Aug. 20, 1957 W. A. RAY 2,803,495

BI-METAL CONTROL

Filed Jan. 11, 1955

Fig. 1.

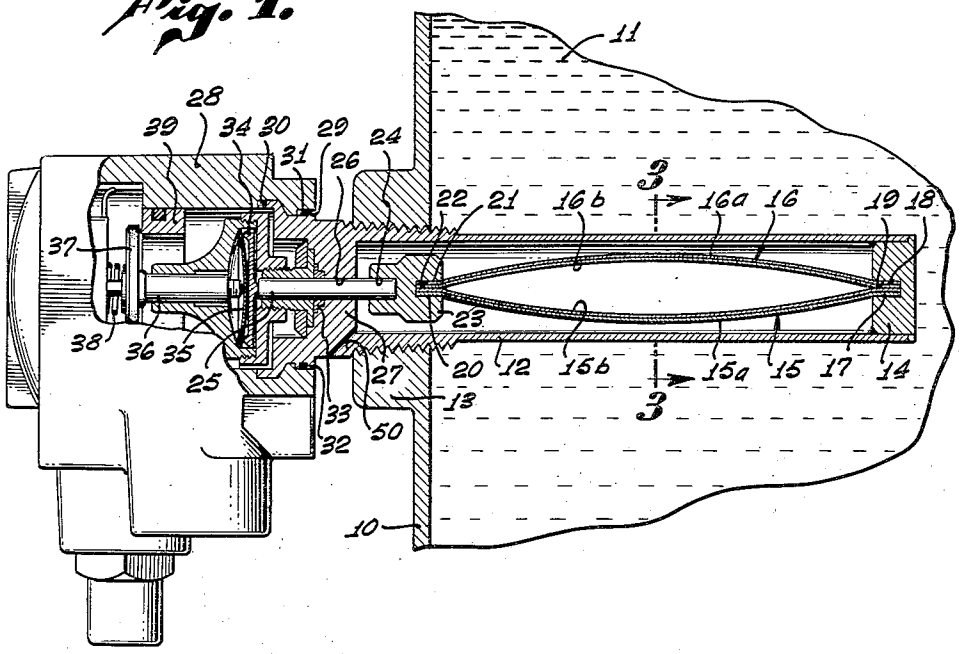


Fig. 2.

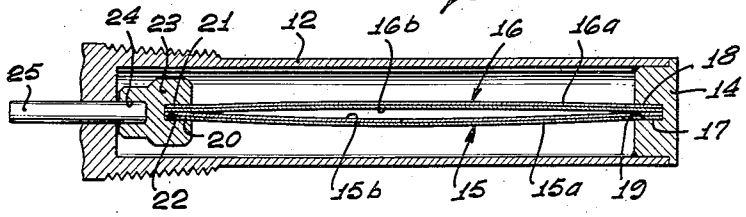
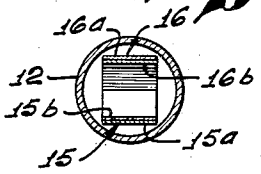


Fig. 3.



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BI-METAL CONTROL

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1 Claim. (Cl. 297—12)

This invention relates to a thermally responsive mechanical operator cooperable with a liquid container, such as a tank, for opening and closing fuel valves or the like.

In operators of this character, it has been common to provide two members, a tube projecting into the boiler and a rod in the tube having its inner end affixed to the inner end of the tube, and its outer end connected to the valve closure. The material of the tube has a coefficient of expansion different from that of the rod. The differential expansion or contraction provides small movement necessary to operate the valve or other device for controlling the intensity of heating, in accordance with the temperature of the medium.

Expensive materials having very low coefficient of thermal expansion are commonly used. But even with such special materials, long tubes and rods are still required in order to realize sufficient movement of the mechanism.

It is an object of this invention to provide a thermal control mechanism which achieves a materially greater thermal movement of the mechanism per unit length thereof than has been achieved by prior devices. This is made possible by an arrangement in which one composite member of the mechanism is foreshortened by thermal expansion of its parts, and the other member in the usual manner elongates upon thermal expansion. Furthermore, the composite member itself achieves a range of movement very much greater than that due to simple thermal expansion. This is achieved by an arrangement of parts to be hereinafter described. In this organization the thermal changes in lengths of the elements are additive, achieving substantial movement of the device.

It is another object of this invention to provide a simple inexpensive device of this character in which the use of expensive materials is minimized.

It is another object of this invention to make it possible to provide a thermal control mechanism that is more compact than heretofore has been possible, all without sacrifice of operating characteristics.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the invention. For this purpose, there is shown a form in the drawings accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claim.

Referring to the drawings:

Figure 1 is a longitudinal sectional view of a thermal control unit embodying the present invention, shown in cooperation with a water heater tank and a fuel valve;

Fig. 2 is a fragmentary sectional view of the unit, showing an alternate position; and

Fig. 3 is a transverse sectional view, taken along the plane indicated by line 3—3 of Fig. 1.

In Fig. 1 there is shown a fragment of a water heater

tank containing a body of water **11**. The usual shell and the insulation between the tank and shell are not shown.

A tubular member **12** projects into the tank **10**, having a substantial portion of its exterior surface exposed to the water **11** in the tank. The left-hand outer end of the tubular member **12**, as viewed in Fig. 2, is exteriorly threaded for cooperation with a thickened portion **13** of the wall of the tank **10**.

A plug **14** closes the otherwise open right-hand inner end of the tubular member **12** and supports a pair of elongate flexible bimetal strips **15** and **16** in the tubular member **12**. For this purpose, corresponding ends **17** and **18** of the bimetal strips are together received in a rectangular recess or slot **19** formed in the inner surface of the plug **14**. The bimetal strips **15** and **16** extend longitudinally of the tubular member **12** and have their other corresponding ends **20** and **21** held together and received in a rectangular recess or slot **22** of a movable support **23**.

The movable support **23** on the opposite side of the bimetal strips **15** and **16** has a circular recess **24** mounting a rod **25** for operating a valve mechanism. The rod **25** is guidingly accommodated in a through aperture **26** of an inwardly directed flange **27** formed adjacent the left-hand outer end of the tubular member **12**.

The bimetal strips **15** and **16** are symmetrically disposed about a plane extending through the axis of the tubular member **12**, the flat surfaces of the strips opposing each other. The outer elements **15***a* and **16***a* of the bimetal strips **15** and **16** are respectively of a material having a higher coefficient of thermal expansion than the inner elements **15***b* and **16***b*. The elements of each bimetal strip **15** and **16** are welded or otherwise firmly secured together.

For a certain relatively low temperature, the bimetal elements of each strip **15** and **16** are flat. Upon a rise in temperature, the strips assume an arcuate or bowed configuration due to different stresses in the elements of the strips caused by their interconnection and different coefficients of thermal expansion. The extent of bowing is dependent upon the flexibility of the strips, which is sufficiently large to permit substantial bowing. The strips **15** and **16** bow in opposite outward directions, those elements **15***a* and **16***a* having the higher coefficient of thermal expansion being outermost.

The outer ends **20** and **21** of the strips normally tend to move arcuately, but are prevented from doing so since they are held together by the support **23**; and, since the strips **15** and **16** are symmetrically disposed, the forces exerted by the strips in a direction normal to the plane of symmetry counterbalance each other.

The difference in the coefficients of expansion between the elements of each strip is sufficiently large with respect to other physical constants of the elements, to cause the ends **20** and **21** to move toward and away from the fixed ends **17** and **18** in accordance respectively with a rise or fall in temperature. The stress differences are sufficiently great to produce columnar type strain, in an axial direction, more than counterbalancing elongation due to thermal expansion. Furthermore, by appropriately designing the strips, the per unit columnar type shortening and corresponding elongation may be many times greater than that due to simple rectilinear thermal expansion and contraction of a bar. The strips together thus may provide a very substantial per unit movement.

Accordingly, upon an increase in temperature, the strips **15** and **16** bow to a greater extent and move the ends **20** and **21** of the strips toward the inner end of the tubular member **12**. Also, the tubular member **12** expands upon an increase in temperature, carrying the plug **14** and the bimetal strips **15** and **16** toward the right, as

viewed in Fig. 1. These effects add together to move the operating rod 25 toward the inner end of the tubular member. The contribution due to the bowing of the strips 15 and 16 may be many times greater than that due to the tubular member 12. Similarly, upon a decrease in temperature, the thermal effects of the strips 15 and 16 and the tubular member 12 add together to move the rod 25 in the other direction.

The strips 15 and 16 are bowed more or less throughout the operating temperature range of the apparatus.

In Fig. 1 the thermal control unit is subjected to a high temperature, causing the bimetal strips 15 and 16 to bow outwardly. The rod 25 is moved inwardly.

In the position shown in Fig. 2, the unit is subjected to a lower temperature, causing the bimetal strips 15 and 16 to be bowed only to a small extent. The rod 25 is moved outwardly.

The left-hand end of the support 23 has sufficient clearance with respect to the inwardly directed flange 27 of the tubular member 12 as to permit appropriate axial movement of the rod 25. The diameter of the tubular member 12 is sufficiently large to permit substantial bowing of the strips. The interior of tube 12 is vented, as indicated by vent 50.

The movement of the rod 25 is availed of to operate a valve structure located within a hollow split valve casing 28. The valve casing 28 has a valve chamber opening outwardly of the body at 29. The flanged end of the tubular member 12 fits in correspondingly shaped grooves 30 at the valve body opening 29. The tubular member is assembled with the casing 28 by closing the split casing about the flanged end of the tubular member. The end of the tubular member 12 effectively closes and defines the chamber formed in the valve body 28.

An O-ring 31, carried between peripheral spaced flanges 32 of the tubular member 12, cooperates with a cylindrical surface of the body opening 29 to ensure a sealing relationship. Suitable sealing means 33 prevents undesired passage of fluid between the rod 25 and the aperture 26 of the inwardly directed flange 27.

The rod 25 cooperates at its outer end with an actuator 34 which, in turn, cooperates with a snap disc 35 engageable with the stem 36 carrying a closure structure 37. A compression spring 38, the tension of which may be adjusted, urges the closure 37 toward seating position with respect to a seat-forming member 39 and, through the

stem 36, moves the disc to the position shown in Fig. 1 upon withdrawal of the rod 25. The valve structure shown in the present instance is by way of example only, as numerous other forms of snap action valves can be operated to open and close by movement of rod 25 respectively toward the left and toward the right.

By the aid of the present apparatus, a substantial movement of the rod 25 is achieved per unit length of the tubular member 12. This is made possible by virtue of the additive relationship between the thermal properties of the tubular member itself and the bimetal strips 15 and 16. Conveniently, the thermal control unit may be sufficiently short to be compactly accommodated in boiler structures having only limited space, such as due to flue tubes from the fire box, to accommodate the thermal unit.

The inventor claims:

In apparatus of the character described: an elongate tubular member having exterior threads adjacent one end, the other end being open; the tubular member being made of material having a high temperature coefficient of expansion; a thermally conductive plug closing the open end of the member, and exposed exteriorly of the member, said plug having an inner surface provided with a slot; a pair of strips each comprising elements having different coefficients of thermal expansion, corresponding first ends of the strips being fitted in the slot of said plug, the strips extending symmetrically and longitudinally toward said one end of said member; the strips having surfaces opposing each other; those elements of the respective strips having like coefficients of expansion being located correspondingly with respect to the plane of symmetry; and a load actuator at said one end of said member and having a surface provided with a slot, the corresponding other ends of the strips being fitted in the slot of said actuator for connecting the actuator to the strips, the actuator confining the said corresponding other ends of the strips for movement together.

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