

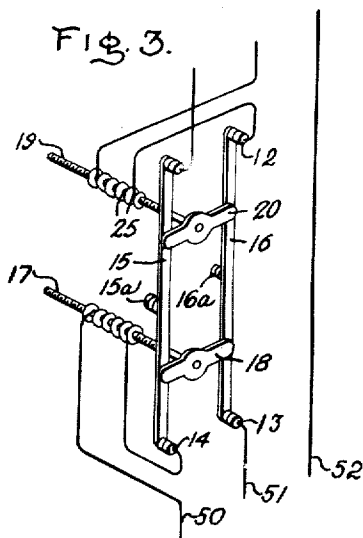
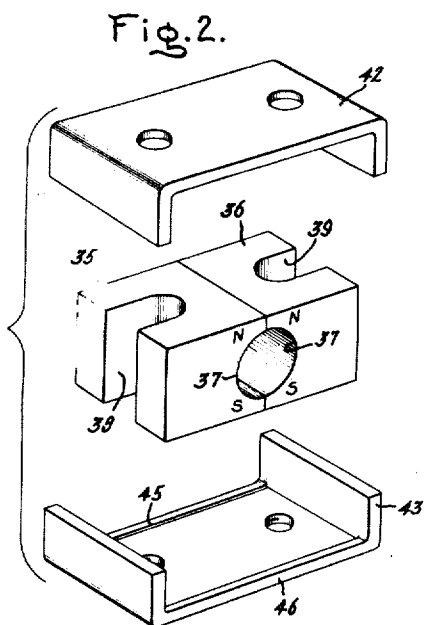
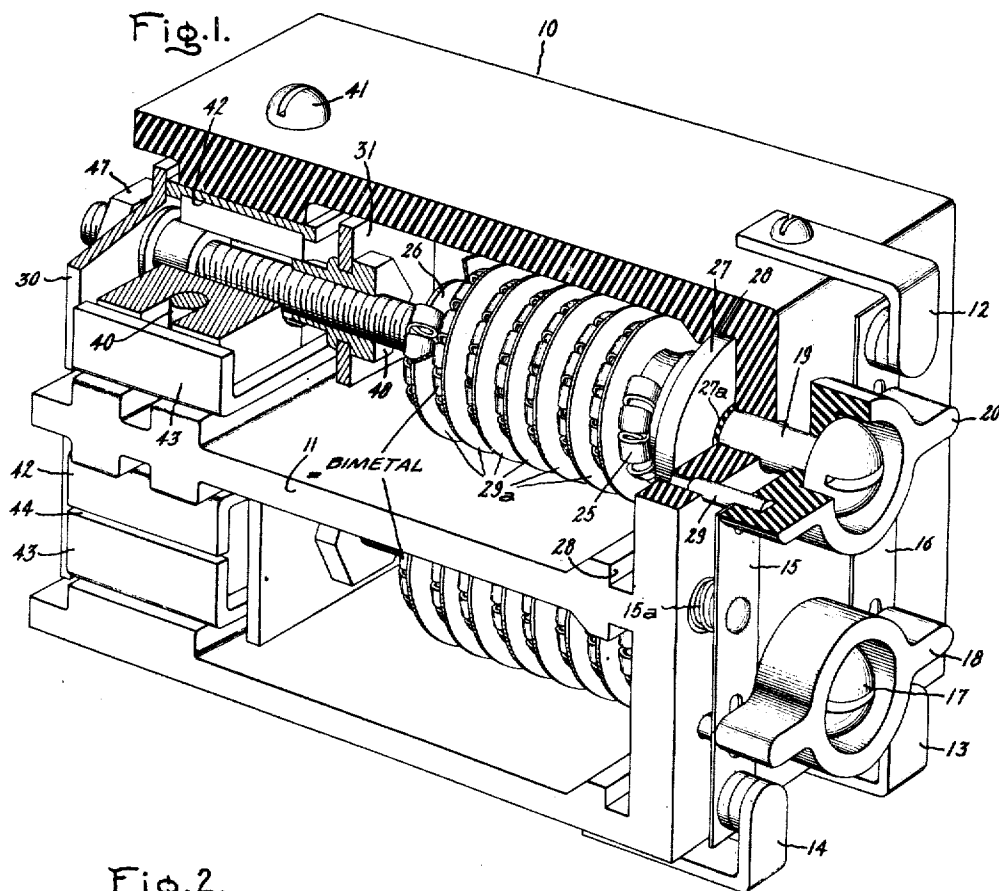
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2,313,597

THERMAL OVERLOAD RELAY

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2,313,597

THERMAL OVERLOAD RELAY

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My invention relates to thermal overload devices and has for its object a provision of a device of this character which is reliable and efficient in operation and simply and readily manufactured at low cost. The device is particularly well suited for the protection of multi-phase electric circuits against overloads occurring in any phase of the circuits.

The simple laterally distortable thermostatic strip provided with a resistance heater leaves much to be desired in efficiency and compactness. For example, the disposition of thermosensitive material in a flat strip is such that it is difficult, if not impossible, to produce a compact device including such a thermosensitive element, while the use of a separate resistance heater produces an inherent and undesirable temperature differential and time lag in operation.

Accordingly, it is an object of my invention to provide a new and approved thermal overload device in which a relatively large amount of thermosensitive material may be disposed within a small space and arranged to provide straight-line motion.

It is a further object of my invention to provide an overload device of the above character having an accurately adjustable and powerful snap action having similar operating characteristics in both directions of operation.

It is a still further object of my invention to provide a magnetic snap action for a device of the above type in which the maximum air gap is substantially independent of the displacement between the magnet and its keeper, thereby greatly enhancing the magnetic pull available from a magnet of a predetermined size.

In accordance with the invention, I provide a thermosensitive actuating element comprising a bimetallic strip wound to form a helix of relatively small diameter, the small helix being wound to form a second helix of relatively large diameter. A switch actuating rod is disposed longitudinally of the second helix and subjected to straight-line movement along its axis by connection to one end of the bi-metallic strip. The double helical bimetallic strip is arranged to deflect in accordance with the heat developed by an electric current passed through the strip, thereby to disengage a pair of normally engaging circuit controlling contacts. I also provide snap acting means for releasably retaining the actuating rod in either a circuit closing or a circuit opening position. Preferably the snap acting means comprises a permanent magnet cooperable with a pair of keepers attached to the actu-

ating rod, one of said keepers engaging the magnet in each switching position. The magnet is also provided with special shunting means to determine a maximum air gap which is independent of the displacement between the magnet and its keepers. Preferably, although not necessarily, two of the devices described are arranged within a single compact casing to control a plurality of phases of a multi-phase electric circuit. For example, a three-phase may be protected by providing each of two actuating rods with a pair of circuit controlling contacts arranged in two of the phases of a three-phase circuit, one contact of each actuating element being connected in series circuit relation with one contact of the other actuating element.

My invention itself may be better understood and its objects and advantages further appreciated by referring now to the following detailed specification taken in conjunction with the accompanying drawing in which Fig. 1 is a perspective view, partly in section, showing a thermal overload device according to my invention and adapted for the protection of a three-phase circuit; Fig. 2 is an exploded perspective view showing details of certain portions of a preferred form of my snap acting mechanism; and Fig. 3 is a partially schematic circuit diagram showing the manner of connection of the device of Fig. 1 for operation in a three phase circuit.

Referring now to the drawing and particularly to Fig. 1, I have shown a thermal overload device according to my invention mounted within a box-like casing 10 of suitable insulating material, such as a molded plastic compound. The casing 10 is provided with a longitudinally-disposed dividing wall 11 preferably formed integrally with and of the same material as the casing. The casing 10 is also provided with suitable bosses and recesses for convenient mounting of an independent thermal overload mechanism in each of the compartments formed by the wall 11. Attached to the casing 10 at one end thereof are a plurality of fixed contacts 12, 13 and 14 and a fourth contact not shown. A pair of pivotally and resiliently mounted movable current carrying contact strips 15 and 16 are mounted upon the casing 10 to connect pairs of opposite stationary contacts. The contact strip 15 carries a movable contact at each end thereof and is biased into normal engagement with the contact 14 and the fourth contact (not shown) by a compression spring 15a. Similarly, the contact strip 16 carries a movable contact at each end thereof and is normally biased into engagement with the con-

facts 12 and 13 by a similar compression spring disposed between the contact strip and the casing 10.

An overload element having an actuating rod 17 connected to a transverse arm 18 of suitable insulating material is arranged to disengage the movable contacts at one end of both of the movably mounted contact strips 15 and 16, while a similar overload element having an actuating rod 19 connected to a transverse arm 20 is arranged to disengage the movable contacts at the opposite end of each of the movable contact strips 15 and 16. Since the overload elements are similar in construction, sectional views of only one element have been shown. The description of this one element will provide also a description of the other.

The actuating rod 19 is slidably mounted longitudinally of the casing 10 and passes through the casing at one end thereof to engage the transverse arm 20 for actuating the movable contact strips. Within the casing and wound helically about the rod 19 is a helical thermosensitive bimetallic strip 25. The bimetallic strip 25 is wound into a minor helix of relatively small diameter which is then coiled to form a major helix of relatively large diameter having an axis coincident with the axis of the actuating rod 19. It will be understood that the axis of the minor helix follows a helical path about the rod 19. The double helical bimetallic strip 25 is mounted upon a pair of suitably threaded adapters or end supports 26 and 27. The end supports 26 and 27 may be made of insulating material, each being of sufficient length to extend substantially halfway through the helix. Preferably, however, if the helix is self-supporting between its ends, the supports are made of aluminum for added lightness and strength and extend inwardly for only a single turn at each end of the helix to avoid short circuiting the turns thereof. The support 26 threadedly engages the actuating rod 19 and normally remains in fixed relation thereto, while the support 27 is suitably bored to receive the actuating rod 19 loosely therein. To prevent short circuiting of the bimetallic strip 25 by the rod 19, if the adapters 26 and 27 are metallic, suitable insulation is provided between the rod 19 and the adapter 27. Such insulation may take the form of an annular clearance space between the rod 19 and adapter 27. If desired, an insulating bushing 27a may be inserted in the clearance space. The support 27 is provided with a disk-like base portion by means of which it is fixedly mounted upon the insulating casing 10. As shown, the disk-like base portion of the support 27 is simply and easily assembled within the casing 10 between a pair of transverse grooves 28 formed in the molded casing. Preferably the turns of the major helix are separated by spacing disks 29a of insulating material. The disks 29a are inserted part way through the helix and serve to space the turns and prevent short circuiting when the helix is collapsed. If desired, of course, a helical strip of insulating material may be interwound with the turns of the bimetallic helix.

As may be seen from the drawing, the actuating rod 19 is in the form of a threaded bolt having a head portion engaging the transverse arm 20. Since the transverse arm 20 is at all times biased into engagement with the head of the actuating bolt 19 by the springs 15a, it is unnecessary to provide more than a slidable connection between the rod 19 and the arm 20. However, it is necessary to preclude rotational movement of

the arm 20 with respect to the bolt 19, and for this purpose a pair of pins 29 extend from opposite sides of the arm 20 and are slidably mounted in suitable holes formed in the end of the casing 10. Similar pins are mounted on the transverse arm 18. It will be noted that the pins 29 extend only partially through the casing 10 so that they will not short circuit the strips 15 and 16 through the metallic support 27.

Within the opposite end of the casing 10 is mounted a double magnetic snap acting mechanism operable in conjunction with the actuating rod 19. This mechanism comprises a permanent magnet mounted in fixed relation to the casing 10 and cooperable with a pair of keepers 30 and 31 mounted upon the actuating rod 19 on opposite sides of the magnet. Referring now particularly to Fig. 2, the permanent magnet is preferably formed of a pair of similar substantially cubical sections 35 and 36, although it will be understood that if desired, the sections may be formed integrally. In order to obtain sufficient coercive force while limiting the physical proportions of the magnet, I prefer to use for the magnet an alloy comprising six to fifteen per cent aluminum, twelve to thirty per cent nickel, about five per cent copper if desired, and the remainder of iron, such as described and claimed in Patents 1,974,274 and 1,968,569, issued February 13 and July 31, 1934, respectively, to William E. Ruder. For convenience in mounting the magnets 35 and 36 centrally with respect to the actuating rod 19 each magnet section is provided with a groove 37 of semicircular cross section, and the magnets are mounted so that the grooves 37 are oppositely disposed to form a cylindrical bore within which the rod 19 is slidably supported. The outer ends of the magnet sections 35 and 36 are slotted transversely of the grooves 37 at 38 and 39, respectively, to provide for mounting the magnets between a pair of bolts 40 and 41 which pass transversely through the casing 10.

The magnet sections 35 and 36 are magnetized longitudinally of the slots 38 and 39 so that north and south poles are formed at opposite sides of the rectangular magnet, as indicated at Fig. 2. In order to retain the magnetic flux within predetermined limits, regardless of the displacement between the magnets and their keepers a pair of U-shaped shunts 42 and 43 are disposed at opposite pole faces of the magnets. The shunts 42 and 43 are formed of a magnetizable material such as soft iron and are provided with side portions extending around the ends of the magnet and defining between them predetermined small air gap 44 (Fig. 1). To hold the shunts 42 and 43 in fixed position relative to the magnet sections 35 and 36 the bases of the shunt are formed to provide at their ends upwardly-extending edges 45, 46 (Fig. 2) between which the magnet sections are held in clamping engagement. As may be clearly observed at Fig. 1, the shunts 42 and 43 extend beyond the sides of the magnets 35 and 36 so that the keepers 30 and 31 come into engagement only with the ends of the shunts. The keepers 30 and 31 are adjustably mounted upon the threaded portion of the actuating rod 19 by means of threaded nuts 47 and 48, respectively. The nuts 47 and 48 are machined to provide cylindrical portions extending within the bore formed by the oppositely-disposed grooves 37 in the magnets, thereby providing a slidable bearing support for one end of the actuating rod 19.

In operation the device of Fig. 1 may be connected in a three phase circuit 50, 51, 52 in the

manner shown at Fig. 3. As shown, the conducting strip 15 and the contacts at opposite ends thereof are connected in series with one of the bimetallic helices 25 in the phase 50, while the conducting strip 16 and the contacts 12 and 13 are connected in series with the other helix 25 in the phase 51. Under normal current conditions, the current carrying strips 15 and 16 are biased into engagement with their respective stationary contacts by means of the springs 15a disposed between the current carrying strips and the end of casing 10. Thus, the device is in the position of Fig. 1, in which the double helical thermosensitive elements are contracted and the keeper 30 is in engagement with the outer end of the snap action magnet shunts. Upon the occurrence of an excessive current in any phase of the circuit, for example in the phase 51, the associated thermosensitive bimetallic strip 25 will become heated and its free end will tend to move with a straight-line motion in a direction to disengage the keeper 30 from the magnets 35 and 36. As soon as the energized thermosensitive element 25 builds up sufficient force to disengage the keeper 30, the actuating rod 19 moves longitudinally with a snap action. Preferably the parts are so constructed and arranged that the keeper 31 will come into engagement with the magnet shunt without further heating of the thermosensitive element. By this movement the connected cross arm 20 is drawn toward the end of the casing 10 thereby to depress one end of the current carrying strips 15 and 16 and disengage the circuit controlling contacts. While the actuating rod 19 is thus moving from its circuit closing to its circuit opening position, both keepers 30 and 31 are momentarily disengaged from the magnet shunt. During this interval the magnetic flux is shifted from its normal path through the keeper 30 to a shunt path including the sides of the shunts 42 and 43 and the air gap 44. Thus it will be observed that the distance between the shunts 42 and 43 defines a maximum air gap 44 which is constant regardless of the displacement between the keepers and the magnets. As soon as the keeper 31 engages the shunt, the magnetic flux path again shifts so that the major part of the flux passes through the keeper 31.

In view of the above detailed description it will be evident that I have provided a thermal overload device in which a relatively large amount of thermosensitive material may be simply and economically arranged within a relatively small space so that a device of large capacity may be made in a small size. Furthermore, my invention includes snap acting means having the same operating characteristic in both directions of motion, that is, the double keeper construction cooperating with a single magnet is so arranged that movement of the actuating rod from either its circuit closing or its circuit opening position requires the building up of a predetermined and adjustable initial force in the thermosensitive element 25. To provide a large magnetic pull a magnet of high inherent coercive force is provided with special shunting means for defining a maximum air gap and thereby maintaining the magnetic flux within predetermined limits. In addition to the foregoing advantages my overload device is arranged to provide direct heating of the thermosensitive element so that the device is not subject to an inherent temperature differential and time delay in cooling.

While I have shown and described but one preferred embodiment of my invention by way of

illustration, many further modifications will occur to those skilled in the art, and I therefore 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 overload device for an electric circuit comprising fixed and relatively movable contacts in normal engagement, thermosensitive actuating means arranged to disengage said contacts with a straight line motion upon the occurrence of a predetermined excessive current in said circuit, snap acting means including a permanent magnet and a keeper for retaining said movable contact in either a circuit closing or a circuit opening position, and means for maintaining the flux of said permanent magnet within predetermined limits regardless of the maximum displacement between said magnet and keeper.

2. A thermal overload device for an electric circuit comprising fixed and relatively movable contacts in normal engagement, thermosensitive actuating means arranged to disengage said contacts with a straight line motion upon occurrence of a predetermined excessive current in said circuit, snap acting means including a permanent magnet and a keeper for retaining said movable contact in either a circuit closing or a circuit opening position, and means independent of said keeper for providing a return path of a predetermined maximum reluctance for the flux of said permanent magnet.

3. A thermal overload device for an electric circuit comprising fixed and movable contacts in normal engagement, an actuating member for said movable contact, thermosensitive means connected to move said actuating member with a straight line motion thereby to disengage said contacts upon the occurrence of a predetermined excessive current in said circuit and to reengage said contacts upon the occurrence of the predetermined lower current of said circuit, snap acting means for retaining said actuating member in either a circuit closing or a circuit opening position, said snap acting means including a fixed permanent magnet and a movable keeper connected to said actuating member, and magnetic shunting means for said permanent magnet arranged to determine a maximum air gap independent of the maximum displacement of said movable keeper with respect to said magnet.

4. A thermal overload device for an electric circuit comprising fixed and movable contacts in normal engagement, an actuating member for said movable contacts, thermosensitive means connected to move said actuating member with a straight line motion thereby to disengage said contacts upon the occurrence of a predetermined excessive current in said circuit and to reengage said contacts upon the occurrence of a predetermined lower current in said circuit, snap acting means for retaining said actuating member in either a circuit closing or a circuit opening position, said snap acting means including a fixed permanent magnet of substantially rectangular configuration and a pair of movable keepers of magnetic material alternatively engageable with opposite faces of said magnet, and fixed shunting means of magnetizable material positioned to determine a fixed air gap through which the flux of said magnet is shunted when both said keepers are disengaged from said magnet.

5. A thermal overload device for an electric

circuit comprising fixed and movable contacts in normal engagement, an actuating member for said movable contacts, thermosensitive means connected to move said actuating member with a straight line motion thereby to disengage said contacts upon the occurrence of a predetermined excessive current in said circuit and to reengage said contacts upon the occurrence of a predetermined lower current in said circuit, snap acting means for retaining said actuating member in either a circuit closing or a circuit opening position, said snap acting means including a fixed permanent magnet of substantially rectangular configuration and a pair of movable keepers of magnetic material connected to said actuating member in spaced relation, said actuating member and said magnet being so positioned that said keepers are arranged alternatively to engage opposite sides of said magnet, said magnet being magnetized in a direction substantially parallel to the plane of said first-named sides so that its intermediate opposite sides are of opposite polarities, and a pair of U-shaped shunts of magnetic material having side portions extending around the ends of said magnet and defining a fixed air gap therebetween thereby to provide a shunt path of predetermined magnetic reluctance for the flux of said magnet regardless of the relative positions of said magnet and keepers.

6. A thermal overload device for an electric circuit comprising fixed and movable contacts in normal engagement, an actuating rod connected to move said movable contacts, a helical bimetallic strip coiled about said actuating rod to form a helix, one end of said bimetallic strip being fixedly mounted and the other end being attached to said actuating rod for moving said rod with a straight line motion to disengage said contacts upon the occurrence of a predetermined excessive current in said circuit and to reengage said contacts upon the occurrence of a predetermined lower current in said circuit, snap acting means for retaining said actuating rod in either a circuit closing or a circuit opening position, said snap acting means including a fixed permanent magnet and a pair of movable keepers of magnetic material connected to said actuating rod in spaced relation, said keepers being arranged alternatively to engage opposite sides of said magnet, and magnetic shunting for said permanent magnet arranged to determine a maximum air gap independent of the maximum displacement of said movable keepers with respect to said magnet.

7. A thermal overload device for an electric circuit comprising a base of insulating material, relatively fixed and movable contacts mounted upon said base and biased into normal engagement, an actuating rod slidably mounted upon said base and arranged to engage said movable contact and open said circuit upon the occurrence of a predetermined excessive current in said circuit, a double helical bimetallic strip coiled about said actuating rod and having one end connected to said base and the other end connected to said rod thereby to move said rod relative to said base with a straight line motion, a permanent magnet of substantially rectangular configuration having a transverse bore therein, said magnet being so positioned that said actuating rod passes freely through said bore and having opposite sides magnetized transversely of

said rod, a pair of U-shaped shunts of magnetic material arranged transversely with respect to said rod and extending over the ends of said magnet between said opposite sides to define therebetween a predetermined maximum air gap and to provide a shunt path of maximum reluctance for the flux of said magnet, and a pair of movable keepers of magnetizable material mounted upon said actuating rod in spaced relation and arranged alternatively to engage and magnetically to shunt said U-shaped shunts.

8. A double snap acting device comprising a movable actuating member, a permanent magnet and relatively movable magnetizable means operable in conjunction with said movable member selectably and releasably to retain said member in either of two spaced positions, and means independent of said magnetizable means providing a return path of predetermined maximum reluctance for the flux of said permanent magnet thereby to retain said flux within predetermined limits regardless of the displacement between said permanent magnet and said magnetizable means.

9. A double snap acting device comprising a movable member, a permanent magnet and a pair of magnetizable keepers, said magnet and keepers being relatively movable in conjunction with said movable member, and said keepers being arranged for alternative engagement with opposite faces of said magnet selectably and releasably to retain said movable member in either of two spaced positions, and fixed shunting means of magnetizable material positioned to determine a fixed air gap through which the flux of said magnet is shunted when both said keepers are disengaged from said magnet.

10. A double snap acting device for a movable actuating member comprising a permanent magnet, a pair of magnetizable keepers connected to said actuating member in spaced relation, said keepers being arranged on opposite sides of said magnet alternatively to engage opposite faces thereof selectably and releasably to retain said actuating member in either of two spaced positions, and magnetic shunting means for said permanent magnet arranged to determine a maximum air gap independent of the displacement of said movable keepers with respect to said magnet.

11. A double snap acting device for a movable actuating member comprising a permanent magnet of substantially cubical configuration, a pair of movable keepers of magnetizable material connected to said actuating member in spaced relation on opposite sides of said magnet, said actuating member and said magnet being so positioned that said keepers are arranged alternatively to engage opposite faces of said magnet, said magnet being magnetized in a direction substantially parallel to the plane of said faces so that its intermediate opposite faces are of opposite polarities, and a pair of U-shaped shunts of magnetic material having side portions extending around the ends of said magnet and defining a fixed air gap therebetween thereby to provide a shunt path of predetermined magnetic reluctance for the flux of said magnet regardless of the relative positions of said magnet and keepers.

ALLEN G. STIMSON.

CERTIFICATE OF CORRECTION.

Patent No. 2,313,597.

March 9, 1943.

ALLEN G. STIMSON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 29, for the patent number "1,974,274" read --1,947,274--; page 4, second column, line 57, claim 11, for "beng" read --being--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of April, A. D. 1943.

Henry Van Arsdale,

Acting Commissioner of Patents.

(Seal)