April 30, 1940. R. R. PITTMAN ET AL 2,198,840

THERMALLY RESPONSIVE DEVICE

Filed July 17, 1939

Fig. 1

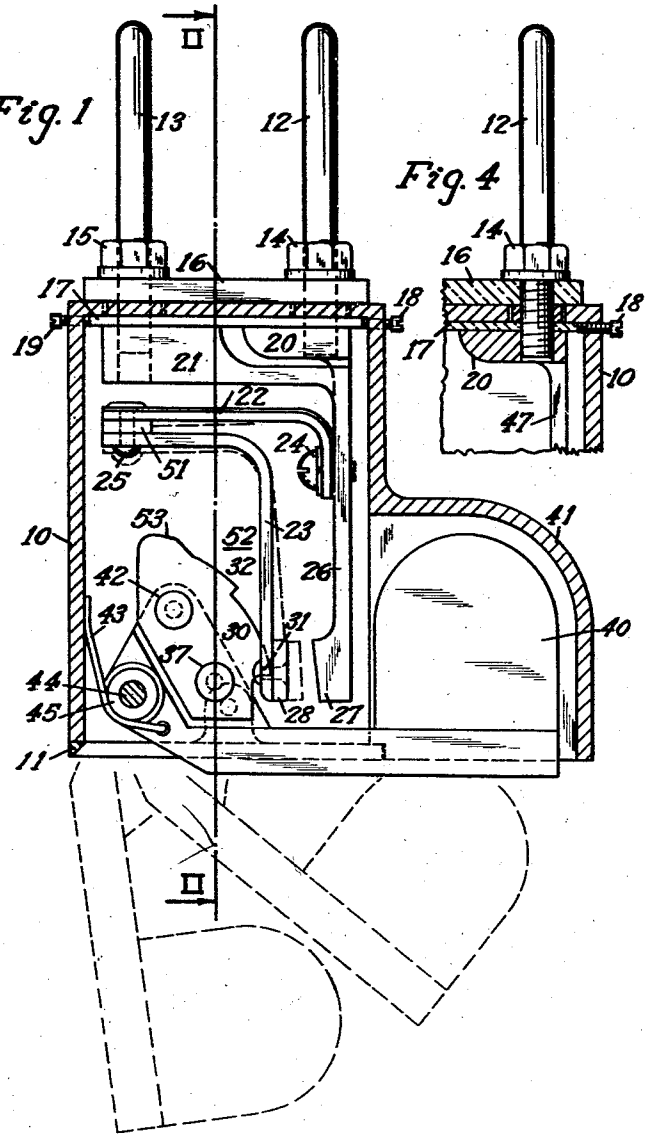


Fig. 4

Fig. 2

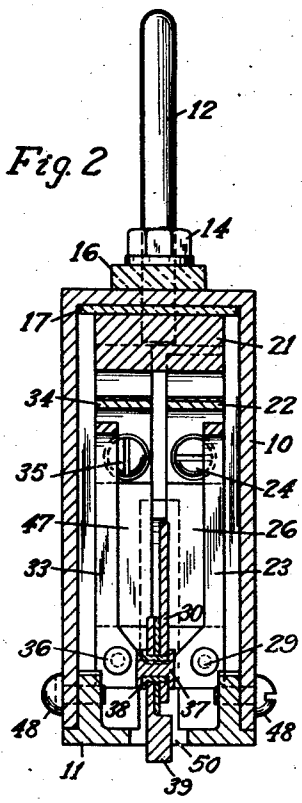
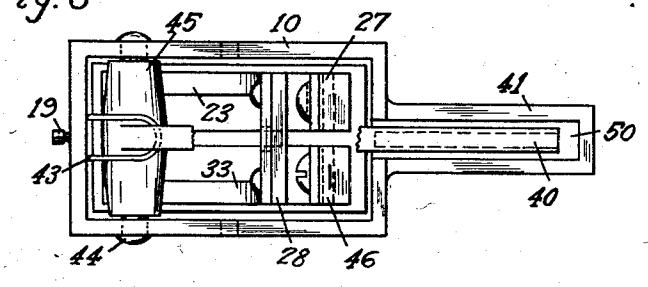


Fig. 3



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THERMALLY RESPONSIVE DEVICE

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4 Claims. (Cl. 177—311)

This invention relates generally to electrical devices actuated in response to a movement of a thermally responsive element. More particularly, it relates to a thermally responsive element for use in such devices, and an indicating device incorporating the element.

Among the objects of the present invention may be noted (*a*) the provision of a thermally responsive element in which the controlling movement may be the same in distance as elements heretofore used but in which the time for accomplishing the movement may be much greater; (*b*) the provision of indicating means controlled by the element, such that the organization is peculiarly adapted to indicate certain predetermined points of the temperature characteristic of electric apparatus, particularly insulated self cooled transformers, which are in a circuit with the element; (*c*) the provision of a thermally responsive element including a bimetallic strip which bends when heated and on which is mounted, for movement in response to the bending of the bimetallic strip, a heater-strip of relatively higher resistance material which does not bend when heated, the bimetallic and heater strips being electrically in series circuit relation; and (*d*) an indicating device, including the thermally responsive element, embodying a novel arrangement for shunt-circuiting the element in response to predetermined movement of the indicator.

The present invention is a continuation in part of our pending application Serial No. 212,613, filed June 8, 1938.

With the above and other objects in view which will appear as the description proceeds, our invention resides in the novel combination, construction and arrangement of the parts, and the scope of the invention will be pointed out in the appended claims.

In the drawing, in which similar reference characters indicate corresponding parts:

Fig. 1 is a side elevational view of the device, illustrated with one side of the housing removed to show the members within.

Fig. 2 is a section taken along the line II—II of Fig. 1.

Fig. 3 is an end view of the device, shown with the housing closure removed.

Fig. 4 is a fragmentary view of the terminal arrangement.

Referring now to the drawing, a hollow metal housing 10, having a forwardly extending hollow integral portion 41, is provided with a closure 11, the latter being held in position by the screws 48 and 49. An indicator 39 is pivotally mounted at one end thereof on the housing 10 by means of the shaft 44 extending laterally therethrough, the indicator bearing 45 being journalled for rotative movement about the latter. A central slotted opening 50 extends longitudinally along the closure 11, and the indicator semaphore 40 is arranged to move through the opening 50 into and out of the housing 10.

A pair of spaced insulated conducting terminals 12 and 13 extend downwardly through the top of the housing 10 in spaced relationship therewith, and in threaded engagement with the internal downwardly extending spaced metal supports 20 and 21. The latter are respectively clamped against the internal insulating block 17 by means of the nuts 14 and 15, and an external insulating block 16 is interposed between the latter and the housing 10.

The thermally responsive element, indicated in its entirety by the numeral 52 includes a pair of spaced horizontally extending bimetallic strips 22 and 34, which are rigidly secured to the supports 21 and 20 respectively intermediate of the ends thereof by the screws 24 and 35 respectively. A pair of non-bimetallic heater-strips 23 and 33 are rigidly secured to the free ends of the bimetallic strips 22 and 34 by means of the rivets 25, and spaced therefrom by the metal spacing blocks 51, the heater-strips 23 and 33 extending first longitudinally along and below the bimetallic strips 22 and 34 in spaced parallel relation with each other and with the bimetallic strips 22 and 34, and thence downwardly in spaced parallel relation to a point near the bottom of the housing 10 and remote from the bimetallic strips 22 and 34.

From the above description, it may be seen that the thermally responsive element includes a series circuit arrangement of a bimetallic strip and a non-bimetallic strip, so arranged that a small movement of the former due to rise in temperature thereof causes a relatively larger movement of the free end of the latter. The non-bimetallic strip is of relatively high resistance metal, so that the heat therefrom will be slowly conducted to the bimetallic strip, thus slowly heating the bimetallic strip, and thereby delaying its bending movement due to heating. We have found "Monel" metal a suitable material for the non-bimetallic heater-strip. The rate of transfer of heat from the heater strips to the bimetallic strips may also be varied by a change in the distance which separates the parallel portions of these strips, as the heater strips, being

located under the bimetallic strips, radiate a portion of the heat of the former to the latter.

A latch member 30 is rigidly secured to the indicator 39 by means of the rivets 37 and 42, being electrically insulated from the indicator 39 by the sleeves of insulating material 38. (Fig. 2.) The latch member 30 extends toward the lower juncture of the heater-strips 23 and 33, and is provided with a pair of detents 31 and 32, the former having a smaller radius of rotation about the shaft 44 than the latter. When the semaphore 40 is in the concealed position indicated by the solid lines of Fig. 1, the detent 31 is engaged with the portion joining the lower ends of the heater-strips. In response to a movement of the lower end of the heater-strips in a direction away from the shaft 44, the detent 31 is disengaged, and the indicator 39 rotated about the shaft 44 under the influence of the spring 43, which has one end fastened to the indicator 39 and the other end engaged with the inner vertical surface of the housing 10. The indicator 39 is rotated in a clockwise direction until the second detent 32 engages the portion joining the lower end of the heater-strips, and remains in this position until a further outward movement of the heater-strips takes place. In response to such movement, the detent 32 is disengaged and the indicator then assumes a position substantially endwise of the housing 10.

The degree of engagement of the detents 31 and 32 may be varied by means of the externally extending adjusting screws 18 and 19, which are arranged to laterally shift the thermally responsive element assembly in a direction to either increase or decrease the extent of engagement of the detents with the thermally responsive element. This arrangement is of assistance in adjusting the device following assembly.

To prevent damage to the thermally responsive element under heavy currents due to faults in the connected circuit, a novel shunting arrangement is embodied in the device. The conducting supports 20 and 21 are provided with the downwardly extending portions 47 and 26 respectively, and the contacts 46 and 27 provided at the respective lower ends thereof. A shunt-circuiting metal bar 28 is rigidly secured to the lower ends of the heater-strips 23 and 33, by means of the rivets 29 and 36, and the contacts 46 and 27 positioned in the path of movement of the bar 28. Upon the occurrence of a movement of the thermally responsive element which releases the second detent 32, the bar 28 is engaged by the arcuate portion 53 of the latch member 30, and thus driven and held tightly against the contacts 27 and 46, shunt-circuiting the thermally responsive element and preventing the passage of excessive and damaging amounts of current therethrough.

The normal path of current through the device from the terminal 13 includes serially the support 21, the bimetallic member 22, the non-bimetallic heater-strip 23, the non-bimetallic heater-strip 33, the bimetallic member 34, the support 20, and the terminal 12.

A practical application of the device is to the indication of transformer loading. In such an application, it is desirable that the indications follow the temperature-time curve of the copper in the connected transformer. Because of the mass of the winding in a transformer, and of its intimate association with the cooling medium, considerable time is required for a transformer carrying rated load to reach its maximum temperature. In order to conform to the heating characteristic of such a structure, and at the same time obtain sufficient movement for definite latch control, we arrange the indicator so that the bimetallic element is heated both from the current passing therethrough and from the heat conducted and radiated from the heater-strip to the bimetallic strip. The accumulation of the heat necessary to cause sufficient deflection of the bimetallic strip to release the indicator may be delayed for a much longer time with the arrangement above described than if only a bimetallic strip, or a usual arrangement of bimetallic strip and associated heater, was employed. This time may be varied to a certain extent through the use of combinations of strips which differ in electrical and physical characteristics, and by varying the distance between the heater and the bimetallic strips.

In the preferred form, the indicator is calibrated to indicate one of three conditions of a connected transformer. If the indicator has not moved from its concealed position, the transformer is underloaded, and a smaller unit may be safely and economically substituted. If the indicator has moved to a position approximately 45 degrees with the plane of the bottom of the housing, the transformer is operating in the economical range at substantially full load. If the indicator has moved to a position substantially endwise of the housing, the transformer has been subjected to overheating, and should be replaced with a larger unit before it is destroyed. While the three indications above recited are believed to show the essential conditions for practical considerations it will be apparent that additional detents may be readily added to the latch member 30 to provide additional indications.

Specific language has been used in describing the embodiment of the invention herein presented, but it will be understood that this has been done to facilitate an understanding of the construction and operation, and that various changes may be made in the specific construction without departing from the principles of the invention.

We claim, as our invention:

1. In an electric thermal indicating device, for an electric circuit, a movable indicator having a plurality of indicating positions, including a final position, a latch member having detents, said latch member being movable with said indicator, and a thermally responsive element in series relation with said circuit and having a portion movable with respect to said latch member and normally engaging one of said detents to restrain movement of said indicator, means responsive to a predetermined movement of the movable portion of said thermally responsive element for moving said indicator to the final position, and means responsive to the movement of said indicator to the final position for shunt-circuiting said thermally responsive element, said last-named means including a cam portion of said latch member, a relatively low resistance member mounted on said movable portion of said thermally responsive element and positioned in the path of movement of said portion, and a pair of spaced normally insulated conducting contacts electrically connected respectively to the respective ends of said thermally responsive element and constructed and arranged to be bridged by said low resistance member in response to a predetermined movement thereof.

2. In an electric thermal indicating device for

an electric circuit, a movable indicator having a plurality of indicating positions including a final position, a latch member having detents, said latch member being movable with said indicator, a thermally responsive element electrically connected in series relation with said circuit and having a movable portion normally engaging one of said detents, means responsive to a predetermined movement of said movable portion for actuating said indicator to the final position, and means for shunt-circuiting said thermally responsive element following said movement, said last-named means including normally insulated conducting contacts electrically connected to the respective ends of said thermally responsive element, a conducting member movable into and out of engagement with said contacts, and a cam portion of said latch member arranged to engage and urge said conducting member into engagement with said contacts.

3. In an electric thermal indicating device for an electric circuit, a thermally responsive element having a movable portion, means for electrically connecting said element in said circuit, an indicator movable to an indicating position, a latch member rigidly secured to said indicator and normally engaging the movable portion of said thermally responsive element for restraining the movement of said indicator, a relatively low resistance member mounted on the movable portion of said thermally responsive element, a pair of spaced normally insulated contacts electrically connected to the respective ends of said thermally responsive element, means responsive to a predetermined movement of said thermally responsive element for actuating said indicator to the indicating position, and means for urging said low resistance member into bridging engagement with said contacts following said movement, said last-named means including a cam portion of said latch member arranged to engage said low resistance member when said indicator has moved to the indicating position.

4. In an electric thermal indicating device for an electric circuit, a thermally responsive element having a movable portion, means for electrically connecting said element in said circuit, an indicator swingably movable to an indicating position, resilient means urging said indicator to the indicating position, a latch member rigidly secured to said indicator and normally engaging the movable portion of said thermally responsive element for normally restraining the movement of said indicator and for unlatching said indicator in response to a predetermine movement of the movable portion of said thermally responsive element, and means responsive to the unlatching of said indicator for shunting said thermally responsive element, said last-named means including a cam portion movable with said latch member, a pair of spaced normally insulated contacts electrically connected to the respective ends of said thermally responsive element, and a conducting member mounted on the movable portion of said thermally responsive element and positioned in the path of movement of said cam portion, the arrangement being such that said conducting member is urged into engagement with said contacts in response to a predetermined movement of said cam portion.

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