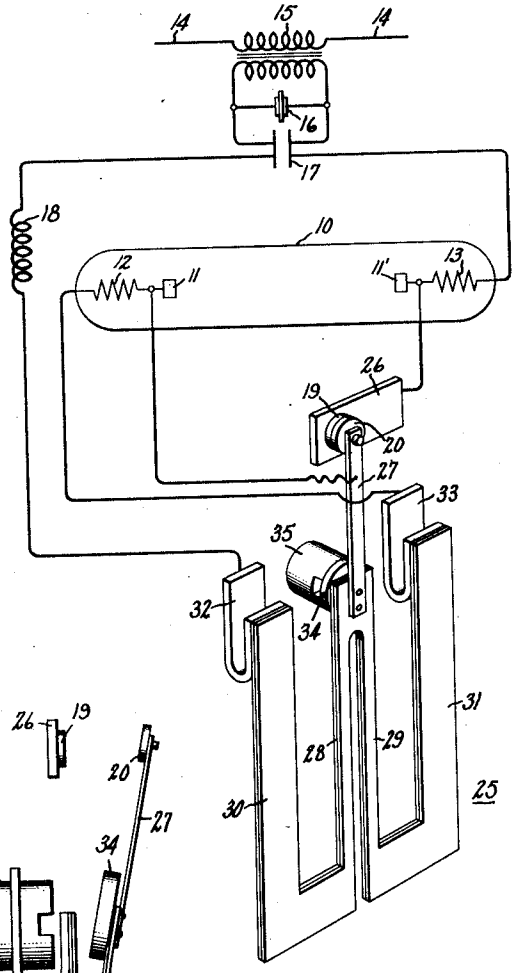
Nov. 17, 1942. A. G. STIMSON 2,302,399

THERMAL RELAY

Filed Feb. 13, 1942

Fig. 1.



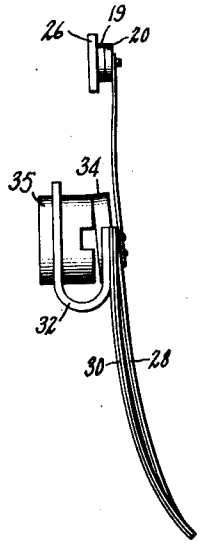


Fig. 2.

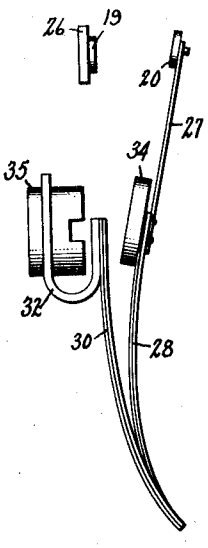


Fig. 3.

Inventor:
Allen G. Stimson,
by Harry E. Dunham
His Attorney.

Patented Nov. 17, 1942 2,302,399

UNITED STATES PATENT OFFICE

2,302,399

THERMAL RELAY

Allen G. Stimson, Lynnfield, Mass., assignor to General Electric Company, a corporation of New York

Application February 13, 1942, Serial No. 430,784

15 Claims. (Cl. 200—113)

My invention relates to thermal relays and particularly to ambient temperature compensated bimetallic relays of the snap action type.

The thermal relay of my invention has particular application to the control of electric discharge lamps and is suitable as a thermal timing device for initiating discharge in such lamps. In certain types of electric discharge lamps, such as sodium vapor lamps, it is necessary to preheat the cathodes before initiating the lamp discharge current. While relays have been previously designed which are very efficient in this application they are of relatively complicated structure and are subject to the disadvantage of high cost.

Accordingly, it is an object of my invention to provide a thermal relay which shall be efficient and reliable in operation and simple and inexpensive to manufacture in quantity.

It is a further object of my invention to provide a thermal relay having relatively long time delay in operation and capable of exerting a relatively large force over a wide range of movement.

It is a still further object of my invention to provide an ambient temperature compensated thermal relay which shall operate to increase the pressure of normally closed contacts immediately prior to separation of the contacts.

It is a specific object of my invention to provide a thermal time delay starting for electric discharge lamps which shall operate efficiently and which shall be simple and inexpensive to manufacture.

My relay comprises essentially a pair of movable bimetallic members disposed in parallel spaced relation and connected together at one end. The other end of one of the members is fixed to the base, the adjacent end of the other bimetallic member being free and carrying a movable switch contact. Upon unequal heating of the bimetal members they will deflect unequally so that the free end of the member carrying the movable contact will move relative to the juxtaposed fixed end of the other member. On the other hand, if the members are equally heated or cooled, as by a change in the ambient temperature, they will deflect synchronously so that there will be no relative movement between the fixed end of the one member and the juxtaposed free contact carrying end of the other member.

My invention will be better understood by referring now to the following detailed description taken in conjunction with the accompanying drawing, in which Fig. 1 is a schematic perspective view of a relay embodying one form of my invention and connected in circuit with an electric discharge lamp; Fig. 2 is a side elevation of the relay in its deflected position immediately before tripping; and Fig. 3 is a side view of the relay in its position of deflection immediately after tripping.

In the drawing I have represented at **10** an electric discharge lamp such, for example, as the sodium vapor lamp, having at the ends thereof the anodes **11** and **11'** and the filamentary cathodes **12** and **13**, each cathode being connected at one end with the adjacent anode and at the other end with one of the lamp terminals by which the energy is supplied to the lamp. The source of energy supply is represented at **14** as being an alternating current circuit of the constant current type such as is commonly used in series lighting systems. Energy is shown taken from the circuit **14** by means of a series transformer **15** between the ends of the secondary of which and the lamp I have shown the usual film cutout **16**, the radio frequency capacitor **17** and the radio frequency choke **18**.

In order that the lamp cathodes may be heated to the desired temperature and suitably activated before the discharge starts in the lamp I connect them at starting by a low resistance circuit for a predetermined time after which the circuit is automatically opened and the discharge starts. For this purpose I have provided a thermal relay comprising a pair of switch contacts **19** and **20** and an operating element in the form of a sinuous bimetallic member **25**. The fixed contact **19** is mounted upon a base member of the relay indicated at **26** and the movable contact **20** is carried at the end of a resilient cantilever spring strip **27** which is attached to and extends from the connected free ends of an inner pair of movable leg portions of the bimetallic element **25**.

The bimetallic operating member **25** comprises a juxtaposed pair of inner leg portions **28, 29** and a pair of outer leg portions **30, 31**. The leg portions are disposed in edge-to-edge parallel spaced relation and are connected together at alternate juxtaposed ends to form a sinuous current path through all the legs in series circuit relation. The inner bimetallic members **28** and **29** are of substantially the same length as the outer members **30** and **31** but are of considerably smaller cross-sectional area. Hence, each inner leg member **28, 29** has a greater electrical resistance and a smaller heat dissipating capacity than each outer leg member **30, 31**. The bimetallic element **25** may easily be fabricated from an E-shaped punching

by slotting the central leg of the punching longitudinally for substantially its entire length, the slot falling somewhat short of the free end of the center leg, thereby to form in effect a pair of juxtaposed U-shaped bimetallic members connected together at the free ends of their parallelly disposed smaller inner legs. The bimetal **25** is supported upon the relay base at the extremities of the relatively large outer legs. As shown, the extremities of the outer leg portions **30** and **31** are rigidly connected to terminal conductors **32** and **33** which form part of the relay base. The bimetallic member **25** is arranged so that in its unheated position the contacts **19** and **20** assume a normally closed position. The contacts are further held in this position and are provided with a snap action in operation by providing at the free ends of the inner leg portions **28** and **29** a magnetizable keeper **34** disposed for operation in conjunction with a small permanent magnet **35** mounted upon the relay base.

In the form of my invention shown by way of illustration in the drawing the bimetallic element **25** is permanently connected in series circuit relation with the discharge lamp **10**. In operation, when energy is supplied to the circuit **14** an alternating current passes through the sinuous bimetallic element **25** in series circuit relation with the filamentary cathodes **12** and **13** and the anode short circuiting relay contacts **19** and **20**. The inner and outer legs of the bimetallic element **25** are heated by the current passing through them, so that the lower end of the element **25** moves to the right, and away from the relay base, as viewed in the drawing, as the entire element assumes a curved shape. Due to the fact that the inner legs **28** and **29** are of higher resistance than the outer legs **30** and **31** and due also to the fact that the inner legs have a smaller heat dissipating capacity than the outer legs, the inner and outer legs are unequally heated and the inner legs will attain a temperature higher than that of the outer legs. Because of the higher temperature of the inner legs these legs will tend to curl to a greater extent than the outer legs **30** and **31**. The tendency of the inner legs **28** and **29** to deflect to a greater extent than the outer legs is initially restrained by the snap action magnet **35** and its keeper **34**. During this initial period of deflection before the central leg portions **28** and **29** have built up by their higher temperature sufficient internal stress to pull the keeper **34** away from the magnet **35** both the inner and outer leg portions are constrained to deflect in a substantially synchronous manner, since the upper ends of the outer leg members are fixed to the base and the upper end of the inner leg members is magnetically held in substantially its initial position while the lower ends of the inner and outer leg members are firmly connected together by transverse portions of the bimetal. The position of the bimetallic member immediately before opening of the contacts is shown at Fig. 2. It is important to note that during the initial period of substantially synchronous deflection of the inner and outer legs the movement of the lower end of the bimetal **25** away from the relay base causes the free end of the inner legs **28** and **29** to pivot about the upper end of the magnet keeper **34**, as shown at Fig. 2. This pivotal movement tends to pull the lower end of the magnet keeper **34** away from the magnet but does not of itself sufficiently diminish the magnetic force to permit the center leg portions **28** and **29** to snap to their open circuit positions. It is evident that the pivotal movement just described will increase the contact pressure between the fixed contact **19** and the movable contact **20**. When finally the inequality in the heating of the inner and outer leg portions of the bimetallic element **25** has attained a predetermined degree the internal strain built up in the inner leg portions **28** and **29** tending to deflect these leg portions farther than the outer leg portions **30** and **31** will be sufficient to pull the keeper **34** away from the magnet **35** and thereby separate the relay contacts **19** and **20** with a snap action. The position of the bimetallic member immediately after separation of the contacts is shown at Fig. 3. Separation of the relay contacts initiates a discharge current in the lamp **10** by removing the short circuit across the anodes **11** and **11'**.

Ambient temperature compensation of my thermal relay is inherent due to the fact that the movable contact **20** is mounted at the same end of the bimetallic member **25** at which attachment of the bimetallic member to the relay base is made. Thus, under changing ambient temperature conditions, the inner and outer legs of the bimetal **25** are equally heated and deflect equally so that the free end of the inner leg portions **28** and **29** to which the movable contact **20** is attached does not move with respect to the extremities of the outer leg portions **30** and **32** which are attached to the relay base.

By reason of the construction of the bimetallic device which I have provided the time delay between its energization and its movement to open circuit position is sufficient to permit the cathodes **12** and **13** to become heated to the desired temperature and thus to become activated. This time delay may be of the order of 25 to 45 seconds. A bimetallic member of the configuration which I have provided is particularly adapted to applications requiring such a relatively long time delay and also provides a substantial operating force effective over a wide range of movement.

While for convenience of fabrication I prefer to form my bimetallic element **25** from an E-shaped punching having three legs of substantially the same size so that when the center leg is slotted it forms two central leg portions having both a higher electrical resistance and a lower dissipating capacity than the outer legs, it will be understood by those skilled in the art that it is in the scope of my invention to provide a sinuous bimetallic member in which any desired means is provided for unequally heating a pair of parallelly-disposed connected leg portions. For example, this may be effected by supplying to both leg portions equal amounts of heat but constructing the leg portions to have dissimilar heat dissipating characteristics. On the other hand, the same effect may be obtained by providing leg portions having similar heat transfer characteristics but to which unlike quantities of heat are supplied.

In the particular form of device which I have provided adjustment of the time delay may be attained by variation of the relative cubicle content of the inner and outer leg portions. This possibility arises from the fact that the inner and outer leg portions have different heat storage capacities so that a certain amount of heat generated in the inner leg portion tends to be conducted to the outer leg portion because of the difference in temperature between the two. Thus, the larger the outer leg portion is with re-

spect to the inner leg portion the greater will be the transfer of heat from the inner leg to the outer leg and hence, the greater will be the time delay before the inner leg assumes a sufficiently high temperature to assume its independent open circuit position of greater deflection with respect to the outer leg.

While I have shown only one preferred embodiment of my invention by way of illustration, many other modifications will occur to those skilled in the art and I wish to have it understood that I intend by the appended claims to cover all 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 relay comprising a base, a fixed contact mounted upon said base, a pair of thermal responsive movable members in parallel spaced relation, one of said thermal responsive members being mounted at one end upon said base and having its other end connected to the juxtaposed end of the other of said thermal responsive members, a movable contact mounted upon the free end of said other thermal responsive member for cooperation with said fixed contact, means for unequally heating said thermal responsive members to separate said contacts, and snap acting means operable in conjunction with said free end of said other thermal responsive member releasably to retain said contacts in engagement.

2. A compensated thermal relay comprising a base, a fixed contact mounted upon said base, a pair of thermal responsive movable members in parallel spaced relation, said thermal responsive members being arranged for deflection in the same direction upon similar changes in temperature thereof and one of said members being mounted at one end upon said base and having its other end connected to the juxtaposed end of the other of said thermal responsive members, a movable contact mounted upon the free end of said other thermal responsive member for cooperation with said fixed contact, means for unequally heating said thermal responsive members to separate said contacts, and snap acting means operable in conjunction with said free end of said other thermal responsive member releasably to retain said contacts in engagement.

3. A compensated thermal relay comprising a base, a fixed contact mounted upon said base, a pair of thermal current responsive movable members in parallel spaced relation, one of said current responsive members being mounted at one end upon said base and having its other end mechanically and electrically connected to the juxtaposed end of the other of said current responsive members, said current responsive members having dissimilar thermal transfer characteristics and being arranged to deflect in the same direction upon the application of heat thereto, a movable contact mounted upon the free end of said other current responsive member for cooperation with said fixed contact, means for supplying substantially equal heating currents to said current responsive members thereby unequally to heat said members and to separate said contacts, and snap acting means for releasably retaining said contacts in engagement.

4. A compensated thermal relay comprising a base, a fixed contact mounted upon said base, a pair of thermal current responsive movable members in parallel spaced relation, one of said current responsive members being mounted at one end upon said base and having its other end mechanically and electrically connected to the juxtaposed end of the other of said current responsive members, said current responsive members having substantially the same length but being of dissimilar electrical resistance, a movable contact mounted upon the free end of said other current responsive member for cooperation with said fixed contact, means for supplying substantially similar heating current to said current responsive members thereby unequally to heat said members and to separate said contacts, and snap acting means for releasably retaining said contacts in engagement.

5. A thermal relay comprising a base, fixed and movable switch contacts, a U-shaped movable member having two thermal responsive leg portions arranged for deflection in the same direction upon similar changes in the temperature thereof, the free end of one of said leg portions carrying said movable contact and the juxtaposed end of the other of said leg portions being fixedly attached to said base, means for unequally heating said leg portions to separate said contacts, and snap acting means for releasably retaining said contacts in engagement.

6. A compensated thermal relay comprising a base, a fixed contact mounted upon said base, a U-shaped bimetallic movable member having two leg portions of dissimilar cross sectional areas, a movable contact mounted at the free end of one of said leg portions for cooperation with said fixed contact, means for rigidly attaching the juxtaposed end of the other leg portion to said base, means for supplying a heating current to said bimetallic movable member with said leg portions connected in series circuit relation thereby unequally to heat said leg portions and to separate said contacts, and snap acting means operable in conjunction with said free end of said one leg portion for releasably retaining said contacts in engagement.

7. A compensated thermal relay comprising a base, a fixed contact mounted upon said base, a U-shaped bimetallic movable element comprising a pair of leg portions of substantially equal length lying in edge-to-edge parallel spaced relation, said leg portions having dissimilar cross-sectional areas and being electrically connected in series circuit relation, a movable contact mounted upon the free end of one of said leg portions for cooperation with said fixed contact, means for rigidly connecting the juxtaposed end of the other of said leg portions to said base, means for supplying a heating current to said U-shaped bimetallic element thereby unequally to heat said leg portion and to separate said contacts, and snap acting means operable in conjunction with the end of said other leg portion releasably to retain said contacts in engagement.

8. A compensated thermal relay comprising a base, a fixed contact mounted upon said base, a pair of bimetallic members disposed in parallel spaced relation, a first of said bimetallic members being mounted at one end upon said base and having its other end mechanically and electrically connected to the juxtaposed end of the second of said bimetallic members, said bimetallic members being of substantially the same length but of dissimilar cross-sectional areas and being disposed to deflect in the same direction upon the application of heat thereto, a resilient contact spring extending from the free end of said second bimetallic member and carrying at

its end a movable contact for cooperation with said fixed contacts, means for supplying a heating current to said bimetallic members in series circuit relation thereby unequally to heat said members and to separate said contacts, and snap acting means engaging said free end of said second bimetallic member releasably to retain said contacts in engagements and to increase the contact pressure prior to their separation.

9. A compensated thermal relay comprising a base, a fixed contact mounted upon said base, a U-shaped thermal responsive bimetallic element comprising a pair of leg portions of substantially equal length lying in edge-to-edge parallel spaced relation, said leg portions having dissimilar cross-sectional areas and being electrically connected in series circuit relation, a resilient contact spring connected to and extending from the free end of one of said leg portions and carrying at its end a movable contact disposed normally to engage said fixed contact, supporting means for rigidly connecting the juxtaposed end of the other of said leg portions to said base, a magnet mounted upon said base adjacent said free end of said one leg portion, a keeper for said magnet connected to said free end of said one leg portion, means for supplying a heating current to said U-shaped bimetallic element for unequally heating said leg portions thereby to produce unequal deflections of said portions and to separate said contacts, said magnet releasably retaining said keeper in engagement therewith over a portion of the heating period and constraining said one leg portion to pivot about its free end thereby to increase the contact pressure prior to the separation of said contacts.

10. A thermal relay comprising a base, a fixed contact mounted upon said base, a bimetallic element of sinuous configuration comprising an interconnected pair of inner legs and a juxtaposed pair of outer legs connected to said inner legs, said pairs of legs being disposed in substantially edge-to-edge parallel spaced relation, a movable contact mounted upon the interconnected ends of said inner legs for cooperation with said fixed contact, supporting means for connecting the juxtaposed ends of said outer legs to said base, means for unequally heating said inner and outer legs to separate said contacts, and snap acting means operable in conjunction with the free end of said inner legs releasably to retain said contacts in engagement.

11. A thermal relay comprising a base, a fixed contact mounted upon said base, a bimetallic element of sinuous configuration comprising an interconnected pair of inner legs of relatively small cross section and a juxtaposed pair of outer legs connected to said inner legs and having a relatively large cross section, said pairs of legs being disposed in substantially edge-to-edge parallel spaced relation, means for mounting said bimetallic element upon said base at the ends of said outer legs lying adjacent the interconnected ends of said inner legs, said interconnected ends carrying a movable contact for cooperation with said fixed contact, means for supplying a heating current to said bimetallic element, said heating current passing through said legs in series circuit relation thereby unequally to heat said inner and outer pairs of legs, the unequal heating of said pairs of legs tending to produce a greater deflection of said inner legs than of said outer legs and to separate said contacts, and magnetic means mounted upon the free ends of said inner legs releasably to constrain both said pairs of legs to substantially synchronous deflection during an initial portion of their movement and thereafter to release said inner legs with a snap action for movement to an open circuit position.

12. A compensated thermal relay comprising a base, a fixed contact mounted upon said base, a bimetallic element of sinuous configuration comprising an interconnected pair of inner legs and a juxtaposed pair of outer legs connected to said inner legs, said legs being disposed in substantially edge-to-edge parallel spaced relation and said pairs of legs having dissimilar cross-sectional areas, a resilient contact spring connected to and extending from the interconnected ends of said inner legs and carrying at its end a movable contact disposed normally to engage said fixed contact, supporting means for rigidly connecting the juxtaposed ends of said outer legs to said base, a magnetic keeper mounted upon said interconnected ends of said inner legs, a magnet mounted upon said base adjacent said keeper releasably to restrain movement of said inner legs, means for supplying a heating current to said bimetallic element traversing said legs in series circuit relation, said heating current unequally heating said inner and outer legs thereby to produce unequal deflections thereof to separate said contacts, said magnet releasably retaining said keeper in engagement therewith over an initial portion of the heating period and constraining said inner and outer legs to deflect substantially synchronously during said initial period while said inner legs pivot upon said keeper thereby to increase the contact pressure prior to the separation of said contacts.

13. A thermal relay comprising a base, a fixed contact mounted upon said base, a U-shaped bimetallic member having a pair of leg portions in parallel spaced relation, said bimetallic member being mounted upon said base at the extremity of one of said leg portions and carrying a movable contact at the free end of the other of said leg portions, said movable contact being disposed to engage said fixed contact in the unheated position of said bimetallic member, means for unequally heating said leg portions to separate said contacts, and magnetic means operable in conjunction with said free end of said leg portion initially to constrain said leg portions to deflect synchronously and subsequently to permit said contacts to separate with a snap action.

14. A thermal relay comprising a base, a fixed contact mounted upon said base, a pair of thermal responsive movable members in parallel spaced relation, one of said thermal responsive members being mounted at one end upon said base and having its other end connected to the juxtaposed end of the other of said thermal responsive members, a movable contact mounted upon the free end of said other thermal responsive member for cooperation with said fixed contact, and means for unequally heating said thermal responsive members to separate said contacts.

15. A compensated thermal relay comprising a base, a fixed contact mounted upon said base, a pair of thermal current responsive movable members in parallel spaced relation, one of said current responsive members being mounted at one end upon said base and having its other end mechanically and electrically connected to

the juxtaposed end of the other of said current responsive members, said current responsive members having dissimilar thermal transfer characteristics and being arranged to deflect in the same direction upon the application of heat thereto, a movable contact mounted upon the free end of said other current responsive member for cooperation with said fixed contact, and means for supplying substantially equal heating currents to said current responsive members thereby unequally to heat said members and to separate said contacts.

ALLEN G. STIMSON.