Nov. 7, 1944. R. R. PITTMAN 2,362,398

THERMALLY RESPONSIVE DEVICE

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Fig. 1

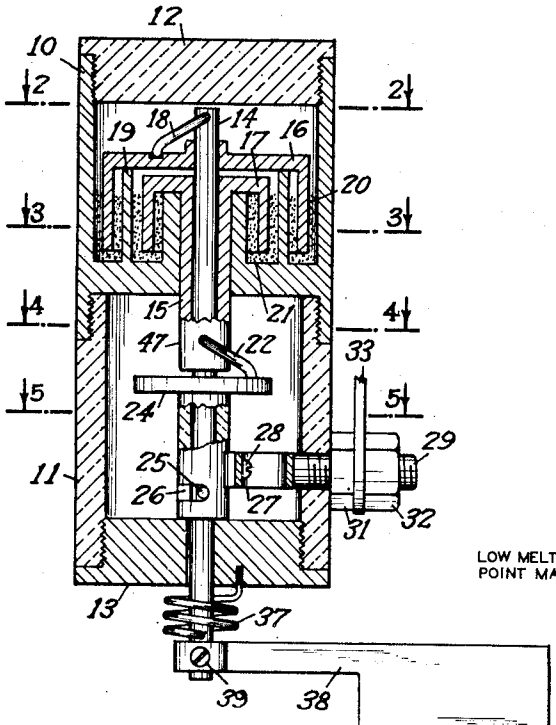

Fig. 2

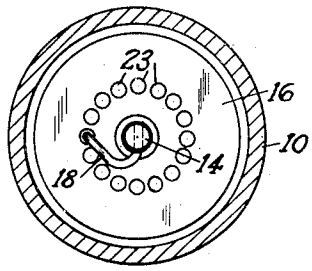

Fig. 3

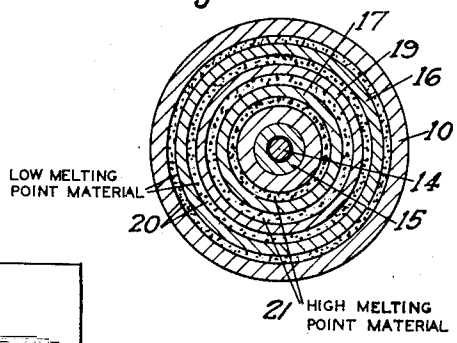

Fig. 4

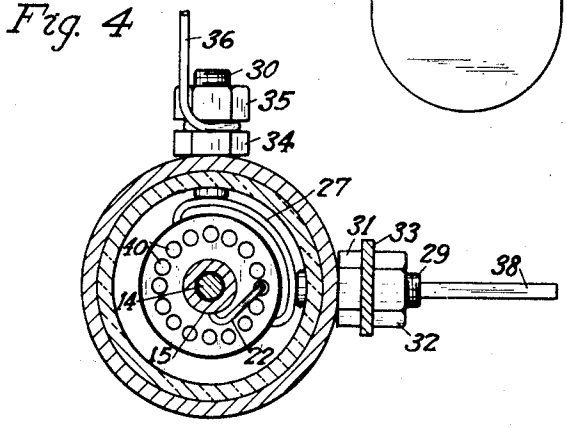

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Fig. 5

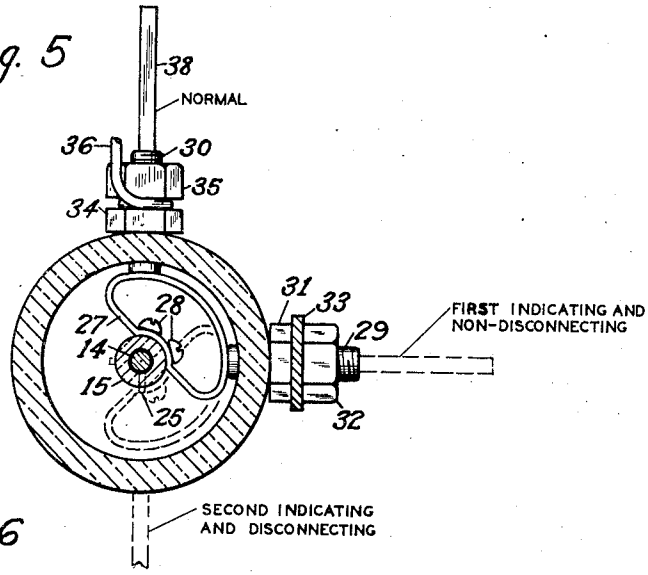
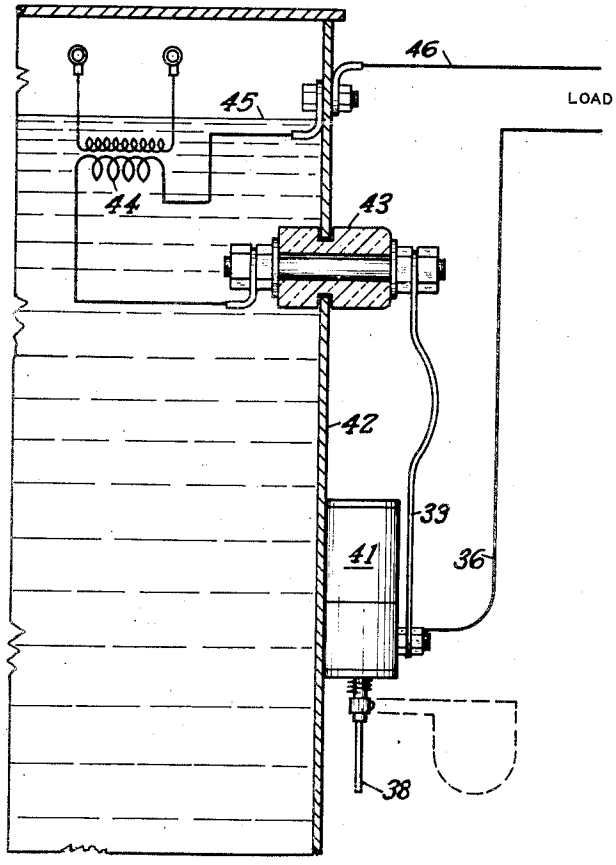


Fig. 6



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UNITED STATES PATENT OFFICE

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THERMALLY RESPONSIVE DEVICE

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Application August 1, 1942, Serial No. 453,297

5 Claims. (Cl. 116—114.5)

This invention relates generally to devices the operation of which is dependent upon the attainment of a predetermined temperature by an associated body. More particularly, the present invention is characterized by the fusible materials employed in the device, and the indication and switching construction which depends for operation upon the fusing of these materials.

Among the objects of the present invention is the provision of a temperature responsive device embodying indicating means and both indicating and switching means which functions in response to fusing of fusible material to first indicate attainment of a predetermined temperature and to subsequently concurrently indicate attainment of a relatively higher predetermined temperature and actuate the switching means; and means for re-setting the device to the normal position when the fusible material embodied therein has frozen. Other objects will be in part obvious, and in part pointed out hereinafter.

The invention comprises certain of the elements, and combinations thereof, features of construction and arrangement of parts to be exemplified in the description to follow, and the scope of the invention will be indicated in the accompanying claims.

In the drawings: Fig. 1 is a side elevational view of the device, shown partly in section; Figs. 2, 3, 4, and 5 are respectively sections taken along the lines 2—2, 3—3, 4—4, and 5—5 of Fig. 1; Fig. 6 illustrates a method of application of the device. Similar reference characters indicate corresponding parts in the several figures of the drawings.

Referring to the drawings, particularly first to Figs. 1 to 5 inclusive, the upper chamber of conducting material 10 is threadedly joined to the lower chamber 11, these members, along with the upper closure 12 and the lower closure 13 constituting a housing for mechanism of the device. A partition 19, which is shown integral with and within the upper chamber 10 and which extends upwardly from the floor thereof toward the closure 12, divides the lower portion of the chamber 10 into two concentric annular channels.

The inner retaining member 17 extends downwardly into the inner channel, and the member 17 may be formed integrally with the hollow shaft 15, the latter extending downwardly into the lower chamber 11 through a centrally located bearing 47. In somewhat similar manner, the outer and larger retaining member 16 extends coaxially downward into the outer channel, and the solid shaft 14 extends successively, from a point near the closure 12, downwardly through a centrally positioned opening in the upper horizontal portion of the retaining member 16 and thence coaxially through the hollow shaft 15 to a point beyond the lower surface of the closure 13. The outer retaining member 16 is rigidly fastened to the upper chamber 10 by means of the normally frozen fusible material 20 within the outer annular channel, and similarly the inner retaining member 17 is normally held in fixed position through its engagement with the fusible material 21 within the inner annular channel.

The semaphore 38 is rigidly secured to the extended lower end of the inner and solid shaft 14 by means of the set screw 39, and the driving spring 37 arranged with its convolutions around the shaft 14 so as to continuously urge the latter member toward rotation in a clockwise direction when viewed from above. To normally restrain such movement, the pawl 18 is interposed between the upper end of the solid shaft 14 and the horizontal portion of the retaining member 16, one end of the pawl 18 being rigidly secured to the shaft 14 and the other end arranged to engage one of the circumferentially spaced openings 23, as shown in Fig. 2. Upon fusing of the fusible material 20, the retaining member 16 is freed to rotate within the outer channel under the influence of the driving spring 37, the retaining member 16, the pawl 18, the shaft 14 and the semaphore 38 all moving together until stopped in the first indicating position.

To establish the first indicating position, the ratchet wheel 24, through which the shaft 14 coaxially extends, is provided with the circumfentially spaced openings 40. The pawl 22, one end of which is rigidly secured to the hollow shaft 15 and the other end of which is arranged to engage one of the openings 40, as shown in Fig. 4, normally locks the ratchet wheel against rotary motion in a clockwise direction when viewed from above. The detent pin 25 is rigidly secured to the shaft 14 and extends outwardly therefrom within the circumferential slot 26 of the lower portion of the ratchet wheel 24, so that, after movement of the shaft 14 so as to cause the pin 25 to move the length of the slot 26, no further movement occurs until the ratchet wheel 24 is released for movement.

So long as the hollow shaft 15 is restrained from movement by the frozen condition of the fusible material 21, the ratchet wheel 24 is not free to turn, but when both the fusible materials 20 and 21 melt, all of the rotatable elements of the indicating means turn as a unit until the en-

ergy stored in the spring 37 is expended or the movement otherwise impeded. These elements include the solid shaft 14, the pawl 18, the outer retaining member 16, the hollow shaft 15, the retaining ring 17, the pawl 22, the ratchet wheel 24, the pin 25 and the semaphore 38, the movement of these elements concurrently causing establishment of the second indicating position.

In certain applications it is desirable to disconnect a connected circuit the load of which is causing excess temperature rise of associated apparatus, and to accomplish this end, a pair of conducting contacts 29 and 30 are peripherally spaced and extend through the insulating wall of the lower chamber 11, being respectively held in place by the lock nuts 31 and 34, and provided with the terminal nuts 32 and 35 for connecting the extended conductors 33 and 36. A resilient bridging contact 27 is secured, by means of the screws 28, to the hub of the ratchet wheel 24 for movement therewith, and arranged to electrically connect the respective contacts until the ratchet wheel 24 moves from the normal position, and to disconnect these contacts in response to such movement.

The device is illustrated when applied to an electric transformer in Fig. 6. The transformer casing 42 contains the cooling liquid 45 and the winding 44, the latter being serially connected to a load circuit through the bushing 43, the resilient conducting support 33, the device 41, and the extended conductors 36 and 46.

For such application, it is desirable that a first indication be initially provided when the casing 42 attains a predetermined temperature corresponding to the full thermal load on the transformer, and that, upon attainment of a relatively higher predetermined temperature corresponding to damaging or excess load, a second indication be provided concurrently with disconnection of the load causing the excessive temperature rise.

To illustrate, assume that the fusible material 20 which is in engagement with the outer retaining member 16 is such that its melting point is 50 degrees centigrade, and that the fusible material which is in engagement with the inner retaining member 17 is such that its melting point is 65 degrees centigrade. Under such conditions, the first indication occurs when the fusible material 20 melts to free the outer retaining member 16 for movement, the semaphore moving in response from the normal position to the first indicating position, as shown in Fig. 5. If the temperature rise continues, the fusible material 21 subsequently melts, freeing the inner retaining member 17, in response to which occurrence the semaphore 38 moves from the first to the second indicating position and the movable contact 27 moves concurrently to the open circuit position to effect disconnection of the load circuit.

When both of the fusible materials are fused, the device will not latch in either the normal or first indicating positions. If, however, the material 21, in the inner channel, is frozen, the solid shaft 14 may be moved counterclockwise in direction, viewed from above, as the pawl 22 ratchets along the openings 40 of the ratchet wheel 24, to establish the semaphore 38 in the first indicating position and to close the switch. In somewhat similar manner, the semaphore may be turned to and latched in the normal position following the freezing of the material 20, in the outer channel, and in so doing the pawl 18 ratchets along the openings 23 of the upper and outer retaining member 16.

The arrangement above described, and illustrated by Fig. 6, has certain advantages over previous organizations. Heretofore indicating and switching temperature responsive devices have been used to perform functions substantially identical to those accomplished by the construction described herein, but such organizations have in general employed devices submerged within the cooling liquid, requiring more complicated and expensive arrangements which are relatively inaccessible and not at all suitable for embodying in existing transformers. It will be apparent from the description herein that the external construction employed in the present invention makes possible ready combination of the protective arrangement with existing transformers which may or may not be in service.

In the foregoing description of my invention, specific examples have been used, but it will be understood that this has been done for illustrative rather than for limiting purposes.

I claim as my invention:

1. A temperature indicator comprising a hollow tubular chamber, a rotatable shaft extending coaxially into and journalled for rotary movement with respect to said chamber, a concentrically disposed partition within said chamber arranged to provide an annular channel extending around said shaft in coaxial relationship therewith, a retaining member extending into said annular channel, ratchet means connecting said retaining member to said shaft so as to cause movement therewith in response to rotation of said shaft in only one direction, means biasing said shaft toward rotary movement in said one direction, and a body of fusible material positioned within said annular channel in engagement with said retaining member and joining said retaining member to said partition when said fusible material is unfused, the arrangement being such that said retaining member is released for rotary movement with said shaft when said material fuses, and a visible indicator secured to said shaft externally of said chamber.

2. A temperature indicator comprising a hollow tubular chamber, a concentrically disposed partition within said chamber arranged to provide an inner and an outer annular channel, said channels extending within said tubular chamber in concentric relationship to one another, inner and outer retaining members extending downwardly respectively into said inner end outer channels, a hollow rotatable shaft integral with the inner retaining member extending therefrom coaxially with respect to said container and to a point outside of said chamber, another rotatable shaft extending through said hollow shaft into said chamber, detent means carried by said another shaft arranged to engage said hollow shaft when a predetermined rotary movement of said another shaft occurs ratchet means connecting said outer retaining member to said another shaft so as to cause movement therewith in response to rotation of said shaft in only one direction, fusible materials differing as to melting point disposed respectively in said channels in engagement with said retaining members for normally fastening said members to said chamber, means biasing said another shaft toward rotation in said one direction for rotating said another shaft sequentially from the normal position to a first position and thence to a second position in response to the

sequential fusing of said fusible materials, and a visible indicator movable with said shaft for respectively indicating the positions thereof.

3. A temperature indicator comprising a hollow tubular chamber, a concentrically disposed partition within said chamber arranged to provide inner and outer annular channels extending within said tubular chamber in concentric relationship one to the other, inner and outer retaining members extending downwardly respectively into said inner and outer channels, a rotatable shaft associated with said retaining members and movable sequentially from a normal position to a first indicating position and thence to a second indicating position, ratchet means connecting said outer retaining member to said shaft so as to cause movement therewith in response to rotation of said shaft in only one direction, and detent means operatively connecting said shaft to the inner retaining member following a predetermined movement of said shaft in said one direction, fusible materials differening as to melting point disposed respectively in said channels in engagement with and normally restraining movement of said retaining members when said fusible materials are unfused, and individually releasing each of said retaining members when the material with which it is engaged fuses, means responsive to the sequential fusing of said fusible materials for rotating said shaft sequentially from said normal position to said first position and thence to said second position, and a visible indicator movable with said shaft for respectively indicating the positions thereof.

4. A temperature indicator comprising a hollow tubular chamber, a concentrically disposed partition within said chamber arranged to provide inner and outer annular channels within said tubular chamber in concentric relationship one to the other, inner and outer retaining members extending downwardly respectively into said inner and outer channels, a hollow rotatable shaft movable with the inner retaining member extending therefrom to a point outside of said chamber and along the longitudinal axis of the chamber, another rotatable shaft extending through said hollow shaft into said chamber, ratchet means connecting said outer retaining member to said another shaft so as to cause movement therewith in response to rotation of said shaft in only one direction, fusible materials differing as to melting point disposed respectively in said channels in engagement with and restraining movement of said retaining members when said fusible materials are unfused, resilient means urging said another shaft toward rotation in said one direction, detent means carried by said another shaft and engageable with said hollow shaft for establishing the position of said another shaft with respect to said chamber when the fusible material in said outer channel is fused and the material in said inner channel is unfused, and a semaphore rigidly connected to said another shaft for visibly indicating said position.

5. A thermally responsive device comprising a chamber divided into at least two separate channels, a rotatable shaft journalled in said chamber, said shaft being serially and rotatably movable in one direction from a normal position to a first indicating position and thence to a second indicating position, means urging said shaft for movement in said one direction, a first fusible material disposed within one of said channels, a first retaining member extending in said one of said channels in contact with said first fusible material, means connecting said shaft to said first retaining member to normally restrain the first movement of said shaft from the normal to the first indicating position when said first fusible material is frozen and for releasing said shaft to permit said first movement when said first fusible material fuses, a second fusible material having a higher melting point than said first fusible material disposed within the other of said channels, a second retaining member extending into the last-named channel in contact with said second fusible material, means connecting said shaft to the second retaining member to restrain the second movement of said shaft from the first indicating position to the second indicating position when said second fusible material is frozen and for releasing said shaft to permit said second movement when said second fusible material fuses, ratchet means cooperating with said shaft to permit restoration of said shaft from either indicating position to the normal position when said materials are frozen, and a semaphore movable with said shaft for respectively visibly indicating said positions.

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