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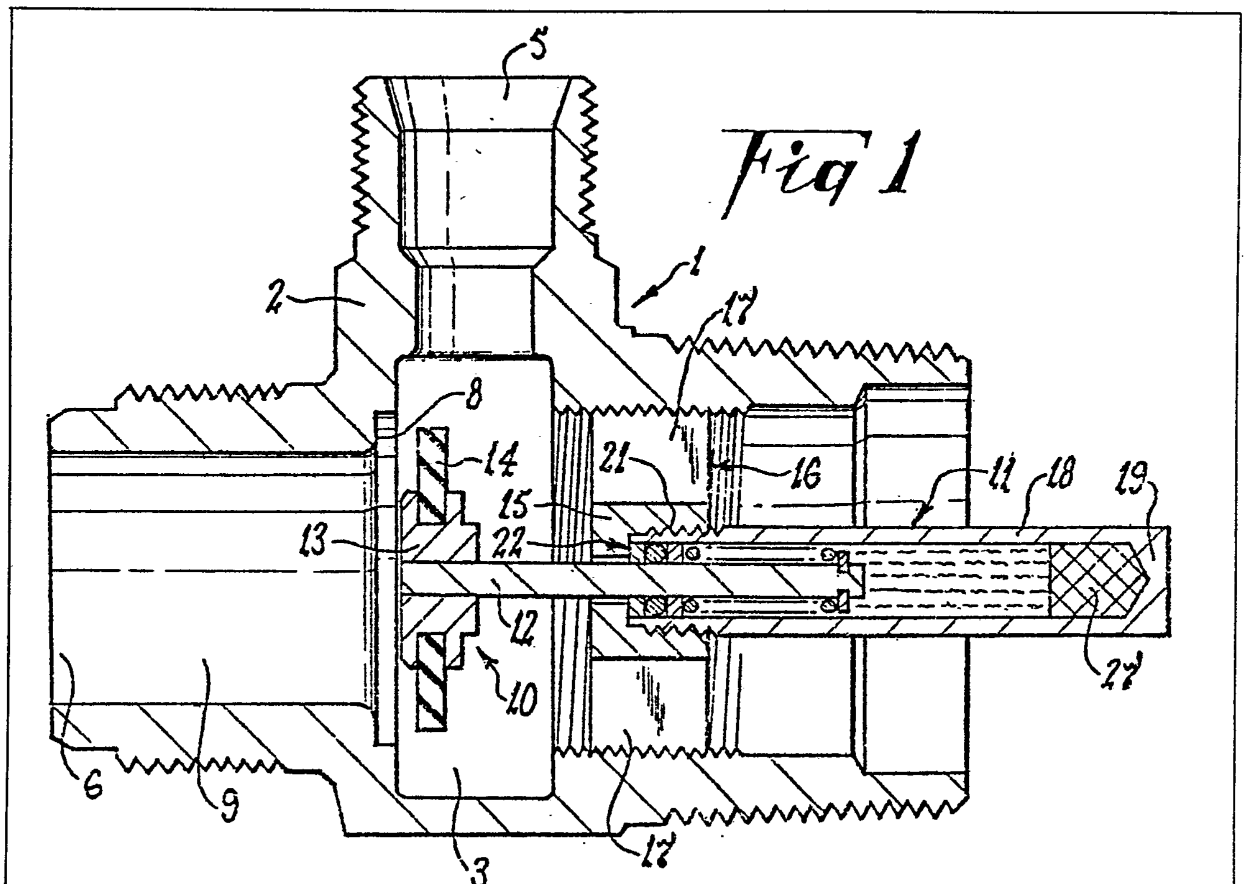
(54) Valve and system incorporating same

(57) A temperature-responsive valve for use in a fluid circulating loop of a solar water heating system includes a body (1) having a primary inlet (4) and a secondary inlet (5) which are in continual communication through a chamber (3) within the body (1). An outlet (6) communicates with the chamber (3) through a valve orifice (8) and a valve member (10) is movably mounted within the body (1) to open and close the orifice (8). A temperature-responsive probe (11) extends through the primary inlet (4) and is connected to the valve member (10) to cause opening and closing of the orifice (8) according to the water temperature at the primary inlet (4). When the valve is installed in a solar water heating system, the primary inlet (4) is connected to a water storage container (34), the secondary inlet (5) is connected to a water supply and the outlet (6) is connected to the solar heating panel (36).



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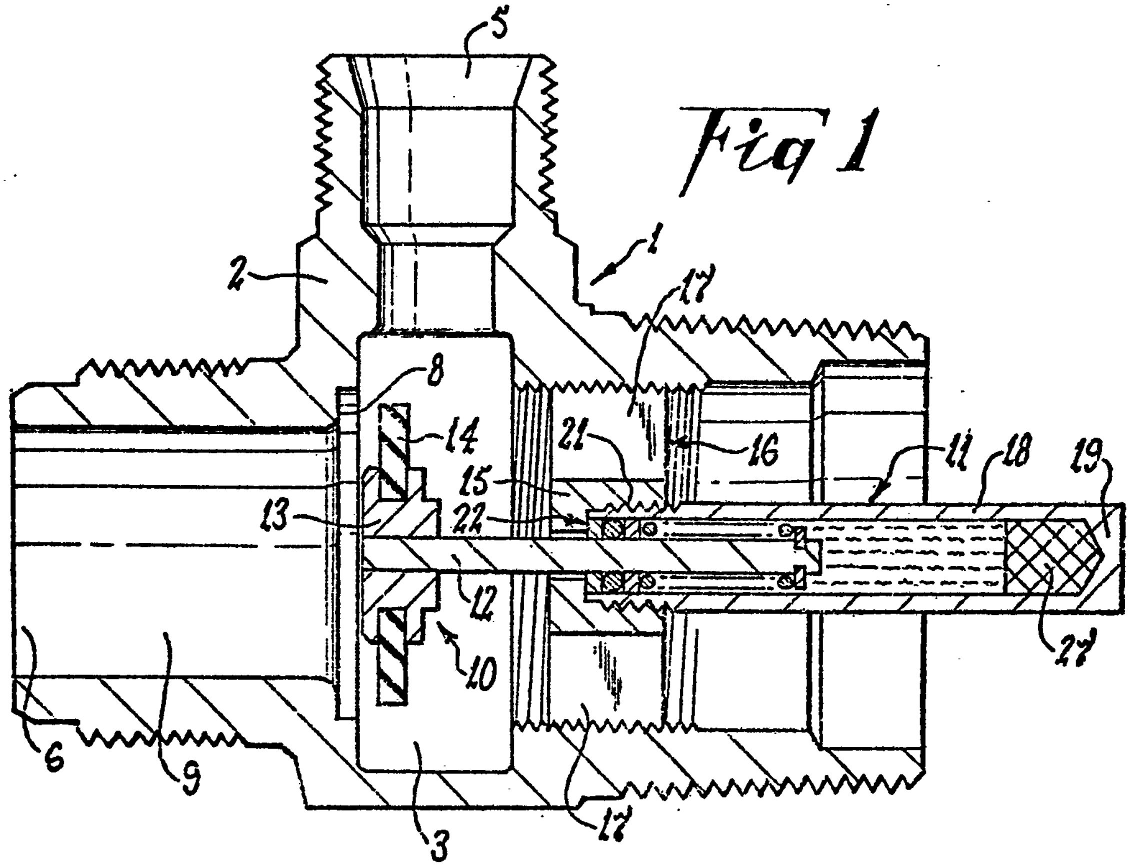

Fig 1

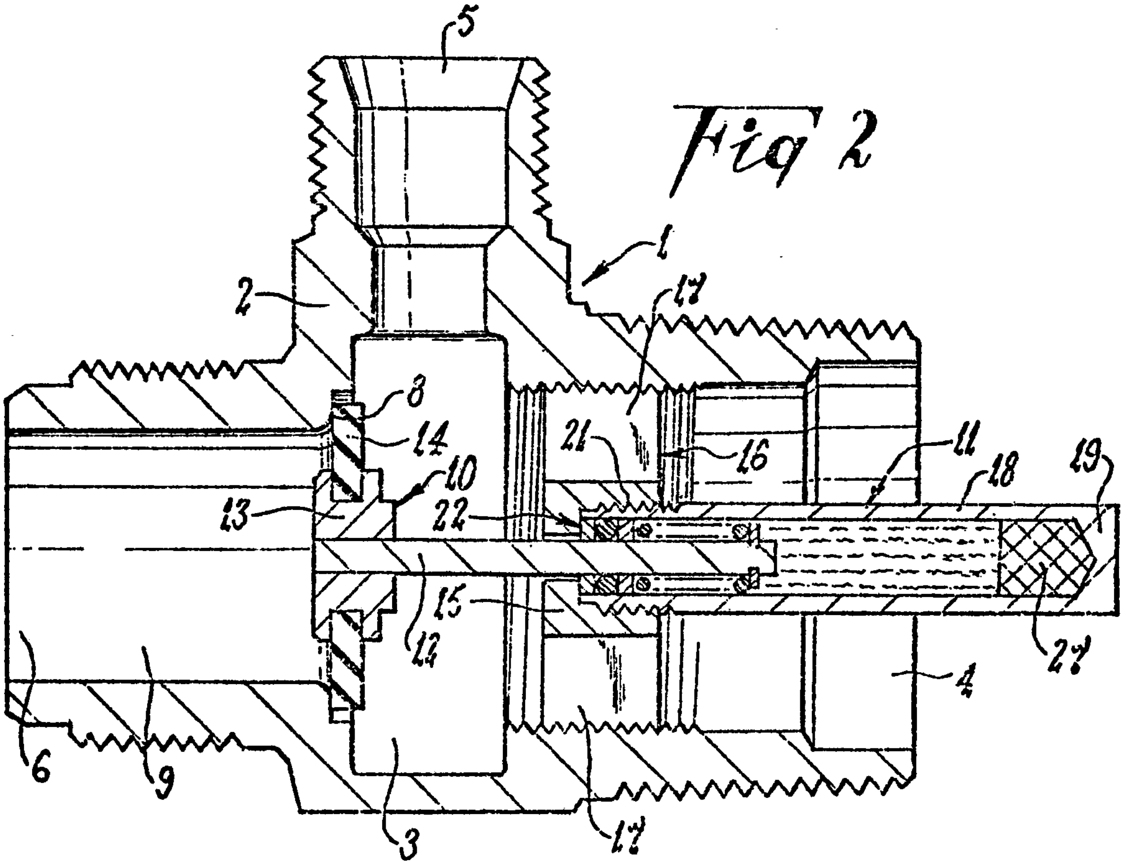

Fig 2

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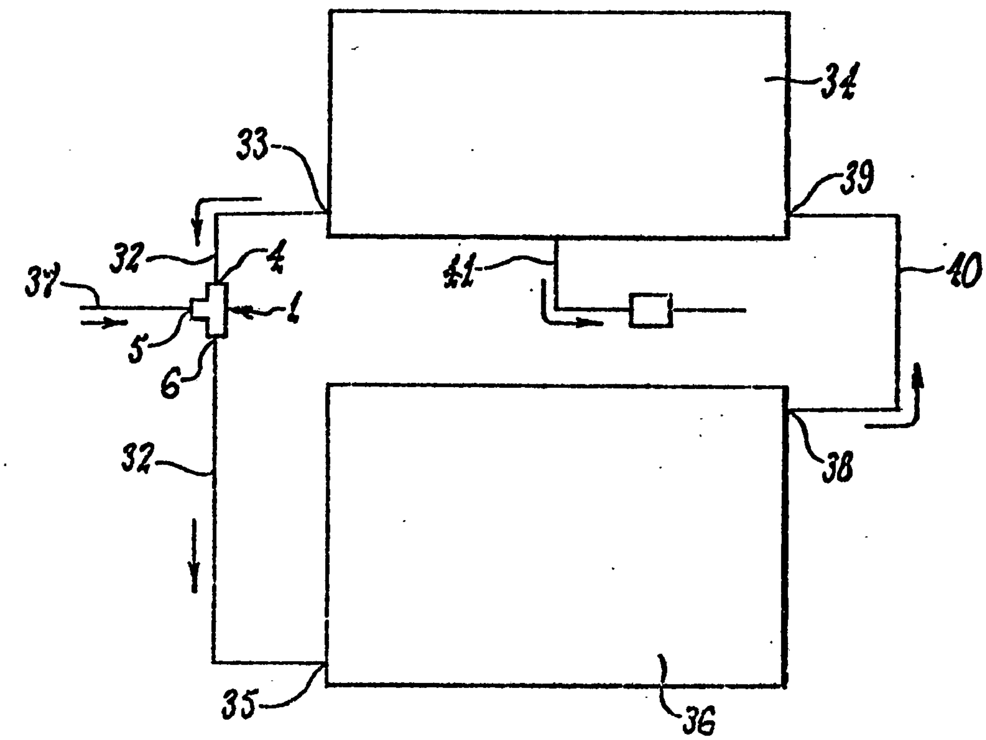

Fig 3

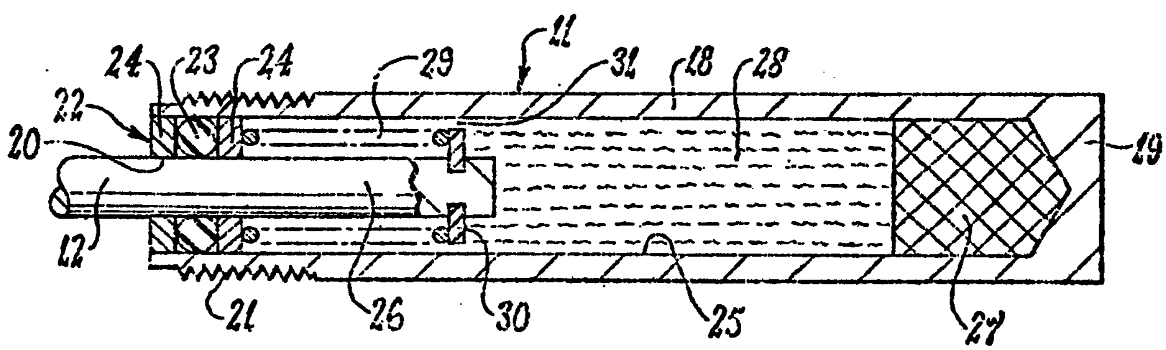

Fig 4

SPECIFICATION

Valve and system incorporating same

This invention relates to a valve for closing a fluid circulating loop in response to fluid temperature rising to a predetermined level. The invention is also concerned with a fluid heating system of the type having a fluid circulating loop which can be tapped to draw off fluid and means whereby fluid can be replaced from an external source.

The valve has been particularly designed for use in a thermo-syphon water heating system in which water circulates by convection, but it is not limited to that use. Such a water heating system includes a solar heating panel and a storage tank located at a higher level that the heating panel and connected to the upper end of the heating panel to receive heated water therefrom. A feedback line is also connected between the storage tank and the lower end of the heating panel so that water can circulate throughout the system by convection. In such a system water can be drawn from the storage tank and a source of replenishment water is connected to the system, usually by way of the aforementioned feedback line. Problems may arise in such a system if the water in the storage tank exceeds a predetermined temperature and that may occur if heated water is continually being introduced into the storage tank from the heating panel under the convection flow.

Accordingly, it is an object of the present invention to provide a valve for closing a fluid circulating loop in response to the fluid temperature rising to a predetermined level. It is a further object of the invention to provide an improved fluid heating system which includes such a valve.

Although the valve according to the present invention will be hereinafter particularly described in use in a hot water system it will be appreciated that the valve may be used in other situations where it is desirable to stop flow if the fluid temperature rises to the predetermined level.

According to one aspect of the present invention, there is provided a temperature responsive valve including, a hollow body, a chamber defined within said body, a primary inlet port and a secondary inlet port, each communicating with said chamber so as to be in continual communication with one another, an orifice within said chamber, an outlet port communicating with said chamber through said orifice, a valve member mounted within said body for movement towards and away from a position at which it closes said orifice, and a temperature responsive means connected to said valve member and being operative to control said movement thereof, said temperature responsive means being located within or adjacent said primary inlet port.

According to a further aspect of the present invention, there is provided a fluid heating system including, a storage container, a fluid circulating loop having opposite ends respectively connected to an outlet and an inlet of said container, fluid heating means within said loop, means for drawing fluid from said container and/or said loop, a valve as described above connected into said loop between said heating means and said container outlet, said primary inlet port being connected to said container outlet, said outlet port being connected to that part of said loop leading to said heating means, and a source of said fluid connected to said secondary inlet port.

According to yet another aspect of the invention there is provided a temperature responsive element including, a tubular body closed at one end and having an opening at the opposite end thereof, sealing means defining said opening, a rod projecting into the bore of said body through said opening and slideably engaging said sealing means, said rod having a cross sectional size substantially less than that of said bore, a temperature responsive medium within said body adjacent said closed end thereof, and a body of flowable material between said medium and said sealing means.

The essential features of the invention, and further optional features, are described in detail in the following passages of the specification which refer to the accompanying drawings. The drawings however, are merely illustrative of how the invention might be put into effect, so that the specific form and arrangement of the features (whether they be essential or optional features) shown is not to be understood as limiting on the invention.

In the drawings:

Figure 1 is a cross sectional view of one form of valve incorporating an embodiment of the invention;

Figure 2 is a view similar to Figure 1 but showing the valve in a closed condition;

Figure 3 is a diagrammatic illustration of a fluid heating system according to one embodiment of the invention;

Figure 4 is an enlarged cross sectional view of the temperature responsive element shown in Figure 1.

The valve 1 includes a hollow body 2 having a chamber 3 defined therein. A primary inlet port 4 and a secondary inlet port 5 both communicate with the chamber 3 and in the preferred arrangement shown are arranged at substantially 90° relative to one another. Such a relationship however, is not essential. An outlet port 6 is also provided in the body 2, but that communicates with the chamber 3 by way of an orifice 7 having a valve seat 8 formed thereabouts. A passage 9 between the port 6 and orifice 7 constitutes a main circulating passage in that it forms part of the connection between the primary inlet port 4 and the outlet port 6. It is preferred that the primary inlet port 4 and the outlet port 6 are in substantial alignment as shown.

The valve 1 also includes temperature responsive means arranged to close the main circulating passage 9 in response to the temperature of the fluid flowing through the valve 1 rising to a predetermined level. The temperature responsive means includes a valve member 10 mounted in the body 2 for movement towards and away from the valve seat 8, and a temperature responsive element 11 connected to the valve member 10 and being operative to cause that movement of the valve member 10. The valve member 10 is preferably constructed as shown having an elongate stem 12, an enlarged head portion 13 secured to an end of that stem 12 and a resilient element 14 carried by the head portion 13 so as to be engageable with the valve seat 8 (Figure 2). The stem 12 slideably passes through a boss 15 forming part of a mounting member 16 which is located between the primary inlet port 4 and the orifice 7. The member 16 has passages 17 through which the inlet port 4 communicates with the orifice 7 and the secondary inlet port 5.

The temperature responsive element 11 includes an elongate tubular body 18 closed at one end 19 and having an opening 20 at its opposite end 21. The opening 20 is preferably defined by sealing means 22 as best shown in Figure 4, comprising a resilient O-ring 23 interposed between two annular supports 24 which may be made of PTFE or any other suitable material. It is preferred that the annular supports 24 slideably engage the stem to enhance the sealing effect. The end 21 of the tubular body 18 is attached to the mounting member boss 15 by a screw thread or other means so that the body 18 is substantially coaxial with the orifice 7. As shown, the valve stem 12 preferably extends into the bore 25 of the body 18 and slideably engages with the seal 22 so that its terminal end portion 26 in effect constitutes a piston of the temperature responsive element 11. A body 27 of a temperature responsive medium such as wax, which expands with increase in temperature, is located within the bore 25 at the closed end 19 of the body 18. A body 28 of suitable liquid or other flowable material fills the remainder of the bore 25.

Spring means preferaby urges the valve member 10 away from the valve seat 8 and in the construction shown that means includes a coil compression spring 29 which surrounds the stem portion 26 and act between the seal 22 and a flange 30 releasably connected to the stem 12 near its terminal end. As best shown in Figure 4, a clearance space 31 exists between the periphery of the flange 30 and the surface of the coil 25. It is preferred that the stem 12 has a diameter substantially less than that of the bore 25 for a reason hereinafter made clear. The spring 29 may have an added function of pressing the adjacent annular support 24 against O-ring 23 so as to compress it axially and thereby improve the sealing effect.

With the arrangement shown, the temperature responsive element is located adjacent to and in fact projects through the primary inlet port 4. As a consequence, the element 11 responds to the temperature of fluid entering the valve 1 through the port 4. When the fluid temperature reaches the predetermined level, the wax body 27 expands to push the stem 12 outwards by a sufficient amount for the valve element 14 to engage the valve seat 8 as shown in figure 2. The orifice 7 is thereby closed so preventing fluid flow from chamber 3 into the passage 9.

Because of the size differential between the cross-sections of the stem 12 and the bore 25, the stem 12 tends to magnify the expansion or contraction of the wax body 27. That is, the stem 12 must move to compensate for changes in the volume of the body 27 and the change in displaced volume of the stem — i.e., the volume of liquid 28 displaced by the stem 12 — must be the same as the change in actual volume of the body 27. In view of the smaller cross sectional size of the stem 12 it must then move through a greater distance than the wax body 27 during any such change of volume. That magnifying effect is a valuable advantage in installations requiring sensitive response to temperature changes. For example, a valve as shown may move from the fully open position to the fully closed position in a temperature range of approximately 4°C.

The secondary inlet port 5 is located upstream of the orifice 7 so that its communication with the inlet 4 is not effected by closure of the main circulating passage 9.

Figure 3 shows a water heating system which might usefully incorporate a valve as described above. In that example arrangement, the valve 1 is installed in the water feedback line 32 which extends from an outlet 33 of a storage container 34 to an inlet 35 of a solar heating panel 36. The primary inlet 4 of the valve 1 is connected to the container outlet 33 and the valve outlet 6 is connected to the panel inlet 35. A source of water is connected to the secondary inlet 5 of the valve 1 through the make-up line 37. An outlet 38 of the panel 36 is connected by way of line 40 to an inlet 39 of the container 34 and water may be drawn from the system through a take-off line 41 connected to the container 34. The feed-back line 32, panel 36 and line 40 constitute a water circulating loop of the system.

When the temperature of the water within the system reaches the predetermined level, the element 11 will function to cause the orifice 7 to be closed thereby preventing further circulation of water through the loop 32, 36 and 40. If water is then tapped from the system through line 41, replenishment water will flow into the valve 1 by way of line 37 and will pass through the inlet 4 to enter the container 34 through the outlet 33. As a consequence the replenishment water, which is relatively cool, will flow over the temperature responsive element 11 and cause it to cool sufficiently to lift the valve member 10 from the valve seat 8 and thereby enable some flow through the loop 32, 36 and 40 under convective force. The convective force is relatively weak however, and the panel 36 provides greater resistance to flow than does the section of the feed-back line 32 adjacent to the cointainer 34. Consequently most of the replenishment water will continue to flow out of the valve 1 through the inlet port 4 and the remainder will leave by way of the outlet port 6. Cessation of tapping through line 41 will enable convective flow to predominate so allowing the loop 32, 36 and 40 to operate normally. The valve orifice 7 will remain open until feed-back water from the container 34 again rises to the predetermined temperature.

A valve according to the present invention may be used in a system of the kind disclosed in Australian patent application 74447/81 and that disclosure is to be understood as being imparted into the present specification by cross-reference. Such a system would then combine the fluid high temperature closing function as herein described with a low temperature closing function and a low temperature drainage function.

It will be clear from the foregoing description that the present invention provides a simple yet effective valve for guarding against overheating of a fluid system. The valve particularly described is sensitive to small temperature changes and is therefore ideally suited for solar water heating systems.

Finally, it is to be understood that various alterations, modifications and/or additions may be introduced into the constructions and arrangements of parts previously described without departing from the spirit or ambit of the invention as defined by the appended claims.

CLAIMS

1. A temperature responsive valve including, a hollow body, a chamber defined within said body, a primary inlet port and a secondary inlet port, each communicating with said chamber so as to be in continual communication with one another, an orifice within said chamber, an outlet port communicating with said chamber through said orifice, a valve member mounted within said body for movement towards and away from a position at which it closes said orifice, and a temperature responsive means connected to said valve member and being operative to control said movement thereof, said temperature responsive means being located within or adjacent said primary inlet port.

2. A valve according to Claim 1, wherein said primary inlet port and said outlet port are in substantial alignment.

3. A valve according to Claim 1 or 2, wherein the valve seat surrounds said orifice, and said valve member includes a resilient element which is engageable with said valve seat to close said orifice and a stem to which said resiliant element is connected and which is arranged substantially co-axial with said orifice.

4. A valve according to Claim 3, wherein said temperature responsive means includes a cylindrical tubular body, a piston mounted within said body for movement longitudinally thereof, and a temperature responsive medium which expands and contracts in response to temperature variations, said stem is connected to or forms said piston, and spring means urges said valve member away from the orifice closed position.

5. A valve according to Claim 4, wherein said stem forms said piston and projects into said tubular body through an opening in one end thereof, said one end is attached to a mounting member having at least one passageway through which said primary inlet port communicates with said secondary inlet port and said orifice, and said tubular body extends from one side of said mounting member towards said primary inlet port and said valve member is located on the opposite side of said mounting member.

6. A valve according to Claim 5, wherein said stem slideably locates within a seal at said one end of the tubular body, and said stem has a cross sectional size less than that of the bore of said tubular body so that expansion or contraction of said medium is magnified by the longitudinal movement of said stem.

7. A valve according to any one of Claims 4 to 6, wherein said spring means is located within said tubular body.

8. A fluid heating system including, a storage container, a fluid circulating loop having opposite ends respectively connected to an outlet and an inlet of said container, fluid heating means within said loop, means for drawing fluid from said container and/or said loop, a valve according to any preceding claim connected into said loop between said heating means and said container outlet, said primary inlet port being connected to said container outlet, said outlet port being connected to that part of said loop leading to said heating means, and a source of said fluid connected to said secondary inlet port.

9. A system according to Claim 8, wherein said heating means is a solar heating panel.

10. A temperature responsive element including, a tubular body closed at one end and having an opening at the opposite end thereof, sealing means defining said opening, a rod projecting into the bore of said body through said opening and slideably engaging said sealing means, said rod having a cross sectional size substantially less than that of said bore, a temperature responsive medium within said body adjacent said closed end thereof, and a body of flowable material between said medium and said sealing means.

11. An element according to Claim 10, wherein a coil compression spring acts between said sealing means and a flange on said rod so as to urge the rod towards the closed end of said tubular body, and a clearance space exists between said flange and the surface of said tubular body defining the bore thereof.

12. An element according to Claim 10 or 11, wherein said sealing means includes a resilient O-ring interposed between two annular supports.

13. An element according to any one of Claims 10 to 12, when included in a valve according to any one of claims 1 to 7.

14. A temperature responsive valve substantially as herein particularly described in the accompanying drawings with reference to what is

shown in the accompanying drawings.

15. A fluid heating system substantially as herein particularly described in the accompanying drawings with reference to what is shown in the accompanying drawings.

16. A temperature responsive element substantially as herein particularly described in the accompanying drawings with reference to what is shown in the accompanying drawings.

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