March 23, 1954 R. T. CASEY 2,673,263

THERMOMAGNETIC ELECTRIC RELAY

Filed May 18, 1951

Fig. 1.

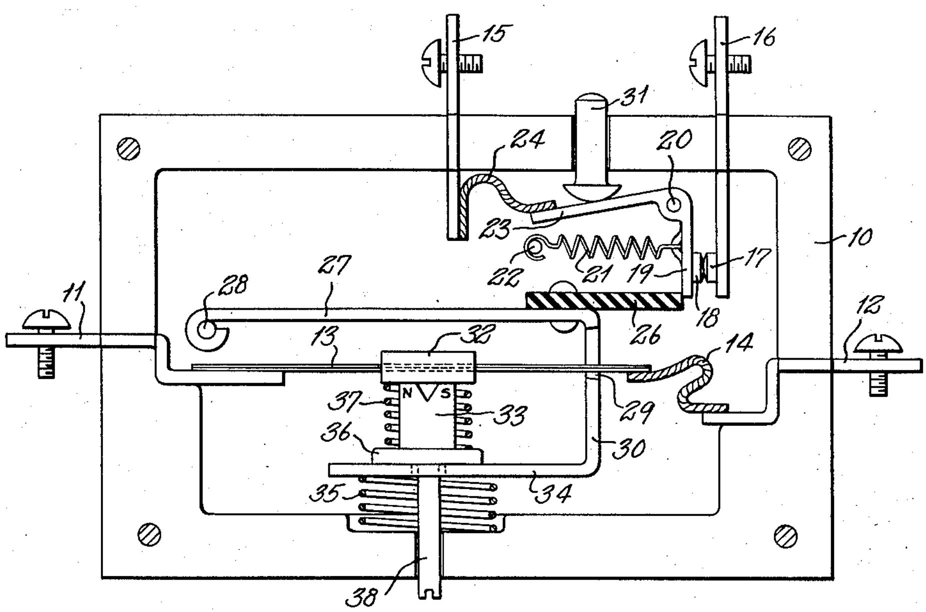


Fig. 2.

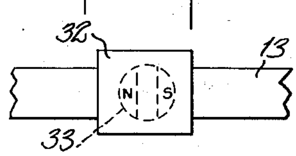


Fig 4.

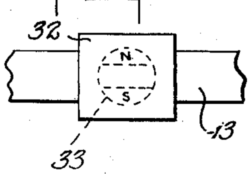


Fig. 3.

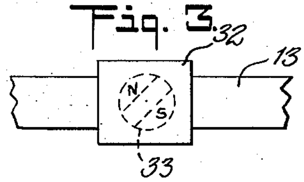
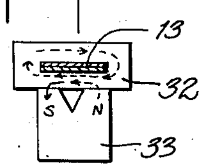


Fig. 5.



Inventor:
Robert T. Casey,
by [signature]
His Attorney.

Patented Mar. 23, 1954 2,673,263

UNITED STATES PATENT OFFICE

2,673,263

THERMOMAGNETIC ELECTRIC RELAY

Robert T. Casey, Bristol, Conn., assignor, by mesne assignments, to General Electric Company, a corporation of New York

Application May 18, 1951, Serial No. 227,048

9 Claims. (Cl. 200—88)

1

My invention relates to improvements in devices or apparatus for controlling electric circuits.

One object is to provide a current responsive device of simple and economical construction.

Another object is to provide a current responsive device which is responsive to both thermal and magnetic effects of current.

Another object is to provide a current responsive device of the magnetic type which can be readily adjusted.

In carrying out my invention, I provide separable contacts, holding means for retaining the contacts in closed position, and thermal and magnetic means for causing the release of the holding means at predetermined current values.

Fig. 1 is a side view illustrating one form of my invention, the side cover being omitted and the parts being shown in the closed circuit position.

Figs. 2, 3 and 4 are fragmentary plan views showing the adjustable magnetic control mechanism in "high," "intermediate" and "low" current positions, respectively.

Fig. 5 is a semi-schematic view of the magnetic circuit involved in the magnetic control.

In Fig. 1, an insulating casing, housing or support 10 is shown in which is mounted main circuit elements, branch circuit elements and mechanism for controlling the branch circuit.

The main circuit terminals 11 and 12 are supported by the housing and connected by a bimetal strip 13 which is fixed to terminal 11 at one end and flexibly connected to the other terminal by a flexible conductor 14.

A branch circuit has terminals 15 and 16. A stationary contact 17 is connected to the terminal 16 inside the housing, and a movable contact 18 is carried by one arm of a tilting lever 19 which is pivoted at 20 in the housing. A spring 21 connects under tension one arm of the lever 19 with a fixed abutment 22. The other arm 23 of the lever 19 is connected by a flexible conductor 24 to the terminal 15. The action of the spring 21 applies tension to the lever 19 tending to open the branch circuit between the contacts 17 and 18. The opening movement, however, is opposed by the insulating abutting member 26 which is carried by the frame 27 pivoted at 28 to the housing. The movable end of the bimetal strip 13 extends through a notch or opening 29 in the member 30 which is connected to the frame part 27. The spring 35 is biased upwardly against arm 34 of frame 27.

When the bimetal member 13 is warped by a gradual low overload in the main circuit, it bears down on the frame member 30 against the bias of spring 35 and retracts the member 26 from the tilting lever 19. The spring then tilts the lever 19 and separates contact 18 from contact 17 thus opening the branch circuit.

2

The branch circuit may be manually closed after such automatic opening by pressing on the plunger member 31 which returns the lever 19 and its contact 18 to closed position, allowing spring 35 to return frame 27 and abutment 26 to latching position when the bimetal 13 has cooled sufficiently.

I have also provided an electro-magnetic system for moving the frame 27 and automatically opening the circuit, which system coacts with the bimetal strip 13 and includes a ferro-magnetic armature piece or sleeve 32 and the magnet 33. Sleeve 32 encircles the bimetallic member 13 and is secured to it.

Member 33 is a high-strength permanent magnet of a material such as "Alnico" and has two poles "N" and "S" normally in contact with sleeve 32. Magnet 33 is fixedly anchored, such as by soldering, to the head 36 of stem 38. Head 36 is of larger diameter than magnet 33 and provides a base flange which serves as an abutment or seat for a spring 37 which is normally compressed between the armature member 32 and the frame member 34.

The magnet member 33 is rotatable and the stem 38 extends freely through an opening in the frame member 34.

The action of this magnetic trip is such that on a sudden high overload magnet 33 is released from sleeve 32, permitting spring 37 to move frame member 30 in a tripping direction against the bias of spring 35. For this purpose, spring 37 is stronger than spring 35.

The magnetic action which causes the release of magnet 33 is considered to be essentially as follows:

When current flows through bimetal 13, its associated magnetic flux will circulate through sleeve 32 as represented by dotted lines in Fig. 5.

At the same time, when magnet 33 is in contact with sleeve 32, its associated magnetic flux will pass through a portion of sleeve 32 as shown by the solid line arrows of Fig. 5.

It will be further understood that the number or density of flux lines due to magnet 33 will depend on the strength of the magnet and the reluctance of the portion of sleeve 32 which these lines pass through. While, technically speaking, there are many paths which such lines may take through piece **32**, the practical operation of the device will be understood by a consideration of the effect on the theoretical flux lines taking the shortest available path as shown.

It is well known that in ferro-magnetic materials magnetic permeability varies with flux density in a predeterminable way. The outstanding characteristic of this variation is that following an initial increase permeability decreases with increased flux density up to a certain point at which the permeability substantially equals that of air.

Applying these considerations to the structure of Fig. 5, it will be seen that as the current in bimetal **13** increases, its associated flux will increase, causing a simultaneous increase in the magnetic permeability of sleeve **32**.

Since the amount of flux from magnet **33** depends on the reluctance of sleeve **32**, it will be seen that this flux will decrease as the current in bimetal **13** increases. When this flux has decreased to a certain minimum value, the magnetic resultant holding force will decrease to a point where it can no longer overcome the force of spring **37**, which will then be free to push the magnet **33** and stem **38** away from bimetal **13**, at the same time moving frame member **30** so as to cause release of the contacts as previously described.

The above action, although described in terms of direct current flow, also takes place when alternating current is flowing through bimetal **13**. This is thought to be due to the fact that the flux from current in bimetal **13** on a given half cycle materially decreases the holding force of magnet **33**, and regardless of what happens on the succeeding half cycle, this momentary decrease is sufficient to permit the spring **37** to operate. Another theory is that while it is apparent how current on one half cycle can decrease the pull of magnet **33**, as explained above, it is not apparent that the current on the succeeding half cycle would equally increase the pull, so that the average holding force of magnet **33** is, therefore reduced.

The effect of an excess of current in bimetal **13** in causing tripping magnetically as described above may be varied or adjusted, in accordance with my invention, by merely rotating the magnet **33** manually by means of the stem **38**. Thus, the effect will be at a maximum (i. e. a lower value of current required to cause release) when the poles of the magnet lie on a line perpendicular to the bimetal strip **13** as in Fig. 4. It will be at a minimum (i. e. a higher value of current required to cause release) when the poles of the magnet lie on a line parallel to the bimetal strip, as in Fig. 2. This is because the saturation effect described above exhibits a directional characteristic. By this adjustment, therefore, the magnetic action of the device may be varied independently of the overload characteristics of bimetal strip **13**.

While I have shown a construction with terminals for making connections so that current conditions in a first circuit can control contacts in a second circuit, it will be understood that the terminals may be connected so that the contacts are in series with the thermal and magnetic current responsive portion to provide a conventional small "automatic circuit breaker" or resettable cut-out. For convenience, all such devices may be termed "relays."

I claim:

1. In an electrical control device having an

element movable upon the occurrence of predetermined electrical conditions in a reference circuit, means for moving said movable element comprising a bimetallic member adapted to be warped by heat generated in said reference circuit, an operative connection between said bimetallic member and said movable element, a magnetic armature member providing a closed magnetic circuit means for causing magnetic flux generated by current in said reference circuit to pass through said armature member along said closed magnetic circuit, a magnet member having pole-faces normally in contact with said magnetic armature said magnet member being arranged to cause magnetic flux to flow in said armature member through a portion of said magnetic circuit in the same direction as said first-named flux, means biasing said magnet member away from said armature, and an operative connection between one of said members and said movable element to cause movement of said movable element upon release of said magnet member.

2. In an electrical control device having an element movable upon the occurrence of predetermined electrical conditions in an electric circuit, a magnetic armature member of a material whose reluctance varies directly with density of flux therethrough, said magnetic armature member providing a substantially closed magnetic circuit, means for causing magnetic flux generated by current in said electric circuit to pass through said armature member along said magnetic circuit, a permanent magnet having pole-faces normally in contact with a continuous portion of said armature member, means biasing said magnetic armature member and said permanent magnet apart, means for rotatably adjusting said permanent magnet with respect to said armature, and operative connecting means between at least one of said magnetic members and said movable element to cause movement of said movable member upon release of said permanent magnet away from said armature member.

3. In an electrical control device having an element movable upon the occurrence of predetermined electrical conditions in an electric circuit, a magnetic armature member of a material whose reluctance varies directly with density of flux therethrough, said armature member providing a substantially closed magnetic circuit, means for causing magnetic flux generated by current in said electric circuit to pass through said armature member along said magnetic circuit, a rotatably-mounted permanent magnet having pole-faces normally in contact with a continuous portion of said armature member, means biasing said magnetic armature member and said permanent magnet apart, a stem projecting from said permanent magnet for rotating said magnet to adjust its position with respect to said armature, and operative means of connection between at least one of said magnetic members and said movable element to cause release of said movable element upon movement of said permanent magnet away from said armature member.

4. In an electrical control device having an element movable upon the occurrence of predetermined electrical conditions in a reference circuit, circuit terminals, means for moving said movable element comprising a current carrying bimetallic strip connected to one of said terminals and adapted to be warped by heat generated in said reference circuit, an operative connection between said bimetallic member and said

movable member, a magnetic armature on and substantially surrounding said bimetallic strip, a magnet member having pole-faces normally in contact with a continuous portion of said armature, means biasing said magnet member away from said armature, and an operative connection between said magnet member and said movable element to cause movement of said movable element upon release of said magnet member away from said armature member.

5. In an automatic circuit breaker, a stationary contact, a movable contact, means for biasing said movable contact to open circuit position, an element movable upon the occurrence of predetermined electrical conditions in a reference circuit, said movable element normally holding said biasing means against action, means for moving said movable element comprising a bimetallic member adapted to be warped by heat generated in said reference circuit, an operative connection between said bimetallic member and said movable element, a magnetic armature providing a substantially closed magnetic circuit means for causing magnetic flux generated by current in said reference circuit to pass through said armature member along said circuit, a magnet member having pole-faces normally in contact with said magnetic armature, means biasing said magnet member away from said armature member, and an operative connection between one of said members and said movable element to cause movement of said movable element upon release of said member whereby said biasing means moves said movable contact to open circuit position.

6. In a device responsive to current in an electric circuit, a magnetic armature member made of a material whose reluctance varies directly with density of flux therethrough, said magnetic armature member providing a complete magnetic circuit in itself, means for causing flux associated with current in said electric circuit to flow through said armature member along said circuit in a predetermined direction, a magnet member having pole faces normally in contact with a continuous portion of said armature, means biasing said magnet and said armature apart, supporting and guiding means providing for rotation of said magnet to a plurality of positions while maintaining its pole faces in contact with said armature, said pole faces having one position in which the flux from said magnet flows through the portion of said armature between said pole faces in said predetermined direction.

7. The invention as described in claim 6 and in which the said magnet has a second position in which the flow of flux from said magnet through the portion of said armature between

said pole faces is substantially at right angles to said predetermined direction.

8. In a device responsive to current in an electric circuit, an elongated electrical conductor adapted to be connected in said circuit so as to pass said current therethrough, a ferro-magnetic sleeve surrounding a portion of said conductor and having a flat area on at least one portion of its outer surface, a magnet having its pole faces normally held magnetically in contact with said flat area of said sleeve, spring means biasing said magnet away from said sleeve, and supporting and guiding means for said magnet including a stem portion attached to and projecting from said magnet, said stem also serving as a means for rotatably adjusting the position of said magnet pole faces on said flat area of said sleeve.

9. In a device responsive to current in an electric circuit, an elongated bimetal having a connection at each end for connection in said electric circuit so as to pass said current therethrough, a sleeve surrounding a portion of said bimetal and having a flat area on at least one portion of its outer surface, said sleeve being made of a material whose reluctance varies directly with the density of magnetic flux lines therethrough, a permanent magnet having its pole faces normally held magnetically in contact with said flat area of said sleeve, spring means biasing said magnet away from said sleeve, a movable control element, an operative connection between a first part of said movable control element and the outer end of said bimetal, an operative connection between a second part of said movable element and said magnet, said second part being provided with an aperture, and supporting and guiding means for said magnet including a stem portion attached to said magnet and extending through said aperture, said stem also serving as a means for rotatably adjusting said magnet pole faces on said flat area of said sleeve.

ROBERT T. CASEY.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
Re. 15,441	Tritle	Aug. 29, 1922
1,248,084	Curtis	Nov. 27, 1917
1,687,515	Roberson	Oct. 16, 1928
2,004,114	Hubbell, Jr.	June 11, 1935
2,035,743	Frank et al.	Mar. 31, 1936
2,170,341	Shaw	Aug. 22, 1939

FOREIGN PATENTS

Number	Country	Date
211,158	Great Britain	Sept. 11, 1924