June 22, 1948. F. A. SWING 2,443,968

TEMPERATURE COMPENSATED RELAY

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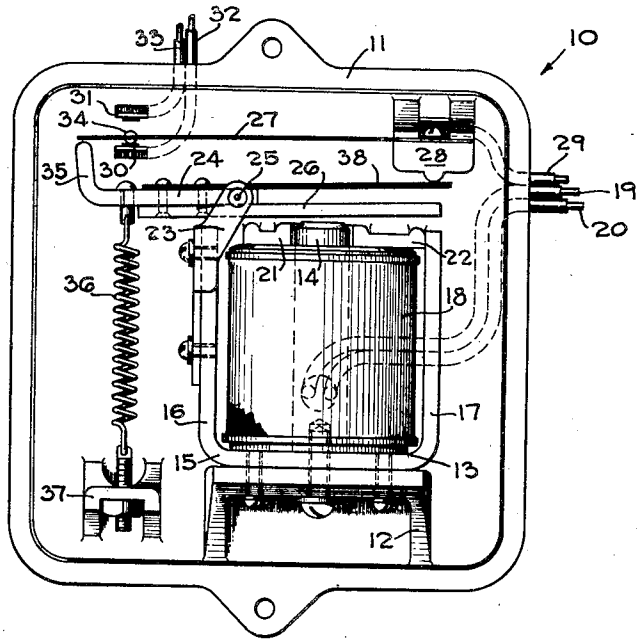


FIG. 1

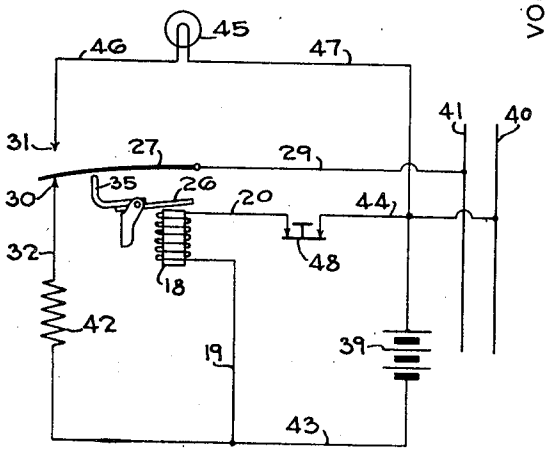


FIG. 2

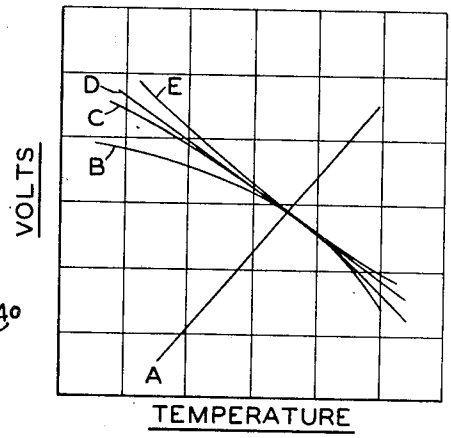


FIG. 3

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TEMPERATURE COMPENSATED RELAY

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5 Claims. (Cl. 200—87)

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This invention relates to electromagnetic relays and particularly to relays suitable for use in storage battery charging circuits for controlling the charge in accordance with battery voltage.

More particularly this invention relates to improvements in temperature compensated voltage relays of the type described and claimed in Patent No. 1,960,198, issued May 22, 1934, on an application filed by Frank G. Beetem and assigned to assignor of the present application. The relay described and claimed in said patent is of the solenoid and pivoted armature type, the length of air gap between the pole of the solenoid and the armature being varied with changes in temperature by distortions produced in a bimetallic strip.

The relay operates satisfactorily, but intricacies in design render manufacture somewhat difficult and costly. For example, to obtain uniformity of pressure between the contacts irrespective of the position of the armature, the relay embodies a "lost motion" connection between the bimetallic strip and the movable contact member. Such connection includes a pin that is fixed to the strip and passes through an aperture in the contact member and that has an enlarged head adapted to engage said member to effect movement thereof, an arrangement that complicates manufacture to an undesirable extent. Likewise various intricacies in design have complicated the manufacture of other prior art relays embodying bimetallic strips for temperature compensation. Furthermore the use of the lost motion connection renders the construction suitable only in relays of the single throw type.

It is the principal object of the present invention to provide improved relays of the type in which temperature compensation is accomplished by use of a bimetallic strip wherein intricacies in design are eliminated, thereby facilitating manufacture. A further object of the invention is to provide improved relays wherein temperature compensation by means of a bimetallic strip is applied to relays of the double throw type.

Other objects of the invention are to provide improved voltage relays which may have substantially straight line voltage-temperature characteristics or in which such characteristics may be other selected curves, whereby the relays respond as desired to battery voltage under varying ambient temperature conditions; and to provide temperature compensated relays which have normally closed contacts and normally open contacts

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in which contact pressure is independent of the temperature and operating voltage.

A further object of the invention is to provide relays as described, wherein control of the contacts is effected by means of an armature and counterbalance therefor that together constitute a lever of the first class, one arm of which is positioned to be attracted by the solenoid, and the other arm of which is adapted to engage the movable contact member, the position of the fulcrum or pivot point relative to the solenoid being a factor in determining the voltage-temperature characteristic of the relay.

Other objects of the invention will appear as the following detailed description proceeds and features of novelty which characterize this invention will be set forth in the claims appended to and forming a part of this specification.

Referring to the drawings:

Figure 1 is a plan view of a relay embodying features of the present invention;

Figure 2 is a diagrammatic view of an example of a circuit in which the relay of the present invention may be employed; and

Figure 3 is a graph showing characteristic curves of uncompensated relays and relays designed in accordance with the present invention.

In Figure 1 there is shown at 10 a relay embodying the features of the present invention, and comprising a base 11, preferably formed as an integral molded piece of suitable insulating material. Ordinarily the base and other working parts of the relay are enclosed by a suitable cover, but which has been removed to illustrate the mechanism of the relay. Mounted on a suitable bracket 12, preferably formed integrally with the base, is an electromagnet 13 that includes a core 14 and a yoke 15 having upstanding arms 16 and 17. A solenoid 18 is wound around the core 14 and has electrical leads 19 and 20 extending therefrom. The electromagnet is further positioned on the base by a pair of lugs 21 and 22 outstanding from the base and also preferably formed integrally therewith and which engage the upper face of the solenoid.

A pair of ears 23 are fixed to the arm 16 of the yoke and extend from said arm inwardly in an oblique direction, their length and the angle at which they extend being a factor in determining the voltage-temperature characteristic of the relay in a manner hereinafter explained. An L-shaped armature counterbalance 24 is pivoted between the ears 23 to turn about a pivot point or fulcrum 25. An armature 26 of magnetic material is secured to the under face of the counter-

balance and extends on both sides of the fulcrum in position to be attracted by the poles of the electromagnet.

A movable contact member 27 is secured at one end to the base, as, for example, on a bracket 28 formed integrally with the base. An electrical lead 29 is connected to said contact member at or adjacent the point of attachment on said bracket. A pair of fixed contact members 30 and 31 are secured to the base and a pair of electrical leads 32 and 33 respectively are secured to said fixed contact members. The movable contact member 27 is resilient and its resiliency normally maintains it in engagement with the lower fixed contact 30, but it may yield to engage the upper fixed contact 31 after breaking the engagement with the lower fixed contact. Suitable contact buttons 34 are provided at the points of engagement between the contact members.

The armature counterbalance 24 includes an upstanding portion 35 adapted to engage the movable contact member 27 when said counterbalance is rotated in a clockwise direction about the fulcrum 25. The armature and counterbalance are normally maintained in the counterclockwise position, in which the upstanding portion 35 is free of the contact member, by a spring 36 connected between said counterbalance and a suitable bracket 37 outstanding from the base 11.

A bimetallic strip 38 is secured to the upper face of the armature counterbalance 24 and extends in the direction of the armature 26 in spaced relation thereto. Adjacent its right end said strip engages the underface of the bracket 28.

The bimetallic strip is mounted in such a manner that its outer end tends to deflect upwardly on increase in ambient temperature; that is, the metal of highest linear temperature coefficient is on the underside of the strip. Deflection of the strip on increase in temperature above normal thereby rotates the armature and counterbalance clockwise about the fulcrum and forces the armature closer to the poles of the electromagnet at the core 14 and arm 17 and moves the armature farther from the pole at arm 16. Such movement decreases the length of the air gaps in the case of the first two poles and increases slightly the length of the air gap in the case of the last mentioned pole. Such change in the relative lengths of the air gaps causes the relay to operate to open the contact 27—30 and to close the contact 27—31 at a lower voltage than at normal temperature. Decrease in temperature tends to deflect the bimetallic strip 37 in the opposite direction thereby reversing the movements just described.

It is to be noted that the armature and counterbalance form a lever of the first class, the force being applied thereto to the right of the fulcrum, as viewed in Figure 1, and the lever performing its work by engagement with the contact member to the left of the fulcrum. Preferably the assembly of armature, counterbalance and bimetallic strip are statically balanced to exert equal moments about the pivot point due to their own weight. By use of a leverage arrangement of this type and by providing for the normal position of the movable contact member to be the down position, the relay is actuated merely by a simple movement of the lever arm against the contact member, thereby eliminating the need for a lost motion connection or other complexities in design and also making possible the double throw contact construction.

It will also be noted that the contact pressure exerted by the resilience of contact member 27 at the fixed contacts 30 and 31, when either of these is closed, is in each case independent of ambient temperature since there is no engagement between the lever arm and the movable contact member prior to actuation and there is engagement at substantially constant pressure after actuation.

I have illustrated the relay as being of the single pole double throw type, but it is obvious that the principles of the invention could be applied in a similar manner to a relay of the single throw type, as, for example, like that shown in the aforementioned Beetem patent.

In Figure 2 is shown a circuit diagram illustrating an application of the relay of the present invention for the control of the charging circuit of a storage battery, but it is obvious that the use of the relay is not limited to a circuit as illustrated. A storage battery 39 is arranged to be charged from the circuit 40, 41, charging current being transmitted from conductor 41, via conductor 29, movable relay contact member 27, lower fixed contact 30, conductor 32, resistor 42, conductor 43, battery 39, conductor 44 to conductor 40. The solenoid 18 is connected to conductors 43 and 44 across the terminals of the battery by conductors 19 and 20.

As the charge progresses, the voltage of the battery increases and when it reaches a predetermined value, armature 26 is attracted, causing counterbalance 24 to rotate clockwise and upstanding portion 35 thereof engage contact member 27 to open the circuit at contacts 27—30, thus interrupting the charge. This travel of contact member 27 when completed closes contacts 27—31, establishing a circuit for lighting signal lamp 45. This circuit may be traced from conductor 41 via conductor 29, movable contact member 27, fixed contact 31, conductor 46, signal lamp 45, conductors 47 and 44 to conductor 40.

At 48 is shown a push-button switch in conductor 20, normally held in the closed position. Opening the switch 48 opens the exciting circuit of solenoid 18 to reset the relay to the position shown in Figure 2.

Figure 3 illustrates voltage-temperature curves such as may be obtained with relays constructed in accordance with the present invention. The ordinates of the curves represent voltages and the abscissas temperatures, points on the curves being the points at which the relay is actuated.

Without temperature compensation, the characteristic is represented by a curve such as that indicated at A in Figure 3, since the solenoid is normally of copper the resistance of which decreases on decrease in temperature to permit more current to flow at a given voltage. The effect of the bimetallic strip is to reverse this characteristic and cause the relay to operate at a higher voltage with reduction of temperature.

It has been found that when the fulcrum is located over or nearly over the arm 16 of the yoke, the voltage temperature characteristic is a curved line as indicated by curve B in Figure 3. If the pivot is located a certain distance to the right, the curvature decreases, as shown by curve C in Figure 4. If the pivot is located still farther to the right, the characteristic becomes approximately a straight line, as shown by curve D. If the pivot is located still farther to the right, the characteristic curve may be given an upward curvature, as shown in curve E. In either case the

pivot is located at some point between the center lines of poles 14 and 16.

Thus it is seen that by choosing a suitable location for the fulcrum, any voltage-temperature characteristic, within certain limits, can be obtained to meet the requirements of the particular application for which the relay is designed. For opening the charge circuit of a storage battery at the same state of charge under varying temperature conditions, a straight line characteristic, as shown by curve D, is desirable, since the battery voltage characteristic with respect to temperature is approximately a straight line.

While I have illustrated but a single embodiment of the present invention, it is obvious that the device is subject to modification without departing from the spirit of the invention. Therefore I do not wish to be limited by the disclosure set forth, but only by the scope of the appended claims.

I claim:

1. In a relay, an electromagnet, a movable contact, at least one fixed contact with which said movable contact may be engaged or disengaged, an armature counterbalance, an armature secured to said counterbalance to constitute therewith a lever, means pivotally mounting said counterbalance intermediate the ends of the lever, the armature being in position to be attracted by said electromagnet, the counterbalance on the opposite side of the pivot point being in position to push against said movable contact and thereby change its engagement with said fixed contact, means normally maintaining the lever in the unattracted position wherein the counterbalance is free of the movable contact, a bimetallic strip secured to said counterbalance and extending in spaced relation to said armature, and fixed means engaged with said strip, whereby increase in ambient temperature forces the armature closer to the electromagnet.

2. In a relay, an electromagnet, a movable contact, means fixing one end of said movable contact, the other end thereof being free, at least one fixed contact with which the free end of said movable contact may be engaged or disengaged, an armature counterbalance, an armature secured to said counterbalance to constitute therewith a lever, means pivotally mounting said counterbalance intermediate the ends of the lever, the armature being in position to be attracted by said electromagnet and the counterbalance on the opposite side of the pivot point being in position to push against the free end portion of said movable contact and thereby change its engagement with said fixed contact, means normally maintaining the lever in the unattracted position wherein the counterbalance is free of the movable contact, and a bimetallic strip secured at one end to said counterbalance and extending in spaced relation to said armature, the free end of said strip engaging said means to which the fixed end of the movable contact is secured, whereby increase in ambient temperature forces the armature closer to the electromagnet.

3. In a relay, an electromagnet having a yoke and a symmetrically arranged core around which a solenoid is wound, a movable contact, at least one fixed contact with which said movable contact may be engaged or disengaged, an extension on an arm of said yoke extending obliquely toward said core, an armature counterbalance pivoted to said extension, an armature secured to said counterbalance to form therewith a lever of the first class, the armature being in position to be attracted by said electromagnet, the counterbalance on the opposite side of the pivot point being in position to push against said movable contact and thereby change its engagement with said fixed contact, means normally maintaining the lever in the unattracted position wherein the counterbalance is free of the movable contact, a bimetallic strip secured to said counterbalance and extending in spaced relation to said armature, and fixed means engaged with said strip, whereby increase in ambient temperature forces the armature closer to the electromagnet.

4. In a relay, an electromagnet having a yoke and a symmetrically arranged core around which a solenoid is wound, a movable contact, a pair of fixed contacts with which said movable contact is selectively engageable, an extension on an arm of said yoke extending obliquely toward said core, an L-shaped armature counterbalance pivoted to said extension, an armature secured to one leg of said counterbalance to form therewith a lever of the first class, the armature being in position to be attracted by said electromagnet, the counterbalance on the opposite side of the pivot point being in position for the other leg thereof to push against said movable contact and thereby change its engagement with said fixed contacts, means normally maintaining the lever in the unattracted position wherein the counterbalance is free of the movable contact, a bimetallic strip secured to said counterbalance and extending in spaced relation to said armature, and fixed means engaged with said strip, whereby increase in ambient temperature forces the armature closer to the electromagnet.

5. In a relay, an electromagnet having a yoke and a symmetrically arranged core around which a solenoid is wound, a movable contact, at least one fixed contact with which said movable contact may be engaged or disengaged, an extension on an arm of said yoke extending obliquely toward said core, an L-shaped armature counterbalance pivoted to said extension, an armature secured to a leg of said counterbalance to form therewith a lever of the first class, the armature being in position to be attracted by said electromagnet on increase in current passing through the solenoid, the counterbalance on the opposite side of the pivot being in position for the other leg thereof to push against said movable contact and thereby change its engagement with said fixed contact, means normally maintaining the lever in the unattracted position wherein the counterbalance is free of the movable contact, a bimetallic strip secured to said counterbalance and extending in spaced relation to said armature, and fixed means engaged with said strip, whereby increase in ambient temperature forces the armature closer to the electromagnet, the choice of the pivot point being such that the voltage-temperature characteristic of the relay is substantially a straight line.

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