July 15, 1941. D. D. WILE 2,249,101

REFRIGERATING APPARATUS

Filed May 14, 1938

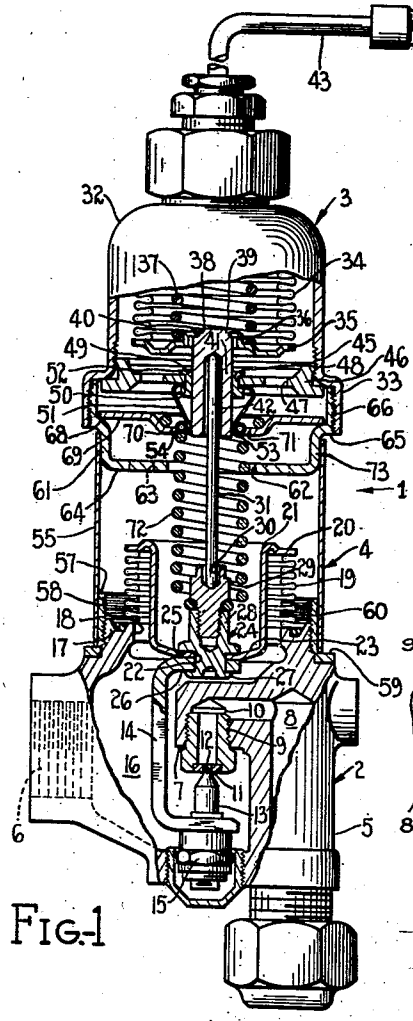


FIG.-1

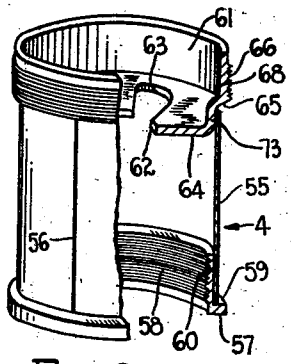


FIG.-2

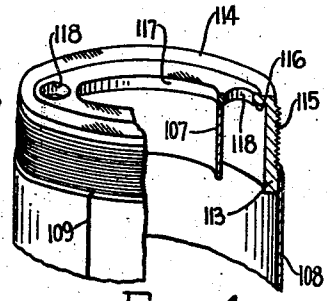


FIG.-4

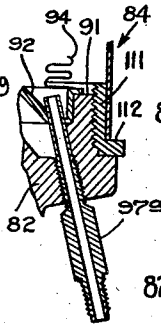


FIG.-6.

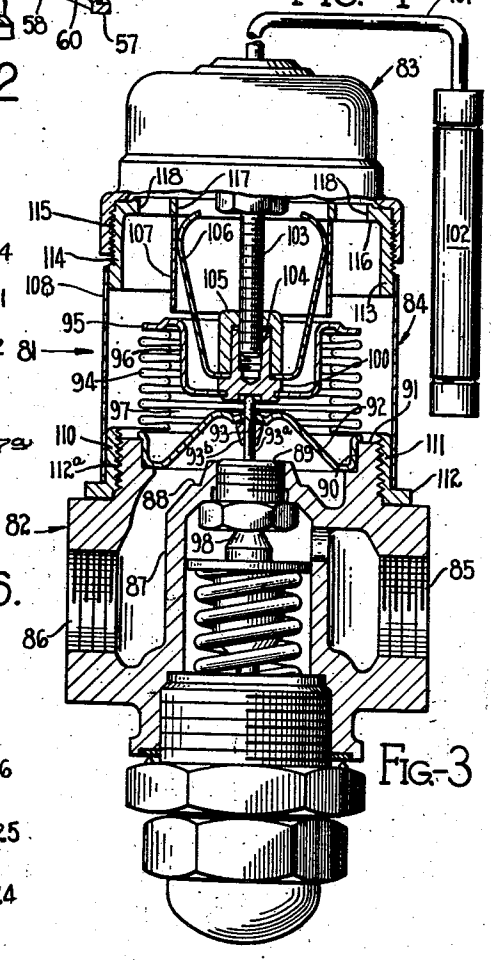


FIG.-3

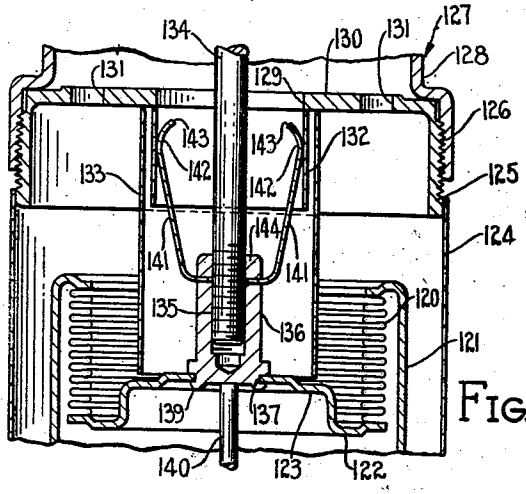


FIG.-5

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UNITED STATES PATENT OFFICE

2,249,101

REFRIGERATING APPARATUS

Daniel D. Wile, Utica, N. Y., assignor to Detroit Lubricator Company, Detroit, Mich., a corporation of Michigan

Application May 14, 1938, Serial No. 207,906

8 Claims. (Cl. 236—92)

My invention relates generally to refrigerating apparatus and more particularly to valves for controlling the flow of refrigerant medium wherein the valve is controlled conjointly by the pressure and the temperature of the refrigerant medium. In valves of this nature which employ a volatile liquid charged thermostatic element relying on vaporization of the liquid for motive power, some means must be provided to prevent chilling of the thermostatic element by the cold refrigerant medium leaving the valve. Heretofore, this has been accomplished by the use of a spacer member of plastic material such as "Bakelite," but such members have certain disadvantages such as swelling and cracking due to absorption of moisture, breakage when dropped or struck severely, and difficulty in maintaining tight joints. It is therefore one object of my invention to provide a valve structure which will eliminate these disadvantages. Another object is to provide a spacer member of simple and rugged construction which will effectively insulate the power element of a thermostatic expansion valve from the valve body.

The invention consists in the improved construction and combination of parts, to be more fully described hereinafter and the novelty of which will be particularly pointed out and distinctly claimed.

In the accompanying drawing, to be taken as a part of this specification, I have fully and clearly illustrated my invention, in which drawing—

Figure 1 is a view partly in elevation and partly in longitudinal central section of a thermostatic expansion valve embodying my invention;

Fig. 2 is a detail view in perspective of the intermediate or heat insulating member of Fig. 1, but with a portion broken away to show the internal construction;

Fig. 3 is a view in partial central vertical cross-section showing another form of thermostatic expansion valve embodying my invention;

Fig. 4 is a partial view in perspective of the intermediate or heat insulating member of Fig. 3, with a portion of the same broken away to show the construction of the upper end ring; and

Fig. 5 is a detail view in cross-section of part of the valve of Fig. 3, but showing a modified form of my invention, and

Fig. 6 is a detail view in vertical section taken on the centerline of the valve, Fig. 3, and at right angles to the showing in Fig. 3.

Referring to the drawing by characters of reference, and specifically to Fig. 1, the numeral 1 designates generally a thermostatic expansion valve having a base or body member 2, an upper or power member 3 and an intermediate or heat insulating member 4. The body member 2 is hollow having an inlet means or extension 5 and an outlet port 6. Within the member 2 there is a lateral projecting portion 7 extending inward from the means 5. Through the means 5 and portion 7 there is an inlet passageway 8 which opens downward through the underface of portion 7. Screw threaded, as at 9, into the outer end of passageway 8 there is a hollow holding member 10 which receives a valve seat member 11 having an orifice or port 12. A valve needle 13 cooperates with the valve port 12 to control flow of fluid therethrough, and is mounted on the lower arm of a U-shaped supporting member 14 by means of a nut 15. The hollow interior of the base member 2 provides an outlet chamber 16 and through the body member top wall 17 there is an aperture 18. A bellows member 19 overlies the aperture 18 and is sealed to the top wall 17 in fluid tight relation. The bellows member 19, at its other end, is sealed in fluid tight relation to a continuous annular lip 20 of a cup-shaped member 21. The cup-shaped member 21 has an aperture 22 through its base 23 for receiving a connecting pin 24. The pin 24 has a downward facing upper shoulder 25 abutting against the base 23 of and within the cup member 21. The top arm 26 of the U-shaped member 14 also has an aperture therethrough for receiving the connecting pin 24. The pin 24 is secured in clamping engagement with arm 26 by a lower flange 27 which may be formed by peening over the pin end so that the U-shaped member 14 is tightly held to the base 23. The pin 24 has a portion 28 which projects upwardly from the shoulder 25. A bearing pin 29 is screw threaded into the upwardly projecting pin portion 28 and has, at its opposite end, a socket 30 for receiving a pin or thrust member 31.

The power member 3 comprises an inverted cup-shaped casing 32 which houses a bellows member 34 and has a lower edge portion 33 of enlarged diameter. The bellows member 34 has, at its lower end, and sealed thereto in fluid tight relation, a plate or end member 35. The plate member 35 has a central embossed portion 36 for receiving and guiding a spring 37 located within the bellows member 34. The plate member 35 also has a central aperture therethrough for receiving a reduced diameter portion 38 of an abutting pin member 39 which is held against the plate member 35, as at 40, such as by peening

over a part of the reduced diameter portion 38. An external projecting portion 41 of the pin 39 has a longitudinally downward, open recess or socket 42 which receives the upper end of the thrust member 31.

One end of a capillary tube 43 is sealed to the bellows member 34, and the other end is sealed to a temperature sensitive or feeler bulb 44 to form a closed system. This system is charged with a temperature responsive fluid so that upon increase in temperature of the bulb 44 the pressure in the system is increased to expand the bellows 34. Screw-threaded, as at 45, into the end portion of the normal diameter at the open end of the cap member 31 is an annular plate member 46 having a plurality of apertures 47 and a central aperture 48 therethrough. Within the aperture 48 there is a guide member 49 having an upwardly facing flange portion 50 which holds one end of each of a plurality of spring fingers or members 51 against the lower face of the plate member 46. The member 49 has a flange portion 52 which overlies member 46 and may be formed, as by peening, to hold the guide member 49 and the plurality of spring fingers 51 to the plate member 46. The guide member 49 serves to hold the external projecting portion 41 of the pin 39 in position for reciprocal movement therein in response to the action of the bellows member 34. Each of the spring members 51 has one face near its free or other end portion in frictional engagement with the pin member 39, to prevent excessive transient motion or chattering which might otherwise be caused by pressure fluctuation in bellows member 19. The extreme free end of each of the spring fingers 51 is bent away from the member 39 in the shape of a hook, as at 53, to form a holding means for receiving and holding an endless helical coil spring 54. The spring 54 surrounds and holds the spring fingers 51 in a predetermined frictional engagement with the pin member 39. The plate member 46 serves as a stop means to limit downward expansion of bellows 34, as well as holding the guide member 49.

The intermediate member 4 comprises a thin stainless steel cylinder member 55 which may be made from a rectangular, flat sheet by rolling the flat sheet and welding the abutting ends together, as at 56. A ring member 57 having screw threads 58 and threaded to the body member 2 has a flange portion 59 against which the member 55 abuts. The ring member 57 also has a cylindrical portion 60 extending upwardly from the flange portion 59 and substantially fitting the interior of the member 55 which is secured thereto. The upwardly projecting or other end of the cylinder member 55 has securely fastened thereto a cup-shaped ring member 61 having a plurality of apertures 62, 63 extending through the bottom 64 of the cup member 61, and which bottom 64 serves to reenforce the walls of the cylinder 55. The member 61 has a portion 65 of enlarged diameter at its upper edge which is screw-threaded, as at 66, to receive the downwardly facing cup-shaped member 32 of the power means 3. The threaded connection of the member 4 with body member 2 and with the power member 3 is preferably treated with a suitable thread compound to substantially prevent passage of moisture therethrough. The cup-shaped member 61 has a shoulder 68 which is formed by the cap portion connecting the normal diameter with the enlarged diameter 65. A spring holding member 69 is supported by the shoulder 68 and has a downwardly projecting embossed portion 70 having a central aperture 71 therethrough. A helical tension spring 72 has the final coil on its upper end of enlarged diameter to fit within the downwardly embossed portion 70, and the normal diameter part of the spring projects downwardly through the central aperture 71 in the embossed portion 70 and through the aperture 62 of the cup-shaped member 61. At its other end the final coil of the spring 72 is of reduced diameter and is held against the upward face of the upwardly projecting pin portion 28 by the bearing pin 29 screw-threaded thereto. The tension spring 72 surrounds the rod member 31 and holds its opposite ends in the sockets 30 and 42. The normal diameter portion 73 of the cup member 61 substantially fits the upper inside wall of the cylinder member 55 and is securely fastened thereto.

In operation, the valve is connected adjacent the refrigerant cooling coil and intermediate the coil and liquid refrigerant supply line to control the supply of refrigerant admitted to the cooling coil. Liquid refrigerant flows from the liquid line connected to the inlet means 5 through the orifice 12 into the chamber 16, and flows from the valve through the outlet port 6. The bellows member 19 is sensitive to the pressure of the refrigerant within the chamber 16 and the pressure therein tends to close valve needle 13 against the seat 11 and close the orifice 12 to further flow of fluid. The spring fingers 53 which are held against the projecting portion 41 of pin 39 offer friction to movement of the valve and prevent rapid motion of small magnitude which might cause a chattering noise. The power element exerts a force tending to open the valve to flow of fluid and is usually so adjusted that it exerts sufficient force so that when the bulb temperature is slightly warmer than the temperature of the refrigerant corresponding to the pressure within the chamber 16, the valve will throttle flow of refrigerant to maintain this predetermined differential. As the refrigerant passes from the liquid line through the valve orifice 12 to the chamber 16 and to the lower pressure coils, the pressure is reduced and as a consequence some of the refrigerant vaporizes, bringing the temperature of the remaining liquid to a temperature corresponding to the lower pressure, as determined from the pressure-temperature curves for the refrigerant employed. This of course chills the body member 2.

The power element system comprising the bellows 34, conduit 43 and bulb 44 is charged with a predetermined amount of the same temperature sensitive fluid as that employed in the refrigerating system, and operates so that the opening force exerted by the power element is ineffective to open the orifice 12 to flow of fluid when the pressure within the chamber 16 is above a predetermined pressure. The predetermined maximum pressure opening of the valve is accomplished by using a small fluid charge in the power element system. This fluid charge must be prevented from distilling over into the bellows 34, which usually has sufficient volumetric capacity to receive the entire fluid in the liquid phase, so that the temperature of the bulb 44 will operate to control the fluid pressure within the power element system, and control the valve operation. To prevent this distillation from happening, the temperature of the bellows 34 must be maintained warmer than the temperature of the body 2. The flow of heat from the power

element to the cold body member must be prevented as far as possible, and to prevent this I have introduced my stainless steel spacer member which has a low rate of heat transfer and is not subject to changes caused by moisture absorption by the material, nor is it easily broken and damaged if struck.

Referring to the construction shown in Fig. 3, the numeral 81 designates generally a thermostatic expansion valve having a body member 82, a power member 83 and an intermediate or heat insulating member 84. The body member 82 is substantially hollow and has an inlet means 85 and an outlet means 86. Within the body member 82 there is a wall means 87 separating the inlet 85 from the outlet 86 and having an aperture in a substantially horizontal upper wall 88 in which is screw-threaded a port means 89. A plate member 92 having a central aperture therethrough overlies and is sealed in fluid-tight relation with the edge portion of an aperture 90 through the top wall 91 of the body member 82. The central aperture 93 receives and is substantially closed by a needle projecting portion 93a to be hereinafter described. Surrounding the portion 93a and having a piston fit relation therewith is a cone-shaped member 93b which is urged by the incoming refrigerant, and by any leakage of fluid from the outlet of the valve, through the aperture 93 against the plate 92 to substantially prevent further flow of fluid through the aperture 93. A bellows member 94 overlies the aperture 90 and the plate member 92 and has its lower end sealed in fluid-tight relation between the top wall 91 of the body member 82 and the plate member 92. To the other end of the bellows member 94 is secured, in fluid-tight relation, an annular, outwardly extending, flange portion 95 of a cup member 96 having a portion extending downward into the interior of the bellows 94. A small pressure chamber 97 of a volume substantially less than that bounded by the bellows itself, is thus formed within the bellows, having the plate member 92 forming the bottom wall of the chamber 97 and the cup member 96 forming the top wall. The chamber 97 has a connection comprising a means 97a, see Fig. 6, extending through and threaded to the body member 82 and extending through the plate member 92 to provide means for maintaining an external pressure therein. A valve needle 98 cooperates with the port means 89 to control flow of fluid therethrough. The needle 98 has an upwardly extending tip portion 93a of reduced diameter which extends through the port means 89 and aperture 93 of the plate member 92, in a piston fit for reciprocal movement therein, and substantially seals the aperture 93. The upper end of the tip portion 93a abuts against an end member 100 extending through and secured to the bottom of the cup-shaped member 96.

The power member 83 comprises a sealed system including a bellows member (not shown), a capillary tube 101 and a feeler bulb 102, and is charged with a temperature responsive fluid. Projecting downward from the power member 83 and fastened to the end wall of the bellows (not shown) is a threaded screw 103 having its downward projecting end screw-threaded, as at 104, into the member 100 against which the valve needle extending portion 93a abuts, thereby operatively connecting the power member 83 to the valve needle 98. A cup-shaped member 105, threaded to screw 103, has downward projecting end portions which hold one end of each of a plurality of spring members 106 against the member 100. One face of each of the blades adjacent the free end of the spring members 106 frictionally engages a cylinder member 107 to be hereinafter described. The extreme ends of the blades are bent away out of engagement with the member 107 so that a smoother engagement is maintained.

The heat insulating member 84 comprises a stainless steel cylinder 108 which may be formed from a flat sheet of metal and the adjacent ends formed as by a butt welded joint 109. A ring member 110 having a cylindrical portion 111 and a flange 112 is threadedly secured, as at 112a, to the body member 82 so that it surrounds the aperture 90 through the wall 91 thereof. One end portion of the steel cylinder 108 substantially fits the cylindrical portion 111 and is in abutting relation with the flange 112 and may be secured in this position by any suitable means. The upper or other end of the member 108 has secured thereto the lip portion 113 of an inverted cup-shaped member 114. The side wall portion away from the lip portion 113 is screw-threaded, as at 115, for screw-threaded reception in the power member 83. The bottom or base 116 of the member 114 has a large concentric aperture 117 therethrough and a plurality of smaller apertures 118 surrounding the aperture 117. Secured to the base 116 along the periphery of the aperture 117 and extending within the cylinder 108 is a cylinder member 107 which cooperates with the spring members 106 to dampen movement therebetween. The length of the member 107 is so adjusted that it cooperates with the member 96 to limit expansion of the bellows 94. Preferably the threaded connections of the member 84 with the body 82 and with the power member 83 are filled with a suitable thread compound to substantially seal the joints against the passage of moisture therethrough.

The operation of the valve shown in Fig. 3 is similar to that of the valve shown in Fig. 1, the main difference being that the pressure within the bellows 94 is not the pressure of the adjacent chamber of the valve body. In this construction a plate member 92 separates the interior of the bellows from the valve body, and the connecting means 97a is added. The usual method of using this valve is to connect the connecting means 97a by a conduit to the outlet conduit from the cooling coil so that the pressure therein at the point where bulb 102 is located may be communicated to the interior of the bellows. By using this method the pressure drop through the cooling coil has no appreciable effect on the amount of liquid admitted to the coil because the pressure and temperature relations by which the valve operation is governed are taken at one point. The valve operates to maintain the exit refrigerant vapor at a predetermined temperature above the temperature corresponding to the outlet refrigerant pressure.

Fig. 5 shows in detail a portion of a modification of the construction shown in Fig. 3. In this modification, the pressure sensitive bellows 120 is inverted with respect to the bellows 94 of Fig. 3. A carrying member 121 having one end secured to the periphery of the aperture 90 of Fig. 3 (not shown in Fig. 5) carries on the other end and sealed thereto the upper end of the bellows 120. To the lower end of the bellows is sealed a reentrant cap member 122 which has a portion 123 extending within the bellows 120. A stainless

steel cylinder 124 is sealed to an inverted cup-shaped member 125 and screw-threaded, as at 126, to the power element 127 carried by a casing 128 in a manner substantially as in Fig. 3. A concentric aperture 129 extends through the bottom wall 130 of the member 125, and a plurality of smaller apertures 131 also extend through the wall 130 and surround the aperture 129. One end of a cylinder 132 is secured to the wall 130 around the periphery of the aperture 129 and has the other end extending within the cup-shaped member 125 toward the bellows 120. A second cylinder member 133 concentric with and surrounding the member 132 and extending in the same general direction has one end secured to the wall 130 and has the other end extending within the upper open end of the bellows 120 secured to the carrying member 121 to serve in cooperation with the reentrant cap member 122 as a stop means limiting contraction of the bellows 120. The power element 127 is operatively connected to the cap member 122 by means of a rod 134 screw-threaded, as at 135, into a thimble member 136 which is secured in an aperture 137 through the reentrant portion 123 of the member 122, and which may be secured by peening, as at 139. The thimble member 136 is operably connected to the valve member (not shown in this figure) by a rod 140 which abuts the member 136. Secured to the member 136 on the power element side of the cap member 122 is the base of a pair of spring fingers 141. The free end portions 142 of the fingers 141 frictionally engage the inner walls of the cylinder 132 to dampen the movement of the thimble member 136, which would otherwise occur with small rapid changes of pressure to which the bellows 120 is subjected. The extreme free ends 143 of the fingers 141 face inwardly, however, and do not engage any surface. A nut 145 may be screw-threaded to the rod 136 to secure the base of the spring fingers 141 to the thimble member 136.

It will thus be seen that I have provided a valve which is simple, rugged and dependable.

What I claim and desire to secure by Letters Patent of the United States is:

1. In a thermostatic expansion valve, a body member having an opening through a wall thereof, a pressure responsive member sealing said opening, an end member secured and sealed to said body member around said opening, a casing member, a thermostatic power element operating member positioned in said casing member, thrust means operatively connecting said operating member and said responsive member, a connecting member secured and sealed to said casing member and having a portion projecting toward and concentric with said end member, the adjacent portions of said projecting portion and of said end member being of substantially equal size, and a thin sheet metal housing member of low heat conductivity positioned between said adjacent portions, said housing member being sealed in fluid-tight relationship at either end to the respective adjacent portions of said connecting member and of said end member.

2. In a thermostatic expansion valve, a body member having an opening through a wall thereof, a pressure responsive member sealing said opening, an end member secured and sealed to said body member around said opening, a casing member, a thermostatic power element operating member positioned in said casing member, thrust means operatively connecting said operating member and said responsive member, a supporting member having opposite end portions, one end portion conforming to and fitting said end member to provide a sealed joint, the other of said end portions including a cup-like portion having an aperture through its end wall for receiving said thrust means, the side wall of said cup-like portion being secured and sealed to said casing member, an intermediate continuous part of said supporting member positioned between said end member and said casing member being of metal of low heat conductivity thereby to maintain a differential of temperature between said casing member and said body member.

3. In a thermostatic expansion valve, a body member having an opening through a wall thereof, a pressure responsive member sealing said opening, an end member secured and sealed to said body member around said opening, a casing member, a thermostatic power element having an operating member positioned in said casing member, thrust means operatively connecting said operating member and said responsive member, a cup-like member secured to said casing member and having a central aperture therethrough and having a portion projecting toward and concentric with said end member, a spring member extending through the aperture in said cup-like member and having one end supported by said cup-like member, the adjacent portions of said projecting portion and of said end member being of substantially equal size, and a thin sheet metal housing member of low heat conductivity positioned between said adjacent portions, said housing member being sealed in fluid-tight relationship at either end to the respective adjacent portions of said cup-like member and of said end member.

4. In a thermostatic expansion valve, a body member having an opening through a wall thereof, a pressure responsive member sealing said opening, an end member secured and sealed to said body member around said opening, a casing member, a thermostatic power element having an operating member positioned in said casing member, thrust means operatively connecting said operating member and said responsive member, a cup-like member secured to said casing member and having a central aperture therethrough and having a portion projecting toward and concentric with said end member, a spring member extending through the aperture in said cup-like member and having one end supported by said cup-like member, the adjacent portions of said projecting portion of said end member being of substantially equal size, a thin sheet material housing member of stainless steel positioned between said adjacent portions, said housing member being sealed in fluid-tight relationship at either end to the respective adjacent portions of said cup-like member and of said end member, guide means secured to said casing member and extending toward said body member and operable to guide said thrust means, and friction means secured to said guide means and operable to frictionally oppose movement of said thrust means.

5. In a thermostatic expansion valve, a body member having an opening through a wall thereof, a pressure responsive member sealing said opening, an annular ring member secured and sealed to said body member around said opening, an annular flange portion on said ring member, a casing member, a thermostatic power ele-

ment having an operating member positioned in said casing member, thrust means operatively connecting said operating member and said responsive member, a connecting member secured and sealed to said casing member and having a portion projecting toward and concentric with said ring member, the adjacent portions of said projecting portion and of said ring member being of substantially equal size, and a thin sheet material housing member of stainless steel positioned between said adjacent portions and having one end abutting said annular flange portion, said housing member being sealed in fluid-tight relationship at either end to the respective adjacent portions of said ring member and of said connecting member, said connecting member bottom portion serving as a reenforcing means for said housing member.

6. In a thermostatic expansion valve, a body member having an opening through a wall thereof, a pressure responsive member sealing said opening, an end member secured and sealed to said body member around said opening, a casing member having a portion of normal diameter and a portion of enlarged diameter, a shoulder on said casing member formed by the intersection of said normal diameter portion and said enlarged diameter portion, plate means secured to said shoulder and having an aperture therethrough, a power element carried by said casing member and having an operating member, thrust means extending through the plate means aperture and operatively connecting said operating member and said responsive member, spring fingers secured to said plate means and frictionally engaging said thrust means to dampen movement thereof, a supporting member having opposite end portions, one end portion conforming to and fitting around said end member to provide a sealed joint, the other of said end portions being sealed to said casing member, an intermediate continuous part of said supporting member being positioned between said end member and said casing member and being of thin low heat conductivity metal thereby to maintain a temperature differential between said casing member and said body member.

7. In a thermostatic expansion valve, a body member having an opening through a wall thereof, a pressure responsive member sealing said opening, an end member secured and sealed to said body member around said opening, a casing member, a thermostatic power element having an operating member positioned in said casing member, thrust means operatively connecting said operating member and said responsive member, a cup-like member having a central aperture therethrough secured and sealed to said casing member and having a lip portion projecting toward and concentric with said end member, the adjacent portions of said lip portion and of said end member being of equal size, a thin sheet metal housing member positioned between said adjacent portions, said housing member being sealed in fluid-tight relationship at either end to the respective adjacent portions of said end member and of said cup-like member, a cylinder member secured to said cup-like member concentric with the aperture therethrough and extending toward said body member, and spring fingers secured to said pressure responsive member and frictionally engaging said cylinder member to frictionally oppose movement of said responsive member.

8. In a thermostatic expansion valve, a valve body, a pressure responsive valve operating element carried by said body, a thin walled tubular resilient heat insulating metal member of low heat conductivity capable of withstanding sharp blows secured and sealed at one end to said body and surrounding said element, a cup-shaped supporting member having a side wall portion fitting within and secured to the other end of said tubular member, said supporting member having a cylindrical screw-threaded side wall portion extending beyond said tubular member, a thermostatic power element having a casing with a screw-threaded flange threadedly engaging said cylindrical portion, and means for transmitting movement from the movable member of said thermostatic power element to said pressure responsive element.

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