K970815062043A	1
6	Machine screw, rd hd, stl		
	Type H,1 /4-20 x 3/4	K721501125075A	1
	Types 4H and V4H, 1/4-20 x 7/8	K721501125087A	2
7	Split lockwasher, med, 1/4, sstl		
	Type H	K900815025000A	2
	Types 4H and V4H	K900815025000A	1
8	Flat washer, 14S, brass	K900525026056A	1
9	Trip adjuster stop	KP231H4	1
10	Machine screw, rd hd, 1 /4-20 x 1 /2, stl	K721501125050A	1
11	Slide valve stop	KP110H4	1
12	Gasket	KP111H4	1
13	Spring	KP177H4	1
14	Slide valve	KA16H4-2	1
	Types 4H and V4H only		
	B curve trip sequence	KA49H4	1
	C curve trip sequence	KA51 H4	1
15	Solenoid frame assembly		
	(includes bridge plate and hardware)		
	Type H KA206H		1
	Type 4H (above S/N 94801) and Type V4H (above S/N 14801)	KA5H4-1S	1
	Type 4H (below S/N 94751) and Type V4H (below S/N 14761)	KA5H4-2S	1
16	Groove pin,1/8 x 3/8	KP2001A3	1
17	Gasket		
	For KP112H4 timing plate	KP113H4	1
	For KP201H4 timing plate	KP202H4	1
18	Timing plate		
	Type H		
	For all A curve operations	KP201 H4	1
	For B and C curve operations	KP112H4-1	1
	Types 4H and V4H		
	For all A curve operations	KP201H4	1
	For B and C curve operations	KP112H4-2	1
19	Preassembled capscrew and split lockwasher 5/16-18 x 1/2, stl	K830101131050A	1
20	Control valve		
	Type H	KA250H1	1
	Type H (below S/N 169460)	KA722H4-3	1
	Types 4H and V4H		
	For all B and C curve operations	KA722H4-1	1
	For all D curve operations	KA722H4-2	1
	Ball Seat Kit (includes items 21-26	KA710H1	1
21	Ball, 1/4, sst	KP2025A2	1
22	Split lockwasher, med, 3/8, stl	K900801037000Z	4
23	Hex nut,3/8-16, stl	K880201116037A	4
24	o-ring gasket	KP2000A3	1
25	Ball seat superseded by	KA710H1	1
26	Pin	KP3051A3	1
27	Impact washer	KP2090A31	1
28	Lower solenoid gasket	KP2090A60	1
29	Gasket, Type 4H (below S/N 94756) and Type V4H (below S/N 14761 only)	KP176H4	1
30	Solenoid plate		
	Type 4H (below S/N 94756) and Type V4H (below S/N 14761 only)	obsolete	1
31	Machine screw, fit hd, 10-24 x 3/4, stl (used to attach KP122H4 solenoid plate	obsolete	4
32	Upper solenoid gasket Type H, Type 4H (above S/N 94800) and Type V4H (above S/N 14800)	KP2090A23	1
	Type 4H (below S/N 94800) and Type V4H (below S/N 14800)	KP2090A55	1
33	Replacement coil kit (state coil rating as suffix to catalog number)		
	Types H,4H and V4H 50 A and below	KA83H- _____	1
	Types 4H and V4H 100 A and below	KA709H4- _____	1
	Type V4H		
	140 A	KA701V4H1	1
	200 A	KA701V4H2	1

Item no.	Description	Catalog number	Qty. per assy.
34	Hex nut,5/16-18, brass Types 4H and V4H	K881025118031A	2
35	Preassembled brass screw and bronze split lockwasher, 5/16-18 x 5/8	K831567131062A	1
36	Coil gap assembly,		
	Types H and V4H	KA100H1	1
36A	Coil gap assembly, Type 4H	KA100H2	1
37	Split lockwasher, med, 5/16, bronze Types 4H and V4H	K900830031000A	2
38	Contact box assembly, complete, Type 4H (includes items 39 through 42)	KA4H4	1
39	Exhaust chamber, Type 4H	KA27H4-1S	1
40	Cross blast tube, Type 4H	KP128H4	1
41	Generating chamber, Type 4H	KA26H4-1S	1
42	Movable contact assembly, Type 4H	KA25H4	1
43	Contact box assembly, complete, Type V4H (includes item 44)	KA101V4H	1
44	Vacuum interrupter, Type V4H	KA116V4H2	1
45	Coil Shield, Type H	KP92H1	1
46	Contact box assembly, complete, Type H	KA32H	1
47	Preassembled lockwasher and brass rd hd screw, 5/16-18 x 5/8, Type H	K831567131062A	3
48	Hex hd bolt,		
	1 /2-13 x 4-3/4, Type H	K730101150475A	2
	1 /2-13 x 5, Type 4H	K730101150500A	2
49	Washer		
	Fiber mounting washer, Type H	KP282H	2
	Lockwasher, Type 4H	K900801050000Z	2

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