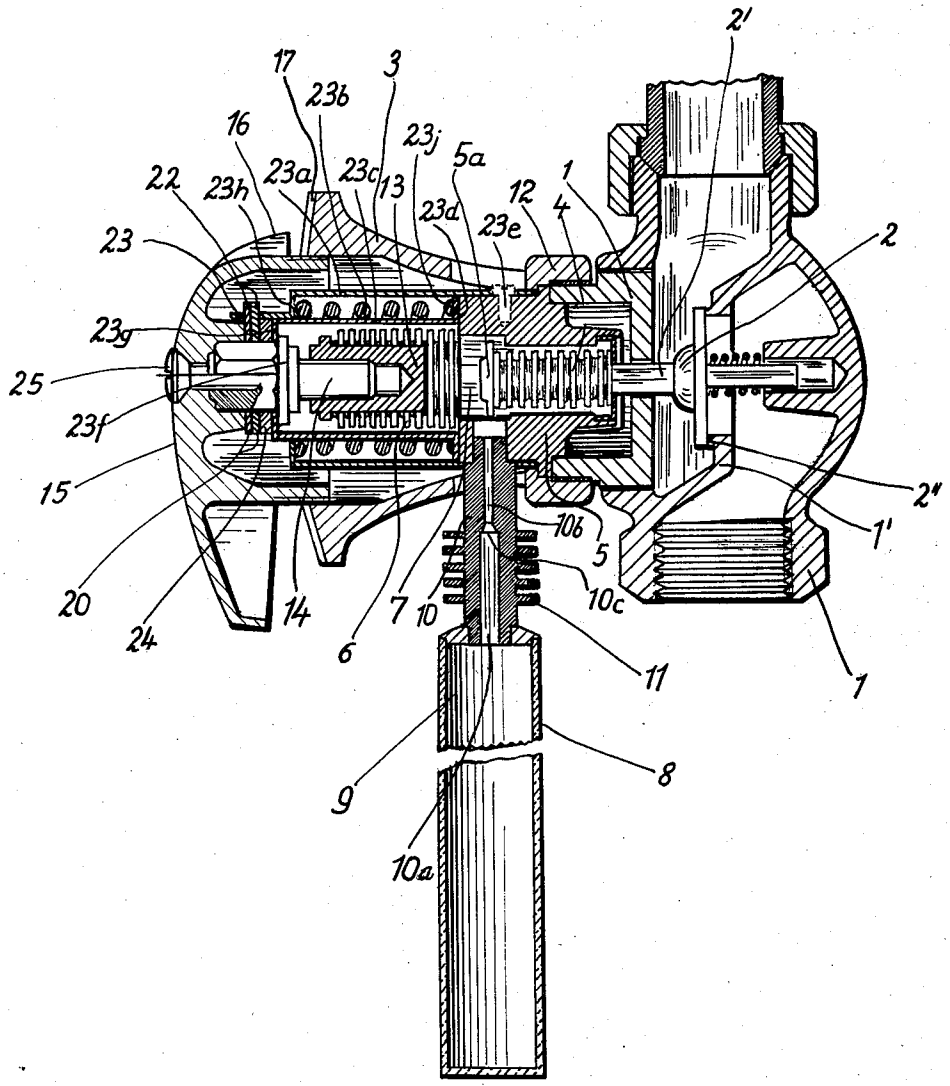
Oct. 21, 1958 K. PORLAND 2,857,106

THERMOSTATICALLY CONTROLLED VALVE

Filed June 26, 1956



United States Patent Office 2,857,106
Patented Oct. 21, 1958

2,857,106

THERMOSTATICALLY CONTROLLED VALVE

Kjeld Porland, Sonderborg, Denmark, assignor to Danfoss ved ingenior Mads Clausen, Elsmark, Nordborg, Als Kingdom of Denmark, a Danish firm

Application June 26, 1956, Serial No. 594,050

Claims priority, application Denmark December 16, 1953

4 Claims. (Cl. 236—99)

This invention relates to a thermostatically controlled radiator valve of that kind described in my copending patent application Ser. No. 475,051, filed December 14, 1954, comprising a valve housing having a valve seat, a movable valve member moving in and out of engagement with said seat, a valve actuating unit being filled with a thermal expansible fluid and provided with a casing, a bulb being filled with a thermal expansible fluid and exposed to the atmosphere and temperature variations, said bulb being placed in immediate proximity to said casing, said bulb having a long and a short dimension and being located such that said long dimension expends substantially in a vertical position beneath said valve actuating unit, means connecting said bulb or said valve actuating unit said connecting means comprising a short tube having low heat transfer and low coefficient of expansion characteristics, said tube being provided with a substantially smaller internal diameter compared with the internal diameter of said bulb, said valve actuating unit including and actuating expansible and collapsible in said casing connected at one end to said casing with the opposite end connected to said movable valve member, said opposite end constituting a movable wall free to move longitudinally with pressure variations resulting from the expansion and contraction of said expansible fluid in said bulb, said valve actuating unit also including an adjusting expanisble and collapsible member in said casing and provided with means to vary and adjust the volume longitudinally, said means comprising an adjustment member extending out through said casing, said expansible and collapsible member being so disposed within said casing as to cooperate in defining an expansion chamber for said expansible fluid.

In said radiator valve the thermostatic system consists of said bulb together with said valve actuating unit which is without any direct physical contact with the water or steam circulating through the radiator. However, it is not possible to prevent that the heated fluid in the radiator transfers through the metallic part of the valve a certain amount of heat to said valve actuating unit and to the fluid in said unit, especially when the radiator has a high temperature. The temperature of the fluid in said unit will in consequence of this be higher than that of the fluid in the bulb and the accurate function of the radiator valve will be effected by this transfer of heat from the radiator to the unit, because the fluid pressure in the system was intended to depend on the temperature of the fluid in the bulb only. The purpose with the specially formed short tube connecting the bulb with the unit, its low-heat transfer and its small internal diameter, is to prevent the heat transfer from the unit to the bulb and to the fluid contained in said bulb, and the dimension of the inner space in said unit is also kept so small as possible compared with the inner space in the bulb so that the fluid pressure in the thermostatic system mainly is determined by the temperature of the bulb.

The experience has shown that when it is wanted to

obtain an action of the valve fully independent of the temperature of the radiator special precautions must be made, and the object of the present invention is to propose such features which prevent the heat transfer from the fluid in the unit to the fluid in the bulb in a more effective way than described in the above mentioned application.

One cause for such heat transfer is the mixing of the higher temperature fluid in the unit with the lower temperature fluid contained in the bulb. Such mixing is due mainly to convection caused by the flow of small amounts of the fluid between the unit and the bulb.

Such flow is of course considerably decreased by the fact that the fluid with the higher temperature in beforehand is situated in the higher situated container, the unit, and that the short tube has a smaller inner diameter, but in an embodiment according to present invention said tube has two coaxial bores situated in continuation of each other a first bore situated nearest to the bulb having a greater inner diameter than the second bore situated nearest to the valve actuating unit, said bores being connected mutually by a breast.

By this is obtained that the flow of fluid between the bulb and the unit is considerably decreased and so is the heat transfer originating from convection.

In another embodiment of the radiator valve according to the present invention the inner space in the valve actuating unit is filled with a substance having a higher viscosity than the viscosity of the heat-expansible fluid in the inner space of the bulb.

By this is obtained that the detrimental space in the unit is eliminated and the accuracy in the action of the radiator valve relates on the temperature and expansion of the fluid in the bulb only.

In a preferred embodiment of the radiator valve according to the invention said substance consists of a plastic, substantially non-compressible matter such as grease or fat having a low-heat expansion coefficient.

In another preferred embodiment of the radiator valve according to the invention said tube has cooling fins extending from the outer surface of that part of the tube enclosing the first bore with the greater inner diameter.

By this is obtained that said part containing said first bore which is filled with the same thermal expansible fluid as that in the bulb will be maintained at nearly the same temperature as the bulb.

The invention will now be further described with reference to the drawing which shows a thermostatically controlled radiator valve in accordance with the present invention partially in section.

The radiator valve is comprising a valve housing 1 of any known design closed by a bushing 1′ and having a valve disc 2. The said valve disc 2 is acted upon through a valve stem 2′ and by cooperating with a valve seat 2″ it regulates the water or steam circulation through the radiator and consequently the temperature in the room where the radiator is placed. Furthermore, the radiator valve comprises a regulator casing 3 in which there is mounted a valve actuating unit 4, 6 consisting of a bush 5 to which is soldered a working bellows 4 which surrounds the end of the valve stem 2′ and through its end plate 5a transmits the variations in length of the bellows 4 to the valve stem 2′ and then to the valve disc 2, and a regulating bellows 6 which together with the working bellows 4 enclose a space 7 filled with a heat-expansible liquid. Outside the said regulator casing 3 is located a preferably slim bulb 8 which is filled with a heat-expansible liquid and is made of a material substantially non-expansible to the action of the heat. The inner space 9 of the said bulb is in direct communication through a heat-insulated intermediary member 10 with the space 7 enclosed by the valve actuating unit. The heat-insulat-

ing intermediary member **10** is made of a material with a low coefficient of thermal conductivity and is formed as a short tube having a small longitudinal dimension compared with the length of the bulb **8**. The tube **10** has in an embodiment according to the present invention two coaxial bores **10***a*, **10***b*, situated in continuation of each other, the first bore **10***a* nearest to the bulb **8** having a greater inner diameter than the second bore **10***b* situated nearest to the valve actuated unit and the inner surfaces of said bores **10***a*, **10***b* being connected mutually by a breast **10***c*. The intermediary member **10** is made of a material having a low coefficient of thermal conductivity, e. g. stainless steel, so that the temperature of the bulb **8** becomes substantially independent of the temperature of the valve housing and the regulating casing and solely depends on the temperature of the air surrounding the bulb **8**, i. e. the room temperature. To further insure that no heat is transmitted to the bulb **8** by conduction through the tube **10** even at a high temperature in the radiator, the tube **10** in a preferred embodiment according to the invention has cooling fins **11** extending from the outer surface of that part of the tube **10** enclosing the bore **10***a* having the greater inner diameter. In order to avoid heat transfer from the valve actuating unit to the bulb **8** by convection in the liquid the bulb **8** is disposed so as to have its longer dimension substantially vertically beneath the valve actuating unit, the tube **10** having in addition a substantially smaller inside diameter than the inner space **9** of the bulb **8**. By this is obtained that the heating part of the liquid substantially remains in the valve actuating unit without being mixed with that part of the liquid which is inside the bulb **8**, but this mixing may be more fully prevented in a preferred embodiment of the present invention in which the inner space **7** in the valve actuating unit **4**, **6** is filled with a substance having a higher viscosity in relation to the viscosity of the heat-expansible fluid in the inner space **9** of the bulb **8**. Said substance consists preferably of a plastic substantially non-compressible matter having a low thermal expansive coefficient such as grease or fat.

The valve actuated unit is replaceable mounted on the regulator casing **3**, fixed on the valve housing **1**, said valve housing being so formed and adapted that the valve can be provided, when required, either with a manually operated handle **15** or with a separate casing containing the valve actuated unit **4**, **6**, said handle **15** coacting in any known manner with the valve stem **2'** to displace said stem in its longitudinal direction to open or close the valve.

The regulator casing **3** is fastened to the valve housing **1** by means of a union nut **12**, whereby the casing **3** and with it the bulb **8** may be turned so that the bulb **8** is brought into its proper vertical position. The regulating bellows **6** has at its end opposite that facing the working bellows **4** an attached threaded bush **13** adapted to be displaced by a regulating spindle **14**, which engages the thread of the bush **13** and supports the handle **15** which is provided with a pointer **16** which point at the scale **17** formed in or mounted on the regulator casing **3**. As a result, a definite manual setting of the regulating spindle **14** may be brought to correspond with definite indications on the scale **17**. The handle **15** may be provided with a polygonal central hole whose inwardly facing sides are located so as to fit with outwardly facing sides of a polygonal nut **19** which is formed in one piece with the regulating spindle **14**, the number of sides of the said hole **18** being an exact multiple of the number of sides of the said nut **19**. By this is obtained that the handle **15** may on adjustment of the radiator valve be placed in such manner as to provide conformity between the indications on the scale **17** which, for example, may have same centigrade graduations, and the room temperature established when the valve regulates the water or steam circulation of the radiator. The nut **19** is provided with at least one stop plate **20** with a polygonal central hole whose inwardly facing sides fit with the outwardly facing sides of the nut **19**, the number of sides of said hole being an exact multiple of the number of sides of the nut **19**. In the form shown there are two such stop plates **20**. Each stop plate is moreover provided with an abutment lug **22** adapted to cooperate with a permanent stop **23** on an outer cap **23***a*, mounted on the bush **5** by means of screws **23***e*. The outer cap **23***a* encloses an inner cap **23***c* which by means of an inwardly extending flange **23***g* supports a spindle **14**, so that the spindle may withstand the thrust of the bellows **6**, when the fluid in the bulb **8** expands. A spring **23***b* is inserted between an inwardly extending flange **23***h* of the outer cap **23***a* and an outwardly extending flange **23***j* of the inner cap **23c**, the spring **23***b* resiliently holding the inner cap **23***c* against a shoulder **23***d* on the bush **5** and acting as a safety device against overloading of the bellows unit. The nut **19** of the regulating spindle **14** has a groove in which is inserted a locking ring **23***f* abutting the inner surface of the inwardly extending flange **23***g* of the inner cap **23***c*. The locking ring transfers the longitudinal stresses in the regulating bellows **6** to the bush **5** and the spring **23***b* when turning the spindle **14**. Between the outer surface and the inwardly extending flange **23***g* of the inner cap **23***c* and the stop plates **20** are positioned spring washers **24**.

The radiator valve operates as follows:

As long as the room temperature, i. e. the temperature of the air surrounding the bulb **8**, is lower than that at which the valve is adjusted, the liquid pressure in the bulb and in the valve actuating unit will be low and through the action on the valve stem **2'** the working bellows **4** will consequently adjust the valve **2**, **2''** at full open position for the circulation of steam or water to the radiator so as to heat the room in which the radiator is installed. The temperature of the bulb and consequently the liquid pressure will rise with a rising room temperature, whereby the working bellows **4** will be more and more compressed and the valve **2**, **2''** will close more and more to restrict the circulation of water or steam until the heat transmitted to the room through the radiator is in equilibrium with the heat given off by the room itself to its surroundings, for instance, by transmission, radiation or convection, when the temperature will be substantially constant. The radiator valve therefore ensures that the room is supplied with just the amount of heat consumed, resulting in increased comfort for the persons staying in the room at the same time effecting an improved fuel economy, since, otherwise, too much heat is generally relieved by an excessive supply of fresh air, for instance, through open windows.

When mounted the adjustment member, the handle **15**, is adjusted for direct reading of the constant room temperature on the scale **17** of the valve. However, this temperature may be changed by manual turning of said handle **15**.

Anyone skilled in the art will understand that a thermostatically controlled radiator valve as that previously described affords the ideal regulations of the temperature in homes, business premises, assembly rooms, schools, hospitals and in similar places otherwise liable to wide variations in temperature, and it is of such simple design that it may be operated by an unskilled person, the handle **15** having only to be set at the figure on the scale corresponding to the desired temperature.

What I claim and desire to secure by Letters Patent is:

1. In a thermostatically-controlled valve having a valve housing providing a valve seat and a valve member movable into and out of engagement with said seat, a valve-actuating unit effective to control the position of said valve member, said valve-actuating unit comprising a casing defining a chamber therein, an actuating expansible and collapsible member in said casing connected at one end to said casing and having its opposite end con-

nected to means acting upon said movable valve member, said last-named means defining a movable wall free to move longitudinally within said chamber, an adjusting expansible and collapsible member in said chamber provided with means to vary and adjust the volume of said chamber, said last-named means comprising an adjustment member extending exteriorly of said casing, said actuating expansible and collapsible member and said adjusting expansible and collapsible member being disposed within said casing chamber to define a confined expansion chamber within said first-named chamber, tube means communicating with said expansion chamber and extending externally of said casing and a bulb communicating with the outer end of said tube means and disposed in immediate proximity to said casing, said bulb having a long and a short dimension and being connected to said tube means in such manner that the longitudinal axis of said bulb is coaxial with the longitudinal axis of said tube means, said tube means comprising a short tube having low heat transfer and low coefficient of expansion characteristics and being provided with a substantially smaller internal diameter than the internal diameter of said bulb, said tube diameter being longitudinally constant, whereby said bulb communicates directly with said tube means and said tube means communicates directly with said expansion chamber, said tube means having a first bore and a communicating coaxial second bore axially aligned with said first bore, said first bore being nearer said bulb than said second bore and said first bore having a greater internal diameter than said second bore, and an expansible fluid in said bulb in said tube means and in said expansion chamber adapted to act upon said expansible and collapsible members with variations in the temperature of said fluid.

2. In a thermostatically-controlled valve having a valve housing providing a valve seat and a valve member movable into and out of engagement with said seat, a valve-actuating unit effective to control the position of said valve member, said valve-actuating unit comprising a casing defining a chamber therein, an actuating expansible and collapsible member in said casing connected at one end to said casing and having its opposite end connected to means acting upon said movable valve member, said last-named means defining a movable wall free to move longitudinally within said chamber, an adjusting expansible and collapsible member in said chamber provided with means to vary and adjust the volume of said chamber, said last-named means comprising an adjustment member extending exteriorly of said casing, said actuating expansible and collapsible member and said adjusting expansible and collapsible member being disposed within said casing chamber to define a confined expansion chamber within said first-named chamber, tube means communicating with said expansion chamber and extending externally of said casing and a bulb communicating with the outer end of said tube means and disposed in immediate proximity to said casing, said bulb having a long and a short dimension and being connected to said tube means in such manner that the longitudinal axis of said bulb is coaxial with the longitudinal axis of said tube means, said tube means comprising a short tube having low heat transfer and low coefficient of expansion characteristics and being provided with a substantially smaller internal diameter than the internal diameter of said bulb, said tube diameter being longitudinally constant, whereby said bulb communicates directly with said tube means and said tube means communicates directly with said expansion chamber, said tube means having a first bore and a communicating coaxial second bore axially aligned with said first bore, said first bore being nearer said bulb than said second bore and said first bore having a greater internal diameter than said second bore, a first expansible fluid of predetermined viscosity in said confined expansion chamber and a second expansible fluid of a lower viscosity in said bulb, said tube means being filled with at least one of said first fluid and said second fluid.

3. In a thermostatically-controlled valve having a valve housing providing a valve seat and a valve member movable into and out of engagement with said seat, a valve-actuating unit effective to control the position of said valve member, said valve-actuating unit comprising a casing defining a chamber therein, an actuating expansible and collapsible member in said casing connected at one end to said casing and having its opposite end connected to means acting upon said movable valve member, said last-named means defining a movable wall free to move longitudinally within said chamber, an adjusting expansible and collapsible member in said chamber provided with means to vary and adjust the volume of said chamber, said last-named means comprising an adjustment member extending exteriorly of said casing, said actuating expansible and collapsible member and said adjusting expansible and collapsible member being disposed within said casing chamber to define a confined expansion chamber within said first-named chamber, tube means communicating with said expansion chamber and extending externally of said casing and a bulb communicating with the outer end of said tube means and disposed in immediate proximity to said casing, said bulb having a long and a short dimension and being connected to said tube means in such manner that the longitudinal axis of said bulb is coaxial with the longitudinal axis of said tube means, said tube means comprising a short tube having low heat transfer and low coefficient of expansion characteristics and being provided with a substantially smaller internal diameter than the internal diameter of said bulb, said tube diameter being longitudinally constant, whereby said bulb communicates directly with said tube means and said tube means communicates directly with said expansion chamber, said tube means having a first bore and a communicating coaxial second bore axially aligned with said first bore, said first bore being nearer said bulb than said second bore and said first bore having a greater internal diameter than said second bore, a first plastic substantially non-compressible fluid of predetermined viscosity having a low thermal expansion coefficient in said confined expansion chamber and a second expansible fluid of a lower viscosity in said bulb, said tube means being filled with at least one of said first fluid and said second fluid.

4. In a thermostatically-controlled valve having a valve housing providing a valve seat and a valve member movable into and out of engagement with said seat, a valve-actuating unit effective to control the position of said valve member, said valve-actuating unit comprising a casing defining a chamber therein, an actuating expansible and collapsible member in said casing connected at one end to said casing and having its opposite end connected to means acting upon said movable valve member, said last-named means defining a movable wall free to move longitudinally within said chamber, an adjusting expansible and collapsible member in said chamber provided with means to vary and adjust the volume of said chamber, said last-named means comprising an adjustment member extending exteriorly of said casing, said actuating expansible and collapsible member and said adjusting expansible and collapsible member being disposed within said casing chamber to define a confined expansion chamber within said first-named chamber, tube means communicating with said expansion chamber and extending externally of said casing and a bulb communicating with the outer end of said tube means and disposed in immediate proximity to said casing, said bulb having a long and a short dimension and being connected to said tube means in such manner that the longitudinal axis of said bulb is coaxial with the longitudinal axis of said tube means, said tube means comprising a short tube having low heat transfer and low coefficient of expansion charac-

teristics and being provided with a substantially smaller internal diameter than the internal diameter of said bulb, said tube diameter being longitudinally constant, whereby said bulb communicates directly with said tube means and said tube means communicates directly with said expansion chamber, said tube means having a first bore and a communicating coaxial second bore xially aligned with said first bore, said first bore being nearer said bulb than said second bore and said first bore having a greater internal diameter than said second bore, said tube having cooling fins extending from the outer surface of that part of the tube enclosing said bore with the greater diameter, a first plastic substantially non-compressible fluid of predetermined viscosity having a low thermal expansion coefficient in said confined expansion chamber and a second expansible fluid of a lower viscosity in said bulb, said tube means being filled with at least one of said first fluid and said second fluid.

References Cited in the file of this patent

UNITED STATES PATENTS

1,285,990	Halsey	Nov. 26, 1918
1,916,814	Shivers	July 4, 1933
1,925,530	Gotthardt	Sept. 5, 1933
2,040,743	Hubbard	May 12, 1936
2,515,765	Dyssart	July 18, 1950