July 22, 1941. G. C. ARMSTRONG 2,249,804

THERMAL OVERLOAD RELAY

Filed Feb. 16, 1940

Fig. 1.

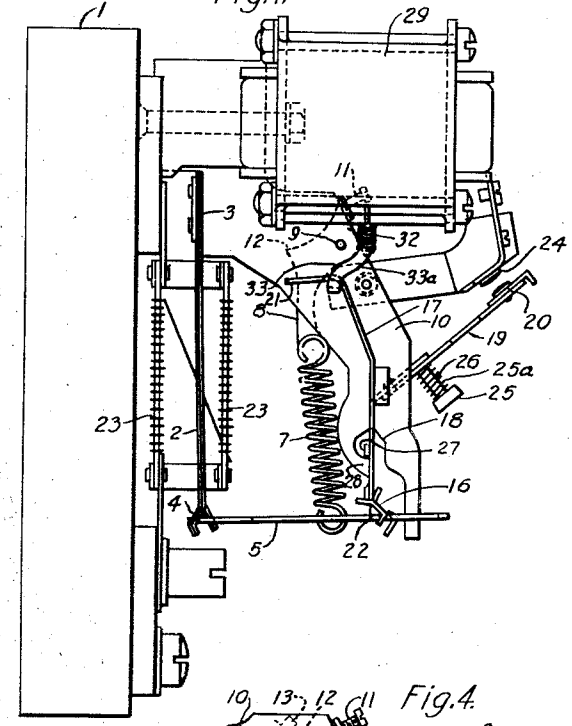


Fig. 2.

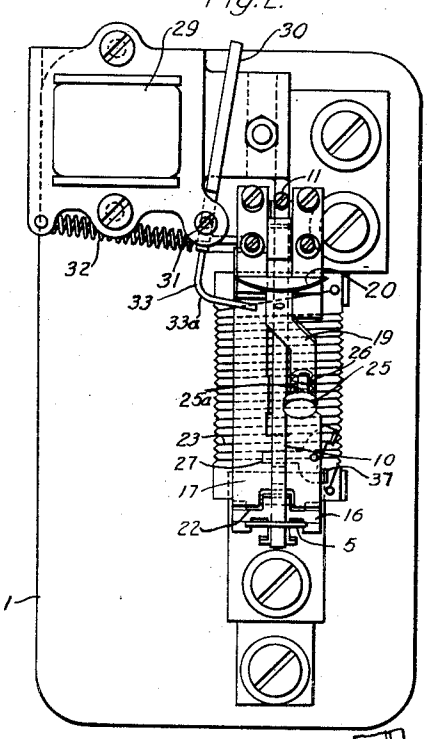
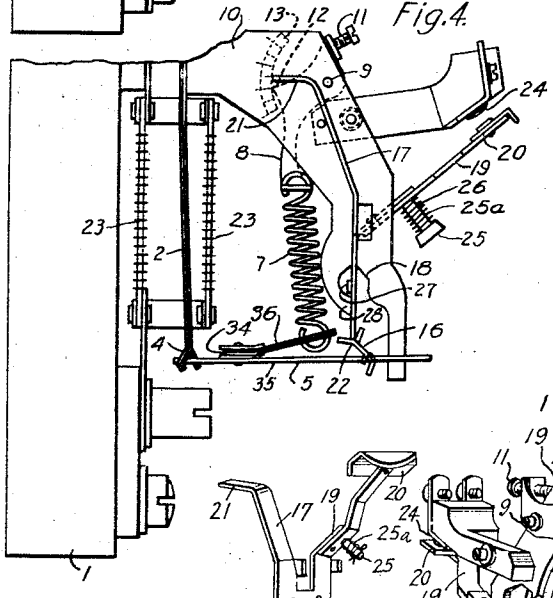


Fig. 4.



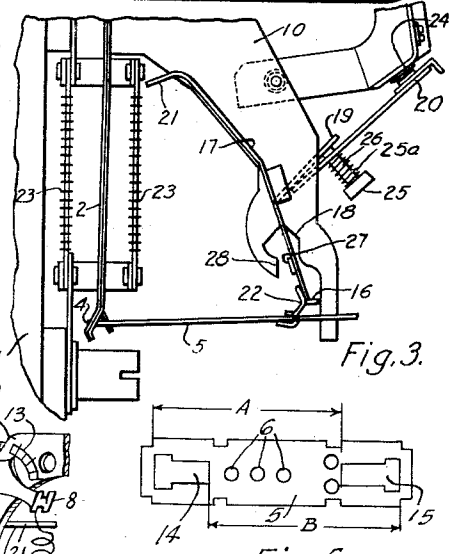


Fig. 3.

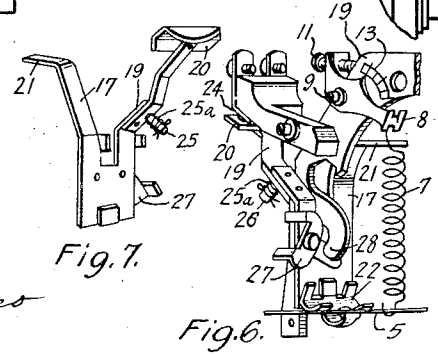


Fig. 7.

Fig. 5.

Fig. 6.

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THERMAL OVERLOAD RELAY

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12 Claims. (Cl. 200—116)

My invention relates to an overload relay, and, more specifically, to one which is of the thermally-responsive type.

An object of my invention is to provide an overload relay which is actuated either by a thermal element as the result of an overload occurring for a predetermined time or interval or which is actuable by a saturable core reactor as the result of an exceedingly high overload current which occurs suddenly.

Another object of my invention is to provide an overload relay which is adjustable merely by reversing one of its parts (the actuating member) and which is selectively automatically resettable or manually resettable.

Another object of my invention is to provide a thermal relay which has a second thermal element to provide for compensating for changes in ambient temperature.

Other objects and advantages will become more apparent from a study of the following specification when considered in conjunction with the accompanying drawing, in which:

Figure 1 is a side view of an overload relay involving the principles of my invention, and in which the contact members are shown in the open position;

Fig. 2 is a front view of the structure shown in Fig. 1;

Fig. 3 is a partial side view of the device shown in Figs. 1 and 2, but in which the contact members are shown in the closed position;

Fig. 4 is a modification of my invention including compensating means for changes in ambient temperature;

Fig. 5 is a top view of the actuating element shown in Figs. 1 to 4, inclusive;

Fig. 6 is a perspective view of the switch arm; and

Fig. 7 is a perspective view of the switch arm and its associated structure as viewed from support 1.

Referring more particularly to Figs. 1, 2 and 3, numeral 1 denotes an insulating support member upon which is mounted a cantilever type thermal element 2 which has its upper end 3 rigidly secured to the support 1 and its lower end 4 secured by means of a V-type of bearing to an actuating member 5 (which is shown more clearly in Fig. 5). In one of the holes 6 of actuating member 5, there is secured an end of spring 7, the other end of which spring is secured to an adjustable lever 8 pivoted at 9 to a bracket 10, which bracket is rigidly secured to support 1.

By turning an adjusting screw 11, the tension of spring 7 may be adjusted, thereby adjusting the rating or the time for tripping the relay. A pointer 12 may be provided on the lever 8 which cooperates with a scale 13 marked on bracket 10 for giving a visual indication of the amount of tension on spring 7. Actuating member 5 has windows 14 and 15, the extreme or outermost edges of either of which forms the bearing surface for the lower end 4 of the thermal element 2. It will be noted, however, that the lengths of windows 14 and 15 are slightly different or stated another way, distance A is different from distance B (see Fig. 5). One of the innermost edges of windows 14 and 15 (depending upon which window forms the bearing for end 4) forms the bearing surface of a toggle arm 16. A second toggle arm 17 of bifurcated configuration is held against the first toggle arm 16 by virtue of the tension of spring 7. Furthermore, the spring 7 also tends to hold the forked portion of the bifurcated arm 17 into engagement with a substantially V-shaped cut-out portion 18 in bracket 10.

The bifurcated shape of the upper toggle arm 17 is more clearly shown in Fig. 2. One of the forked arms thereof carries the yieldable contact carrying arm 19 of the movable contact member 20. The other arm of toggle arm 17 is bent inwardly, as indicated by numeral 21.

It will thus be seen that neither of the toggle arms 16 and 17 is interconnected with any of the associated parts except by virtue of the V-type of bearing. Furthermore, it will also be noted that the knee 22 of the toggle is also devoid of interconnection between arms 16 and 17 and is also of the V-bearing type. Arm 16 has a plurality of extending lug portions for providing abutments or stops for the V-type of bearing. The specific shape of arm 16 is more readily apparent by comparing Figs. 1 and 3 and by noting Fig. 2. One of the outstanding features of this V-type of knee is the substantially straight line bearing surface provided between toggle arms 16 and 17. Such straight line bearing surface eliminates shifting of the fulcrum and provides positive tripping and accurate dead center for the toggle mechanism.

The operation of the device is as follows: When a heater 23 which surrounds the bimetal 2 is heated to a predetermined value as the result of an overload current in a control system, in which the heater forms a part, the thermal element or bimetal 2 will move away from the supporting member 1 so as to push actuating

element 5 longitudinally towards the right as viewed in Fig. 3. As actuating element 5 moves to the right, the left edge of its window 15 abutting in a V-shaped portion one of the toggle arms 16 moves the toggle arm 16 from the position shown in Fig. 3 to that shown in Fig. 1, that is, past dead center of the toggle mechanism. In doing so, the movable contact member 20 will be snapped away from the stationary contact member 24. Separation of contact members 20—24 will interrupt a suitable relay circuit (not shown) for effecting any suitable control function such as interruption of a circuit which will effect disconnection of an electrical device from the system (not shown).

It will be noted that upon interruption of the flow of current through the heater 23, the thermal element 2, as it begins to cool, will retract actuating member 5 and pull it towards the left, pulling with it one of the toggle arms 16 so as to rock toggle arm 16 clockwise about the knee 22 as a pivot. It will be noted that if the toggle, in the position shown in Fig. 1, is not too far past dead center, it will be possible upon retraction of actuating member 5 to throw the toggle past dead center to its original position as shown in Fig. 3. On the other hand, if the toggle in Fig. 1 is already too far past dead center, the retraction of actuating arm 5 will not be sufficient so as to throw the toggle past dead center to its original position. In other words, it will be seen that by adjusting the limit of movement of the toggle past dead center after actuation of the relay by the thermal element, the relay may be set either for automatically resetting or for manual resetting. The latter, or manual resetting, is, of course, for the situation in which the toggle moves from the position shown in Fig. 3 to the position shown in Fig. 1 appreciably past dead center. In this situation, in order to reset the relay, that is, to close contact members 20—24 thereof, it is necessary to depress the insulating button 25 which has a pin 26 secured thereto, which is rigidly attached to a contact carrying arm 19 and extends from toggle arm 17. Spring 25a holds the movable contact carrying element against contact carrying arm 19. In other words, a toggle arm 17 is positively pushed so as to again throw the toggle past dead center from the position shown in Fig. 1 to the position shown in Fig. 3.

Pivotally mounted on the arm 17 is an automatic resetting lever 37 having a stop element 27. By moving arm 37 about its pivot, the stop member 27 may be moved either to the position shown in Figs. 1 and 2, that is, out of alignment with a hook-shaped portion 28 of bracket 10, or in alignment therewith, such as shown in Fig. 3. When it is out of alignment with the hook-shaped portion 28, as shown in Fig. 1, a maximum movement past dead center is afforded. However, when it is in alignment, as shown in Fig. 3, there is a minimum amount of movement past dead center as the actuating element 5 is moved to the right under the influence of heat so as to change the relay elements from the position shown in Fig. 3 to the position shown in Fig. 1. This is because stop element 27 instead of toggle arm 18 abuts the hook-shaped member 28. With a maximum amount of movement past dead center, the relay does not automatically reset after actuation and must be manually reset by pushing button 25. With minimum movement past dead center, however, the relay is automatically resettable upon cooling of the thermal element 2.

In many situations, it is desirable to have two different ratings for the relay, for example, in cases where the relay is adapted either for operation in a closed control cabinet or an open control panel. In many situations, it is desirable to correct the calibration of the relay for the effect of increased ambient temperature, resulting, for example, from enclosure in a control cabinet, perhaps with other heat generating apparatus, or from location of the relay near a steam pipe, or in a room in which the temperature is higher than that in which the motor it protects is located. Of course, one of the usual ways of doing this is to change the heater. In accordance with my invention, I provide this change in rating of the relay merely by reversing end for end the position of actuating element 5. As pointed out hereinbefore, the extreme edges of the windows 14 and 15 are alike and are readily reversible so as to cooperate with the lower end 4 of thermal element 2 to form a V-type bearing therewith. However, inasmuch as distances A and B (Fig. 5) are unequal, the inner edges thereof will be at different distances from the outer edge of the other window. In this manner, the V-shaped bearing between the lower toggle arm 16 and the corresponding window of actuating element 5 may be at selective distances from the lower end for the thermal element 2, merely by the reversing of the mounting of actuating element 5. In this manner the distance required for the bimetal to travel to the trip point is greater with the element 5 assembled in one position than in a reversed position. The reason for a double hold on the right is that the lower end of spring 7 loops through at two places. On the extreme left a single hole 6 and window 14 constitute the two places of passing through of the spring. In this manner, spring 7 maintains substantially the same relative position irrespective of reversal of element 5. Such change in rating of the relay, of course, would be also suitable for situations in which it is desirable to vary the amount of heating current necessary to trip the relay or to increase the operating temperature of the bimetal, in order to make the relay less resistive to changes in ambient temperature.

In some applications it is desirable to have the relay trip instantly at high currents, as in case of a short circuit.

Connected in parallel with heater element 23 is a saturable reactor coil 29 having a coacting armature 30 pivoted about point 31 against the biasing action of a spring 32. In the case of a very high overload current, the potential drop across the heater 23 exceeds the saturating voltage of the shunted reactor 29, therefore causing a substantial degree of saturation of reactor 29 and occurrence of stray or leakage flux lines which will attract armature 30 and move it counter-clockwise, as viewed in Fig. 2.

In moving counter-clockwise, an arm 33a on the tail portion 33 on the armature will abut the arm 21 of the toggle, thereby causing it to move and to throw the toggle past dead center. The trip point may be adjusted by adjusting the tension of spring 32. If instantaneous trip for extreme overload or short circuit currents is not desired, the reactive shunt may be omitted.

In order to compensate for changes in the ambient temperature or room temperature, the lower end of spring 7 instead of being directly

connected to the actuating element 5, as shown in Fig. 1, is connected to a second bimetallic element 36 which, in turn, is rigidly secured to actuating element 35, as shown in Fig. 4. An insulating spacing element 34 of Micarta or other suitable insulating material may be provided to prevent excessive transfer of heat to the spring 7. As the ambient temperature increases, the tension of spring 7 increases, thus the relay is made practically responsive to the same value of overload current regardless of changes in ambient temperature. In order to make the relatively short compensating element 33 sufficiently active to provide the necessary degree of compensation it may be made up of several thin sheets of bimetal. Inasmuch as the thermal element 36 is located below the heater 23, it provides against heating of thermal element 36 by convection from the heater.

Thus it will be seen that I have provided a general purpose relay suitable for a number of situations or applications, which relay has a minimum number of moving parts, which are outstandingly resistant to mechanical shocks. Furthermore, I have provided a relay which is readily adjustable and which is highly reliable in operation, having a toggle mechanism which is not subjected to changes in fulcrum or shifting of dead-center position through ordinary wear. Furthermore, I have provided a relay which is either manually resettable or automatically resettable at will merely by the rocking movement of a resetting lever mounted on one of the toggle arms. Further, it may be adapted to trip instantly at extremely high overloads.

I am, of course, aware that others, particularly after having had the benefit of the teachings of my invention, may devise other devices and systems of control embodying my invention, and I, therefore, do not wish to be limited to the specific showings made in the drawing and the descriptive disclosure hereinbefore made, but wish to be limited only by the scope of the appended claims and such prior art that may be pertinent.

I claim as my invention:

1. A thermal relay comprising, in combination, a thermal responsive actuating element, a toggle mechanism actuated thereby, a switch which is operated by said toggle mechanism, and a stop lever pivotally connected to and supported by one of the arms of said toggle mechanism for selectively adjusting the travel of said toggle mechanism by selectively changing the position of said lever, for selectively making the relay automatically or non-automatically resettable upon movement of said thermal responsive actuating element in a direction opposite to the direction for actuating the switch.

2. A thermal relay comprising, in combination, a thermal element, an actuating element operable thereby, a toggle mechanism operable by said actuating element and a switch operable by said toggle means, said actuating element, toggle mechanism and switch being operable in one direction in response to heating of said thermal element, and said actuating element and toggle mechanism being operable in an opposite direction in response to cooling of said thermal element and a stop lever pivotally connected to and supported by one of the arms of said toggle mechanism for adjusting the limit of travel of said toggle mechanism by selectively changing the position of said lever, so as to selectively make the contacts automatically or non-automatically resettable upon predetermined cooling of said thermal element.

3. A thermal relay comprising, in combination, a thermal element, an actuating element operable thereby, a toggle mechanism operable by said actuating element and a switch operable by said toggle means, said actuating element being operable in one direction in response to a predetermined heating of said thermal element to throw said toggle mechanism past "dead center" to operate said switch, and being operable in an opposite direction in response to a predetermined cooling of said thermal element to throw said toggle mechanism past "dead center" to substantially its original position and an adjustable stop lever pivotally connected to and supported by one of the arms of said toggle mechanism for limiting movement past "dead center" of said toggle mechanism by selectively changing the position of said lever, for selectively rendering said switch either automatically resettable to its original position or not so resettable, in response to said cooling of the thermal element.

4. A thermal relay comprising, in combination, a thermal element, an actuating element operable thereby, a toggle mechanism operable by said actuating element and a switch operable by said toggle means, said actuating element, toggle mechanism and switch being operable in one direction in response to heating of said thermal element, and said actuating element and toggle mechanism being operable in an opposite direction in response to cooling of said thermal element and means for adjusting the limit of travel of said toggle mechanism so as to selectively make the contacts automatically or non-automatically resettable upon predetermined cooling of said thermal element, said actuating element being reversibly mountable and slightly unsymmetrically shaped so as to require two different predetermined values of heating of said thermal element to operate said switch, which values are dependent upon whether said actuating element is mounted in one position or in a reverse position.

5. A thermal relay comprising, in combination, a thermal element, an actuating element operable thereby, a toggle mechanism operable by said actuating element and a switch operable by said toggle means, said actuating element being operable in one direction in response to a predetermined heating of said thermal element to throw said toggle mechanism past "dead center" to operate said switch, and being operable in an opposite direction in response to a predetermined cooling of said thermal element to throw said toggle mechanism past "dead center" to substantially its original positions and adjustable stop means for limiting the latter movement past "dead center" of said toggle mechanism for selectively rendering said switch either automatically resettable to its original position or not so resettable, in response to said cooling of the thermal element, said actuating element being reversibly mountable and slightly unsymmetrically shaped so as to require two different predetermined values of heating of said thermal element to operate said switch, which values are dependent upon whether said actuating element is mounted in one position or in a reverse position.

6. A thermal relay comprising, in combination, a thermal element, a toggle mechanism, a re-

versibly mountable, slightly unsymmetrical actuating member having a pair of symmetrical end portions either of which is connectible to the thermal element, non-symmetrical intermediate portions thereon either of which is pivotable to said toggle mechanism, a switch which is operable by said toggle mechanism and which is selectively responsive to two different predetermined degrees of heating of said thermal element dependent upon whether said actuating element is mounted in one direction or in a reverse direction.

7. A thermal relay comprising, in combination, a thermal element, a toggle mechanism, a reversibly mountable, slightly unsymmetrical actuating member having a pair of connecting portions either of which is connectible to the thermal element and having a pair of toggle engaging portions either of which is pivotable to said thermal element depending upon which connecting portion is connected to the thermal element and a switch which is operable by said toggle mechanism and which is selectively responsive to two different predetermined degrees of heating of said thermal element dependent upon whether said actuating element is mounted in one direction or in a reverse direction.

8. A thermal relay comprising, in combination, a thermal element, a toggle mechanism, a reversibly mountable, slightly unsymmetrical actuating member having a pair of connecting portions either of which is connectible to the thermal element and having a pair on non-symmetrical windows, one of the edges of each serving as pivotal points for said toggle mechanism, depending upon which of said reversible connecting portions is connected to the thermal element, and a switch which is operable by said toggle mechanism and which is selectively responsive to two different predetermined degrees of heating of said thermal element dependent upon whether said actuating element is mounted in one direction or in a reverse direction.

9. A switch comprising, in combination, a support having a V-shaped notch therein, an actuating member which is biased towards said support by an adjustable spring interconnecting the support and actuating member, a toggle comprising two arms which are devoid of mechanically interconnected parts, one of said toggle arms having an end comprising a pair of arms which straddle said support and have a joint which is solely in contact engagement with said V-shaped notch, and the other of said toggles having an end which is solely in contact engagement with a portion of said actuating element, the remaining ends of said toggle arms being solely in contact engagement along a substantially straight line bearing surface, all of said contact engagements being maintained by the biasing action of said spring.

10. A thermal relay comprising, in combination, a support, a thermal element secured thereto, a toggle mechanism comprising two arms pivoted on each other solely by contact engagement, a reversibly mountable, slightly unsymmetrical actuating element having a pair of reversible ends, one of which is secured to said thermal element and the other of which abuts said toggle mechanism, spring means for biasing said thermal element against said toggle mechanism and for biasing the latter against said support so as to hold said arms thereof together, said actuating element having two non-symmetrical windows, about the ends of which one of said toggle arms forms a pivot, only one of said windows being used, depending upon whether said actuating element is mounted in one position or a reverse position, thereby affording selective tripping periods for a predetermined heating of said thermal element.

11. A thermal relay comprising, in combination, a support, a thermal element secured thereto, a toggle mechanism comprising two arms pivoted on each other solely by contact engagement, a reversibly mountable, slightly unsymmetrical actuating element having a pair of ends, one of which is secured to said thermal element and the other of which abuts said toggle mechanism, spring means for biasing said thermal element against said toggle mechanism and for biasing the latter against said support so as to hold said arms thereof together, said actuating element having two non-symmetrical windows, about the ends of which one of said toggle arms forms a pivot, only one of said windows being used, depending upon whether said actuating element is mounted in one position or a reverse position, thereby affording selective tripping periods for a predetermined heating of said thermal element, said toggle arms being non-interconnected at the knee but being merely in abutment along a substantially straight line bearing surface.

12. A thermal relay comprising, in combination, a thermal element, a toggle mechanism, a reversibly mountable, slightly unsymmetrical actuating member having a pair of symmetrical end portions either of which is connectible to the thermal element, non-symmetrical intermediate portions thereon either of which is pivotable to said toggle mechanism, a switch which is operable by said toggle mechanism and which is selectively responsive to two different predetermined degrees of heating of said thermal element dependent upon whether said actuating element is mounted in one direction or in a reverse direction, a second thermal element connected between said actuating element and said toggle mechanism for compensating for changes in ambient temperature.

GEORGE C. ARMSTRONG.