July 19, 1960 W. PRIESEMUTH 2,945,930

SELF INTERRUPTING RELAY

Filed June 22, 1959

FIG. 1

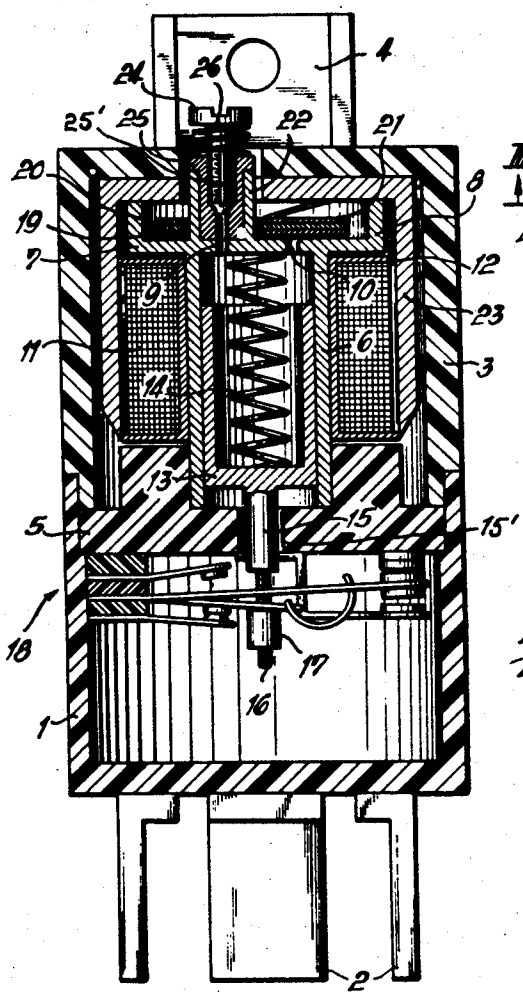


FIG. 2

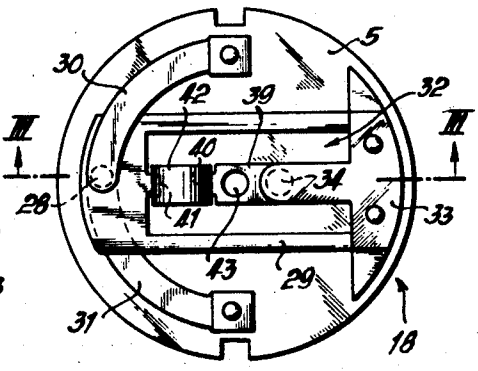


FIG. 3

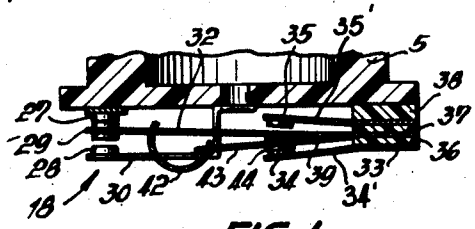
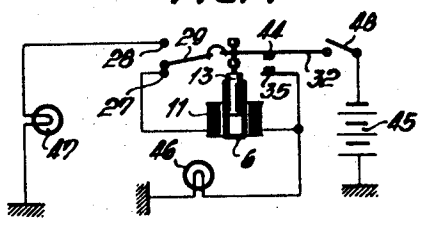


FIG. 4



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SELF INTERRUPTING RELAY

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8 Claims. (Cl. 200—87)

This invention relates to self interrupting solenoid relays of the type used as flashers for electric lights and the like, and refers more particularly to a self interrupting relay of the type having a plunger adapted to be moved in one direction to one defined limit by biasing means and in the opposite direction to another limit by a solenoid, and wherein energization of the solenoid is effected in consequence of movement of the plunger to said one defined limit and de-energization of the solenoid is effected in consequence of plunger movement to the other limit.

A solenoid relay of the type here under consideration is usually provided with a damper to retard movement of the plunger, and generally the damper is unidirectional so as to retard the plunger only when it is moving in response to its normal bias, the movement of the plunger in response to energization of the solenoid being substantially unimpeded so as to minimize the duration of the intervals during which the solenoid draws current.

In a common form of unidirectional damper, the plunger serves as a piston enclosed in a pneumatic cylinder having a port provided with a check valve. As the plunger is moved in one direction by the solenoid, against the bias of a compression spring or the like, the check valve opens to provide a substantially unrestricted flow of air into (or out of) the cylinder. However, when the solenoid is de-energized and the plunger moves in the opposite direction in response to its bias, the check valve closes, and a throttled flow of air compels the plunger to move at a relatively slow rate determined by the rate at which air is permitted to bleed out of (or into) the cylinder.

Heretofore it has been conventional to connect the load to be controlled by a self interrupting relay to the same switch means that controlled energization of the coil. The switch was actuated by the plunger, being closed as the plunger approached the limit of its spring propelled motion and opened as the plunger approached the limit of its solenoid propelled motion. As a result, the load was energized and de-energized for very unequal periods. For example, if a light bulb was connected to be energized concurrently with the solenoid, it would be lit for a relatively short period during each flashing cycle and would be out for a major portion of the cycle. With a double throw switch controlled by the plunger the relationship of the light and dark periods could be reversed, but they were still grossly unequal.

By contrast with this past condition it is an object of the present invention to provide a self interrupting relay of the character described which provides for adjustment of the relative duration of the periods of energization and deenergization of the load, as well as for adjustment of the time of the overall cycle, so that a load connected with the self interrupting relay of this invention can be energized and de-energized for substantially equal periods during each cycle of the relay.

More specifically, it is an object of this invention to provide a self interrupting relay of the character described having a single overcenter snap switch mechanism which controls the energization and de-energization of a solenoid by which the relay is actuated and also controls the relative periods of energization and deenergization of a load connected with the relay, wherein the switch mechanism is adjustable to provide different relative durations of load energization and de-energization, so that the interval during which the load is energized in each relay cycle may be made equal to the interval during which the load is de-energized, or may be changed so as to provide substantially any other desired ratio of "on" to "off" time during the cycle.

Another specific object of this invention resides in the provision of a self interrupting relay of the character described, for intermittently connecting a source of electric current with a load to be controlled, wherein provision is made for ready adjustment of the duration of the complete cycle of energization and de-energization without effecting the relationship of the "on" and "off" periods during the cycle.

With the above and other objects in view which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawing illustrates one complete example of the physical embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a vertical sectional view through a self interrupting relay embodying the principles of this invention;

Figure 2 is a bottom view of the switch mechanism of the relay;

Figure 3 is a sectional view through the switch mechanism taken on the plane of the line III—III in Figure 2; and

Figure 4 is a circuit diagram showing the manner in which the relay of this invention is connected with a source of current and with a load.

Referring now more particularly to the accompanying drawing, the mechanism of the self interrupting relay of this invention is enclosed in a housing comprising a cylindrical, cup-shaped lower housing member 1 and a cylindrical, cup-shaped upper housing member 3 having the same outside diameter as the lower housing member. The upper and lower housing members are coaxially secured together with their end walls remote from one another, and a base member 5 extends across the housing substantially at the junction of the upper and lower members to provide a partition across the housing. The base member 5 and the lower housing member 1 cooperate to define a switch compartment in which is housed an overcenter snap switch mechanism 18 that is secured to the underside of the base member. An upper compartment, conjointly defined by the base member and the upper housing member 3, encloses a solenoid 11 which is supported on the base member, a pneumatic cylinder 6 concentrically embraced by the solenoid, and a magnetically permeable plunger 13 slideable axially in the cylinder.

Both housing members, as well as the base member, are preferably of insulating material, and the lower housing member may be made of transparent material to per-

mit observation of the mechanism therein. Terminals 2 for the relay mechanism, which may comprise the prongs of a standard SAE plug, may be secured to the bottom wall of the housing. A suitable mounting bracket 4 may project upwardly from the top wall of the housing.

The solenoid 11 is wound upon a cylindrical coil form 12 of insulating material, which snugly embraces the pneumatic cylinder 6 and rests upon the base member. The cylinder is held concentric with the housing by having its lower end portion seated in a concentric counterbore in the base member. An inverted cup-shaped hood 23 of magnetically permeable material fits over the solenoid to confine the latter against displacement and to provide a return flux path around it.

The pneumatic cylinder 6 provides a chamber having walls of non-magnetic material and which is air tight except for a bleed port 9 and a check valve controlled port 10, both located in its top wall, and a bore 15' opening through the base member. The top wall of the cylinder is radially extended to provide a circumferential flange 7 which rests upon the top of the solenoid; and an upwardly projecting annular flange 8 extends around the periphery of the flange 7 and cooperates with the base member and with the end wall of the upper housing member 3 to preclude axial displacement of the pneumatic cylinder and solenoid.

The plunger 13 which is of course formed of magnetically permeable material and has a substantially snug sliding fit in the cylinder, has an upwardly opening concentric well therein in which is confined a coiled compression spring 14 that reacts between the bottom of the well in the plunger and the underside of the top wall 8 of the cylinder to bias the plunger downwardly. The well in the plunger performs the further function of lightening the plunger and thereby decreasing its inertia.

The check valve which controls flow of air through the port 10 in the top wall of the pneumatic cylinder comprises a flexible disc 19 of metal foil or similar nonporous material, a cover disc 20 of textile flatwise overlying the foil disc, and a light disc-like plate spring 21 overlying the textile disc and reacting against the underside of the end wall of the hood 23. The three discs 19, 20 and 21 are confined against edgewise displacement by means of a tubular upward projection 22 on the top wall of the cylinder extending through a loosely fitting hole in each disc.

The bleed port 9 opens concentrically to the tubular projection 22, and seated within the latter is a tubular sleeve 25 having a threaded bore in which is engaged a throttling screw or needle valve 24 provided with a narrow longitudinal slot 25' which permits a restricted flow of air into and out of the cylinder through the port 9. A coiled spring 26 confined between the head of the throttling screw and the top of the sleeve 25 inhibits undesired rotation of the screw. The head of the screw projects above the top wall of the relay housing so as to be accessible for adjustment, it being understood that inward adjustment of the screw reduces the rate at which air can flow into and out of the cylinder through the bleed port 9.

When the solenoid is energized the plunger is drawn upwardly against the bias of the spring 14, and by reason of its substantially sung fit in the cylinder the plunger expels air through the bleed port 9 and also through the check valve controlled port 10, which is cleared by reason of the fact that the discs comprising the check valve are lifted away from the top of the cylinder by the force of the air being forced out by the plunger. When the solenoid is de-energized the plunger moves downwardly in response to the bias of the compression spring, and the check valve seats, blocking the port 10 and limiting the amount of air that can enter the cylinder to the restricted flow permitted by the throttling screw 24, thus retarding downward movement of the plunger to a slow rate governed by the setting of the throttling screw. The underside of the plunger is of course subjected to atmospheric pressure through the bore 15' in the base member.

Both the energization of the solenoid and the energization of a load connected with the relay are controlled by the switch mechanism 18 mounted at the bottom of the base 5, which comprises, in general, an actuating member 32, a member to be actuated 29, an overcenter toggle spring 42, and stationary contacts 27, 28, 34 and 35. The actuating member 32 is a resilient blade flexingly movable in directions substantially parallel to the axis of the plunger, while the member to be actuated 29 is a substantially U-shaped flexible element having its bight portion substantially opposing and spaced from the end of the actuating member and flatwise movable in directions substantially parallel to the plunger axis. The overcenter spring is substantially horseshoe shaped, and is connected between the free end of the actuating member and the bight portion of the member to be actuated, to provide a lost motion toggle connection between them, by means of tongues 40 and 41 on said members respectively, projecting toward one another and engaged in substantially loosely fitting slots in the spring, near the ends thereof.

The switch mechanism provides two switches, the first of which comprises a movable contact 29 carried by the member to be actuated and cooperable with the fixed contacts 27 and 28, while the second comprises a movable contact 44 carried by the actuating member and cooperable with stationary contacts 34 and 35. Particular attention is directed to the stationary contacts 27 and 44, the first of which is connected with the solenoid while the latter is connected with a load 46, all as hereinafter more fully described. It will be seen that both the actuating member and the member to be actuated may be regarded as movable contact carriers, and each of said members, by reason of its connection with the U-shaped toggle spring, is movable with a snap action to a position in which the movable contact that it carries is engaged with one of the stationary contacts just referred to.

Substantially rigid conductive arcuate arms 30 and 31, which are secured at opposite sides of the switch blades and extend part way around the base member, have the stationary contacts 27 and 28 mounted on their free end portions, adjacent to the movable contact 29 on the member to be actuated, for circuit making engagement thereby. The contact arm 30 is bent to dispose the stationary contact 28 beneath the member to be actuated, while the stationary contact arm 31 flatwise underlies the base member 5 and has its stationary contact 27 disposed above the member to be actuated.

The stationary contacts 34 and 35, which cooperate with the movable contact 44 of the second switch, comprise substantially rigid conductive arms 34' and 35' projecting substantially parallel to the actuating member and respectively spaced below and above the same by means of insulating spacers 36 and 37, while another insulating spacer 38 spaces the elements comprising the second switch below the bottom of the base member 5, to which they are secured, near one side thereof.

The actuating member 39 extends across the axis of the housing and has a lost motion connection with the plunger, which connection is provided by a coaxial stem portion 15 on the plunger that projects downwardly through the bore 15' in the base member, a threaded rod 16 projecting coaxially downwardly from the stem portion through a loosely fitting hole 43 in the actuating member, and a nut 17 on the threaded rod. The stem portion 15 on the plunger has a diameter substantially larger than that of the hole 43 in the actuating member and thus provides a downwardly facing abutment engageable with the actuating member to swing the latter downwardly during spring propelled motion of the plunger, while the nut 17 provides an upwardly facing abutment spaced from that on the stem portion and by which the actuating member is swung upwardly during upward

movement of the plunger in response to energization of the solenoid.

Referring now to the circuit diagram, Figure 4, it will be seen that the movable contacts 29 and 44 of the two switches are connected, through a master switch 48, with one terminal of a current source 45, the other terminal of which is grounded. The solenoid coil 11 is connected with the stationary contact 27 of the first switch and in series with a load 46, which may be, e.g., a light bulb to be flashed. The stationary contact 35 of the second switch is connected directly with the load 46, and thus the solenoid is short circuited when the second switch closes to connect the current source with the load 46. The stationary terminals 28 and 34 of the first and second switches, respectively, may be connected, if desired, with alternate loads, the terminal 28 being shown, by way of example, connected with a monitor lamp 47, which is illuminated during solenoid responsive movement of the plunger.

Attention is directed to the fact that the movable contact 44 of the second switch is located intermediate the fixed end of the actuating member and the hole 43 which provides the connection between the plunger and the actuating member, and hence the free outer end portion of the actuating member may be regarded as the actuator for the second switch, while the portion thereof on which the contact 44 is mounted may be regarded as a contact carrier. The actuating member also serves, of course, as an actuator for the first switch comprising the movable contact 29 carried by the member to be actuated.

Movement of the actuating member in either direction, to and beyond an overcenter point, causes the member to be actuated to snap from one of its circuit making positions to the other, the direction of snap motion of the member to be actuated always being opposite to the direction of motion of the actuating member. However, those skilled in the art relating to overcenter snap switches will recognize that the mode of action of the second switch is quite different from that of the first switch; and it is this difference in switch actions which permits the self interrupting relay of this invention to provide an adjustably variable relationship between the intervals of load energization and de-energization.

Assuming the plunger to be approaching its limit of downward spring propelled travel, the actuating member is swung downwardly by the abutment on the stem 15, moving at a relatively steady rate as it approaches the overcenter point, and then, at about the limit of spring propelled plunger motion, the member to be actuated snaps upwardly to engage its movable contact 29 with the fixed contact 27, energizing the solenoid and the load 46 in series therewith. This relationship is illustrated in Figure 4. In response to the magnetic field of the solenoid the plunger moves upwardly against the bias of spring 14, and the nut 17, moving upwardly with the plunger, compels the actuating member to swing upwardly. As or shortly before the plunger reaches its limit of upward solenoid propelled travel, the actuating member crosses the overcenter point, snapping the member to be actuated to a position in which its movable contactor 29 is disengaged from the stationary contact 27 and is in circuit making engagement with the stationary contact 28, sending current to the secondary load 47.

The movable contact 44 of the second switch engages the fixed contact 35 thereof very shortly before the plunger reaches its limit of solenoid produced upward travel, and either simultaneously with or shortly before the movable contact 29 of the first switch snaps from engagement with stationary contact 27 to engagement with stationary contact 28. The exact time at which engagement of the second switch contacts 44 and 35 takes place, relative to the instant of snapover of the member to be actuated, will be determined by the position of adjustment of the stationary contact 35 toward or from the contact carrier 39 but in any event it will be seen from Figure 4 that engagement of the contacts 44 and 35 shorts out the solenoid at the same time that it effects continued energization of the load 46. If the solenoid has not quite reached the upper limit of its travel at the instant the second switch closes (i.e., if the actuating member has not yet been moved to the point at which the member to be actuated is snapped over), the inertia of the plunger and the residual magnetism due to the collapsing magnetic field of the solenoid can be relied upon to complete the slight additional plunger motion required.

As the plunger moves downwardly in response to the bias of spring 14, the movable contact 44 of the second switch remains in contact with the stationary contact 35 during a portion of such plunger motion. Thus the load continues to be energized, even though the solenoid is deenergized, unlike the condition that obtains in previous self interrupting relays. The exact point at which the contacts 44 and 35 of the second switch will open depends upon the position of adjustment of the stationary contact 35 toward or from the actuating member 39, and can be very readily regulated by bending the arm 35' which carries stationary contact 35. It will be apparent that opening of the second switch (and consequent deenergization of the load) can be caused to occur at substantially any point in the downward movement of the plunger prior to its attainment of the overcenter position at which it snaps the actuating member. Thus with the relay of this invention the load can be energized during the entire portion of the cycle in which the solenoid is energized and also during such additional portion of the cycle as is determined by the position of adjustment of stationary contact 35.

Obviously, an alternate load (not shown) connected with the other stationary contact 34 of the second switch can be energized during such portion of the spring propelled movement of the plunger as is determined by the bending adjustment of the arm 34', plus, if desired, the time during which the solenoid is energized. It will also be apparent that the time required for the total cycle of plunger movement can be regulated by adjustment of the throttling screw 24, without affecting the ratio of the periods of load energization and de-energization.

From the foregoing description taken together with the accompanying drawings, it will be apparent that this invention provides a self interrupting solenoid actuated relay of the type by which a load may be alternately energized and de-energized, and wherein a unidirectional damper permits free movement of the plunger in one direction in response to energization of the solenoid but retards plunger movement in the opposite direction, in which relay the relative durations of the "on" and "off" periods of load energization may be very readily and accurately controlled, so that if desired the "on" period may be equal to the "off" period despite the difference in the rates at which the plunger travels in opposite directions, and the time duration of the entire "on" and "off" cycle may also be readily controlled without affecting the ratio of "on" to "off" time.

What is claimed as my invention is:

1. In a self interrupting relay for intermittently energizing a load, of the type comprising a solenoid, a plunger movable in one direction to a first defined limit in response to energization of the solenoid and yieldingly biased to move in the opposite direction to a second defined limit upon de-energization of the solenoid, and unidirectional damper means providing for substantially free movement of the plunger in said one direction but retarding movement thereof in said opposite direction: first switch means having fixed and movable contacts connectable with a source of current and with the solenoid, a contact carrier by which the movable contact is carried, movable between two defined positions, in one of which the movable contact engages the fixed contact, an actuator movable in opposite directions, and an over-

center toggle spring connected with the actuator and the contact carrier and by which movement of the actuator in either direction effects snap action of the contact carrier from one of its positions to the other; means providing a lost motion connection between the plunger and the actuator of said first switch means, whereby the contact carrier of said first switch means is moved to its said one position when the plunger is substantially at its second defined limit of motion, to effect energization of the solenoid, and is held in said position until the plunger has substantially reached its first defined limit; second switch means having fixed and movable contacts connectable with a source of current and with a load, a contact carrier by which the movable contact is carried, movable to and from a position in which the movable contact is engaged with the fixed contact, and an actuator movable in opposite directions and by which the contact carrier is moved to and releasably held in said position in consequence of movement of the actuator in one direction to a predetermined point; and means providing a lost motion connection between the plunger and the actuator of said second switch means whereby the actuator of said second switch means is moved in its said one direction to said predetermined point to move the contact carrier of said second switch means to its said defined position, energizing the load, when the plunger moves in its said one direction and whereby the contact carrier of said second switch means is moved out of its said position when the plunger is intermediate its limits of motion and is moving in said opposite direction, so that the load remains energized during a portion of such opposite direction movement of the plunger.

2. In a self interrupting relay for intermittently energizing a load, of the type comprising a solenoid, a plunger movable in one direction to a first defined limit in response to energization of the solenoid and yieldingly biased to move in the opposite direction to a second defined limit upon de-energization of the solenoid, and unidirectional damper means providing for substantially free movement of the plunger in said one direction but retarding movement thereof in said opposite direction: means providing a pair of switches, each having fixed and movable contacts, a contact carrier by which the movable contact is carried and which is movable toward and from a defined position in which the movable contact engages the fixed contact, an actuator movable in opposite directions, and an overcenter toggle spring connected with the actuator and the contact carrier and by which movement of the actuator in one direction effects snap action of the contact carrier to its said position; means for connecting the contacts of one of said switches with a source of current and with the solenoid; means for connecting the contacts of the other of said switches with a source of current and with a load; means providing a lost motion connection between the plunger and the actuator of said one switch whereby the contact carrier of said one switch is snapped to its said position when the plunger is substantially at its second defined limit of motion, to effect energization of the solenoid, and is held in said position until the plunger has substantially reached its first defined limit; and means providing a lost motion connection between the plunger and the actuator of said second switch whereby the contact carrier of said second switch is moved to its said defined position, energizing the load, in consequence of movement of the plunger toward its first defined limit of motion and whereby the contact carrier of said second switch is moved out of its said position when the plunger is moving in said opposite direction, so that the load remains energized during a portion of such opposite direction movement of the plunger.

3. The self interrupting relay of claim 2 further characterized by the fact that said means providing a pair of switches comprises an overcenter snap switch mechanism having an actuating member movable in opposite directions, a member to be actuated movable in directions parallel to the path of motion of the actuating member, and an overcenter toggle spring compressively confined between the actuating member and the member to be actuated; and further characterized by the fact that the movable contact of said first switch is carried by the member to be actuated and the movable contact of the second switch is carried by the actuating member; and further characterized by the fact that the actuating member has a lost motion connection with the plunger which provides said lost motion connections between the plunger and the actuator of each of the switches.

4. The self interrupting relay of claim 3, further characterized by the fact that the lost motion connection between the plunger and the actuating member comprises an element connected with the plunger for movement in opposite directions therewith and a pair of spaced apart opposing abutments on said element, each engageable with the actuating member upon motion of the plunger in one direction.

5. In a self interrupting relay for intermittently energizing a load, of the type comprising a solenoid, a plunger movable in one direction to a first defined limit in response to energization of the solenoid and yieldingly biased to move in the opposite direction to a second defined limit upon de-energization of the solenoid, and unidirectional damper means providing for substantially free movement of the plunger in said one direction but retarding movement thereof in said opposite direction: means providing a pair of switches, each having fixed and movable contacts, a contact carrier by which the movable contact is carried and which is movable toward and from a defined position in which the movable contact engages the fixed contact, and means for readily releasably holding the contact carrier in its said defined position; means for connecting the contacts of one of said switches with a source of current and with the solenoid; means for connecting the contacts of the other of said switches with a source of current and with a load; means providing a lost motion connection between the plunger and the contact carrier of said one switch whereby said contact carrier is moved to its said one position when the plunger is substantially at its second defined limit of motion, to effect energization of the solenoid, and is held in said position until the plunger has substantially reached its first defined limit; and means providing a lost motion connection between the plunger and the contact carrier of said second switch whereby said contact carrier is moved to its said one defined position, energizing the load, in consequence of motion of the plunger in its said one direction of motion and whereby the contact carrier of said second switch is moved out of its said defined position when the plunger is moving in said opposite direction, so that the load remains energized during a portion of such opposite direction movement of the plunger.

6. The self interrupting relay of claim 5, further characterized by the fact that in each of the switches said means for releasably holding the contact carrier in its said position comprises an overcenter toggle spring connected with the contact carrier.

7. The self interrupting relay of claim 6, further characterized by the fact that the contact carrier of said other switch comprises an actuating member of an overcenter snap switch mechanism, movable in opposite directions, and the contact carrier of said one switch comprises a member to be actuated of the overcenter snap switch mechanism, movable in directions parallel to the direction of movement of the actuating member and connected with the actuating member by means of the overcenter toggle spring; and further characterized by a lost motion connection between the plunger and the actuating member.

8. In a self interrupting relay for intermittently energizing a load, of the type comprising a solenoid, a plunger movable in one direction to a first defined limit in response to energization of the solenoid and yieldingly biased to move in the opposite direction to a second defined limit upon de-energization of the solenoid, and unidirectional damper means providing for substantially free

movement of the plunger in said one direction but retarding movement thereof in said opposite direction: a switch mechanism of the type comprising an actuating member movable in opposite directions, a member to be actuated movable in directions substantially parallel to the direction of movement of the actuating member between a pair of defined positions and an overcenter toggle spring connected between said members and by which movement of the actuating member in either direction effects snap action of the member to be actuated from one of its positions to the other; first switch means comprising a movable contact carried by the member to be actuated for motion therewith and a stationary contact engaged by the movable contact when the member to be actuated is in one of its defined positions; second switch means comprising a movable contact carried by the actuating member for motion therewith to and from engagement with a second stationary contact; means for connecting the contacts of said first switch means with a source of current and with the solenoid; means for connecting the contacts

of the second switch means with a source of current and with a load; means providing a lost motion connection between the plunger and the actuating member whereby the actuating member is moved to a position in which it snaps the member to be actuated to its said one defined position when the plunger is substantially at its second defined limit of motion, to thus effect energization of the solenoid, and whereby the member to be actuated is permitted to remain in said one position until the plunger has substantially reached its first defined limit, and whereby the contacts of said second switch means are engaged, energizing the load, in consequence of movement of the plunger in its said one direction of motion and are disengaged when the plunger is intermediate its limits of motion and moving in said opposite direction, so that the load remains energized during a portion of such opposite direction movement of the plunger.

No references cited.