

Nov. 5, 1935.

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2,020,106

THERMAL TIME RELAY

Filed Aug. 15, 1934

Fig. 1.

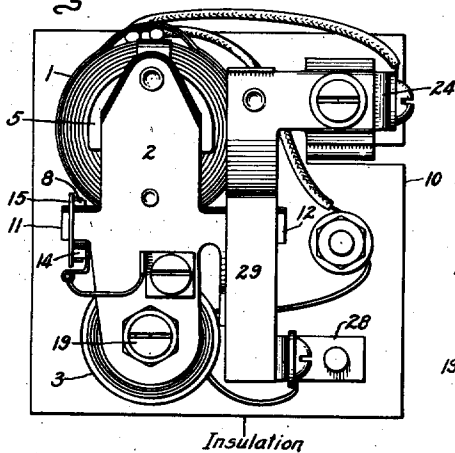


Fig. 2.

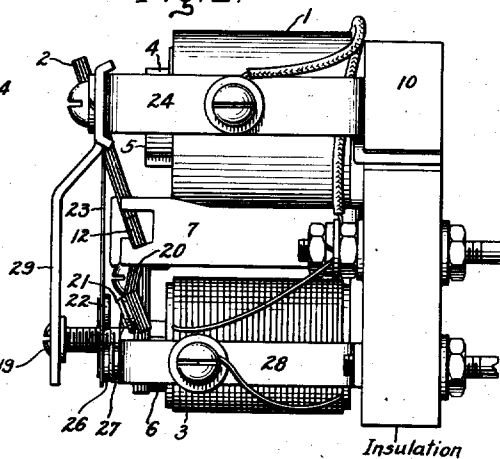


Fig. 3.

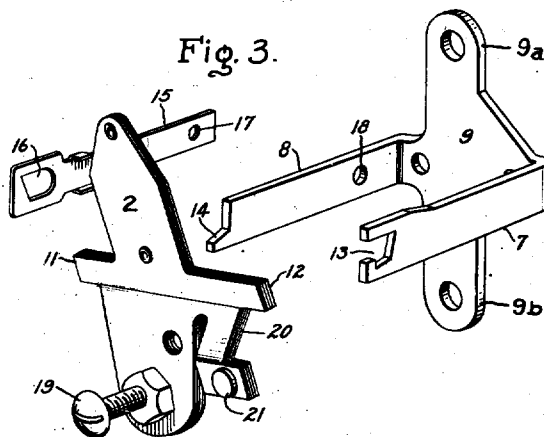
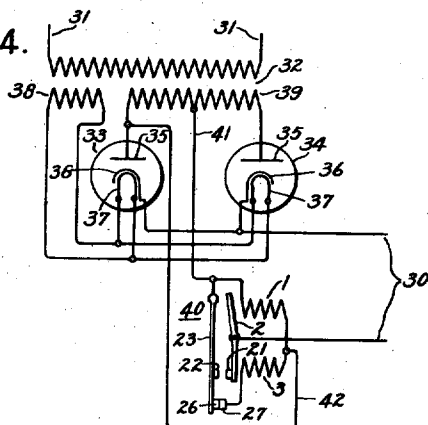


Fig. 4.



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UNITED STATES PATENT OFFICE

2,020,106

THERMAL TIME RELAY

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Application August 15, 1934, Serial No. 739,906

8 Claims. (Cl. 175-320)

My invention relates to relays, more particularly to relays of the electromagnetic thermal time delay type, and has for an object the provision of a simple and reliable thermal time delay relay.

In various electric circuit arrangements it is desirable to provide control relays having means for accomplishing a definite time delay. This time delay is usually provided in order to allow other electrical apparatus in the circuit to assume a certain condition before completing a second circuit. In such installations it is important that the time interval provided shall be of definite duration and that the setting of the relay shall be easily adjustable. It is also desirable that the relay shall operate with substantially a snap action in order that contact pressures may be employed which are sufficiently high to enable the relay contacts to carry substantial currents. It is an object of my invention to provide a simple and reliable thermal time delay relay which, while of simple construction, will have a definite and reliable interval of time delay, which will permit ready adjustment to the time interval desired, and will operate with substantially a snap action.

In carrying out my invention, in one form thereof I provide a relay comprising a movable member controlling contacts adapted to be connected in the circuit to be controlled. Adjacent the movable member is arranged an electromagnetic operating coil for influencing the movable member to circuit-controlling position. The movable member is normally biased to one of its two extreme positions and a time delay lock-out means is arranged adjacent the movable member for holding the same in its normal position. My time delay means preferably comprises a second electromagnet, the core of which is formed from a thermally controlled variable reluctance material. Although such materials are known in the art, and my invention does not depend upon the use of any specific one of these materials, I prefer to use an alloy composed of 59% iron, 36% nickel and 5% chromium. The electromagnetic operating coil and the time delay device are preferably connected in multiple circuit relation for simultaneous energization. The normal biased position of the movable member or armature of my relay is such that in the biased position, a closed, low reluctance magnetic circuit is provided between the armature and the core of the time delay electromagnet, while an air-gap is interposed in the magnetic circuit of the operating magnet. Upon energization of the

relay, therefore, the winding on the time delay electromagnet will set up a flux through the core and the armature, which will prevent the armature from moving in response to the flux set up by the operating coil. The flow of current through the time delay winding serves the double purpose of generating a magnetic flux and generating sufficient heat gradually to raise the temperature of the core of thermally controlled variable reluctance material. The temperature-permeability characteristic of the material forming the core of the time delay coil is such that as the temperature of the coil increases the permeability will gradually decrease until a certain temperature is reached and will then suddenly drop almost to zero. In other words, the temperature-permeability curve of such material does not follow a straight line but includes an abrupt knee point. It is this characteristic which is important in producing a snap action in my relay. When the temperature of the core has increased to a point corresponding to this knee point, the core will become substantially non-magnetic and the armature will quickly be moved by the operating coil to close or open the contacts in the circuit to be controlled. In order to prevent overheating of the time delay electromagnet, I provide a pair of contacts arranged in circuit with the time delay coil and adapted to be opened by movement of the relay armature to its circuit-controlling position, to deenergize the time delay coil.

For a more complete understanding of my invention, reference should now be had to the accompanying drawing in which Fig. 1 is a front view of a relay embodying my invention; Fig. 2 is a side view thereof; Fig. 3 is a detailed view of the movable member or armature and its supporting structure, and Fig. 4 is a circuit diagram of an electric control circuit embodying one application of my relay.

As a preferred embodiment of my invention, I have shown for purposes of illustration a relay resembling in arrangement a conventional balanced type relay and comprising two electromagnetic coils and a movable member or armature pivoted intermediate the coils. The electromagnet 1 comprises the operating coil for influencing armature 2 from its normal biased position, and electromagnet 3 constitutes my time delay means for holding the armature in its biased position for a predetermined time after energization of the electromagnets. Electromagnet 1 is provided with the usual iron core 4 and shading coil 5, while the core 6 of electromagnet 3 consists of 54

a body of the variable reluctance material referred to above. The magnetic circuits for the two electromagnet coils are completed by a U-shaped member comprising arms 7 and 8, upon which the armature is pivoted, and a transversely elongated yoke member 9, the opposite ends 9a and 9b of which carry cores 4 and 6 respectively. The whole magnetic structure is suitably fastened to an insulating base member 10.

As may be seen best in Figs. 2 and 3, armature 2 comprises angularly arranged upper and lower portions which intersect at the pivotal axis of the armature. Outwardly extending ears 11 and 12 on armature 2 cooperate with arms 7 and 8 to pivotally support the armature. Arm 7 is provided with an irregularly shaped slot 13 having a restricted opening through which ear 12 may be inserted by tilting the armature member, and arm 7 is provided with a shoulder 14 upon which ear 11 is adapted to rest. A leaf spring 15 having an irregularly shaped opening 16 in one end thereof is fastened to arm 8, as by passing a rivet or bolt through holes 17 and 18 (Fig. 3), to retain ear 11 on shoulder 14. Armature 2 may be removed from its pivotal supports by pressing spring 15 outwardly from arm 7 and tilting armature 2 so that ear 12 will pass through the mouth of slot 13.

Carried on the lower body portion of armature 2, is a weight 19 which serves to bias the armature to its normal position. As illustrated, a threaded connection is provided between biasing weight 19 and the armature in order that the respective positions of the two members may be changed to increase or decrease the effective bias on the armature. Weight 19 also serves to adjust the reluctance of the magnetic circuit for electromagnet 3. The threaded end of weight 19 may be advanced so as to extend entirely through armature 2 into contact with the end of core 6. Although a non-magnetic material such as brass may be used, I prefer to form weight 19 from a magnetic material such as steel to provide a low reluctance path. It will be obvious that when weight 19 is advanced so as to extend beyond the face of armature 2, the reluctance of the magnetic circuit will be considerably higher than when weight 19 is retracted to permit the face of armature 2 to bear directly against the end of core 6, and that the time setting of the relay may be varied by adjusting the position of weight 19 to change the reluctance of the magnetic circuit of electromagnet 3. Carried on finger 20 which extends downwardly from the pivotal axis of armature 2, is a contact 21 which is arranged to cooperate with a second contact 22 carried by spring bar 23. Spring bar 23 is supported on arm 24 which is suitably fastened to base member 10 and extends outwardly therefrom. Also carried by spring bar 23, is contact 26 adapted to cooperate with a fixed contact 27 supported on arm 28 which is also suitably fastened to the base member 10.

Contacts 21 and 22 constitute the circuit-controlling contacts of my relay and are adapted to be connected in the circuit to be controlled, while contacts 26 and 27 are interposed in the energizing circuit of electromagnet 3. It will be evident from an inspection of Fig. 2 that in the normal biased position shown of armature 2, the circuit-controlling contacts 21 and 22 are in open circuit position, while contacts 26 and 27 are closed. When armature 2 is moved to its circuit-controlling position, contact 21 will engage contact 22 before armature 2 has completed its travel, and the continued movement of armature 2 will force spring bar 23 to flex so as to exert considerable

pressure upon circuit-controlling contacts 21 and 22, and the flexing of spring bar 23 will move contact 26 to open circuit position to deenergize electromagnet 3.

In order to render my relay more rugged and less susceptible to injury from accidental blows, I have provided a guard member 29 interposed in front of spring bar 23 and its associated contacts and supported from arm 24. Guard 29 is formed from rather heavy material and will serve to protect the more delicate parts of the relay from injury in case the relay is to be used in an exposed position.

The operation of my relay and some of its advantages will be more evident on consideration of Fig. 4 wherein I have illustrated somewhat diagrammatically the circuit connections by means of which my relay may be utilized to protect the cathode circuits of a thermionic rectifier. In the arrangement illustrated, rectified current is supplied to a direct-current circuit 30 from an alternating-current source 31 through a transformer 32 and a pair of rectifier tubes 33 and 34 connected for full-wave rectification. Each rectifier tube includes an anode 35, an incandescent cathode 36 and a cathode heater 37, the heaters being connected for energization from a secondary winding 38 of transformer 32, and the anode-cathode circuit of the rectifier tubes being supplied from secondary winding 39. My improved time delay relay indicated generally at 40 is arranged with its normally open contacts 21 and 22 interposed between the anode-cathode circuit of the rectifier and the direct-current load circuit. In the operation of rectifier tubes of the incandescent cathode type, it is highly desirable that the application of load to the rectifier tubes should be delayed until the cathodes have had an opportunity to become heated to their normal operating temperature, otherwise excessive deterioration of the cathodes will take place.

My relay is designed to accomplish this delayed application of load to the rectifier tubes in the following manner: When the line switch (not shown) in the alternating-current supply circuit 31 is closed, cathode heaters 37 will be energized from secondary winding 38 and relay coils 1 and 3 will be energized from the left-hand part of secondary winding 39. The circuit for coil 1 may be traced from secondary 39 through connecting lead 41, winding 1 and lead 42 back to secondary 39. The circuit for coil 3 includes lead 41, spring bar 23, normally closed contacts 26 and 27 and lead 42. As will be more evident from an inspection of Fig. 2, when armature 2 is in its normal biased position, the lower portion thereof rests against or is in proximity to the end of core 6 and thus provides a closed magnetic circuit for the flux produced by the flow of current through coil 3. The force exerted on armature 2 by coil 3, therefore, greatly exceeds the force exerted by electromagnet 1, due to the large air-gap interposed between the upper portion of armature 2 and core 4, and coil 3 is initially predominating to hold armature 2 in its normal position against the force exerted by the electromagnet 1. As current continues to flow through coil 3, the temperature of core 6 is gradually increased and due to the fact that core 6 is formed from thermally controlled variable reluctance material, the permeability of core 6 gradually decreases until, at a certain predetermined temperature, a sudden change of permeability will take place and core 6 will become substantially non-magnetic. Upon the occurrence of this change of permeability in

core 6, the force exerted by the electromagnet 1 becomes suddenly predominating and armature 2 is moved with a snap action to its circuit-controlling position, closing contacts 21 and 22 to connect load circuit 30 to the rectifier and opening contacts 26 and 27 to deenergize coil 3. During the time interval in which core 6 is being heated by the current flowing through coil 3, cathodes 36 of the rectifier tubes have been heated to their normal operating temperature and application of the load circuit to the rectifier tubes will result in no deterioration of the cathodes. Deenergization of coil 3 through the opening of contacts 26 and 27 will permit core 6 to cool down again so that the relay will be in condition to repeat the above operation when coil 1 is deenergized and armature 2 is returned to its normal position by biasing weight 19. It will be apparent that within narrow limits in the region of the knee point on the temperature permeability curve of the material of core 6, the time setting of the relay may be varied by adjusting the position of weight 19.

It will be seen, therefore, that I have provided a simple and reliable electromagnetic thermal time delay relay which may be easily adjusted and which will operate with substantially a snap action.

In some cases it may be advantageous to dispense with electromagnet 3 and substitute therefor a heater element arranged adjacent core 6. By properly proportioning the two parallel magnetic circuits, one of which constitutes a low reluctance path comprising the core 6, the lower portion of armature 2 in its normal biased position, the arms 7 and 8 and yoke portion 9b, and the other of which constitutes a high reluctance path comprising the core 4, yoke member 9a, the arms 7 and 8, the upper portion of armature 2 and the air-gap between the armature and the core 4, the flux generated by electromagnet 1 will be sufficiently predominating in the low reluctance circuit to hold the armature 2 in its normal biased position. The heater element, which may be connected in multiple with electromagnet coil 1 in exactly the same manner as is the electromagnet 3 in my preferred embodiment, raises the temperature of core 6 until the reluctance of that circuit becomes sufficiently high to render the other circuit predominating to move the armature 2 to its circuit-controlling position.

While I have shown a particular embodiment of my invention, it will be understood of course that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as 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 thermal time delay relay comprising a movable member, electromagnetic operating means for moving said member to one of two positions, and electromagnetic time delay means for holding said movable member in the other of said two positions, said time delay means comprising a core of thermally controlled variable reluctance material and a winding thereon arranged to generate a flux through said core to hold said member in said other position, said winding also serving to heat said core to vary the permeability thereof whereby the flux through said core is decreased to release said member after a predetermined period of time.

2. A thermal time delay relay comprising a piv-

oted member, electromagnetic means adjacent one end thereof for moving said member about its pivot, and electromagnetic time delay means adjacent the other end of said member for holding said member against movement, said time delay means comprising a core of thermally controlled variable reluctance material and a winding arranged thereon to generate a flux therethrough for holding said member against movement, said winding also serving to heat said core to vary the permeability thereof whereby the flux through said core is decreased to release said member after a predetermined period of time.

3. A thermal time delay relay comprising a movable member, electromagnetic operating means for moving said member to one of two positions, and electromagnetic time delay means for holding said movable member in the other of said two positions for a predetermined time after energization of said two electromagnetic means, said time delay means including a winding and a core of thermally controlled variable reluctance material arranged to be heated by said winding to release said member.

4. A thermal time delay relay comprising a pivoted member, electromagnetic means adjacent one end thereof for moving said member about its pivot, and electromagnetic time delay means adjacent the other end of said member for holding said member against movement for a predetermined time after energization of said two electromagnetic means, said time delay means including a winding and a core of thermally controlled variable reluctance material arranged to be heated by said winding to release said member.

5. A thermal time delay relay comprising a movable member, a pair of windings energizable simultaneously for actuating said member between two positions one of said windings initially predominating to hold said movable member in its normal position, and means including a core of thermally controlled variable reluctance material in thermal relation to said initially predominating winding for varying the magnetic effect thereof, the permeability of said core decreasing as said core is heated by said winding, whereby said other winding becomes predominating a predetermined time after energization of said windings to actuate said movable member to its second position.

6. A thermal time delay relay comprising a movable member, an operating electromagnet for said member, time delay means adapted to prevent movement of said member for a predetermined time, said means including a winding and a core of thermally controlled variable reluctance material in thermal relation therewith, whereby said winding heats said core to vary the permeability thereof, means connecting said electromagnet and said winding for energization in multiple circuit relation, and means responsive to movement of said member for deenergizing said winding to permit said heated core to cool.

7. A thermal time delay relay comprising a movable member, a core member adjacent said movable member and cooperating therewith to provide two magnetic circuits arranged in parallel and so proportioned that one of said circuits is normally of relatively low reluctance, said one circuit including a portion consisting of a thermally controlled variable reluctance material, means on said core for generating a magnetic flux through said circuits, the flux through

said low reluctance circuit being initially predominating, means adjacent said portion of thermally controlled material for heating the same to increase the reluctance of said normally low reluctance circuit whereby said movable member is influenced from its normal position by the flux through said other circuit.

8. A thermal time delay relay comprising an E-shaped core member having one leg formed from a thermally controlled variable reluctance material, a movable member pivoted on the central leg of said core and normally biased toward said variable reluctance leg to provide a pair of

magnetic circuits arranged in parallel, one of said circuits being normally of low reluctance, means on said core for generating a magnetic flux there-through, the flux through said one circuit being initially predominating to retain said movable member in its biased position and means adjacent said variable reluctance portion for heating said portion whereby the reluctance of said one circuit is increased to render the flux through said other magnetic circuit predominating to influence said movable member from its biased position.

HARRY R. CRAGO.