Nov. 28, 1933. W. R. WOOD 1,936,779

THERMAL RELAY

Filed July 29, 1932 2 Sheets-Sheet 1

Fig. 1.

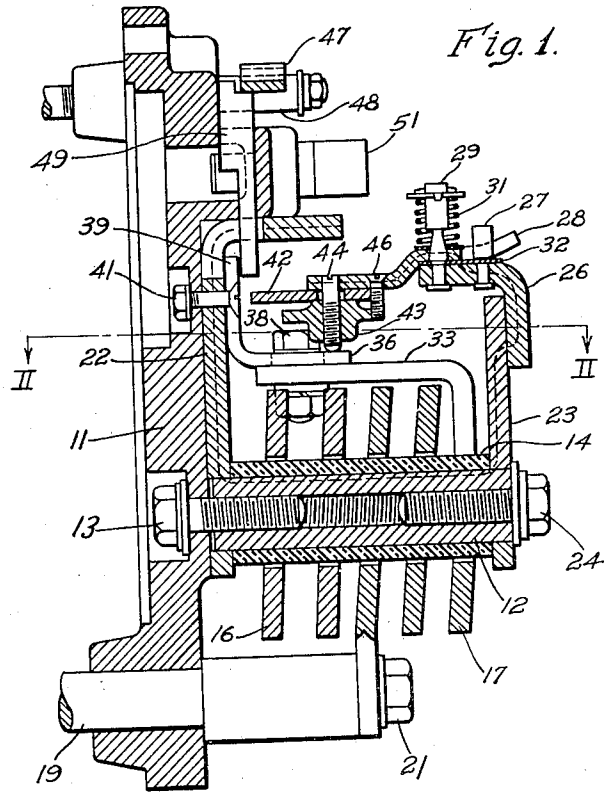
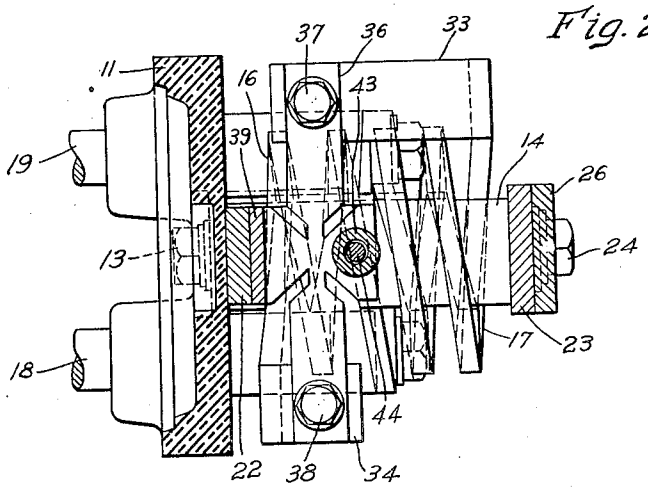


Fig. 2.



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THERMAL RELAY

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Fig. 3.

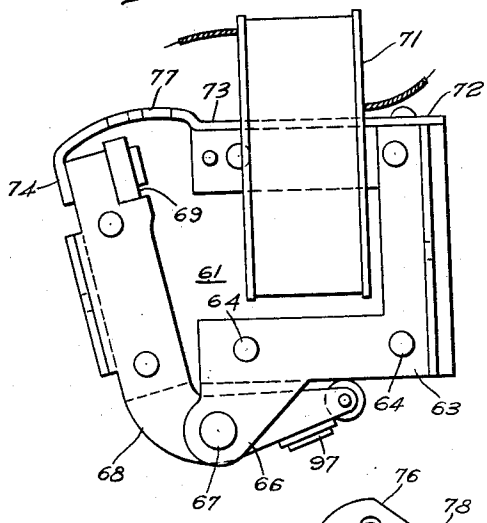


Fig. 4.

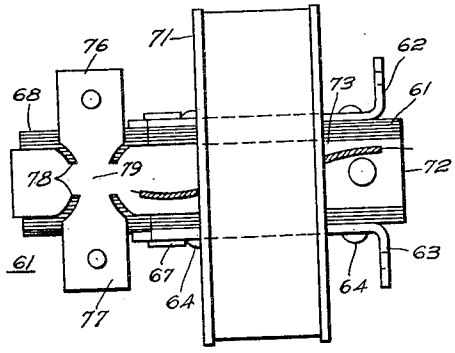


Fig. 5.

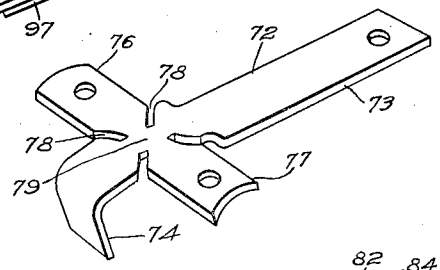


Fig. 6.

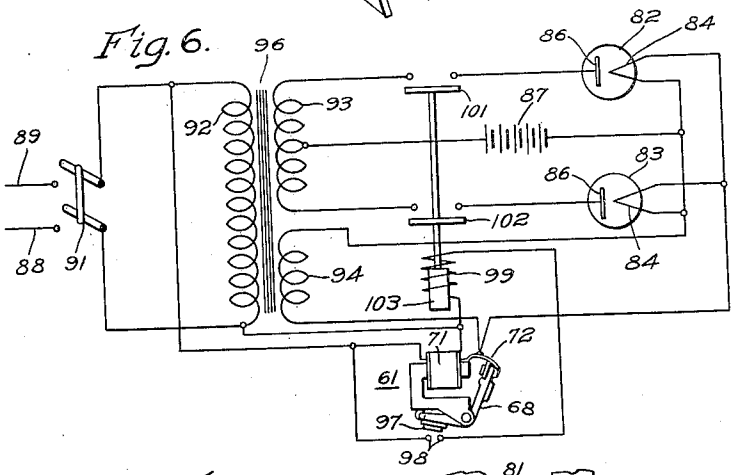


Fig. 7.

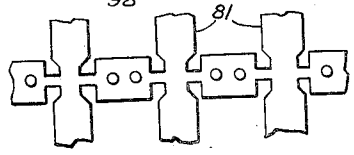
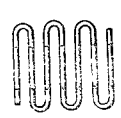


Fig. 8.



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UNITED STATES PATENT OFFICE

1,936,779

THERMAL RELAY

William R. Wood, Carthage, N. Y., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application July 29, 1932. Serial No. 625,793

13 Claims. (Cl. 175—336)

My invention relates to relays and particularly to electromagnetic thermal relays.

An object of my invention is to provide a relatively simple time delay element for a relay.

Another object of my invention is to provide a relay including a magnetically reversible element for effecting a time delay in its operation.

Another object of my invention is to provide a relay in which a temperature controlled variable reluctance element is so shaped as to definitely locate a hot spot therein, and is further provided with means for quickly conducting away the heat from the hot spot when the heating circuit has been interrupted.

In practicing my invention, I provide a temperature controlled variable reluctance element, which is of substantially cross shape to define a centrally located spot of relatively small area, which is heated by an electric current. This element may be operatively associated either with the usual electromagnetic relay or with an electromagnetic lock-out relay.

In the drawings,

Figure 1 is a view, in vertical section, through an electromagnetic relay including the particular part embodying my invention;

Fig. 2 is a view in horizontal section therethrough taken on line II—II of Fig. 1;

Fig. 3 is a view, in side elevation, of a lock-out relay embodying my invention;

Fig. 4 is a top plan view thereof;

Fig. 5 is a view in perspective of a thermally controlled variable reluctance element;

Fig. 6 is a schematic diagram of connections illustrating one use of a lock-out relay, such as illustrated in Figs. 3 and 4;

Fig. 7 is a developed view of a modified form of thermally controlled variable reluctance element, and

Fig. 8 is a view in end elevation of the member shown in Fig. 7 in partially finished condition.

Referring first to Figs. 1 and 2 of the drawings, I have there illustrated an electro-magnetic relay of the general kind disclosed and claimed in copending application Serial No. 593,994, filed February 19, 1932, by W. J. Hudson, and assigned to the Westinghouse Electric and Manufacturing Company. Only such general description will be given of the device as is necessary for an understanding of the operation thereof.

A base 11, which may be of electric insulating material, is suitably shaped to have mounted thereon a magnetizable core member 12, which may be held against the front surface of the base by a bolt 13. Member 12 is surrounded by a tubular member 14 of electric-insulating material, in order to suitably insulate the core member 12 from a plural section energizing coil having a rear section 16 and a forward section 17, each made of bare copper strip bent on edge and having one end thereof connected respectively to terminal studs 18 and 19. Suitable connections are made by nuts 21 to the studs 18 and 19.

One part of the magnetic circuit connected in series circuit with the core member 12 is constituted by a strap 22 of magnetizable material and of substantially L-shape. A front portion of the magnetic circuit is constituted by a bar 23 of magnetizable material which is secured against the tubular member 12 by a nut 24 and a plurality of washers. The member 23 has properly secured thereto a bracket 26, which is of substantially L-shape, and which has a pin 27 fixed therein to extend above the upper surface of the horizontally extending portion of the member 26. A movable magnetizable armature 28 is pivotally mounted on bracket 26, a locating pin 29 with a helical spring 31 therearound tending to hold the armature 28 in a predetermined position. A spacing strip 32 of non-magnetic material is located between armature 28 and bracket 26.

The other ends of the two coil sections 16 and 17 are located in substantially the same horizontal plane, as is shown in Fig. 1 of the drawings, the end 33 of section 17 extending toward the base 11. The end of section 16 extends away from base 11, and is indicated by 34 in Fig. 2 of the drawings.

A thermally controlled variable reluctance member 36 of substantially cross-shape has two laterally extending leg or wing portions to permit of electrically connecting the member 36 to the respective ends 33 and 34 of the two coil sections, as by means of machine bolts 37 and 38, so that a restricted portion of the member 36 of cross shape may be included in the electric circuit of the coil including the sections 16 and 17. One laterally extending portion 39 of the member 36 is extended laterally of the general plane of the member so that it, as well as the member 22, may be secured against the front of the base 11 by one or more small machine bolts 41.

The armature 28 is provided with a striker plate 42, preferably of non-magnetic material, which is secured to the armature 28 to project therefrom in any suitable or desired manner. A nut 43 has screw threaded engagement on a pin 44, upon which it may be adjusted and held in any desired position by a short machine screw 46, all

substantially in a manner set forth in the copending application of W. J. Hudson.

A switch arm 47 is pivotally mounted at one end thereof, while the other end normally engages a contact rod 48, from which the arm 47 may be disengaged, by a push rod 49 when the same is moved vertically upwardly by a similar movement of striker plate 42 and armature 28. An adjusting knob 51 is provided whereby it is possible to adjust the switch including the contact 48 and the blade 47, so that it will either remain in its opened position, or so that it will close when the armature 28 is moved to the position shown in the drawings.

Referring now to Figs. 3 and 4, I have there illustrated a relatively simple, compact, and highly efficient form of what is usually called a lock-out relay. A magnetizable core structure 61 of substantially C-shape has located at each side thereof metal plates 62 and 63, rivets 64 extending through the plates and the magnetizable laminations in order to hold them in proper operative position relative to each other, as shown in the drawings. The plates 62 and 63 are each provided with depending portions 66 through which extends a pin 67, on which is pivotally mounted a movable armature structure including a plurality of laminations and side plates 68. A shading coil 69 is provided at the free end of the armature structure in a manner well known in the art. An energizing coil 71 is located on one of the legs of the core structure.

A thermally controlled variable reluctance member 72, of substantially cross-shape, is operatively associated with one part of the core structure substantially as shown in Figs. 3 and 4 of the drawings, a part thereof being so bent and extending forwardly of the core structure as to provide a path for a part of the flux traversing the core and the armature structures. To this effect, member 72 includes one portion 73, which is located directly against one part of the core structure, and a latch portion 74, which normally holds the free end of the armature in a predetermined limiting inoperative position. Means for passing an electric current through the member 72 includes lateral portions 76 and 77 and a plurality of substantially radially extending slits 78, in this case four in number, cooperating with the respective portions of member 72 to provide a common central part 79 of relatively small area, which carries both a magnetic flux and an electric current.

Referring to Figs. 7 and 8, I have there illustrated one means for varying the area of the normally magnetic path and of also varying the resistance of the electric circuit. To this end, I provide a thermally controlled variable reluctance member 81, which may be so punched out of a large sheet of suitable material as to provide a plurality of elements of the kind designated by numeral 72 and illustrated in Figs. 3, 4 and 5. This punched-out plural element, may be bent as shown in Fig. 8 of the drawings, or any suitable and desired combination of individual members of the kind shown in Fig. 5 may be provided by suitably connecting a plurality of such elements in series, in parallel or in series parallel.

With reference to the material constituting member 72, I prefer to use a nickel steel alloy containing on the order of 36% nickel, which has the characteristic that it is magnetically reversible with changes of temperature, or, in other words, it has a temperature controlled variable reluctance. An element of this kind is magnetizable at all temperatures up to about 210° C., but loses its magnetism at temperatures above this value if it is heated to such temperature either by a current directly traversing the element or by an electric current-traversed resistor member located closely adjacent thereto. As element of this kind recovers its magnetizable characteristic immediately upon fall of its temperature to a value below approximately 210° C.

Referring to the device shown in Figs. 1 and 2 of the drawings, it is obvious that the paths of the flux and of the current intersect or cross each other at one point only, namely, in the element designated by 36 in Figs. 1 and 2, at a portion of restricted area corresponding to the hot spot 79 of element 72 of Fig. 5. The design and construction of the different parts of the relay illustrated in Figs. 1 and 2 are such that when this relay is connected in an electric circuit to be protected, the element 36 will not be heated at any part thereof to a temperature over 210° C. as long as the current traversing the circuit and the coil does not exceed a predetermined value. If, however, an overload current traverses the circuit and coil, as well as element 36, the element 36 will be heated to such a temperature as will cause the common part of the magnetic and electric circuits to lose its magnetizable characteristic so that, because of the parallel flux paths, including the armature 28 and the horizontal part of rear frame 22 as well as the member 36, it will cause a movement of armature 28 so that striker plate 42 engages push rod 49 to actuate switch blade 47 to thereby open a controlling circuit, which, for instance, may include the holding coil of a circuit breaker.

Referring now to the device shown more particularly in Figs. 3 and 4, which I have hereinbefore called a lock-out relay, reference may be had to Fig. 6 of the drawings in which I have illustrated one application of such a relay.

It is desired to properly control two rectifier tubes 82 and 83, which are shown in their simplest form as including an incandescent cathode 84 and an anode 86. It is desired to utilize these rectifier tubes to operate some kind of a load by rectified current, and as illustrative of all such loads I have shown a storage battery 87. The use of two tubes permits of obtaining full wave rectification of an alternating current. The alternating current may be provided by a suitable source including conductors 88 and 89, a switch 91 being provided between this source and the primary coil 92 of a transformer, which transformer has two secondary coils 93 and 94 and a core structure 96.

It is highly desirable in the practical use of such rectifier tubes to insure that there will be no load current traversing the tube until the temperature of the hot cathode has reached its proper normal value. This is because of the fact that deterioration of the cathode 84 will take place if a current passes between it and the anode when the temperature of the cathode has not reached its proper operating value. It is, therefore, desirable to first energize the cathodes 84 by connecting them to the one secondary winding 94, the current passing through the secondary 94 being also passed through the leg portions 76 and 77 of member 72 shown in Fig. 5.

The element 72 is so designed and constructed, particularly as to its dimensions, that there will be a time delay in the heating up or rise of temperature of the hot spot 79, which, for purposes of information, may be mentioned as being

on the order of 20 seconds. As long as member 72 is magnetizable, that is, as long as the temperature of the hot spot 79 is below 210° C., the armature will remain in the position shown in Figs. 3 and 6, but when member 72 becomes non-magnetic or loses its magnetizable characteristic, the armature will be moved against the core structure. In order to make use of this movement in the control of an electric circuit, I provide a contact plate 97 on a part of the armature and provide a pair of contact terminals 98, which are connected in circuit with an actuating coil 99 of a contactor provided with a pair of contact bridging members 101 and 102. The coil 71, it will be observed, is energized from a suitable source, which may be the supply circuit, including the conductors 88 and 89, thus the coil 71 will be energized as soon as switch 91 is moved to its closed position, at which time the incandescent filaments 84 will be energized from secondary coil 94, this current traversing member 72 in the manner already described. Thus, after a time delay on the order of 20 seconds or such other time as may be necessary to bring the incandescent cathodes to their operating temperature, the armature will be moved to close the circuit of coil 99, whereby a movable core member 103, operatively associated with the contact bridging members 101 and 102, will be moved upwardly to close the circuit to the plates 86, whereupon the load 87 will be energized, it being understood that the contact bridging members engage fixed contact members in a manner well known in the art.

That part of my invention constituted by the element 72 has a very important advantage over such prior constructions of which I have knowledge in that the four leg portions 73, 74, 76 and 77 can be made relatively large, both as to mass and also in regard to the superficial or heat radiating area. Thus, in Figs. 1 and 2 of the drawings, the rear frame portion 22 directly in engagement with member 36 and the coil sections 16 and 17 also in direct supporting engagement with member 36 will operate to quickly draw heat from the hot spot, and, therefore, the temperature of this spot will be quickly reduced after the circuit has been opened, making it possible to again close the circuit through the energizing coil including the sections 16 and 17. Substantially the same comments apply with regard to element 72, which is so located as to be quite open and not be covered by other parts of the structure with which it is associated, but such parts of the core structure as are directly in engagement therewith also assist in quickly reducing the temperature of the hot spot 79.

The construction of the magnetically reversible member 72 makes it possible to dispense with the use of any electric-insulating material between the member 72 (or 36) and the other parts of the magnetic circuit. This may be seen from the following: if an electric current were to be caused to traverse the member 72 through arms 74 and 73, an electric potential difference would exist between the spaced parts, being the greatest between the ends. As the element 72 is connected in electric shunt to the magnetic core and armature (as will be evident by reference to Fig. 3) a part of the electric current would traverse this shunt circuit.

If now the electric current traverses arms 76 and 77 there will be no appreciable difference of electric potential between the other ends of arms 74 and 73 and hence no current of any appreciable value will traverse the magnetic structure. The paths of the flux and of the electric current cross each other at one point only.

Various modifications may be made in the device embodying my invention without departing from the spirit and scope thereof, and I desire, therefore, that only such limitations shall be placed thereon as are imposed by the prior art or are set forth in the appended claims.

I claim as my invention:

1. In a lockout relay including a magnetizable core structure, a coil thereon, and a movable armature for said core structure, and a thermally controlled variable reluctance member operatively associated with the core structure and the armature for controlling the position of the armature.

2. In a thermal relay including a magnetizable core structure, an energizing coil therefor and a movable armature, a thermally controlled variable reluctance member constituting a part of the magnetic circuit of the relay and means whereby a predetermined limited portion only of the variable reluctance member is heated.

3. In a thermal relay including a magnetizable core structure, an energizing coil therefor and a movable armature, a thermally controlled variable reluctance member constituting a part of the magnetic circuit of the relay and means effecting a current flow through the variable reluctance member substantially laterally of the path of the flux therethrough and at a predetermined limited portion only of the variable reluctance member.

4. In a thermal relay including a magnetizable core structure, an energizing coil therefor and a movable armature, a thermally controlled variable reluctance member constituting a part of the magnetic circuit of the relay and means whereby a relatively short portion only of the variable reluctance member is heated by an electrical current.

5. In a thermal relay including a magnetizable core structure, an energizing coil therefor and a movable armature, a magnetically reversible member forming a part of the flux path of the core structure, means including said core structure for supporting said member, and means for passing an electric current through a predetermined small portion only of the member to heat said portion, said supporting means constituting a heat dissipating means for the heated portion.

6. In a thermal relay including a magnetizable core structure, an energizing coil therefor and a movable armature, a magnetically reversible member forming a part of the flux path of the core structure, and having a plurality of substantially radially extending slits therein at one point defining a portion of relatively small area, and electric means for heating the portion of relatively small area.

7. In a thermal relay including a magnetizable core member, an energizing coil therefor, and a movable armature, a magnetically reversible member of substantially cross-shape for controlling the position of the armature, a longitudinal portion of the member defining a flux path and a lateral portion defining a path for an electric current, said paths having a small area only in common.

8. In a thermal relay including a magnetizable core member, an energizing coil therefor and a movable armature, a current-traversed magnetically-reversible member controlling the position of the armature and providing intersecting flux

and current paths having a restricted portion only in common.

9. In a thermal relay including a core structure, a movable armature, a thermally controlled variable reluctance element operatively associated with the armature and core structure and in electric shunt therewith, means for passing an electric current through the variable reluctance element while maintaining substantially zero difference of potential between points of different magnetic potential in the armature and core structure.

10. In a thermal relay including a magnetic core structure, a movable armature, and an elongated thermally controlled variable reluctance element, supported by the core structure and in electric shunt therewith, for controlling the movable armature, means for passing an electric current through the variable reluctance element to heat a restricted portion thereof while maintaining substantially zero difference of electric potential between the ends of the elongated variable reluctance element.

11. A device as set forth in claim 10 in which said means includes laterally extending current leads engaging the variable reluctance element at one point thereof.

12. A thermal relay including a magnetic core structure, a movable armature and a current traversed thermally controlled variable reluctance element operatively associated with the core structure and the armature, the flux and current paths in said variable reluctance element having only a single common point.

13. A device as set forth in claim 12 in which the current and flux paths intersect each other at substantially right angles.

WILLIAM R. WOOD.