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THERMOSTATIC EXPANSION VALVE HAVING PRESSURE RESPONSIVE MEANS FOR VARYING THE SUPERHEAT SETTING THEREOF

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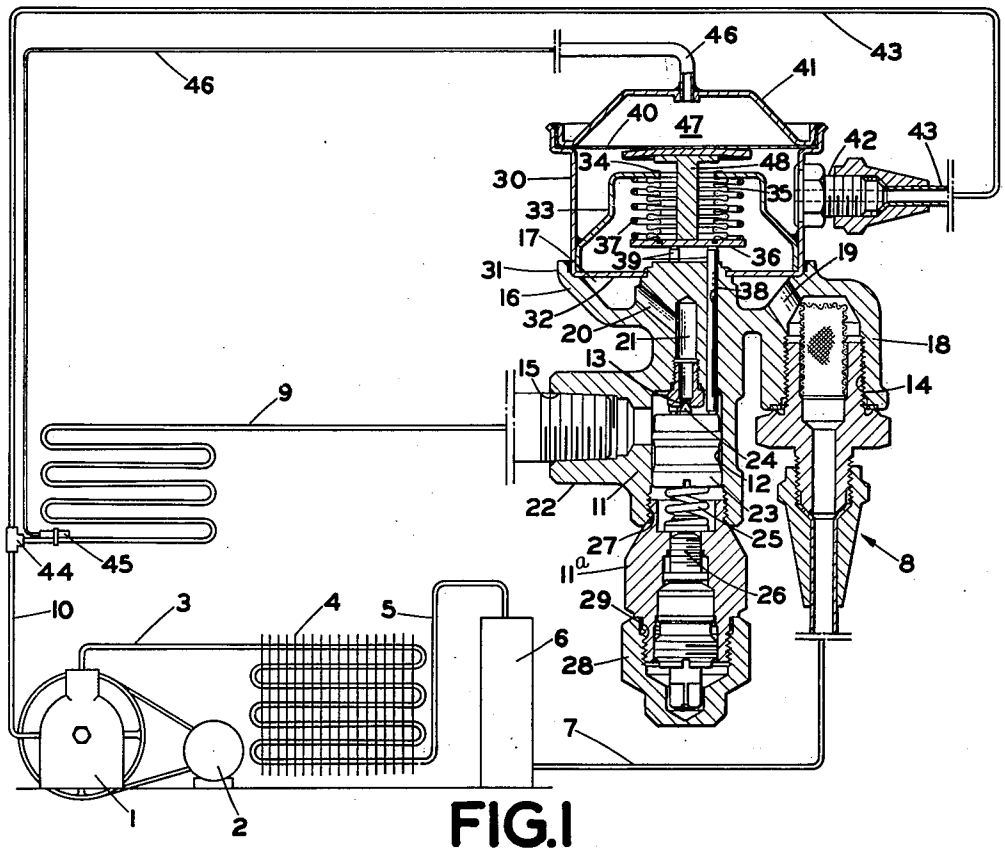


FIG.1

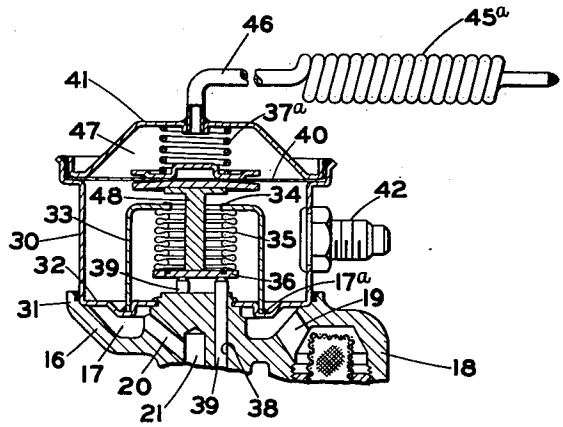


FIG.2

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THERMOSTATIC EXPANSION VALVE HAVING PRESSURE RESPONSIVE MEANS FOR VARYING THE SUPERHEAT SETTING THEREOF

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10 Claims. (Cl. 62—8)

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This invention relates to new and useful improvements in thermostatic expansion valves.

An object of this invention is to provide means operable to reduce variation in the superheat setting of a thermostatic expansion valve.

Another object of this invention is to provide means for adjusting the superheat in accordance with the differential of pressures across the evaporator to be supplied by the valve.

Other objects of this invention will become apparent hereinafter from the specification and claims.

This invention consists of the new and 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 part of this specification, there are clearly and fully illustrated two preferred embodiments of this invention in which drawing:

Figure 1 is a view in longitudinal cross section of a valve embodying the invention and shown operatively connected in a refrigeration system which is diagrammatically illustrated, and

Fig. 2 is a view in longitudinal section of a part of the valve of Fig. 1; but having a different construction of valve operating means.

Referring to the drawing by characters of reference, the numeral 1 refers to a compressor driven by a motor 2. Refrigerant from the compressor 1 is conducted through a conduit 3 to a condenser 4 and thence by a conduit 5 to a receiver 6. From the receiver 6 refrigerant fluid passes through a conduit 7 to an expansion valve 8. From the expansion valve 8 the refrigerant passes into an evaporator 9 and returns to the suction side of the compressor 1 through a conduit 10.

The system thus far described is the standard well-known compression and expansion refrigeration cycle.

The expansion 8 comprises a casing 11 having a longitudinal passageway 12 therein including a valve port 13 and having an inlet port 14 and an outlet port 15. The casing 11 has an enlarged end portion 16 having an annual recess 17 therein. A hollow projection 18 extends downward from the enlarged end portion 16 and includes the inlet port 14. The annular recess 17 communicates with the inlet port 14 by a passageway 19. A passageway 20 connects the annular recess 17 with another passageway 21 communicating through the valve port 13 with the passageway 12. A lateral hollow projection 22 from the casing 11 includes the outlet port 15 which communicates with the passageway 12. A valve carrier member 23 is positioned in the passageway 12 and is operable for reciprocal movement therein. A valve 24 is secured to and extends from the valve carrier member 23 and seats in closed position upon the valve port 13, the valve carrier member 23 being urged towards a valve closed position by a spring 25. An adjustment screw 26 bears against the spring 25 and is operable to determine the force required to open the valve 24. The adjustment screw 26 is carried by a separate portion 11a of the casing which is secured to the main casing 11 by a screw-thread connection as at 27. A cap member 28 covers the screw 26 and is secured to the portion 11a by a screw-threaded connection as at 29. A cylindrical end member 30 is carried by and affixed to the annular rim 31 of the enlarged end portion 16, and has a lower end wall 32 closing the annular recess 17. An internal wall 33 in the shape of an inverted cup having tapering side walls and an end wall portion is positioned within the end member 30 and has its edge carried by and hermetically sealed to the wall of the end member 30 adjacent the annular rim 31. The end wall portion of the internal wall 33 has an aperture therethrough of less than one-half the area of the cross section of the end member 30 and which aperture is alined with the passageway 12. A hollow flexible bellows 35 extends downward through and seals the aperture 34 and has a plate member 36 sealing its lower open end and extending outward to form a flanged edge portion. A spring 37 is positioned between the flanged edge portion of the plate 36 and the end wall portion of the interior wall 33 which urges the bellows 35 toward an expanded position. A plurality of longitudinal passageways 38, preferably three in number of which only two are shown, enclose push pins 39 positioned between the plate member 36 and the valve carrier member 23, push pins 39 being operative to transmit thrust from the plate member 36 to the valve carrier member 23. A flexible diaphragm 40 closes the open end of the end member 30 and is sealed thereto by a dish-shaped cover member 41. The end member 30 has an inlet port or connection 42 in its wall between the diaphragm 40 and the interior wall 33. The inlet port 42 is connected by a conduit 43 to a T 44 joining with the conduit 10 and the outlet end of the evaporator 9. A thermostatic bulb element 45 contains a fluid for translating the effect of temperature at the outlet end por-

tion of the evaporator 9 into fluid pressure, such fluid pressure being transmitted by a conduit 46 to the space 47 enclosed by the dish-shaped cover member 41 and the diaphragm 40. The fluid pressure from the thermostatic bulb element 45 is operable to move the diaphragm 40 and actuate the valve 24. A push rod 48 is positioned between the bellows plate 36 and the diaphragm 40 and is operable to transmit thrust therebetween. The space enclosed between the interior wall 33 and bellows 35 and the lower wall 32 is open to pressure from the inlet end of the evaporator 9 through the longitudinal passageways 38 surrounding the push pins 39.

In operation this form of the invention functions as follows:

The diaphragm 40 is responsive to a differential of pressure between the fluid pressure in the space 47 on one side and the pressure from the outlet end of the evaporator 9 on the other side. The bellows 35 is responsive to the differential of pressure between the outlet and inlet ends of the evaporator 9 and acts in opposition to movement of the diaphragm 40. As in all conventional expansion valves, an increase in temperature of the thermostatic bulb element 45 will cause pressure to be transmitted to the diaphragm 40 causing it to move downward and acting through the push rod 48, the end plate 36 and the push pins 39 to open the valve 24. However, since the other side of the diaphragm 40 is open to pressure from the outlet end of the evaporator 9, the operations of the valve will be compensated for variations in pressure at the outlet end of the evaporator. The bellows 35 being responsive to the differential of pressure between the outlet and inlet ends of the evaporator 9 and acting in opposition to the movement of the diaphragm 40 will cause the operation of the valve to be compensated for variations in the last-named pressure differential. This action of the bellows 35 will also function to automatically vary the superheat setting of the valve with the aforementioned compensating action (e. g. the normal tendency of the superheat setting of the valve to increase with lower suction pressure is decreased by this compensating action), but since the area of the bellows 35 is small as compared to the area of the diaphragm 40 the variation of the superheat setting will be small and within predetermined desirable limits.

In the operation of a conventional type valve at high suction pressure the superheat setting of the valve is usually low (assume a setting of 10° superheat). As the suction pressure is decreased the normal tendency is for the superheat setting to increase (to say 13° at low suction pressure) but since the bellows 35 responds to the pressure differential across the evaporator 9 and acts in opposition to the diaphragm 40, and since the pressure drop across the evaporator decreases as at lower suction pressure, this tendency is decreased (so that the superheat setting at low suction pressure would be say 11°). It should be obvious then to one skilled in the art, that since the diaphragm 40 responds to the difference of pressure between the bulb 45 and the outlet end of the evaporator 9 the operation of the valve will be compensated for fluctuations in pressure drop across the evaporator 9 and that the operation of the bellows 35 as heretofore described will produce the described adjustment of the valve superheat setting.

In Fig. 2 the construction of the valve is altered slightly to provide a "gas" charged valve. The lower wall 32 of the cylindrical end member 30 has an annular depression 17ª therein to which is affixed the inner cup-shaped wall 33. The spring 37 of the principal form of the invention (Fig. 1) is removed and replaced by a spring 37ª positioned between the dish-shaped cover member 41 and the diaphragm 40. The thermostatic bulb element 45 is replaced by a section of helical tubing 45ª which performs the same function but with a greater heat transfer area as is required for "gas" charged operation. In all other respects this modification is the same as shown and described in Fig. 2. In operation this modification of the invention functions substantially as described for the form shown in Fig. 1 with the same features of compensation and superheat adjustment.

What is claimed and is desired to be secured by Letters Patent of the United States is:

1. In an expansion valve for controlling the flow of a refrigerant medium to a refrigerant evaporator, a casing having a passageway therethrough including a valve port, and having an inlet and an outlet port, a valve carrier member within said casing positioned for reciprocal movement, a valve secured to and extending from said valve carrier member, a spring urging said valve carrier member toward valve closed position, a bulb element containing a thermostatic fluid and adapted for translating the effect of the temperature of the outlet end portion of the evaporator into fluid pressure; means adapted for response to the differential between said fluid pressure and the pressure at the outlet end of the evaporator and operable to actuate said valve, means adapted for response to the differential of pressure between the inlet and the outlet of the evaporator acting in opposition to said first-named pressure responsive means and operable to compensate for variations in said last-named pressure differential in the operation of said valve, and said last-named pressure responsive means being further operable to automatically vary the superheat setting of said valve with said compensatory action.

2. In an expansion valve for controlling the flow of a refrigerant medium to a refrigerant evaporator, a casing having a passageway therethrough including a valve port, and having an inlet and an outlet port, a valve carrier member within said casing positioned for reciprocal movement, a valve secured to and extending from said valve carrier member, a spring urging said valve carrier member toward valve closed position, an adjustment screw bearing against said spring and operable to determine the force required to open said valve, a bulb element containing a thermostatic fluid and adapted for translating the effect of the temperature of the outlet end portion of the evaporator into fluid pressure, a flexible diaphragm carried by said casing and operable through a push rod to actuate said valve, said diaphragm being adapted for response to the differential between said fluid pressure and the pressure at the outlet end of the evaporator, a flexible bellows carried by said casing and operable to resist movement of said diaphragm, said bellows being adapted for response to the differential of pressure between the inlet and the outlet ends of the evaporator, and said diaphragm and said bellows being jointly operable to compensate for variations in said last-named pressure differential in the operation of said valve and being further operable to automatically vary the superheat setting of said valve with said compensating operation.

3. In an expansion valve for controlling the flow of a refrigerant medium to a refrigerant evaporator, a casing having a passageway therethrough including a valve port, and having an inlet and an outlet port, a valve carrier member within said casing positioned for reciprocal movement, a valve secured to and extending from said valve carrier member, a spring urging said valve carrier member toward valve closed position, an adjustment screw bearing against said spring and operable to determine the force required to open said valve, a bulb element containing a thermostatic fluid and adapted for translating the effect of the temperature of the outlet end portion of the evaporator into fluid pressure, a cylindrical end portion carried by and affixed to said casing having a wall portion sealing one end of said end portion from said inlet port, a dish-shaped cover member sealing the other end of said end portion and having a conduit interconnecting said end portion and said thermostatic bulb element, a flexible diaphragm sealed to and covering said other end portion and held in position by said dish-shaped cover member, an inner wall portion within said end portion and having an aperture therethrough, a flexible bellows sealing said aperture; said dish-shaped cover member, said first-named wall portion, said diaphragm and said inner wall portion and bellows defining three chamber portions within said end portion, a thrust rod member positioned between said diaphragm and said bellows and operative to transmit thrust therebetween, one or more thrust pins positioned between said bellows and said valve carrier member, said end portion having an inlet port in the middle chamber portion adapted to be connected to and receive pressure from the outlet end of the evaporator, said diaphrgam being adapted for response to the differential of pressure between said fluid pressure on one side and evaporator outlet pressure on the other side and operable to actuate said valve, said end chamber adjacent said bellows being open to pressure from the inlet end of the evaporator so that said bellows is arranged for response to the differential of pressure between the inlet and outlet ends of the evaporator and acts in opposition to said diaphragm, and said diaphragm and said bellows being jointly operable to compensate for variations in said last-named pressure differential in the operation of said valve and being further operable to automatically vary the superheat setting of said valve with said compensating operation.

4. In an expansion valve for controlling the flow of a refrigerant medium to a refrigerant evaporator, a casing having a passageway therethrough including a valve port and having an inlet and an outlet port, said casing having an enlarged end portion having an annular recess therein, a projection extending from said enlarged end portion and including said inlet port, said annular recess intercommunicating with said inlet port and said passageway, a lateral projection from said casing including said outlet port, said outlet port communicating with said passageway, a valve carrier member in said passageway positioned for reciprocal movement, a valve secured to and extending from said valve carrier member, a spring urging said valve carrier member toward valve closed position, an adjustment screw bearing against said spring and operable to determine the force required to open said valve, a cylindrical end member carried by and affixed to the annular rim of said enlarged end portion

and having a wall closing said annular recess, an interior wall in said end member in the shape of an inverted cup and having its edge carried by and hermetically sealed to the wall of said end member adjacent said annular rim, an aperture through said interior wall, a hollow flexible bellows extending downward through and sealing said aperture and having a plate member sealing the lower open end of said bellows, a spring positioned between said plate member and said interior wall urging said bellows toward an expanded position, one or more longitudinal passageways in said casing enclosing push pins positioned between said plate member and said valve carrier member for operation of said valve, a flexible diaphragm closing the open end of said end member and sealed thereto by a dish-shaped cover member, said end member having an inlet port in its wall between said diaphragm and said interior wall, said last named inlet port being adapted to be connected to and receive pressure from the outlet end of the evaporator, a thermostatic bulb element containing a fluid and adapted for translating the effect of temperature at the outlet end portion of the evaporator into fluid pressure, said fluid pressure being transmitted to the space enclosed by said dish-shaped cover member and said diaphragm to actuate said diaphragm, a push rod positioned between said bellows plate and said diaphragm, the space enclosed by said interior wall and bellows and said lower wall being open to pressure from the inlet end of the evaporator through said one or more longitudinal passageways enclosing said push pins; said diaphragm being adapted to respond to the differential pressure between said fluid pressure on one side and evaporator outlet pressure on the other side and operable to move said valve by acting through said push rod, said plate member, and said push pins; said bellows being adapted to respond to the differential of pressure between the inlet and outlet ends of the evaporator and acting in opposition to said diaphragm, and said diaphragm and said bellows being jointly operable to compensate for variations in said last-named pressure differential in the operation of said valve and being further operable to automatically vary the superheat setting of said valve with said compensating operation.

5. In an expansion valve for controlling the flow of a refrigerant medium to a refrigerant evaporator, a casing having a passageway therethrough including a valve port and having an inlet and an outlet port, said casing having an enlarged end portion having an annular recess therein, a projection extending from said enlarged end portion and including said inlet port, said annular recess intercommunicating with said inlet port and said passageway, a lateral projection from said casing including said outlet port, said outlet port communicating with said passageway, a valve carrier member in said passageway positioned for reciprocal movement, a valve secured to and extending from said valve carrier member, a spring urging said valve carrier member toward valve closed position, an adjustment screw bearing against said spring and operable to determine the force required to open said valve, a cylindrical end member carried by and affixed to the annular rim of said enlarged end portion and having a wall closing said annular recess, said wall having an annular recess therein, an interior wall in said end member in the shape of an inverted cup and

having its edge carried by and hermetically sealed to said wall along said last-named annular recess, an aperture through said interior wall, a hollow flexible bellows extending downward through and sealing said aperture and having a plate member sealing the lower open end of said bellows, one or more longitudinal passageways in said casing enclosing push pins positioned between said plate member and said valve carrier member for operation of said valve, a flexible diaphragm closing the open end of said end member and sealed thereto by a dish-shaped cover member, a spring positioned between said diaphragm and said dish-shaped cover member urging said diaphragm toward a downward position, said end member having an inlet port in its wall, said last-named inlet port being adapted to be connected to and receive pressure from the outlet end of the evaporator, a thermostatic bulb element containing a fluid and adapted for translating the effect of temperature at the outlet end portion of the evaporator into gaseous pressure, said gaseous pressure being transmitted to the space enclosed by said dish-shaped cover member and said diaphragm to actuate said diaphragm, a push rod positioned between said bellows plate and said diaphragm, the space enclosed by said interior wall and bellows and said lower wall being open to pressure from the inlet end of the evaporator through said one or more longitudinal passageways enclosing said push pins; said diaphragm being adapted to respond to the differential of pressure between said gaseous pressure on one side and evaporator outlet pressure on the other side and operable to move said valve by acting through said push rod, said plate member, and said push pins; said bellows being adapted to respond to the differential of pressure between the inlet and outlet ends of the evaporator and acting in opposition to said diaphragm, and said diaphragm and said bellows being jointly operable to compensate for variations in said last-named pressure differential in the operation of said valve and being further operable to automatically vary the superheat setting of said valve with said compensating operation.

6. In an expansion valve for controlling the flow of a refrigerant medium to a refrigerant evaporator, a casing having an inlet and an outlet and an interconnecting passageway therebetween, a valve member controlling flow through said passageway, means biasing said valve member toward a valve closed position, temperature responsive means for moving said valve member toward an open position, and pressure responsive means adapted to vary automatically the superheat setting of said valve in accordance with the differential of pressure across the refrigerant evaporator.

7. An expansion valve as defined in claim 6 wherein the pressure responsive means is interposed in position for transmission of motion from said temperature responsive means to said valve member.

8. In an expansion valve for controlling the flow of a refrigerant medium to a refrigerant evaporator, a casing having an inlet and an outlet and an interconnecting passageway therebetween, a valve member controlling flow through said passageway, means biasing said valve member toward a valve closed position, temperature responsive means for moving said valve member toward an open position, and means including a pressure responsive member adapted to respond to the differential of pressure across the refrigerant evaporator and operable to vary automatically the superheat setting of said valve in accordance with variations in said pressure differential.

9. In an expansion valve for controlling the flow of a refrigerant medium to a refrigerant evaporator, a casing having an inlet and an outlet and an interconnecting passageway therebetween, a valve member controlling flow through said passageway, means biasing said valve member toward a valve closed position, responsive means for moving said valve member toward an open position; said responsive means comprising a pressure responsive member adapted to respond on one side to the pressure at the outlet end of the refrigerant evaporator, and thermostatic means operable to apply a valve opening force to the other side of said pressure responsive member; and means including a pressure responsive member adapted to respond to the differential of pressure across the refrigerant evaporator and operable to vary automatically the superheat setting of said valve in accordance with variations in said pressure differential.

10. An expansion valve as defined in claim 9 wherein the last-named pressure responsive member is interposed for transmission of motion from said thermostatic means to said valve member.

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