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REFRIGERATION EXPANSION VALVES

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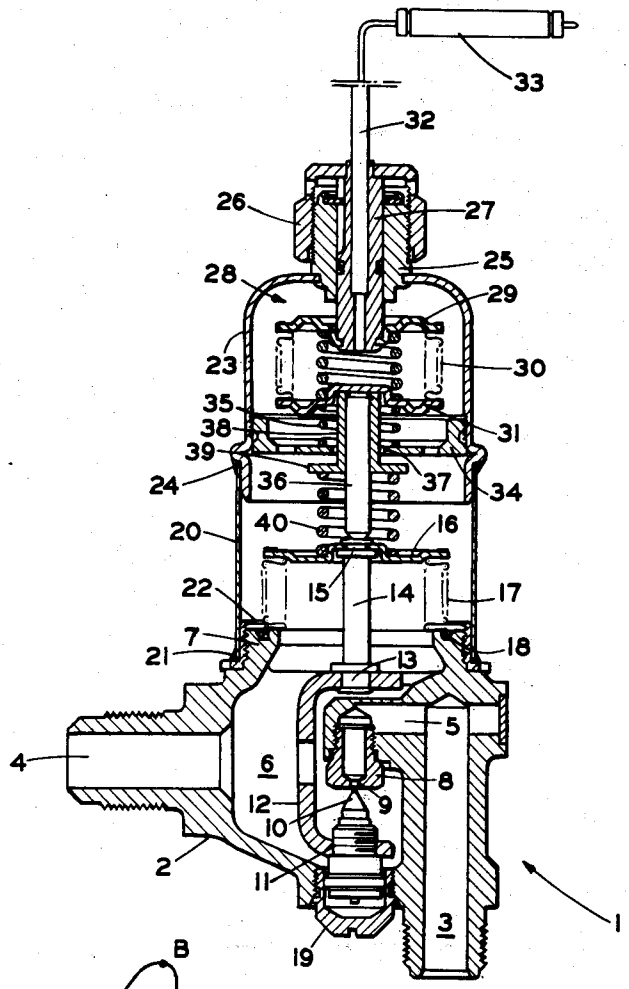


FIG. 1

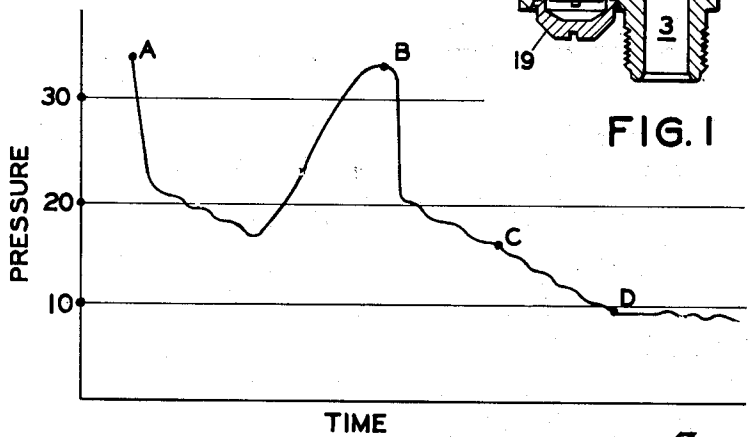


FIG. 2

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REFRIGERATION EXPANSION VALVES

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5 Claims. (Cl. 236—92)

This invention relates to new and useful improvements in refrigeration expansion valves and more particularly to a thermostatically operated refrigeration expansion valve which changes over to "automatic" operation at a predetermined temperature of operation.

It has been found in certain types of refrigerating apparatus that it is desirable to have an expansion valve which will operate thermostatically above a predetermined temperature, but which will function as an automatic or pressure responsive valve at temperatures of response below said predetermined temperature. The desirabily of such a valve has become apparent particularly in connection with certain types of water coolers and other refrigerating apparatus wherein it is desirable to provide a minimum temperature and pressure of operation.

Accordingly it is one object of this invention to provide a new and improved refrigeration expansion valve which is responsive to different refrigerant characteristics in different ranges of operation of the apparatus with which the valve is associated.

Another object of this invention is to provide a refrigeration expansion valve which operates as a thermostatic valve at temperatures of response above a predetermined value, but which operates as an automatic or pressure responsive valve at temperatures of response below said predetermined value.

Another object is to provide a refrigeration expansion valve which has a compressible valve operating rod which is compressed to a solid connection at a predetermined condition of operation and expanded for elastic movement at another predetermined condition of operation.

Another object of this invention is to provide an improved refrigeration expansion valve of the type described which is inexpensive to manufacture and assemble.

Other objects will become apparent from time to time through the specification and claims as hereinafter related.

This invention comprises the new and improved construction and combination of parts, which will be described more fully hereinafter, and the novelty of which will be particularly pointed out and distinctly claimed.

In the accompanying drawings to be taken as part of the specification there is clearly and fully illustrated a preferred embodiment of this invention, in which drawing,

Figure 1 shown is a view in longitudinal section of a refrigeration expansion valve which is constructed and arranged to operate as a thermostatic valve above a predetermined temperature and as an automatic valve below another predetermined temperature, and

Fig. 2 is a pressure-time graph for a refrigeration system using thi svalve, showing both a normal and an abnormal cycle of operation.

Referring to the drawing by characters of reference, in Fig. 1 there is shown a refrigeration expansion valve

generally designated **1**, comprising a valve casing **2**, having an inlet **3** and an outlet **4**. Within the casing **2** there is provided a passageway interconnecting the inlet **3** and outlet **4** comprising a laterally extending passage **5** and an enlarged casing chamber portion **6** which opens through the end portion **7** of the casing **2**. Within the casing **2** there is provided a threaded valve seat member **8** which defines a valve port **9**. A valve member **10** is positioned in the casing chamber **6** and is co-operable with the valve port **9** to control flow of refrigerant therethrough. The valve member **10** is threadedly carried as at **11** by a yoke member **12** which in turn is supported by one end **13** of a thrust rod **14**. The other end **15** of the thrust rod **14** is secured to the movable end wall **16** of a bellows member **17** which has its lower periphery secured and sealed as at **18** around the open end **7** of the valve casing **2**. Below the valve member **10** the valve casing **2** has a threaded cap member **19** which is removable for access to the valve member **10** for adjustment thereof relative to its supporting yoke **12**. There is provided a tubular casing portion **20** which is secured at its lower end as by a soldered connection **21** to a threaded supporting sleeve **22** threadedly secured to the open end **7** of the valve casing **2**. The other end of the tubular casing portion **20** is closed by a cup shaped casing member **23** which is hermetically sealed thereto as by a soldered connection **24**. In the end wall of the cup shaped casing **23** there is secured a sleeve member **25** which is externally threaded and which carries thereon a threaded adjustment member **26** for adjusting the position of a cylindrical supporting member **27** which is carried in the bore of the member **25**. Within the cup shaped casing **23** there is a power element bellows structure **28** comprising a fixed end wall or bellows head **29** which is carried by the lower end of the supporting member **27**. The bellows head **29** has secured thereto a temperature responsive bellows **30** which carries at its lower end a movable bellows end wall **31**. At the upper end of the supporting member **27** there is secured and sealed in position one end of a connecting tube **32** for a remote responsive bulb element **33**. The bulb element **33**, tube **32** and power element bellows structure **28** are charged with a suitable temperature responsive volatile liquid such as Freon or methyl chloride or one of the other refrigerants. At the lower end of the cup shaped casing **23** there is threadedly secured in position a disc shaped and apertured wall member **34**. A spring **35** is compressively positioned between the bellows wall **31** and the disc shaped wall member **34** and determines some of the operating characteristics of this valve. A thrust rod **36** is positioned through an aperture **37** in the wall member **34** and abuts at its opposite ends the power element bellows wall **31** and the pressure responsive bellows wall **16**. A sleeve member **38** is slidably positioned on the thrust rod **36** and has a flange **39** positioned below the wall member **34**. A second spring **40** is compressively positioned between the flange **39** of the sleeve **38** and the movable wall **16** of the bellows **17**. The spring **40** urges the sleeve **38** into engagement with the movable wall **31** of the power element **28** and urges the flange **39** toward engagement with the wall member **34**. The spring **40**, rod **36**, and sleeve **38** thereby function as a collapsible-expansive motion transmitting member between the bellows walls **31** and **16** respectively.

Operation

In operation this valve functions generally as follows:

This valve would be normally connected in an ordinary compressor-condenser-evaporator type refrigeration system and would be connected with the inlet **3** receiving liquid refrigerant from the condenser or receiver

and the outlet 4 discharging refrigerant to the evaporator. The bulb element 33 would normally be positioned in heat exchange relation to the outlet end of the evaporator so that the power element bellows 28 would respond to evaporator outlet temperature. The bellows 17 is responsive to pressure of refrigerant flowing through the valve and particularly to the refrigerant pressure on the outlet side of the valve. As long as the temperature of the bulb element 33 remains above a predetermined value so that the pressure in the bellows 30 plus the pressure under the bellows 17 exceeds the force of spring 40, the spring 40 will be collapsed so that the thrust rod 36 will be maintained in engagement with the pressure responsive bellows end wall 16. In such a position only the rod 36 is transmitting movement from the bellows 30 to the valve member 10 and valve member movement will be in accordance with the relationship of the temperature of the bulb element 33, the pressure below the bellows 17, and the force of the spring 35. In such a position the valve functions as a normal thermostatic expansion valve. When the temperature of response of the bulb element 33 is reduced below the aforementioned predetermined value the bellows walls 16 and 31 will be moved apart by the springs 35 and 40 and the sleeve member 38 will be moved upward until the flange 39 engages the wall member 34 and the thrust rod 36 is out of operating engagement with the bellows wall 16. At this point in the operation of the valve the bulb element 33 and power element 28 are no longer operative to modify the movement of the valve member 10 by the pressure responsive bellows 17. The pressure responsive bellows 17 will then continue, in response to pressure variations in the valve, to control the operation of the valve member 10 in a manner determined by the force of the spring 40. The compressive force of the spring 40 determines the temperature of the bulb element 33 and pressure beneath bellows 17 above which there is a direct connection (thrust rod 36) between the power element and valve. The upper adjustment structure 26, 27 is operable upon adjustment to vary the position of the power element bellows 28 relative to the spring 35 and thus vary the compressive force of the spring 35 upon the bellows wall 31 and thereby determine the superheat setting of the valve and the temperature at which the valve changes over from thermostatic to "automatic" operation.

The graph shown in Fig. 2 is a suction pressure vs. time graph. From point A to point B on the graph there is shown a normal operating cycle. The suction pressure decreases while the system is in operation and when the system thermostat is satisfied the pressure increases to point B, the beginning of a new cycle, on a new cycle after point B the decrease in pressure is normal to point C. At this point we will assume the system thermostat to be stuck closed and operation continued. If an ordinary thermostatic expansion valve were in use the suction pressure would decrease further and the refrigerated media cooled excessively (which in the case of water might be frozen solid). With the present expansion valve in use the suction pressure can decrease only until the valve has changed to "automatic" operation, as previously described (point D on the graph), at which point a constant suction pressure will be maintained. It should be noted, however, that in practice this valve could be used practically only in systems having a limited charge or having an accumulator for preventing compressor overload.

Although there has been described only one modification of this invention, it will be apparent to those skilled in the art that numerous modifications are possible without departing from the intended scope of this invention as defined in the appended claims.

Having thus described the invention what is claimed and desired to be secured by Letters Patent of the United States is:

1. A refrigeration expansion valve for controlling flow of refrigerant to an evaporator, comprising, a casing having an inlet and an outlet and an interconnecting passageway, a valve seat member in said passageway defining a valve port, said passageway having an enlarged chamber portion on the outlet side of said valve port and opening through one end of said casing, a valve member positioned in said chamber portion and movable toward and away from said valve seat member to close and to open said passageway, a supporting yoke in said chamber portion carrying said valve member, a pressure responsive bellows member having an end wall and closing the open end of said casing chamber portion and responsive to refrigerant pressure therein, a thrust rod secured at one end to said bellows end wall and carrying on its other end said valve member supporting yoke, a tubular casing portion secured at one end to said casing and surrounding said bellows, a cup shaped casing member secured to and closing the other end of said tubular casing portion, a threaded tubular supporting sleeve secured in the end wall of said cup shaped casing member, a hollow cylindrical member guided in said sleeve, a threaded adjustment member carried externally on said sleeve for adjusting said cylindrical member, a power element bellows positioned in said cup shaped casing member and having a fixed wall carried by the inner end of said supporting sleeve and having a movable wall, a remote bulb element having a connecting tube secured in the outer end of said supporting sleeve, said power element bellows, bulb element, and tube being charged with a temperature responsive volatile liquid, an apertured disc shaped wall member extending across the inner end portion of said cup shaped casing member, a spring compressively positioned between said last named wall member and said movable power element bellows wall, a thrust rod extending through an aperture in said last named wall member and engaging at opposite ends the movable wall of each of said bellows, a sleeve member slidably positioned on said last named thrust rod and having a flange at its lower end below said last named wall member and having its upper end abutting said power element bellows movable wall, a spring positioned between said flange and said first named bellows end wall and urging said flange toward engagement with said last named wall member, said thrust rod, sleeve member, and last named spring comprising a compressible-expansible lost-motion connector for valve operation, above a predetermined temperature and pressure of valve operation said lost-motion connector being compressed so that only said thrust rod transmits movement, and at conditions of operation below said predetermined temperature and pressure said lost-motion connector being expanded until said flange engages said last-named wall member, said thrust rod is inoperative to transmit movement, and said last-named spring only is controlling operation of said pressure responsive bellows.

2. A refrigeration expansion valve for controlling the flow of a refrigerant to an evaporator comprising, a casing having a passageway therethrough, said passageway having an inlet, an outlet, and a valve port therein, a valve member cooperable with said valve port to control flow of refrigerant therethrough, pressure responsive means positioned to respond to refrigerant pressure beyond the outlet side of said valve port and operatively connected to said valve member to control movement thereof, temperature responsive means adapted to respond to refrigerant temperature on the outlet side of said valve port and spaced from said pressure responsive means, a lost motion connecting means between said pressure responsive means and said temperature responsive means, said lost motion connecting means comprising a thrust rod positioned between and engageable at its opposite end portions with said pressure and temperature responsive means, a sleeve member slidably positioned on said thrust rod and having one end portion

abutting said temperature responsive means and the other end portion having an outwardly flanged portion, a spring member having one end portion abutting said last named flanged portion and its other end portion abutting said pressure responsive means thereby urging said flanged portion away from said pressure responsive means, and stop means positioned between said temperature responsive means and said flanged portion and operable to limit movement of said flanged portion away from said pressure responsive means, said thrust rod being operable above a predetermined temperature condition to transmit movement of said temperature responsive means to said pressure responsive means, said spring member being operable below a predetermined temperature condition to urge said sleeve member flanged portion against said stop means so that said thrust rod is disengaged from said temperature responsive means and said temperature responsive means is rendered ineffective to control said valve member.

3. A refrigeration expansion valve for controlling the flow of refrigerant to an evaporator comprising, a casing having a passageway therethrough, said passageway having an inlet, an outlet, and a valve port therein, said passageway defining a chamber portion on the outlet side of said valve port, said chamber portion having an opening through one end of said casing, a valve member cooperable with said valve port to control flow of refrigerant therethrough, a pressure responsive bellows member having an end wall closing the open end of said casing chamber portion and responsive to refrigerant pressure therein, means to operatively secure said pressure responsive bellows end wall to said valve member, a cup-shaped casing member secured by its open end portion to one end of said casing and surrounding said pressure responsive bellows, a temperature responsive means adapted to respond to refrigerant temperature on the outlet side of said valve port, said temperature responsive means being positioned in said cup-shaped casing and spaced relative to said pressure responsive bellows, a wall member having an aperture therethrough extending across said cup-shaped casing between said temperature responsive means and said pressure responsive bellows, a thrust rod extending through said aperture in said last named wall member and engageable at its opposite end portions with said temperature responsive means and said movable end wall of said pressure responsive bellows, a sleeve member slidably positioned on said thrust rod and having one end portion abutting said temperature responsive means and another end portion having an outwardly flanged portion, said flanged portion being positioned between said wall member and said pressure responsive bellows end wall, and a spring member having an end portion abutting said last named flanged portion and its other end portion abutting said pressure responsive bellows end wall thereby urging said flanged portion toward engagement with said last named wall member, said thrust rod being operable above a predetermined temperature condition to transmit movement of said temperature responsive means to said pressure responsive bellows movable end wall and said spring member being operable below a predetermined temperature condition to urge said sleeve member flanged portion against said last named wall member so that said thrust rod is disengaged from said temperature responsive means and said temperature responsive means is rendered ineffective to control said valve member.

4. A refrigeration expansion valve for controlling the flow of refrigerant to an evaporator comprising, a casing having a passageway therethrough, said passageway having an inlet, an outlet and a valve port therein, said passageway defining a chamber portion on the outlet side of said valve port, said chamber portion having an opening through one end of said casing, a valve member cooperable with said valve port to control flow of refrigerant therethrough, a pressure responsive bellows member having a movable end wall and closing the open end of said casing chamber portion and responsive to refrigerant pressure therein, means to operatively secure said pressure responsive bellows movable end wall to said valve member, a cup-shaped casing member secured by its open end portion to one end of said casing and surrounding said pressure responsive bellows, a temperature responsive bellows adapted to respond to refrigerant temperature on the outlet side of said valve port, said temperature responsive bellows being positioned within said cup-shaped casing member and having a movable end wall, said temperature responsive bellows being spaced relative to said pressure responsive bellows, a wall member having an aperture therethrough extending across said cup-shaped casing between said temperature responsive bellows and said pressure responsive bellows, a spring member positioned between said last named wall member and said temperature responsive bellows movable end wall, a thrust rod extending through said aperture in said last named wall member and engageable at its opposite end portions with the movable end wall of each of said bellows, a sleeve member slidably positioned on said thrust rod and having one end portion abutting said temperature responsive bellows movable wall and another end portion having an outwardly flanged portion, said flanged portion being positioned between said wall member and said pressure responsive bellows movable end wall, and a spring member having one end portion abutting said last named flanged portion and its other end portion abutting said pressure responsive bellows movable end wall and urging said flanged portion toward engagement with said last named wall member, said thrust rod being operable above a predetermined temperature condition to transmit movement of said temperature responsive bellows movable end wall to said pressure responsive bellows movable end wall, said last named spring member being operable below a predetermined temperature condition to urge said sleeve member flanged portion against said last named wall member so that said thrust rod is disengaged from said temperature responsive bellows movable end wall and said temperature responsive bellows is rendered ineffective to control said valve member.

5. A refrigeration expansion valve for controlling the flow of refrigerant to an evaporator comprising, a casing having a passageway therethrough, said passageway having an inlet, an outlet, and a valve port therein, said passageway defining a chamber portion on the outlet side of said valve port, said chamber portion having an opening through one end of said casing, a valve member cooperable with said valve port to control the flow of refrigerant therethrough, a pressure responsive bellows member having a movable end wall and closing the open end of said casing chamber portion and responsive to refrigerant pressure therein, means to operatively secure said pressure responsive bellows movable end wall to said valve member, a tubular casing portion secured at one end to said casing and surrounding said bellows, a cup-shaped casing member secured to and closing the other end of said tubular casing portion, an adjusting means secured to the inner wall of said cup-shaped casing member, a temperature responsive bellows positioned in said cup-shaped casing member and having a fixed wall secured to said adjusting means and having a movable wall, a remote bulb element having a connecting tube secured to said temperature responsive bellows, said temperature responsive bellows, bulb element, and tube being charged with a temperature volatile liquid, a wall member having an aperture therethrough extending across the inner end portion of said cup-shaped casing member, a spring compressively positioned between said last named wall member and said temperature responsive bellows end wall, a thrust rod extending through said aperture in said last named wall member and engageable at its opposite end portions with said movable end wall of each of said

bellows, a sleeve member slidably positioned on said thrust rod and having one end portion abutting said temperature responsive bellows movable wall and another end portion having an outwardly flanged portion, said flanged portion being positioned between said wall member and said pressure responsive bellows movable end wall, and a spring member having one end portion abutting said last named flanged portion and its other end portion abutting said pressure responsive bellows movable end wall and urging said flanged portion toward engagement with said last named wall member, said thrust rod being operable above a predetermined temperature condition to transmit movement of said temperature responsive bellows end wall to said pressure responsive

bellows end wall, said last named spring member being operable below a predetermined temperature condition to urge said sleeve member flanged portion against said last named wall member so that said thrust rod is disengaged from said temperature responsive bellows movable end wall and said temperature responsive bellows is rendered ineffective to control said valve member.

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