United States Patent [19]

Eschbaugh et al.

[11] **3,738,573**

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[54] **EXPANSION VALVE**

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[73] Assignee: **Parker-Hannifin Corporation,** Cleveland, Ohio

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[52] **U.S. Cl.** ..... **236/92 B,** 62/210, 62/225, 251/282

[51] **Int. Cl.** **F25b 41/04**

[58] **Field of Search** ..... 62/225, 210; 236/92 B; 251/282

[56] **References Cited**

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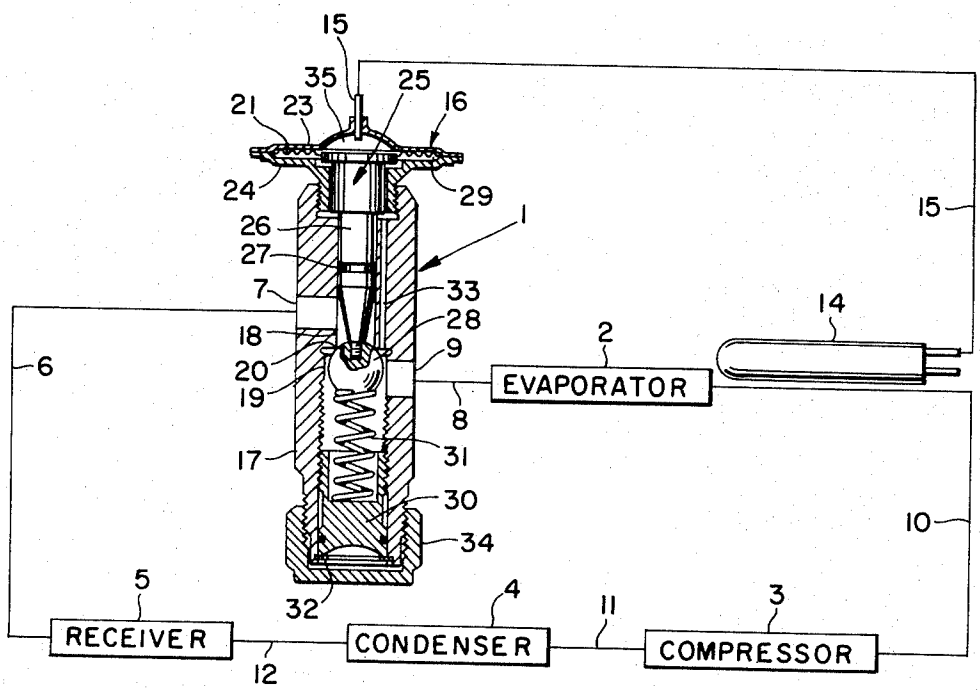
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[57] **ABSTRACT**

An expansion valve for a compression refrigerating system characterized in that the valve member thereof which controls the flow of refrigerant from the condenser to the evaporator has a stem portion on the inlet side of the seat which pressure balances the refrigerant pressure in the inlet port of the valve so that it is ineffective to tend to move the valve member either in opening or closing direction.

4 Claims, 2 Drawing Figures



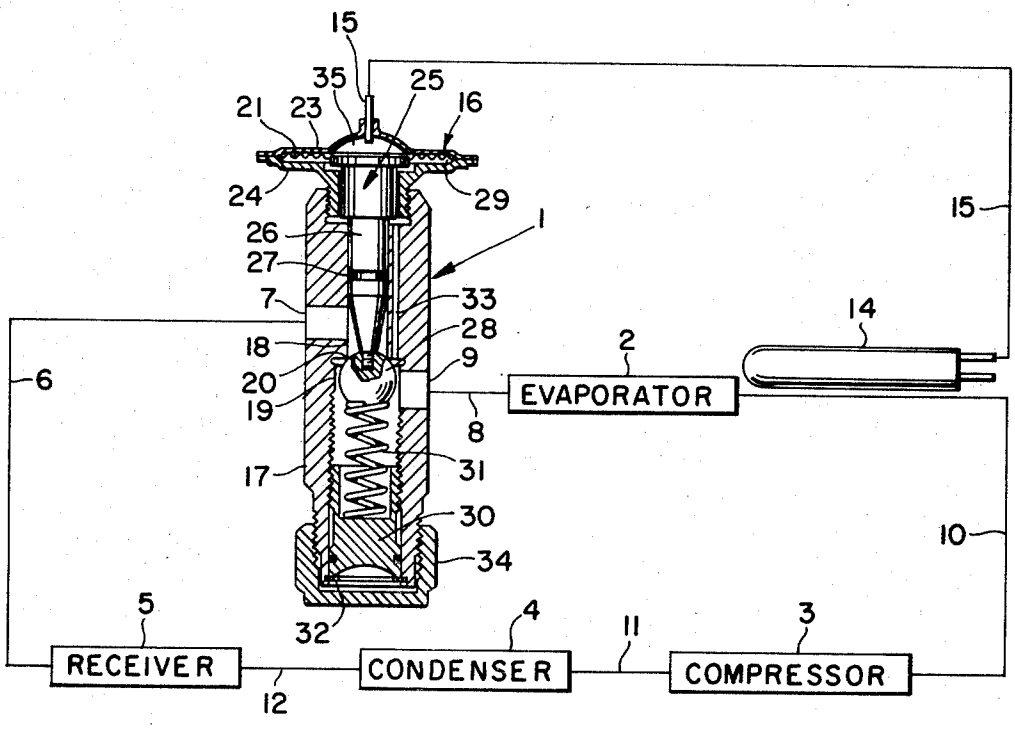


Fig. 1

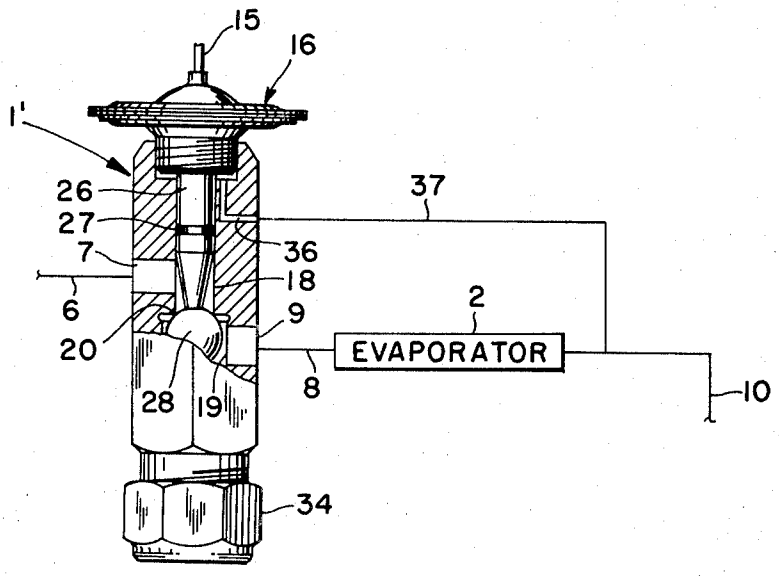


Fig. 2

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EXPANSION VALVE

BACKGROUND OF THE INVENTION

In a compression refrigerating system, the refrigerant in a gaseous state is compressed in a compressor and flows into a condenser where it is cooled and condensed and accumulated as a liquid in a receiver. The liquid refrigerant at high pressure flows from the receiver to the inlet port of an expansion valve which has its outlet port connected to an evaporator, the expansion valve generally being a spring-loaded pressure reducing valve which allows the refrigerant to pass therethrough at a rate so as to maintain a predetermined low pressure in the evaporator. The reduction of pressure causes the refrigerant to evaporate and the heat of vaporization is absorbed from the fluid (air or water for example) flowing over the evaporator coil. The temperature attained in the evaporator depends primarily upon the pressure-temperature characteristics of the particular refrigerant which is used. From the evaporator the superheated gas flows into the compressor.

The temperature control device conventionally comprises an expansion or thermostat bulb containing the same or similar refrigerant whose vapor pressure acts on one side of a flexible diaphragm contained in a power unit secured to the expansion valve body, and operatively connected to the valve member of the expansion valve, the other side of the diaphragm being referenced to low pressure at the valve or evaporator outlet.

In one known form of expansion valve (see for example the patent to Merchant et al. U.S. Pat. No. 3,414,014) the pressure of the refrigerant in the inlet port acts on the area of the seat of the movable valve member to tend to hold it in seated position to prevent flow of liquid refrigerant through the valve to the evaporator and thus the differential pressure on opposite sides of the diaphragm of the power unit must overcome, not only the force of the spring which acts to tend to seat the valve member, but also the seating force of the inlet pressure acting on said valve member. In other known forms of expansion valves, the valve members thereof are exposed to inlet pressure tending to move them to open position whereby the valve member biasing springs must be correspondingly stiffer to bias the valve members toward their seats.

It is also known to provide balanced pressure regulators not necessarily for use in refrigeration systems which are balanced insofar as inlet pressure is concerned and which are actuated by differential pressure on opposite sides of a diaphragm. As shown for example in each of the patents to Mitchell U.S. Pat. No. 2,752,941, and Hughes U.S. Pat. No. 3,023,093 the valve construction is rather complex in that the valve body is provided with two spaced apart seats which cooperate with two axially spaced seat engaging portions of the valve member, and when the valve member is urged to open position the flow of fluid from the inlet port is divided into two streams which join together at the outlet port.

As yet another example of a regulating valve for refrigeration systems, reference may be had to the Leimbach U.S. Pat No. 3,402,566, in which the valve member is pressure balanced by way of an orifice therethrough which communicates the inlet port with a chamber defined by the valve housing and valve member, the inlet pressure thus acting on equal areas on opposite sides of said valve member.

SUMMARY OF THE INVENTION

The present invention has for its principal object the provision of an expansion valve for a refrigerating unit which is of simple, compact pressure balanced construction and which requires for its operation a relatively small and sensitive power unit to accommodate a wide range of applications, i.e., refrigerating units from one-fourth to 10 tons, for example. The valve member and seat combination is large enough to control the flow of refrigerant in a large unit (10 tons for example) but yet is sensitive enough to control the flow of refrigerant in a small unit (one-fourth ton, for example).

Other objects and advantages of the present invention will appear hereinafter.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a central vertical cross-section view of an expansion valve embodying the present invention; and

FIG. 2 is a fragmentary cross-section view of another form of expansion valve.

DETAILED DESCRIPTION OF THE DRAWING

In FIG. 1 the expansion valve 1 is shown installed in a compression refrigerating unit comprising an evaporator 2, a compressor 3, a condenser 4, and a receiver 5. As known, at the beginning of the refrigeration cycle the refrigerant, such as freon, leaves the receiver or storage tank 5 under high pressure and is conducted through the conduit 6 to the inlet port 7 of the expansion valve 1 which reduces the pressure of the refrigerant as it enters the evaporator 2 which is connected by conduit 8 to the outlet port 9 of the expansion valve 1. The evaporator 2 may consist of pipes or coils and at low pressure the liquid refrigerant evaporates inside the evaporator and absorbs heat from air or water flowing thereover, thus causing refrigeration to take place. The compressor 3 pumps the refrigerant from the evaporator 2 via conduit 10 as a vapor to increase its pressure, the high pressure vapor being discharged from the compressor 3 through conduit 11 into the water or air cooled condenser 4, wherein the high pressure vapor condenses into a liquid for flow into the receiver 5 via conduit 12. A thermostat bulb 14 is mounted adjacent the evaporator 2 outlet and is connected by the capillary tube 15 to the power unit 16 of the expansion valve, the bulb containing liquid refrigerant whose vapor pressure varies according to the temperature at the evaporator outlet.

Referring now in detail to the expansion valve 1, the same comprises an elongated body 17 made as of hex bar stock having longitudinally offset lateral openings 7 and 9 constituting the aforesaid inlet and outlet ports. The body 17 has coaxial bores 18 and 19 of different diameters defining a valve seat 20 therebetween, the inlet port 7 intersecting the smaller bore 18 and the outlet port 9 intersecting the larger bore 19.

The power unit 16 is screwed into the upper end of the body 17 and has therein power element such as a flexible diaphragm 21 of which the peripheral portion is secured between the housing parts 23 and 24 of the power element 16 as by brazing or like expedient. The upper housing part 23 has secured thereto the end of the capillary tube 15 which leads to the thermostat bulb

14. The central portion of the diaphragm 21 has secured thereto a flow control valve assembly 25 comprising a valve stem 26 which is slidably sealed in the bore 18 as by means of the O-ring 27 and which has screwed onto its lower end a valve member 28 preferably in the form of a ball, which moves toward or away from the seat 20 as the diaphragm 21 is flexed by differential pressure on opposite sides thereof. In the form of the invention shown in FIG. 1, the chamber 29 on the bottom side of the diaphragm 21 is exposed to outlet port pressure via the passage 33 and likewise the valve member 28 is exposed to outlet port pressure acting upwardly on the area of the valve seat 20.

Screwed into the lower end of the valve body 17 is an adjusting screw 30 by which the compressive force of the spring 31 against the valve member 28 may be varied to yieldably urge it into engagement with said seat 20. Inadvertent removal of the adjusting screw 30 is prevented as by means of the snap ring 32, and a protective cap 34 is screwed onto the lower end of the body 17 to prevent tampering with the adjusting screw and to exclude dirt and other foreign matter.

As shown, the stem 26 is tapered to provide a flow passage for refrigerant between the seat 20 and the ball 28 when the latter is moved down out of engagement with the seat 20. By reason of the seal 27 in the bore 18 being of the same diameter as the seat 20, pressure variations of the refrigerant in the inlet port 7 or the outlet port 9 will not tend to move the ball 28 toward or away from the seat 20, and thus the movement of the ball 28 away from the seat 20 is a function only of the pressure differential in the power element between chamber 35 and chamber 29. When the pressure differential is such that the resulting force overcomes the force of the spring 31, the ball 28 will move away from the seat 20 to permit predetermined rate of flow of refrigerant through the expansion valve 1, the flow being accurately metered in accordance with the pressure differential. The expansion valve 1 in FIG. 1 is internally equalized in that the chamber 29 beneath the diaphragm 21 is exposed to pressure in the outlet port 9 of the valve body 17.

The expansion valve 1' shown in FIG. 2 may be of the same construction as just described except that it is externally equalized in that the chamber 29 beneath the diaphragm 21 is exposed to refrigerant pressure at the outlet end of the evaporator 2 via passage 36 and conduit 37 which would be somewhat less than the pressure in the outlet port 9 owing to the pressure drop between the expansion valve 1' and the outlet end of the evaporator 2. However, the annular area of the chamber 29 is substantially greater than the area of the seat 20 and only small pressure drops or variations in pressure occur at the evaporator 2 which are generally not significant to unbalance the valve element 28 and the pressure differential across the power element 21 will effect predominant control of the movements of the ball 28.

We, therefore, particularly point out and distinctly claim as our invention:

1. An expansion valve for a compression type refrigerating unit having an evaporator, a compressor, and a condenser; said valve comprising an open ended tubular body having coaxial longitudinal bores of different diameters defining a shoulder therebetween with the smaller bore terminating in a valve seat at said shoulder, and having longitudinally spaced apart lateral openings which provide inlet and outlet ports intersecting the respective smaller and larger bores upstream and downstream of said valve seat for flow of refrigerant from the condenser to the evaporator; a valve member movable in said larger bore into and out of engagement with said valve seat to regulate the flow of refrigerant from said inlet port to said outlet port; said valve member having a stem portion of diameter substantially equal to the diameter of said valve seat and said smaller bore, and a packing ring between said stem portion and said smaller bore effective to slidably seal said stem portion in said smaller bore axially beyond said inlet port; said stem portion between said valve member and said inlet port being of diameter smaller than said smaller bore thereby to provide an annular passage for flow of refrigerant from said inlet port to said outlet port when said valve member is moved out of engagement with said valve seat; said smaller bore terminating at one end of said body in an enlarged internally threaded bore, and said larger bore having an internally threaded portion adjacent to said outlet port and an unthreaded counterbored portion open at the other end of said body; a temperature responsive power unit screwed into said enlarged threaded bore and having a movable power element engaged with said stem portion and exposed to refrigerant pressure downstream of said valve seat via a passage in said body opening into a shoulder defined between said smaller bore and said enlarged internally threaded bore thus to move said valve member to control the flow of refrigerant from said inlet port to said outlet port via said seat; an adjusting screw having threaded engagement with said threaded portion, and a packing ring between said adjusting screw and said unthreaded counterbored portion to provide sliding sealed engagement of said adjusting screw with said unthreaded counterbored portion in various positions of adjustment of said adjusting screw and during adjustment thereof; and spring means adjustably compressed between said adjusting screw and said valve member tending to urge said valve member into engagement with said valve seat.

2. The expansion valve of claim 1 wherein said passage extends alongside said smaller bore and opens at the shoulder between said smaller and larger bores whereby said power element is exposed to refrigerant pressure immediately downstream of said seat.

3. The expansion valve of claim 1 wherein said body is externally threaded at said other end; wherein a closure cap is screwed onto said other end of said body to prevent access to said adjusting screw except when said cap is removed from said body; and wherein said unthreaded counterbored portion has an internal groove with a retaining ring therein which radially overlaps said adjusting screw to prevent inadvertent withdrawal of said adjusting screw from said body even when said cap is removed.

4. The expansion valve of claim 1 wherein said body is in the form of a length of bar stock.

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