Dec. 18, 1928. 1,695,877

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TEMPERATURE RESPONSIVE DEVICE

Filed Dec. 17, 1925

Fig. 1.

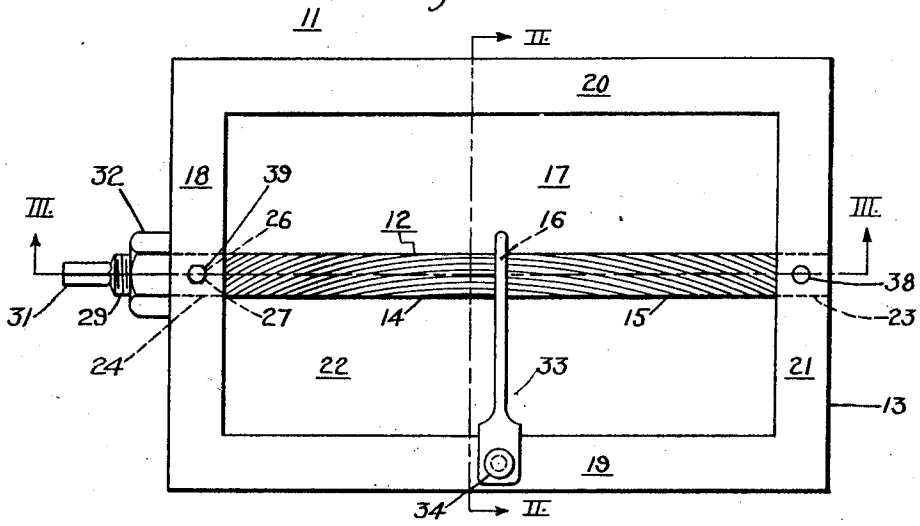


Fig. 2.

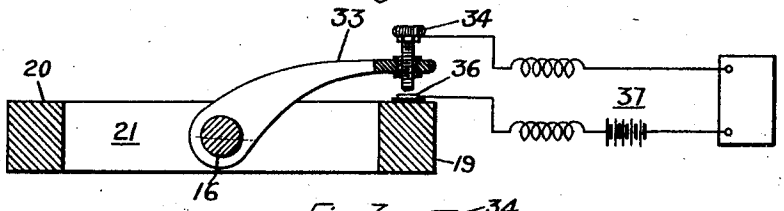


Fig. 3.

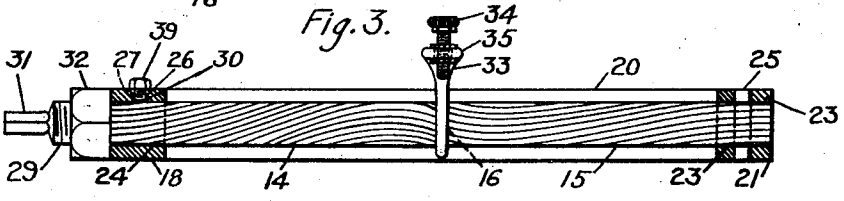


Fig. 4.

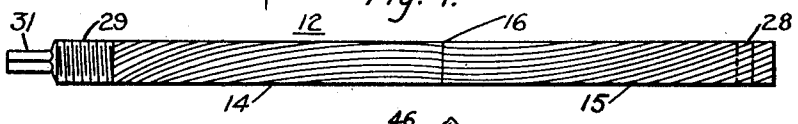
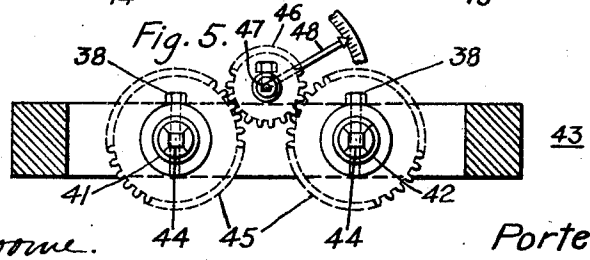


Fig. 5.



WITNESSES:

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Patented Dec. 18, 1928. 1,695,877

UNITED STATES PATENT OFFICE.

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TEMPERATURE-RESPONSIVE DEVICE.

Application filed December 17, 1925. Serial No. 76,133.

My invention relates to temperature responsive devices and particularly to devices that are dependent upon the respective temperature coefficients of the elastic moduli of the elements constituting such devices.

An object of my invention is to provide a temperature responsive device that shall be operable in accordance with the internal stress variations in response to temperature variations and to external stresses applied thereto.

In practicing my invention, I provide, in general, a compound bar comprising a plurality of elemental bars joined end-to-end. I provide an arm member that is preferably located concentrically with the bar member at one of its ends and I provide also a frame in which the compound bar member is positioned. The compound bar member is fixedly mounted at one end and adjustably mounted at the other end. I provide means at the adjustable end for applying a twisting force or an external torque thereto in order that the bar shall be under a twisting strain in its operable position. I provide an electrical contact member on the movable arm which is mounted on the compound bar and another contact member that is mounted on the frame of the temperature responsive device. The contact members are so disposed that when the bar has turned sufficiently, the contact members will engage to control an electric circuit.

In the accompanying drawings,

Figure 1 is a plan view of a thermal responsive device embodying my invention,

Fig. 2 is a view in section of the device illustrated in Fig. 1 taken along the line II—II,

Fig. 3 is a view in section of the device illustrated in Fig. 1 taken along the line III—III,

Fig. 4 is a view of a compound bar member employed in the device illustrated in Fig. 1, and

Fig. 5 is a modification of the device illustrated in Figs. 1, 2 and 3.

Referring more particularly to Fig. 1, a temperature responsive device 11 comprises a compound bar member 12 and a frame 13. The compound bar member 12 comprises a bar 14 of a desired metal and a bar 15 of a different metal or alloy, the said bars 14 and 15 being joined end-to-end at 16, preferably by welding. The bar 14 may be of aluminum and the bar 15 of an alloy of Ni., Cr., and iron.

It is to be understood that the bars 14 and 15 may be made of other metals and alloys than those specified above, it being essential that the moduli of elasticity of the respective bars employed be different and that the rate of change in the modulus of elasticity of one bar with respect to the other be greater per degree change in temperature thereof. The rate of change in the elastic modulus of elasticity per degree change in temperature may be denominated as the temperature coefficient of elastic modulus.

The frame 13 comprises in general, a plurality of side members 18, 19, 20 and 21 that enclose a comparatively large rectangular opening 22. The sides 18 and 21 have openings 23 and 24, respectively, located in substantially the central portion of the respective sides mentioned. A pin hole 25 is provided in the side 21 and a similar hole 26 having screw threads 27 located therein is provided in the side 18.

The compound bar member has a pin hole 28 located at the end of the portion 15 of the compound bar 12. The end of the portion 14 of the compound bar 12 is provided with a threaded portion 29 and a square end portion 31. A nut member 32 is provided to register with the threaded portion 29 of the portion 14 of the compound bar 12. The bar 12 is also provided with a contact arm 33 which is preferably shrunk on the bar member 12 at the welded junction 16. An adjustable contact screw 34 is provided at the free end 35 of the contact arm 33 and is insulated from the contact arm 33. A stationary contact member 36 is provided on the frame 13 and is insulated therefrom. The contact member 36 is suitably located on the side 19 of the frame 13 in order that, when the contact arm 33 is turned, the contact members 34 and 36 will engage to complete an electric circuit 37.

The compound bar member 12 is located in the holes 23 and 24 of the frame 13. A pin member 38 is provided that registers with the coaxial holes 28 and 25 of the frame side 21 and the bar portion 15 of the compound bar member 12. The threaded end of the portion 14 of the compound bar 12 is suitably located in the frame 13 as illustrated in Fig. 1 in order that a suitable lever (not shown) may be applied to the portion

31, whereby the bar 12 may be twisted in such direction that the contact members 35 and 36 will be disengaged. The nut 32 is then advanced on the threaded portion 29, sufficiently against the member 18 to hold the compound bar 12 in its twisted position. To further secure the bar 12 in its twisted position, I provide a set screw 39 that registers with a threaded portion 30 of the hole 26 and engages the bar member 14.

In Fig. 5, I have shown a modification of the device illustrated in Fig. 1. I have provided in this modified form of my device a pair of compound bar members 41 and 42 that are similar to the compound bar 12 illustrated in Figs. 1 to 4. The frame structure 43 is substantially the same as the frame 13 illustrated in Fig. 1. The compound bars 41 and 42 are held at the fixed end by pin members 38, the same as are used in holding the fixed end of the bar 12 illustrated in Fig. 1. The torque end of the bars 41 and 42 are provided with square end portions 44 similar to the square portion 31 of the bar 12. I also provide a pair of gear wheels 45 which are firmly secured to the center of the bars 41 and 42 in substantially the same position as the contact arm member 33 is located on the compound bar 12 of Figs. 1, 2 and 3. I also provide a pinion 46 that is mounted on a shaft 47 which is free to turn in bearings provided therefor. An indicating member 48 is attached to the shaft 47 for indicating any movement thereof on a suitable scale. The number of teeth in the gear wheels 45 is preferably much larger than that of the teeth in the pinion 46 in order that any turning motion of the bars 41 and 42 may be multiplied many times to produce a relatively large movement of the pointer 48. In order that the bars 41 and 42 will both impart the same direction of motion to the pinion 46, they must, therefore, be twisted in the same direction. If the desired external torque has been applied to the square portions 44 of the bars 41 and 42, the bars may then be held in their twisted position by screw members (not shown) that correspond with the screw member 39 illustrated in Fig. 1.

As previously mentioned herein, the bar 14 of the compound bar 12 may be of such material as aluminum, and the bar 15 of an alloy containing 22% Ni., 3% Cr. and iron, although minor quantities of other metals and impurities may be added if so desired.

The modulus of elasticity of the bar 14, being of aluminum, is different from that of the bar 15, it being an alloy having preferably a higher modulus of elasticity. If the temperature of the bar 14 is increased its modulus of elasticity decreases, but at a higher rate than the rate of decrease in the modulus of elasticity of the bar 15 for corresponding increases in temperature.

The compound bar 12 is twisted a predetermined amount by applying a twisting or turning force to the portion 31 thereof. Thus, the members or bars 14 and 15 are subjected to a torsional stress that is distributed throughout their lengths.

The operation of my device is substantially as follows: The temperature responsive device 11 is located within a body or chamber, the temperature of which is to be regulated. If the temperature of the twisted bar 12 is increased to a predetermined value, the elastic modulus of elasticity of the bar 15 will decrease more rapidly than that of the bar 14, and, since the torsional stress at all points of the bar 12 must remain equal, the bar 15 will be twisted in a direction that tends to increase the torsional stresses therein. Therefore, the bar 14 will twist or turn correspondingly in a direction that tends to decrease the torsional stresses to which it is subjected. Thus, the bars 14 and 15 will twist or turn together to such a position that the torsional stresses existing in the compound bar 12 have again become stabilized and uniform throughout its length. The twisting of the bar to the above position is utilized to move the contact 34 carried by the arm 33 into engagement with the stationary contact 36, thereby energizing the electric circuit 37.

If the temperature of the compound bar is reduced to a value below that referred to above, the elastic moduli of the respective bars 14 and 15 will increase but at unequal rates, thus effecting a turning or twisting of the compound bar 12 to such a position that the arm 33 is actuated to cause disengagement of the contact 34 from its cooperating contact 36, thereby deenergizing the electric circuit 37. It may be assumed that a source of heat, to which the compound bar 12 is subjected, is deenergized when the contact members 34 and 36 are in engagement, and reenergized when the said contact members are out of engagement with each other.

The temperature difference required for the operation of my device may be made relatively small by making the ratio, $\left(\frac{L}{D}\right)$, of length to diameter of the bar 12, large.

In Figs. 1, 2 and 3, I have shown the temperature responsive device as controlling an electric circuit but obviously the device need not necessarily control an electric circuit for it may be used as an indicating device as illustrated in Fig. 5 or it may be used for actuating, in general, any suitable device.

Various modifications may be made without departing from the spirit and the scope of my invention. I, therefore, desire that only such limitations shall be placed thereon as are imposed by the prior art.

I claim as my invention:

1. In a temperature responsive device, in combination, actuable means, a bimetal mem-

ber disposed to actuate said actuable means, means for applying a predetermined torque to said bimetal member, said bimetal member being responsive to said torque upon changes in temperature thereof to cause a twisting action for actuating said actuable means.

2. In a temperature responsive device, in combination, actuable means, a bimetal member, means for applying a torque of a predetermined value to said bimetal member, said bimetal member being responsive to said torque upon changes in temperature thereof to cause a twisting action, and means associated with said bimetal member adapted to utilize said turning action for actuating said actuable means.

3. In a temperature responsive device, in combination, actuable means, and means comprising a bimetal member, the individual metals of which have a definite ratio of elastic modulus at a predetermined temperature, means for applying a torque of a predetermined value to said bimetal member, said bimetal member being responsive to said torque to cause a twisting action thereof for actuating said actuable means upon a change in said ratio of elastic modulus effected by a change in said predetermined temperature.

4. A temperature responsive device comprising alined members, joined at their ends only, and means for applying a torsional force thereto, said members being adapted to yield in response to said force in accordance with variations in the ratio of the elastic moduli of said members when subjected to temperature variations.

5. A temperature responsive device comprising a plurality of bars, having different moduli of elasticity, joined end to end, means for holding one end fixed and means for applying a predetermined torque to the other end thereof, said plurality of bars being actuated in accordance with variations in said moduli of elasticity in response to temperature variations.

6. A temperature responsive device comprising a plurality of parallel compound bar members, corresponding elements of each bar member having the same moduli of elasticity and the elements of each bar member having different moduli of elasticity, means for holding one end of each of said bar members fixed and means for applying a predetermined torque to the other ends thereof, said compound bar members being actuated in accordance with the torque applied thereto and the variations in the moduli of elasticity of said bar members in response to temperature variations.

7. In a temperature responsive device, in combination, actuated means, a pair of parallel compound bars, each of said bars having a pair of elements joined end to end, the elements thereof having different temperature coefficients of elastic moduli, means for holding said compound parallel bars in a twisted position, said bars being adapted to turn towards an untwisted position upon changes in the elastic moduli thereof in response to temperature variations, and means associated with said bars for multiplying the untwisting motion thereof for actuating said actuated means.

8. In a temperature responsive device comprising a pair of parallel compound bars, each of said bars having a pair of bars joined end to end, said bars having different temperature coefficients of elastic moduli, means for applying a torque to said bars and for holding the same under the stress thereof, said bars being adapted to turn in accordance with changes in the elastic moduli thereof in response to temperature variations and to the torque applied thereto, and means associated therewith for multiplying said turning motion.

9. A temperature responsive device comprising a pair of parallel compound bars, each of said bars having a pair of bars joined end to end having a gear mounted on each of said compound bars, said bars having different temperature coefficients of elastic moduli, and a pinion pivotally mounted in common relation to said gears for multiplying the turning motion of said compound bars.

10. In a temperature-responsive device, in combination, a metallic rod, and means for applying a torsional force to said rod, said torsional force being effective to cause said rod to twist in accordance with changes in the elastic modulus thereof responsive to changes in temperature.

In testimony whereof, I have hereunto subscribed my name this 7th day of December, 1925.

PORTER H. BRACE.