March 30, 1943. E. A. LEACH 2,314,885

RELAY

Filed May 22, 1941 2 Sheets-Sheet 1

Fig. 1.

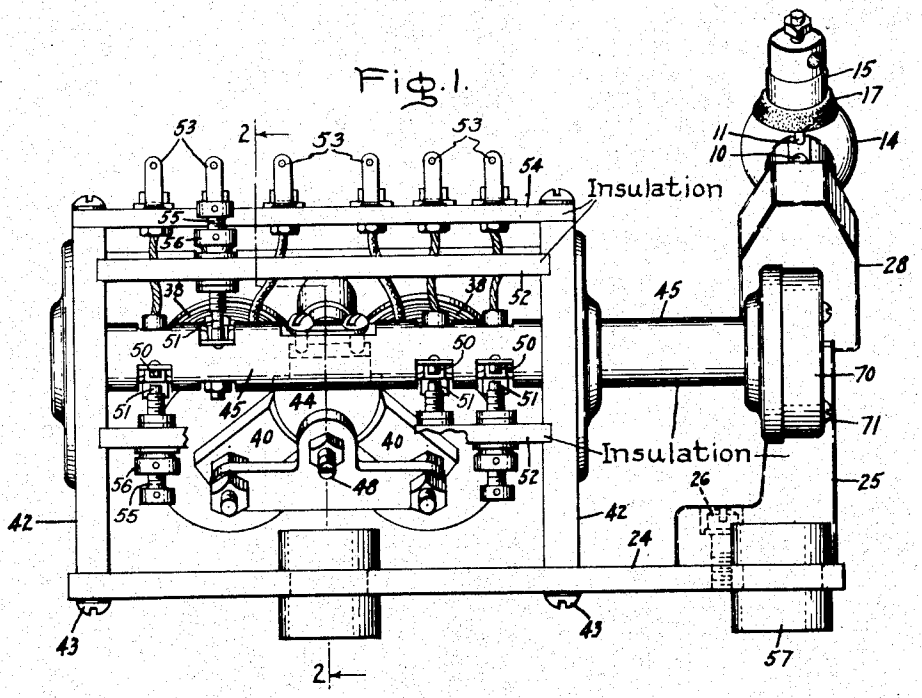
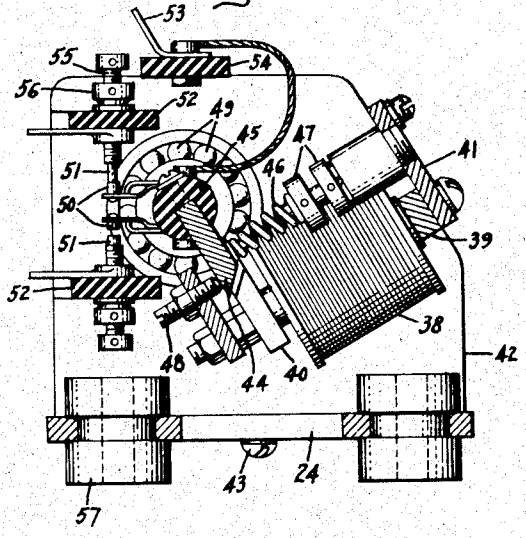


Fig. 2.



Inventor:
Edward A. Leach,
by Harry E. Dunham
His Attorney.

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Fig. 3.

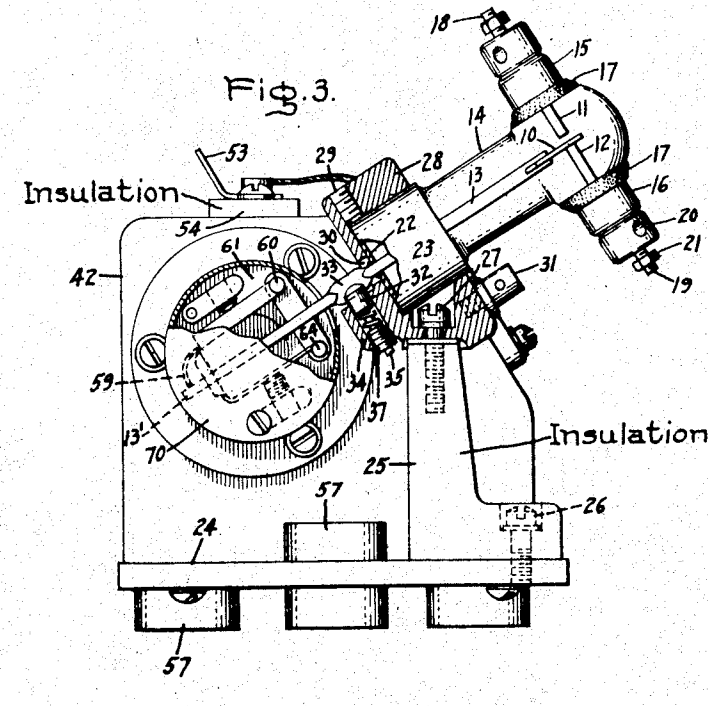


Fig. 4.

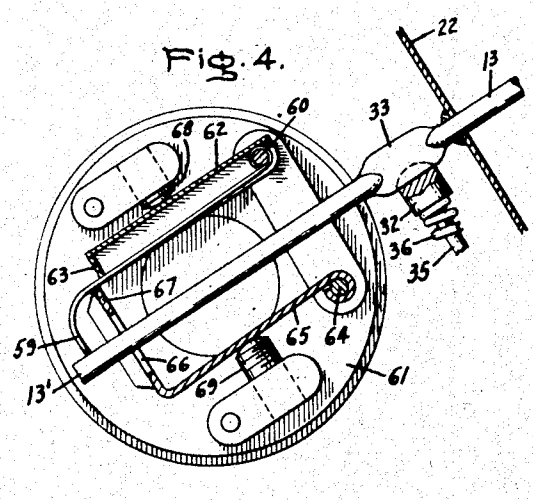
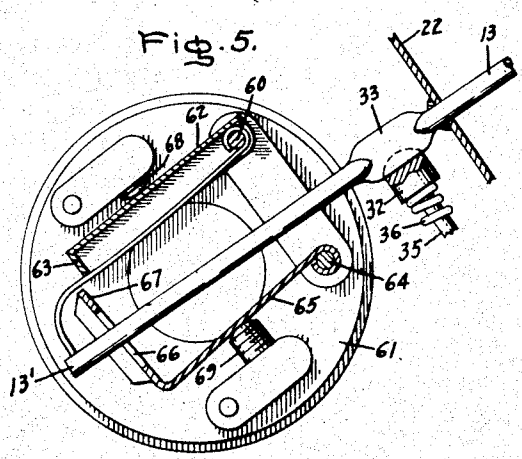


Fig. 5.



Inventor:
Edward A. Leach,
by Harry E. Dunham
His Attorney.

Patented Mar. 30, 1943

2,314,885

UNITED STATES PATENT OFFICE

2,314,885

RELAY

Edward A. Leach, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application May 22, 1941, Serial No. 394,737

13 Claims. (Cl. 200—104)

My invention relates to improvements in relays and more particularly to relays the frequency of the contact operations of which is relatively high and the contacts of which have to function satisfactorily under relatively severe voltage and insulating conditions.

In radio reception and code transmission, there is frequently used a so-called antenna switching and keying relay the principal functions of which are to keep the receiver connected when there is no transmission and to enable the desired transmission under the control of a sending key. In order to transmit rapidly and effectively at a relatively high rate, for example 40 words per minute, the frequency of contact operations must necessarily be high. Prior relay devices, with which I am familiar, have been unsatisfactory at high sending speeds because of the inertia of the moving parts including the contacts and the consequent repeated closing and opening of the contacts or bouncing before reaching a state of equilibrium in the closed position. This bouncing produces false or chopped signal characteristics, which are a deterrent to clear and dependable reception. In some cases this chopped effect has been more or less remedied by delaying the transmitter long enough to ride over the period of contact bouncing. Although this time is relatively short, nevertheless it is objectionable since it means that, either the speed of transmission must be reduced or the clarity of the transmitted characters impaired. Even with the injection of this time lag, some fast sending operator's dashes may be so shortened as to seem like dots. Moreover, since it is often desirable to transmit at high frequencies with voltages as high as 5,000 volts and at relatively high altitudes, the problems of insulation and contact duty are especially severe particularly when weight reduction is imperative.

An object of my invention is to provide an improved relay in which the effect of the inertia of the moving parts is so minimized as effectively to reduce contact bouncing. Another object of my invention is to provide an improved relay, the motion of whose contacts is so damped at contact closing as to eliminate bouncing even when the frequency of contact operations is relatively high. A further object of my invention is to provide an improved relay having double throw contacts which can be operated at high speed in a relatively high voltage circuit and under relatively rare atmospheric conditions. These and other objects of my invention will hereinafter appear in more detail.

In accordance with my invention I provide, particularly for a double throw relay, a contact actuating mechanism which is mechanically linked to the contact structure by means operative to damp the moving contact so as to avoid bouncing during the direct contact actuating movement by said mechanism. Also, according to my invention, I provide a contact actuating mechanism the inertia of whose parts is ineffective to cause contact bouncing during the reverse movement which is accomplished by a suitable operating or biasing means with a contact damping action. Further, in accordance with my invention, I arrange to drive a movable contact by the actuating mechanism through a resilient means in which energy is stored during the direct contact actuating movement and which permits a free return of the actuating mechanism while dissipating the stored up energy, the reverse movement of the movable contact being effected by resilient means independent of the contact actuating mechanism except that it has energy stored therein during the direct contact movement. Further, according to my invention, I preferably provide a contact structure of the so-called vacuum type in order to obtain the maximum interrupting service under high voltage and rare atmospheric conditions particularly in high frequency circuits.

My invention will be better understood from the following description when considered in connection with the accompanying two sheets of drawings, and its scope will be pointed out in the appended claims.

In the accompanying two sheets of drawings, Fig. 1 is a side elevation of a relay embodying my invention with the relay shown in the de-energized condition; Fig. 2 is a section on the line 2—2 of Fig. 1; Fig. 3 is an end elevation of the relay shown in Fig. 1 with parts broken away for clearness, the contact mechanism being shown in the lower throw position; Fig. 4 is an enlarged view of a portion of the contact operating and damping mechanism in the position shown in Fig. 3 and Fig. 5 is a view similar to Fig. 4 with the contact mechanism operated to the upper throw position.

For the purpose of illustrating my invention, I have shown a relay comprising a plurality of contacts 10, 11, and 12, which appear more clearly in Fig. 3, and means for actuating one of the contacts 10 to cause it to engage either of the remaining contacts 11 and 12 comprising an operating member 13. In order to obtain a relatively high interrupting capacity, the switching

means so far described is preferably of the so-called vacuum type, examples of which are well known to the art. The vacuum switch illustrated includes an envelope 14, which is preferably of high insulating value, for example glass, and within which the contacts 10, 11, and 12 and part of the operating member 13 are mounted. In order to secure good voltage gradients, the contacts 11 and 12 may be supported on suitable metallic ferrules, such as cups 15 and 16, respectively. These are sealed to the envelope 14 and further provided with suitable insulation grading 17 at the junction. The contacts 11 and 12 are provided with terminals 18 and 19, respectively, which may have wire connection nuts 20 and lock nuts 21, as shown. In the use of my device as a keying relay, the transmitter and receiver are respectively connected to the terminals 18 and 19.

The operating member 13 extends through the wall 22 of a metallic ferrule or cup 23 which is suitably sealed to and serves to complete the enclosure of the envelope 14. This end wall 22 to which the operating member 13 is suitably secured as by soldering, or the like, is sufficiently flexible to constitute a fulcrum for the operating member at an intermediate point thereof.

The switching means so far described is suitably supported on and insulated from a relay base or supporting structure 24 by an insulating post 25 suitably secured to the base 24 as by screws 26. Suitably secured to the post 25 as by a screw 27, is a metallic head member 28 in a socket of which is set and clamped, as by one or more set screws 29, the cup 23 with the operating member 13 extending through an enlarged opening 30 on the lower side of the head. Also the head 28 is provided with a terminal 31 to which, in the keying application of my relay, the antenna is connected. Thus, depending upon whether contact 10 engages contact 11 or contact 12, the antenna is connected either to the transmitter terminal 18 or the receiver terminal 19.

In accordance with my invention, I provide biasing means for turning the operating member 13 in a direction, clockwise as shown in Figs. 3, 4 and 5, to cause the contact 10 to engage the contact 12. This biasing means may be exterior to the envelope 14 and adjacent the fulcrum wall 22 although it could be positioned elsewhere as far as my invention is concerned. As shown, the biasing means comprises a plunger 32 which is slotted at its upper end to engage a flattened portion 33 of the operating member 13 and which slides in a suitable opening in a projection 34 on the head 28. Associated with the plunger 32 is a rod 35 which carries suitable resilient means, such as a compression spring 36. For purposes of adjustment, this spring is backed by a member 37, as shown in Fig. 3, threaded into the projecting portion 34 of the head 28.

For turning the operating member in a direction, counter-clockwise as viewed in Figs. 3, 4 and 5, to cause the contact 10 to engage the contact 11, I provide, in accordance with my invention electromagnetic means which is effective, through resilient means, to produce the desired turning action without causing contact bouncing. As shown, this electromagnetic means comprises two series connected energizing windings 38, a magnetic structure comprising a core tie member 39 and two pole pieces 40. This electromagnetic structure is suitably secured to a non-magnetic supporting member 41 which is, in turn, supported on two uprights 42 suitably secured to the base 24, as by screws 43. Movable by the magnetic structure described is an armature 44 which is mounted on a shaft 45 so as to be positioned adjacent the ends of the pole pieces 40. The shaft 45 and the armature 44 are biased for clockwise movement, as viewed in Fig. 2, by suitable means, such as a spring 46. In order to adjust the pickup of the armature 44, the spring 46 may be adjustably positioned on the support 41 through the medium of an adjustable post 47. The gap between the armature 44 and the pole pieces 40 may be adjusted by suitable means, such as a screw 48, in order to secure the desired angular movement of the operating member 13. Since high speed operation is necessary, the shaft 45 may be mounted in ball bearings 49, or the like, supported in the uprights 42. Inasmuch as it is desirable to be able to control other auxiliary circuits in response to the movement of the armature 44, the shaft 45 may be of insulating material and have mounted thereon contacts 50 which cooperate with stationary contacts 51, as shown in Fig. 1. These stationary contacts are mounted on insulating members 52 suitably secured between the uprights 42. Terminals 53, mounted on an insulating member 54 carried by the uprights 42, may be provided for connections to the windings 38 and to certain of the movable contacts 50 and to the upper one of the stationary contacts 51, all as shown in Fig. 1. For purposes of contact gap adjustment, each of the stationary contacts 51 may be mounted on a screw 55 which is adjustably positioned relatively to the supporting member 52 and provided with a lock nut 56. For mounting the relay so as to minimize shocks, the base 24 may be provided with a plurality of resilient buffers, such as rubber cylinders 57 through which mounting screws, or the like, can be inserted.

The resilient means through which the movement of the armature 44 and the shaft 45 is imparted to the operating member 13 is, in accordance with my invention, arranged to cumulate energy in the counter-clockwise movement (as viewed in Figs. 3, 4 and 5) of the operating member to prevent bouncing upon engagement of the contacts 10 and 11 without tending to cause bouncing when the operating member moves clockwise to effect engagement of contacts 10 and 12 under the biasing action of the spring 36. As illustrated in Figs. 3, 4 and 5, this resilient means comprises an L-shaped leaf spring 59 hinged on a pin 60 which is carried by a rotatably mounted element such as a disk 61 mounted on the end of the shaft 45 adjacent the end 13' of the operating member 13. Above the spring 59 is a channel-shaped member 62 also movable about the pin 60 and forming a partial housing for the spring. At the end of the housing 62 opposite the pin 60, the housing carries a cross member 63 in the path of movement of the longer leg of the spring 59. The short leg of the spring extends towards the end 13' of the operating member 13. Below the end 13' of the operating member, there is pivotally mounted on a pin 64 in the disk 61 an L-shaped member 65 through a hole 66 in which the end 13' of the operating member extends. As shown, the short leg portion of the member 65 may be channel-shaped, as shown, for strength and stiffness and also partially to guide the end 13' of the operating member. The end 67 of the short leg portion of the member 65 furthermore constitutes a spring support or fulcrum just to the left of the

fulcrum 63. In order to adjust the fulcrums 63 and 67 relatively to the spring, the members 62 and 65 are backed by screws 68 and 69 adjustably positioned in the disk 61. In accordance with my invention the adjustment of these screws relatively to the end 13' of the operating member 13 is such that the short leg of the spring 59 is just clear of the end 13' when the contact 10 is in engagement with the contact 12 as shown in Figs. 3 and 4 but is, in substantially all other positions of the operating member, in slidable engagement with the end 13' as shown in Fig. 5. In order to protect the resilient control means just described from damage and keep out dirt, I provide a protecting cover 70 shown partly broken away in Fig. 3. This cover may be kept in place on the disk 61 by suitable means, such as screws 71.

Assuming the parts positioned as shown in Figs. 1, 2, 3 and 4, then the biasing means comprising the spring 36 provides a clockwise torque on the operating member 13 to maintain the contacts 10 and 12 closed which, under ordinary operation of my invention as a keying relay, would keep the antenna connected to the receiver so that the operator of the craft, in which the equipment is located, could listen in at all times. Under these conditions, the short leg of the spring 59 is just clear of the end 13' of the operating member 13, shown more clearly in Fig. 4. The spring 59, therefore, does not exert any pressure on the member 13 opposing the bias of the spring 36. If now it is desired to actuate the relay for transmission, then the circuit of the windings 38 is controlled from a suitable source through the usual key to leads connected to the two intermediate terminals 53 shown in Fig. 1. Other auxiliary contacts 51 and 50, shown on the lower side of the shaft 55, may be used to energize the transmitter circuit. When the electromagnet is energized, the shaft 45 is rotated counter-clockwise from the position shown in Figs. 3 and 4 to the position shown in Fig. 5. Immediately upon such rotation the lower end of the spring 59 engages the end 13' of the operating member and the longer leg of the spring is deformed from the straight condition shown in Fig. 4 to the slightly reversed curve condition shown in Fig. 5 by reason of the force exerted by the end 13' against the end of the spring 59 and about the fulcrum 63. During this action, in accordance with my invention, the end of the spring 59 moves on and along the end 13' of the operating member, and there is also a slight movement of the spring 59 on and relatively to the fulcrum 63. Each of these relative sliding movements produces a frictional damping which is highly effective in preventing oscillatory spring movements to avoid contact bouncing. At the same time frictional damping of the operating member 13 results from the sliidng movement of the plunger 32 in its opening in the head projection 34. In other words, during the counter-clockwise movement of the shaft 45, energy is stored in the spring 59 up to the maximum condition shown in Fig. 5. This energy stored in the spring 59, as will be obvious, tends to turn the operating member counter-clockwise to maintain the contacts 10 and 11 in the closed position without bouncing under the turning action of the electromagnetic means and the counter torque of the spring 36. Immediately upon de-energization of the windings 38, however, the armature is promptly returned to its unattracted position under the bias of the spring 46. The spring 36 is then effective to turn the operating member clockwise to move the contact 10 against the contact 12. During this movement, the energy stored in the spring 59 is released and the parts returned to the position shown in Figs. 1, 2, 3 and 4. While this clockwise movement of the operating member is taking place, frictional damping due to the movement of the spring 59 on and relatively to the end 13' of the operating member and the fulcrum 63 and the movement of the plunger 32 in its opening is again effective to eliminate spring oscillations and thereby prevent contact bouncing. In this way it is possible to key the antenna at a high rate of speed with sharp and clear signals which are not chopped or effected by contact vibration and in which the personal factor does not play such a large part for intelligible signals.

While I have shown and described my invention in considerable detail, I do not desire to be limited to the exact arrangements shown, but seek to cover in the appended claims all those modifications that fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A relay comprising a plurality of contacts and means for actuating one of said contacts to cause it to engage either of two of the remaining contacts comprising an operating member fulcrumed at a point intermediate its ends and carrying at one end said one contact, biasing means adjacent the fulcrum of said operating member for turning the operating member in a direction to cause the contact thereon to engage one of said two contacts, resilient means positioned on the same side of the fulcrum as said biasing means and adjacent the other end of said member for sliding engagement therewith, and electromagnetic means effective through said resilient means to turn said operating member in a direction to cause the contact thereon to engage the other of said two contacts and to cause said resilient means to cumulate energy for frictionally damping said member during sliding engagement therewith whereby to prevent bouncing of the member under the turning action of said electromagnetic means and said biasing means.

2. A relay comprising a plurality of contacts and means for actuating one of said contacts to cause it to engage either of two of the remaining contacts comprising an operating member fulcrumed at a point intermediate its ends and carrying at one end said one contact, means for turning said operating member in a direction to cause the contact thereon to engage one of said two contacts, resilient means positioned adjacent the other end of said member for sliding engagement therewith, and electromagnetic means for causing said sliding engagement effective through said resilient means to turn said operating member in a direction to cause the contact thereon to engage the other of said two contacts and to cause said resilient means to cumulate energy for frictionally damping said member during sliding engagement therewith whereby to prevent bouncing of the member under the turning action of said electromagnetic means.

3. A relay comprising a plurality of contacts and means for actuating one of said contacts to cause it to engage either of two of the remaining contacts comprising an operating member fulcrumed at a point intermediate its ends and

carrying at one end said one contact, biasing means adjacent the fulcrum of said operating member for turning the operating member in one direction to cause the contact thereon to engage one of said two contacts and arranged to have energy stored therein during movement of the operating member in the opposite direction, resilient means positioned on the same side of said biasing means and adjacent the other end of said member, movable into sliding engagement therewith, and electromagnetic means for moving said resilient means into sliding engagement with said member effective through said resilient means to turn the member in a direction to cause the contact thereon to engage the other of said two contacts and to cause said resilient means to cumulate energy for frictionally damping said member during sliding engagement therewith whereby to prevent contact bouncing under the turning action of said electromagnetic means and said biasing means.

4. A relay comprising a plurality of contacts and means for actuating one of said contacts to cause it to engage either of two of the remaining contacts comprising an operating member fulcrumed at a point intermediate its ends and carrying at one end said one contact, means for turning said operating member in a direction to cause the contact thereon to engage one of said two contacts, resilient means positioned adjacent the other end of said member and movable into sliding engagement therewith, electromagnetic means for moving said resilient means into sliding engagement with said operating member effective through said resilient means to turn the member in a direction to cause the contact thereon to engage the other of said two contacts and to cause said resilient means to cumulate energy for frictionally damping said member during sliding engagement therewith, and means for reversely moving said resilient means to dissipate the energy stored therein.

5. A relay comprising three contacts, and means for actuating one of said contacts to cause it to engage either of the remaining two contacts comprising an operating member fulcrumed at a point intermediate its ends and carrying at one end said one contact, biasing means adjacent the fulcrum of said operating member for turning the member in one direction to cause the contact thereon to engage one of said two remaining contacts, resilient means adjacent the other end of said operating member movable into sliding engagement therewith for mechanically damping the movement of the member to prevent contact bouncing, and electromagnetic means for moving said resilient means into sliding engagement with the member effective through said resilient means to turn the member in a direction to cause the contact thereon to engage the other of said remaining two contacts whereby to cause said resilient means to exert a frictional damping effect during sliding engagement with the member for preventing contact bouncing under the turning action of said electromagnetic means and said biasing means.

6. A relay comprising two stationary contacts, a cooperating contact, and means for actuating said cooperating contact to cause it to engage either of said stationary contacts comprising an operating member fulcrumed at a point intermediate its ends and carrying said cooperating contact at one end, means intermediate the fulcrum and the other end of said operating member for turning the member in a direction to cause said cooperating contact to engage one of said stationary contacts, and means for turning said operating member in a direction to cause said cooperating contact to engage the other of said stationary contacts comprising a shaft, electromagnetic means for turning said shaft in one direction from an initial position through a predetermined angle to a final position, means for turning said shaft in the opposite direction to said initial position, and resilient means forming a driving connection between said shaft and the other end of said member movable relatively to and on the member during movement of the shaft from the initial position to the final position, said resilient means being arranged to cumulate energy during such shaft movement for mechanically damping said operating member in its engagement with said other contact and to dissipate such energy during the return movement of the shaft to the initial position for mechanically damping the movement of said operating member.

7. A relay comprising relatively movable cooperating contacts and means for effecting relative movement of said contacts to cause engagement thereof comprising an operating member fulcrumed at a point intermediate its ends and carrying at one end one of said contacts, biasing means comprising two rectilinearly relatively movable slidably engaging members adjacent the fulcrum of said operating member for turning the operating member in a direction to cause the separation of said contacts, resilient means positioned adjacent the other end of said member for movement into sliding engagement therewith, and actuating means for causing said sliding engagement effective through said resilient means to turn said operating member in a direction to cause the engagement of said contacts and to cause said resilient means and said biasing means to cumulate energy for preventing bouncing of said member under the turning action of said electromagnetic means and said biasing means.

8. A relay comprising a plurality of contacts and means for actuating one of said contacts to cause it to engage either of two of the remaining contacts comprising an operating member fulcrumed at a point intermediate its ends and carrying at one end said one contact, biasing means comprising two rectilinearly relatively movable slidably engageable members adjacent the fulcrum of said operating member for turning the operating member in a direction to cause the contact thereon to engage one of said two contacts, resilient means positioned adjacent the other end of said member and electromagnetic means effective through said resilient means to turn said operating member in a direction to cause the contact thereon to engage the other of said two contacts and to cause relative movement of said slidably engageable members for preventing contact bouncing under the turning action of said electromagnetic means and said biasing means.

9. A relay comprising relatively movable cooperating contacts and means for effecting relative movement of said contacts to cause engagement thereof comprising a pivoted operating member carrying one of said contacts, means for turning said operating member in one direction to cause said contact engagement, resilient means positioned to be moved into sliding engagement with said member upon movement of said turning means in said one direction to effect movement of the member in a direction to cause said

contact engagement and to cause said resilient means to cumulate energy for frictionally damping said member during sliding engagement therewith whereby to prevent contact bouncing under the turning action of said turning means.

10. A relay comprising a plurality of relatively movable contacts and means for effecting relative movement of said contacts to cause engagement thereof comprising a pivoted operating member carrying one of said contacts, biasing means for turning the operating member in a direction to cause separation of said contacts, resilient means positioned to be moved into frictional engagement with said member for effecting movement thereof in a direction to cause engagement of said contacts, and actuating means effective through said resilient means to turn said member in a direction to cause engagement of said contacts and to cause said resilient means to cumulate energy for frictionally damping said member during sliding engagement therewith whereby to prevent contact bouncing under the turning action of said actuating means and said biasing means.

11. A relay comprising relatively movable cooperating contacts and means for effecting relative movement of said contacts comprising a pivoted operating member carrying one of said contacts, means biasing said member to an initial position to effect separation of said contacts and means for turning said member from said initial position against the bias thereon in a direction to cause engagement of said contacts comprising a rotatably mounted element, resilient means mounted on said element so as to be just clear of engagement with said member when the member is in the initial position, means carried by said element for moving said resilient means into sliding engagement with sad member to effect movement thereof to the contact engaging position when said element is turned in a predetermined direction and to stress said resilient means, and means for rotating said element in said predetermined direction.

12. A relay comprising a plurality of contacts and means for actuating one of said contacts to cause it to engage either of two of the remaining contacts comprising an operating member fulcrumed at a point intermediate its ends and carrying at one end said one contact, biasing means comprising two relatively movable engaging members adjacent the fulcrum of said operating member for turning the operating member in a direction to cause the contact thereon to engage one of said two contacts, a rotatable element, a curved spring mounted on said element and having one end arranged for sliding engagement with said operating member, stressing means rigidly supported on said rotatable element and comprising a fulcrum in engagement with said spring at an intermediate point thereof, said stressing means acting upon rotation of said element in a predetermined direction to effect sliding engagement between said end of the spring and said operating member and to stress the spring to effect movement of the member to engage the other of said two contacts, and means for rotating said element in said predetermined direction.

13. A relay comprising relatively movable cooperating contacts and means for effecting relative movement of said contacts comprising a pivoted operating member carrying one of said contacts, means tending to move said member to an initial position, and means for turning said member from said initial position in a direction to cause engagement of said contacts comprising a rotatably mounted element, resilient means mounted on said element for sliding engagement with said operating member, means carried by said element for effecting a relatively sliding movement of said resilient means and said member when said element is turned in a predetermined direction and to stress said resilient means, an dmeans for rotating said element in said predetermined direction.

EDWARD A. LEACH.