

Types H, 4H, V4H single-phase and Types 6H and V6H three-phase recloser series-trip solenoid hydraulic control mechanism

The basic mechanism of series-trip solenoid-operated, hydraulically controlled H-group reclosers has been proven reliable through many years of field service. Series tripping provides simple, reliable operation since the tripping energy is taken directly from the fault itself. During tripping, the mechanism stores energy for reclosing. Hydraulic control permits accurate coordination with other protective equipment.

Interruption takes place in oil. The contact structure provides two breaks in series. Each break is in a separate interrupting chamber which employs the self-generating arc interruption principle.

Series-trip solenoid

Fault currents are sensed by a series-connected solenoid coil carrying rated line current. When a fault occurs, the movement of the solenoid plunger initiates tripping. The plunger, normally held at rest by closing springs, is drawn into the coil by the magnetic force produced by the fault current. Downward travel of the plunger overtoggles springs in the contact assembly to open the recloser contacts. The same motion charges the closing springs in preparation for a reclosing operation.

When the circuit is opened, the solenoid coil is deenergized, allowing the heavy-duty closing springs to close the contacts and simultaneously return the plunger to its original position.

Since it is controlled entirely by the closing springs, contact closing time is independent of the magnitude of the fault current. Time to contact opening is related to the level of fault current passing through the series-trip solenoid. Even under minimum overcurrent conditions, the rate of contact separation is always ample for fault-current interruption.

When the recloser operates to lockout, the hydraulic mechanism releases a lockout spring and mechanism, preventing the plunger from returning and the contacts from reclosing. The series-trip coil is capable of withstanding forces caused by maximum-rated fault currents and is effectively shunted with a bypass gap for surge protection.

Hydraulic control mechanism

H-group reclosers provide selectivity in timing, permitting coordination with other protective devices. All timing is governed by the hydraulic mechanism which:

- Controls timing before contact opening
- Establishes closing time
- Counts operations
- Causes the recloser to lock out when the preset number of operations has been completed.

Recloser time-current characteristics are established for each solenoid coil rating available (Figure 1). The A characteristic is the fast curve (no intentional time delay). The others are the time-delay curves, one of which may be specified when ordering the recloser. Curve identification is built into the catalog number.

For time-current characteristics of H-group reclosers, see Reference Data R280-91-1 and -2.



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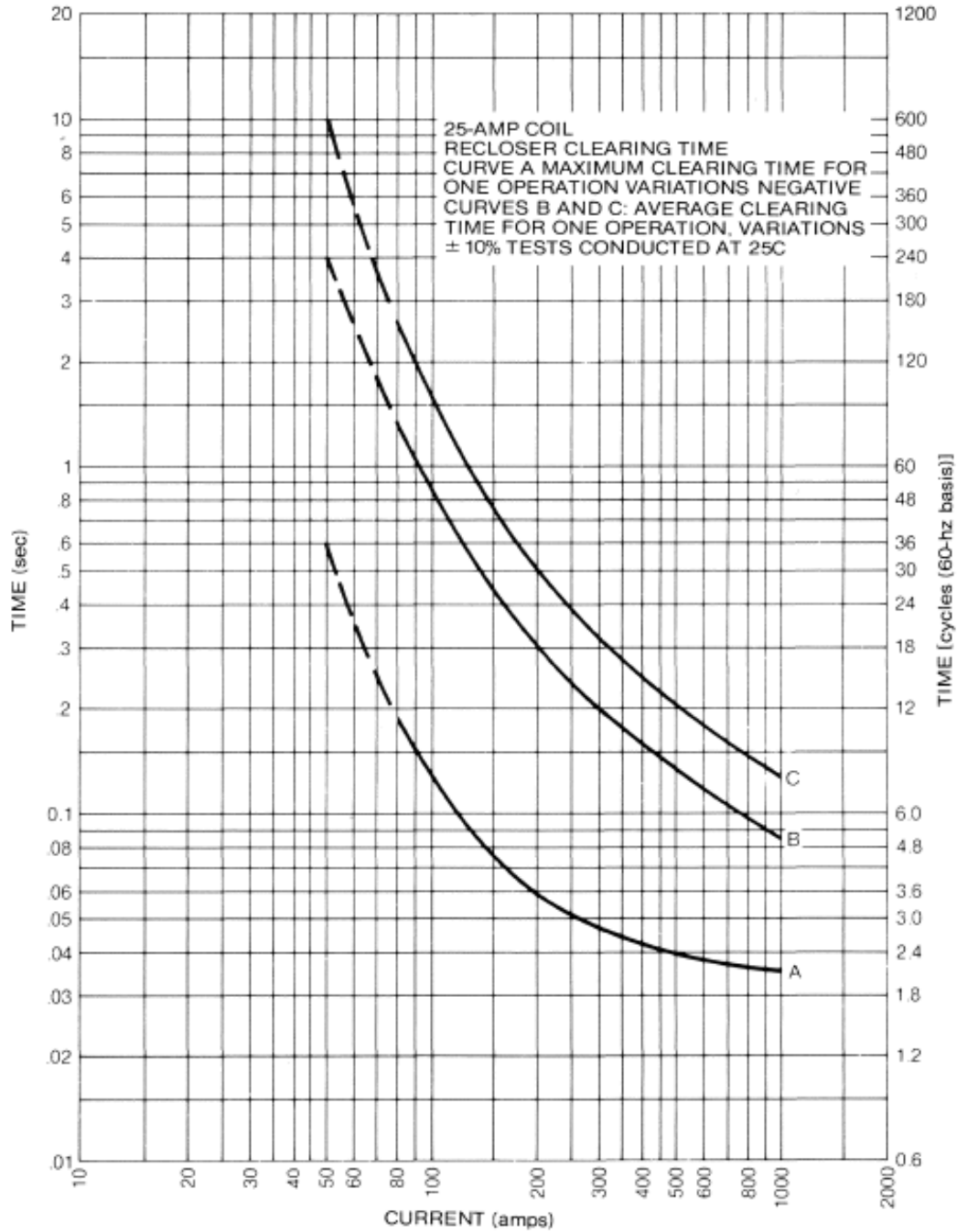


Figure 1. Typical time-current characteristics for H-group reclosers. Curves shown are for Types 4H, 6H, V4H, and V6H reclosers. Full-scale curves are available in Reference Data R280-91-1 and -2.

Fast and delayed tripping

Current above minimum trip flowing through the solenoid coil causes the solenoid plunger to be pulled down, forcing oil out of the plunger chamber. The flow of the displaced oil determines the timing before contact opening. Reference Figure 2.

Fast tripping is obtained by allowing the free flow of oil from the plunger cylinder as the plunger is pulled down. The displaced oil raises the slide valve and flows unimpeded through the escape port between the slide valve cylinder and the trip piston cylinder.

Mechanically linked to the solenoid plunger, the pump piston moves down with the solenoid plunger and pumps a measured charge of oil under the trip piston. This charge is retained by a ball check valve.

As subsequent operations advance the trip piston up, it blocks off the escape port. Oil flow from the plunger cylinder is then limited by the timing orifice, impeding downward travel of the solenoid plunger. This provides time-delayed tripping; the time-current characteristic is determined by the size of the timing orifice. Time current curves B and C are thus developed, permitting close coordination with fuses and other protective devices.

On delayed operations, oil pressure from low-current faults is sufficient only to raise the slide valve. The trip piston blocks the escape port, so the timing orifice is the only opening through which oil can flow. If the fault magnitude is higher, pressure is sufficient to open the spring-loaded control valve. This permits oil to flow through both the timing orifice and the control valve orifice, producing the required time-current characteristic.

After a preset number of operations, the trip piston reaches its lock-out position, releasing a toggle assembly. The lockout springs hold the contacts open until the mechanism is manually reset with the operating handle. The trip piston resettles through a combination of spring action and oil bleeding past the trip piston. Resetting time is approximately one minute per operation at an ambient temperature of 70°F. The recloser is then ready for a new sequence of operation. Should a fault clear before lockout, the bleeding action permits the trip piston to resettle at about the same rate.

Reclosing Time

Reclosing time is controlled by an orifice in the slide valve. When the recloser contacts are open, the closing springs are exerting force to return the solenoid plunger back up to its normal position. The resulting reduced pressure in the plunger cylinder draws the slide valve down and blocks the escape port between the slide-valve cylinder and the trip-piston cylinder. Oil flow into the plunger cylinder is limited to the slide-valve orifice. This restricted flow results in a reclosing time of one second on H reclosers; one and one-tenth seconds on V4H and V6H reclosers; and one and one-half seconds on 4H and 6H reclosers. Reference Figure 3.

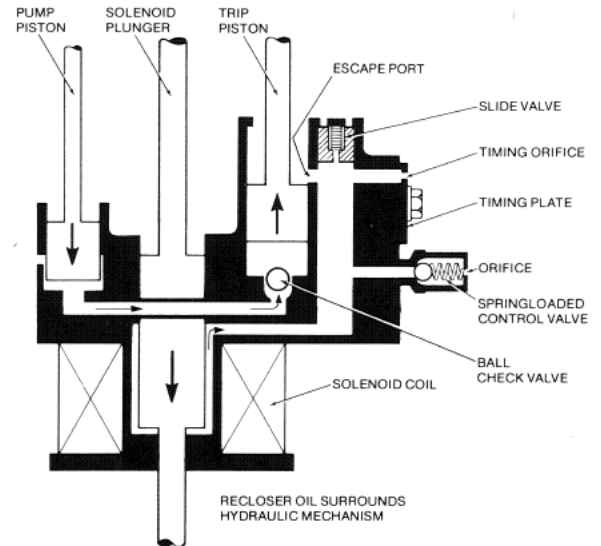


Figure 2. During fast tripping, oil flows freely from the plunger cylinder as the plunger is pulled down. On delayed operations, the trip piston blocks the escape port, so the timing orifice is the only opening through which oil can flow.

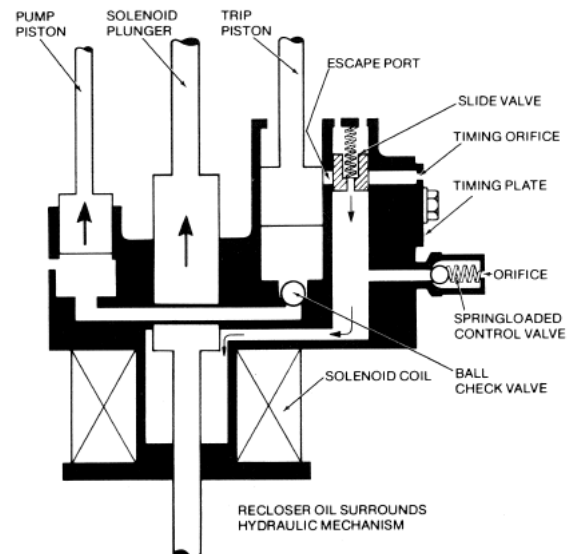


Figure 3. During reclosing, oil flow into the plunger cylinder is limited to the slide-valve orifice, resulting in reclosing times from 1 to 1-1/2 seconds.

Hydraulic control settings

Several variations of timing characteristics and sequences can be programmed for a maximum of four operations. When a recloser is programmed for both fast and delayed operations, the fast operations, involving no intentional time delay, occur first in the sequence and are according to the recloser's A curve time-current characteristic. Delayed operations are according to the recloser's B or C time-current curve; the orifice in the timing plate determines on which delayed curve the recloser will operate.

Two, three, or four operations to lockout are determined by the cotter pin's position in the trip-piston rod; the number of fast operations is determined by the rollpin's position (Figure 4). Either of these settings can be field-changed to alter the recloser operating sequence. The difference between the number of fast operations and the number of operations to lockout will be the number of operations on the delayed curve.

Reclosers that provide either all-fast or all-delayed operations are available; however, these sequences are not easily changed in the field.

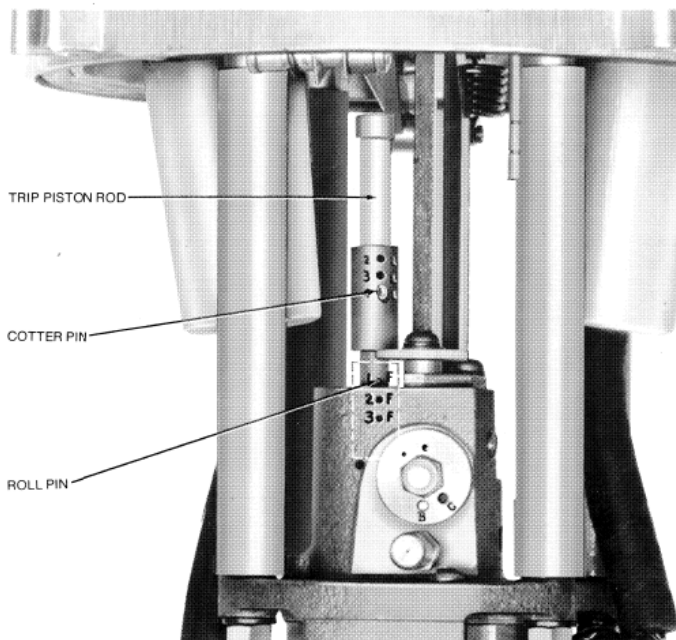


Figure 4. Selection of the number of fast operations is made by adjusting the rollpin. Two, three, or four operations to lockout are obtained by positioning the cotter pin.

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