

Oct. 4, 1932.

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1,880,524

CIRCUIT CONTROL MEANS

Filed July 15, 1931 · 2 Sheets-Sheet 1

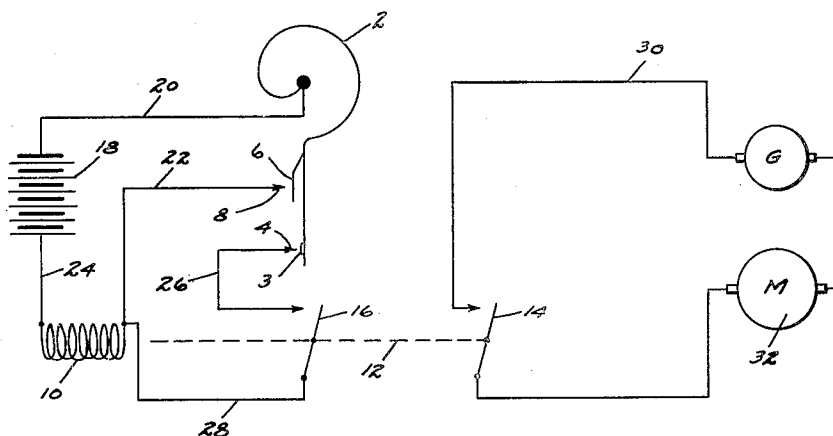


Fig. 1

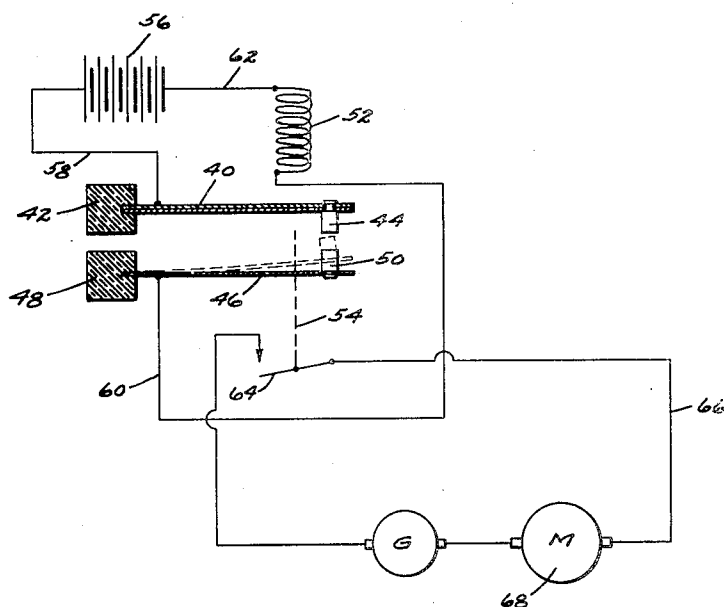


FIG. 2

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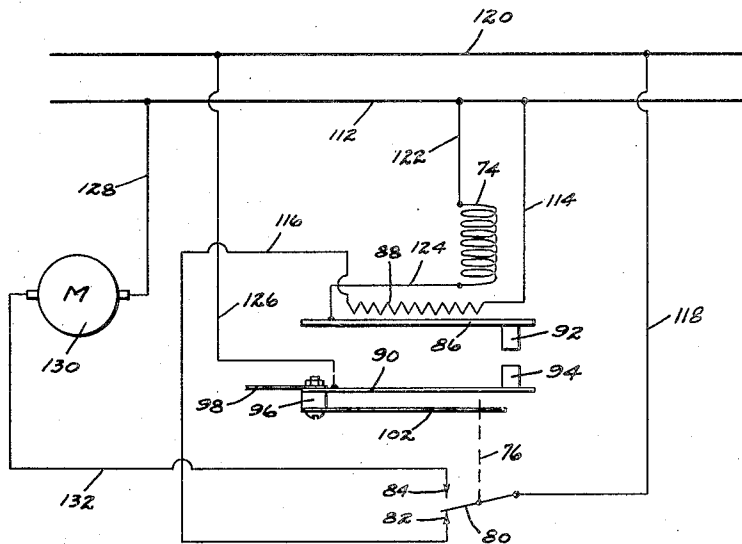


FIG. 3

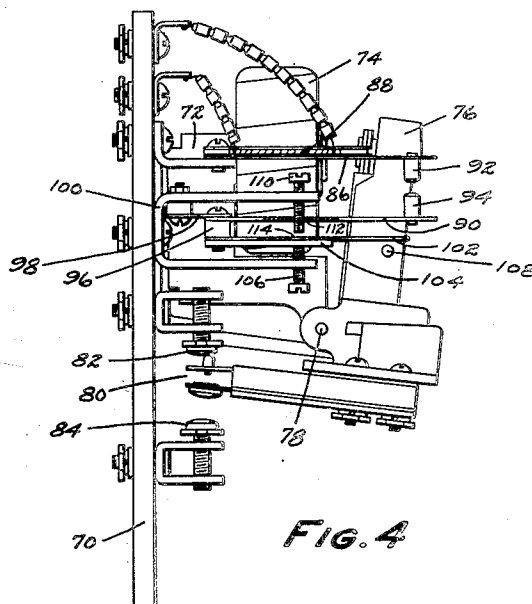


FIG. 4

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CIRCUIT CONTROL MEANS

Application filed July 15, 1931. Serial No. 550,932.

My invention relates generally to the control of electrical circuits and more particularly to control systems utilizing a member movable under the influence of a magnetic field or flux to effect the desired control.

In a simple type of control system, a movable control member is arranged to open and close the energizing circuit of a relay whose armature controls some other circuit by means of a switch or the like connected thereto. The control member carries a contact for engagement with a second contact and the arrangement is such that when these contacts are closed the energizing circuit for the relay is closed and vice versa. When the contacts are very near the breaking point any slight vibration may thus cause interruptions in the energizing circuit for the relay thereby to open and close the same to its own detriment as well as that of the contacts. The action of the relay under such conditions is commonly called chattering.

In order to eliminate relay chattering, it has been proposed to provide the control member with two contacts adapted to engage successively with two other contacts. The proposed arrangement is such that one pair first closes and the other pair subsequently closes while the first remains closed, upon movement of the control member in one direction. When the control member moves in reverse direction the second pair opens first and the first pair opens subsequently. Upon initial closing of the first pair of contacts no circuit will be closed but the closing of the second pair will set up a circuit for initially energizing the relay. The armature of the relay will then close a switch setting up a relay holding circuit through the first pair of contacts. As a result the relay remains energized after the second pair of contacts separate. The instant the first pair separate, however, the holding circuit will be broken so that the relay will be de-energized and its armature will move to open the switch in the holding circuit. Any vibration between the first pair of contacts will not result in chattering since the relay energizing circuit cannot again be closed after the first pair of contacts once separate,

until the second pair of contacts again engage. The result is obtained by so arranging the control that the control member de-energizes the relay at a different point in its path of travel from that at which it was energized. Thus, a vibration of the contacts either at the point of de-energization or the point of initial energization would not result in a making and breaking of the relay energizing circuit.

This proposed arrangement has the disadvantage that it depends for operation upon the making of electrical connection between two pairs of contacts. If the first pair becomes corroded or fails to make proper connection for any other reason, the relay energizing circuit will make and break upon vibration between the second pair of contacts. If the second pair fails to make proper connection, the relay will never become energized. It is a general object of this invention to provide a relay control arrangement which will preclude possibility of relay chattering and which depends for operation upon only a single pair of contacts.

A further object of the invention is the provision of a thermally responsive relay control device which requires only a single pair of contacts to open and close a relay energizing circuit without permitting chattering.

Another object of the invention is the provision of a thermally controlled time switch for periodically energizing and de-energizing a relay, which likewise requires only a single pair of contacts for opening and closing the relay circuit without permitting chattering.

These and various other objects of the invention will become more readily apparent upon a detailed study of the accompanying drawings and specification, together with the appended claims.

In the drawings, Fig. 1 is a diagrammatic showing of a previously proposed relay control arrangement which prevents relay chatter but which depends for operation upon two pairs of contacts;

Fig. 2 is a diagram illustrating a simple application of this invention to the automatic

control of a relay in response to ambient temperature conditions;

Fig. 3 is a diagrammatic showing of an application of the present invention to a thermally responsive time switch for periodically opening and closing a relay circuit; and

Fig. 4 is a side elevation of the apparatus used in connection with the modification illustrated in Fig. 3.

According to the invention, each of the contacts for initially closing the relay energizing circuit is carried on a separate movable member. These members are brought together into predetermined relative positions to close the contacts and thereby energize the relay. Upon resulting movement of the armature, a force is exerted upon one of the members carrying the contacts in the direction of its co-acting member so that the contacts will separate when their carrying members are in different positions from those occupied when the contacts closed. When the contacts do separate the relay will be de-energized, the armature will move back to relieve the force it exerted upon one of the contact carriers, and that carrier will consequently shift its position away from its adjoining one. As a result there will be no possibility of vibration between the contacts after the relay has once been de-energized. So also, there will be no possibility of vibration upon initial energization of the relay for upon first closing of the contacts they will immediately be drawn more tightly together due to the force exerted by the relay armature and will not be able to separate until they assume relative positions different from those when the contacts first closed.

The carrier upon which the force is exerted by the armature is preferably formed of resilient material so that it will return to its normal position when the force is relieved but this carrier may if desired be pivoted so as to return to normal position under the influence of gravity or some equivalent means. In a particularly advantageous application of the invention at least one of the carriers is a thermostatic element. If desired, both carriers may be thermally responsive as in the case of a thermally controlled time switch in which changes in ambient temperature are to be compensated for.

Referring to Fig. 1, which shows a known arrangement for eliminating chattering, 2 designates a thermostatic element, preferably of the bi-metallic type, which carries a contact 3 for engagement with fixed contact 4, and a contact 6 for engagement with fixed contact 8. The arrangement is such that upon movement of the thermostat to the left of the position shown, contacts 3 and 4 will first engage and then contacts 6 and 8 will close while contacts 3 and 4 remain closed. Upon reverse movement to the right, contacts 6 and 8 will first open and contacts 3 and 4

will subsequently open. The relay coil 10 has an armature 12 which moves to the right when the relay is de-energized. Upon energization, the armature moves to the left closing switches 14 and 16.

When the thermostat moves to the left and causes contacts 3 and 4 to engage, no circuit will be closed since switch 16 is open but upon continued movement to the left contacts 6 and 8 will close to set up the following circuit for initially energizing the relay coil 10; battery 18, wire 20, bi-metallic element 2, contact 6, contact 8, wire 22, relay coil 10, wire 24, and battery 18.

The energizing of coil 10 draws armature 12 to the left and closes switch 14 to set up the following holding circuit for coil 10: battery 18, wire 20, bi-metallic element 2, contact 3, contact 4, wire 26, switch 16, wire 28, relay coil 10, wire 24, battery 18. Vibration between contacts 6 and 8 will therefore not result in relay chatter for the relay remains energized through its holding circuit. When contacts 3 and 4 disengage the holding circuit will be broken and armature 12 will move to the right and open switch 16. Re-engagement of contacts 3 and 4 will thus not energize the relay and there will be no chatter upon vibration between these contacts. For purposes of illustration, armature 12 has been shown as controlling a switch 14 in the energizing circuit 30 of a motor 32.

It will be seen that elimination of chatter and proper operation depends upon proper engagement of both pairs of contacts 3 and 4, and 6 and 8. If contacts 6 and 8 become corroded and fail to close properly, relay coil 10 will never energize. If contacts 3 and 4 do not close properly the relay will chatter upon vibration between contacts 6 and 8.

Referring now to Fig. 2, which illustrates a simple embodiment of the principles of the present invention, the numeral 40 designates a bi-metallic element fixed at one end in a block of insulating material 42 and carrying a contact 44 at its other end. A resilient metal strip 46 which is mounted in an insulating block 48 at one end, is positioned opposite the bi-metallic element 40 and carries a contact 50 which is engaged by contact 44 upon movement of bi-metallic element 40 due to temperature change.

The relay coil 52 has an armature 54 which assumes a lowermost position as shown when the coil is de-energized and is drawn upwardly when the coil is energized. Armature 54 has a connection with the resilient metal strip 46 to raise the same together with its contact 50 into the position shown in dotted lines when the relay coil is energized.

If it be assumed that the thermostatic element 40 and the strip 46 occupy the positions shown in full lines, and a change in ambient temperature, for instance a temperature drop,

causes element 40 to move downwardly until contact 44 touches contact 50, the following circuit for energizing relay coil 52 will be set up: battery 56, wire 58, bi-metallic strip 40, contact 44, contact 50, metal strip 46, wire 60, relay coil 52, wire 62, battery 56. At the instant coil 52 is energized, armature 54 will move upwardly and tend to move strip 46 into the position shown in dotted lines. Preferably strip 46 is more flexible than bi-metallic element 40 so that contact 50 will remain in approximately the position shown in full lines even after it has been engaged by contact 44 and the armature has moved to uppermost position. If the temperature now rises and causes element 40 to move upwardly, contact 50 will follow contact 44 due to the force exerted by armature 54 upon strip 46 until the strip and contact reach the position shown in dotted lines. When bi-metallic element 40 finally moves upwardly a sufficient amount above the dotted line position of the resilient strip 46 to cause disengagement of contacts 44 and 50, the energizing circuit for relay coil 52 will be broken and armature 54 will move downwardly into the position shown whereupon resilient strip 46 will also move downwardly into its full line position.

It will be observed that possibility of relay chatter is precluded both upon initial energization of the coil and upon subsequent de-energization. The instant contacts 44 and 50 engage, the force exerted upon resilient strips 46 by the armature will serve to hold them together until bi-metallic element 40 has moved backward an appreciable amount. There can thus be no vibration between the contacts at this time. After the element 40 has moved contact 44 above the dotted line position of contact 50, the latter contact will immediately drop back to its full line position away from contact 44 thereby to preclude vibration between the two. The arrangement allows opening and closing of a relay circuit by means of a single pair of contacts without permitting chatter.

For purposes of illustration, the armature 54 has been shown as controlling the switch 64 which is in the energizing circuit 66 for any desired load such as motor 68.

Referring finally to Figs. 3 and 4, wherein the invention is shown as applied to a time switch for periodically opening and closing the energizing circuit for any desired load, numeral 70 designates a panel of slate or other insulating material upon which is mounted the field core 72 of a relay having an energizing coil 74 and an armature 76 which is pivoted at 78. When the relay is not energized, armature 76 assumes the position shown and when the relay is energized it moves to the left about its pivot 78 (Fig. 4). For purposes of convenience and clarity of illustration, the armature is shown in Fig. 3

as moving between a lower position assumed when the relay is not energized and an upper position assumed and held while the relay is energized. The armature carries contacts 80 which engage contact 82 when the relay is open and engage contact 84 when the relay is closed, contacts 82 and 84 both being mounted on the panel.

A thermostatic element which in this case is a bi-metallic strip 86 is mounted on the panel 70 and is arranged to be heated by the heating coil 88. Mounted opposite the bi-metallic strip 86 is a second, similar bi-metallic strip 90 and the strips 86 and 90 carry oppositely disposed contacts 92 and 94 respectively, which are spaced apart when strips 86 and 90 are at the same temperature. Variations in ambient temperature will not affect the relative positions of contacts 92 and 94 for as one moves down upon ambient temperature rise, for instance, the other will also move down and compensate for the change. If the strip 86 is heated to a higher temperature than strip 90 by means of the heating coil, however, it will move down a greater amount than strip 90 and cause contact 92 to engage contact 94.

The bi-metallic strip 90 is supported from a block 96 carried by a short resilient strip 98 secured to a U-shaped bracket 100 which is fastened to the panel 70. As a consequence, it is capable of resilient tilting movement about the middle of strip 98. The block 96 carries at its lower end a long metal strip 102 and directly beneath it a short rigid bar 104. The lower leg of the bracket 100 has a set screw 106 which engages the lower surface of rigid bar 104 so as to tilt block 96 to the left and raise the outer end of bi-metallic strip 90 which carries contact 94. The setting of screw 106 therefore determines the distance between contacts 92 and 94 under ambient temperature conditions. By adjustment of this set screw, the temperature difference necessary to cause contacts 92 and 94 to engage can be regulated and the time lapse between initial heating of the coil 88 and the engagement of the contacts can thus also be regulated.

The armature 76 carries a projecting lug or stop 108 which is out of engagement with strip 102 when the armature is in open position as shown in Fig. 4. When the relay is energized and the armature moves to the left about its pivot 78 the lug 108 will engage the lower surface of the outer end portion of strip 102 to raise the same and thereby tilt block 96 upwardly to the right with the result that the outer end of strip 90 carrying contact 94 will receive an upward force in the direction of bi-metallic strip 86 and contact 92. A set screw 110 which is mounted in the upper leg of the U-shaped bracket 100 passes through holes 112 and 114 in the bi-metallic strip 90 and the metal strip 102

to engage the upper surface of the rigid bar 104 and thereby limit the upward movement of contact 94 after the armature has closed.

When the coil 88 heats bi-metallic strip 86 sufficiently, it will move downwards until contact 92 touches contact 94. Assuming that the armature closes upon engagement of these contacts, lug 108 will exert an upward force on strip 102 with the result that contact 94 will receive an upward force pressing it against contact 92. If the temperature of strip 86 then falls it will begin to move upwardly but contact 94 will follow contact 92 until block 96 has tilted a sufficient amount to cause the upper surface of rigid bar 104 to engage the lower end of set screw 110. Upon continued upward movement of strip 86 the contacts will separate, the relay will be de-energized with the result that lug 108 will move away from metal strip 102, and contact 94, bi-metallic element 90, block 96, rigid bar 104, and metallic strip 102 will drop down into the position shown in Fig. 4.

It will be noted that bi-metallic strip 86 is at a lower temperature when the contacts separate than when they first engage and that this temperature difference can be regulated by means of set screw 110. If the set screw 110 is adjusted so that its lower edge is very close to bar 104 when the parts are in the position shown in Fig. 4, for example, the outer edge portion of strip 102 will be raised the usual amount upon closure of the relay but the upward movement of bar 104, and consequently of bi-metallic strip 90 and contact 94, will be limited by the set screw. Thus the contacts will separate upon only very slight upward movement of strip 86 away from the position in which they first engaged and it may be said that the contacts will separate when the strip 86 falls to a temperature only slightly lower than that at which they first engaged. If the set screw 110 is raised, however, there will have to be a greater temperature fall on the part of bi-metallic element 86 before the contacts will separate. Since the time necessary for the temperature drop required to effect separation of the contacts varies with the amount of the drop, the set screw 110 further regulates the time during which the contacts are in engagement.

Upon inspection of the wiring diagram shown in Fig. 3, it will be seen that when the contacts 92 and 94 are separated as shown, the relay is not energized and heating coil 88 receives current through the following circuit: side of line 112, wire 114, heating coil 88, wire 116, contact 82, contact 80, wire 118, and side of line 120. As current flows through coil 88 it will radiate heat and raise the temperature of bi-metallic strip 86 with the result that its outer end will move downward carrying contact 92 into engagement with contact 94 thereby to set up the following circuit for energizing relay coils 74: side of line

112, wire 122, relay coil 74, wire 124, bi-metallic strip 86, contact 92, contact 94, bi-metallic strip 90, wire 126, and side of line 120.

When coil 74 is energized the armature 76 will close, pulling contact 80 away from contact 82 and into engagement with contact 84, and exerting an upward force on metal strip 102. Separation of contacts 80 and 82 will break the circuit for heating coil 88 so that it will immediately begin to cool and the closing of contacts 80 and 84 will close the following circuit for any desired load such as a stoker motor, for instance: side of line 112, wire 128, motor 130, wire 132, contact 84, contact 80, wire 118 and side of line 120. As the coil 88 cools bi-metallic element 86 will also cool thereby to raise contact 92 but contacts 92 and 94 will not immediately separate due to the upward force which causes contact 94 to remain in engagement until bi-metallic element 86 is at a temperature lower than that at which engagement was first made. At the instant of separation, contact 94 will occupy a position higher than at the instant of engagement but will drop back as the armature opens upon de-energization of the relay, into substantially the position occupied at the instant of initial engagement. As the armature opens, contact 80 will be moved into engagement with contacts 82 whereby the motor circuit will be broken and the heating coil circuit again closed. When the bi-metallic strip 86 again reaches a sufficiently high temperature, contacts 92 and 94 will close, the heater circuit will be broken, and the motor circuit will be closed and remain closed until strip 86 cools sufficiently to cause separation of contacts 92 and 94.

In operation the relay will be periodically opened and closed to periodically operate the motor and it will be apparent that the time between openings and closings can be regulated by adjustment of the set screws 106 and 110.

It will further be observed that there will be no opportunity for relay chatter. There can be no vibration between contacts 92 and 94 upon initial engagement because of the upward force which presses them together the moment contact is made. Also there can be no relative vibration at the point of disengagement for the contact 94 will drop back an appreciable amount at the instant of separation.

I claim as my invention:

1. The combination with a relay having a movable armature and an energizing circuit, of a pair of contacts controlling said circuit, a member movable in response to changes in a physical condition carrying one of said contacts, a second movable member carrying the other of said contacts in position to be engaged by the contact on said condition responsive member upon relative movement of the latter, and means associated with the relay

armature for exerting a force on said second movable member in the direction of the condition responsive member when the contacts initially engage, said force causing said second movable member and contact to follow the condition responsive member and contact for a limited distance upon movement of the latter in a direction away from its point of original engagement with the former, whereby said contacts separate at a point spaced from that at which they originally engaged.

2. The combination with a relay having a movable armature and an energizing circuit, of a single pair of contacts controlling said circuit, a movable member carrying one of said contacts and being adapted to move it to and from the other in response to changes in its temperature, resilient means supporting the second contact and adapted to assume a normal position of rest, and means associated with the relay armature for exerting a force on said resilient supporting means in the direction of the temperature responsive member when the contacts initially engage, said force causing the contacts to separate at a point spaced from that of initial engagement upon movement of the temperature responsive member in a direction away from the original position of the second contact.

3. The combination with a relay having a movable armature and an energizing circuit, of a temperature responsive bi-metallic strip carrying a contact, a resilient strip carrying a second contact for co-operating with the first said contact to open and close the relay energizing circuit, and means on said movable armature for exerting a force on said resilient strip to move the second contact in the direction of the first said contact when they initially engage to energize the relay and move the armature, whereby said contacts disengage at a point removed from the point of engagement, the resilient strip being adapted to move the second contact away from the first upon their separation and resulting movement of the armature to the position it occupies when the relay is de-energized.

4. The combination with a relay having a movable armature and an energizing circuit, of a single pair of contacts controlling said circuit, a bi-metallic strip movable in response to temperature changes carrying the first of said contacts, a resilient metal strip fixed at one end and being deformable from a position assumed when unrestrained, a block carried at the other end of the deformable strip, a second strip fixed at one of its ends to one end of the block and carrying the second contact on its other end at a point opposite the first contact, a third strip fixed at one of its ends to the other end of said block, and means associated with the armature of the relay for exerting a force on said third strip when the relay is energized.

5. The combination with a relay having a

movable armature and an energizing circuit, of a single pair of contacts controlling said circuit, a bi-metallic strip movable in response to temperature changes carrying the first of said contacts, a resilient metal strip fixed at one end and being deformable from a position assumed when unrestrained, a block carried at the other end of the deformable strip, a second strip fixed at one of its ends to one end of the block and carrying the second contact on its other end at a point opposite the first contact, a third strip fixed at one of its ends to the other end of said block, a rigid bar lying adjacent said third strip and fixed to the same end of the block, means associated with the armature of the relay for exerting a force on said third strip when the relay is energized thereby to tilt the block and the second contact in the direction of the first said contact, and a stop co-operating with the rigid bar to limit the tilting movement of the block.

6. The combination with a relay having a movable armature and an energizing circuit, of a single pair of contacts controlling said circuit, a first thermally responsive member carrying the first of said contacts, a second thermally responsive member carrying the second contact at a spaced distance from the first contact when the thermally responsive members are at like temperatures, a heating coil for heating the first thermally responsive member, means for interrupting the energizing circuit for said coil thereby to move the first contact into and out of engagement with the second contact, and means associated with the relay armature for exerting a force on the second contact in the direction of the first when the relay is energized, whereby said contacts separate and break the relay energizing circuit at a point different from that at which they initially engaged to complete it, upon movement of the first contact away from the second.

7. The combination with a relay having a movable armature and an energizing circuit, of a single pair of contacts controlling said circuit, a first thermally responsive member carrying the first of said contacts, a second thermally responsive member carrying the second of said contacts, said contacts being spaced apart when the thermally responsive members are at like temperatures, a heating coil for heating the first thermally responsive member thereby to move the first contact into engagement with the second, an energizing circuit for said coil, a switch in said coil energizing circuit connected with the relay armature, said switch being closed when the armature is in open position and vice versa, and means associated with the relay armature for exerting a force on the second contact in the direction of the first and moving the former upon retraction of the latter for a limited distance, whereby said contacts separate and break the relay ener-

gizing circuit at a point different from that at which they initially engaged to complete it, when the first contact moves away from the second due to cooling of the heating coil.

8. The combination with a relay having a movable armature and an energizing circuit, of a single pair of contacts controlling said circuit, a first thermally responsive member carrying the first of said contacts, a second thermally responsive member resiliently supported at one end and carrying the second of said contacts at its other end, said contacts being spaced apart when the thermally responsive members are at like temperatures, a heating coil for heating the first thermally responsive member thereby to move the first contact into engagement with the second, an energizing circuit for said coil, a switch in said coil energizing circuit adapted to be closed when the relay is not energized and open when it is energized, and means associated with the relay armature for actuating the second thermally responsive member and contact in the direction of the first thermally responsive member and contact for a limited distance covered upon energization of the relay and retraction of the first contact from its original position of engagement with the second contact an amount equal to said distance.

9. In combination, a relay having a movable armature, an energizing circuit for the relay, a first member movable in response to temperature changes, a second member similarly movable in response to temperature changes, means for heating the first said member thereby to move the same relatively to the second, a pair of contacts carried by said movable members and cooperating to open and close the aforesaid energizing circuit upon movement of the first said member due to changes in its temperature set up by said heating means, and means associated with the relay armature for actuating said second member in the direction of the first upon energization of the relay.

In witness whereof, I have hereunto set my hand this 9th day of July, 1931.

DANIEL G. TAYLOR.

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