

[54] REFRIGERATION VALVE

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[51] Int. Cl. F25b 41/04

[58] Field of Search 62/217, 222-225,
62/206, 474, 509

[56]

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[57]

ABSTRACT

Each of the valves shown has parallel flow paths through the body with an expansion valve in the line leading to the evaporator thermostatically controlled by conditions in the return line. A second valve is positioned in the return line and controlled in response to a condition (temperature or pressure) which is indicative of conditions (temperature and pressure) in the evaporator. This arrangement prevents evaporator freezing. The valves are suited for flange fitting by reason of having all ports parallel enabling the valve to be secured to the evaporator (on one side) and to the compressor suction line and the condenser outlet on the other side. Since the thermostatic expansion valve can be "externally equalized" internally and all control functions are incorporated in the single body, the number of connections to be made by the system assembler are minimized. One version is provided with a receiver-drier which can be changed without disturbing other system connections.

7 Claims, 8 Drawing Figures

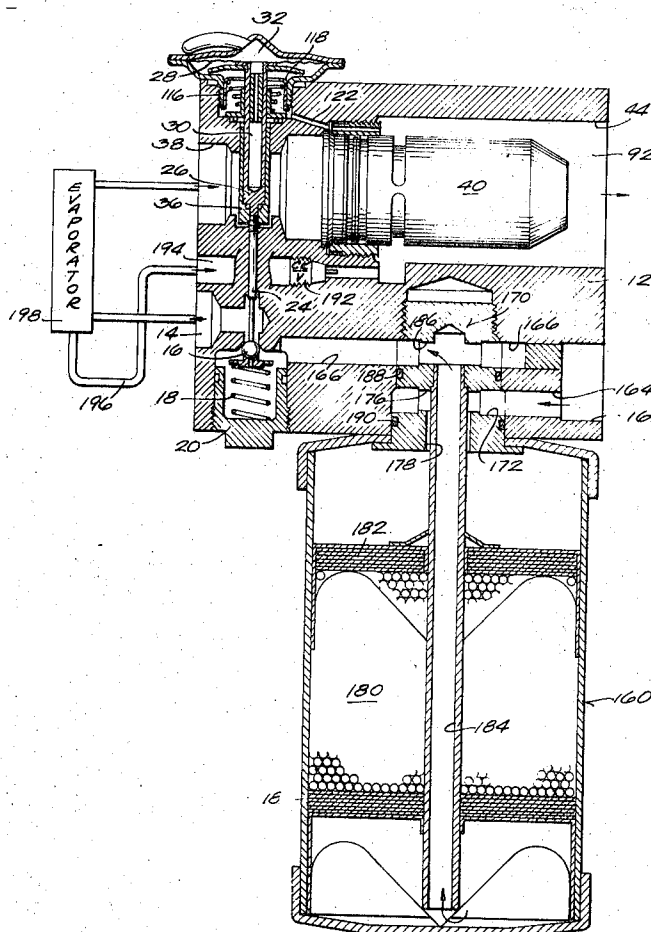
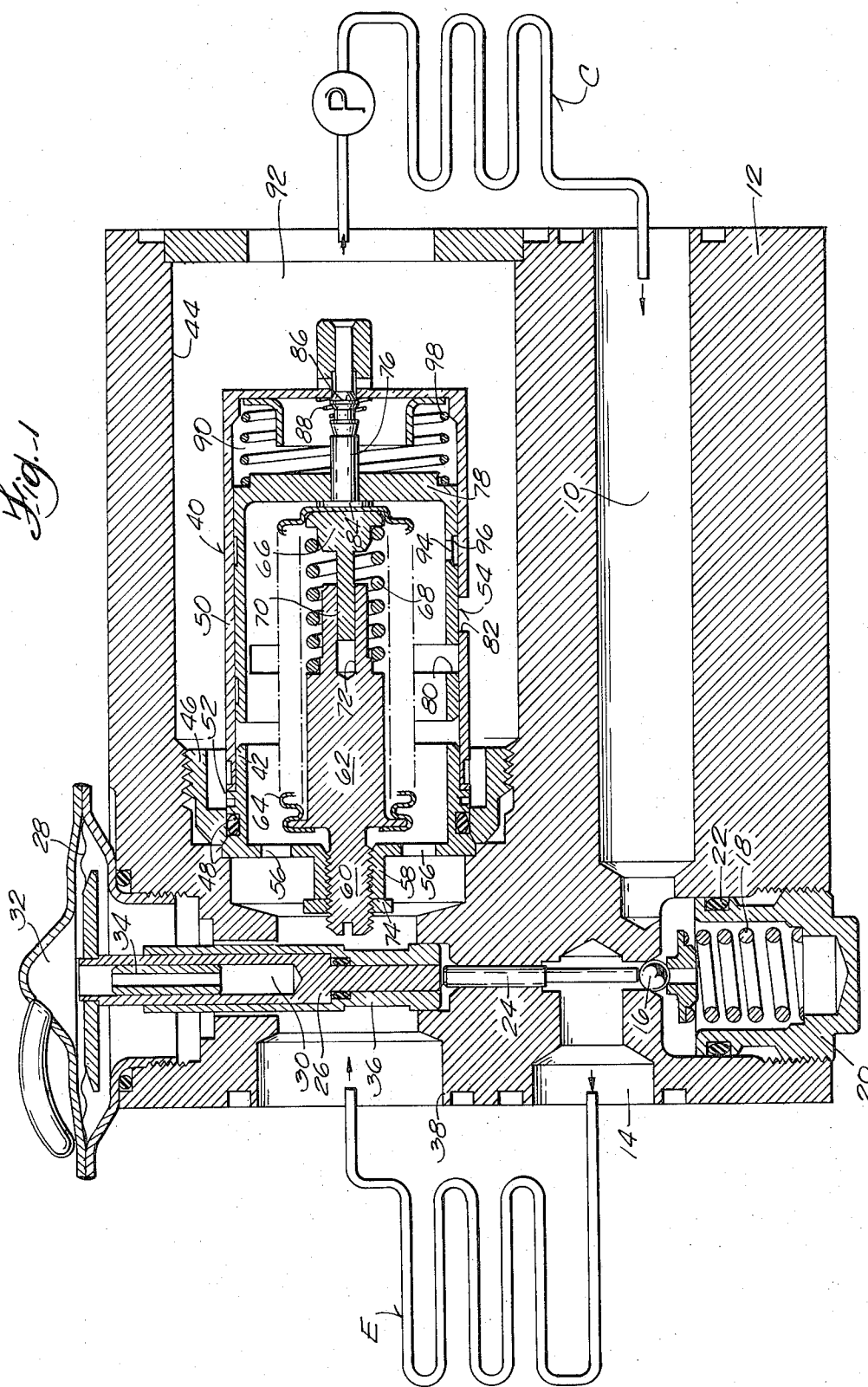
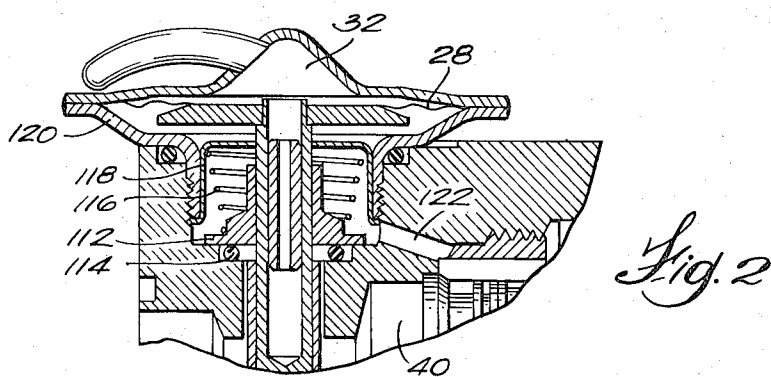
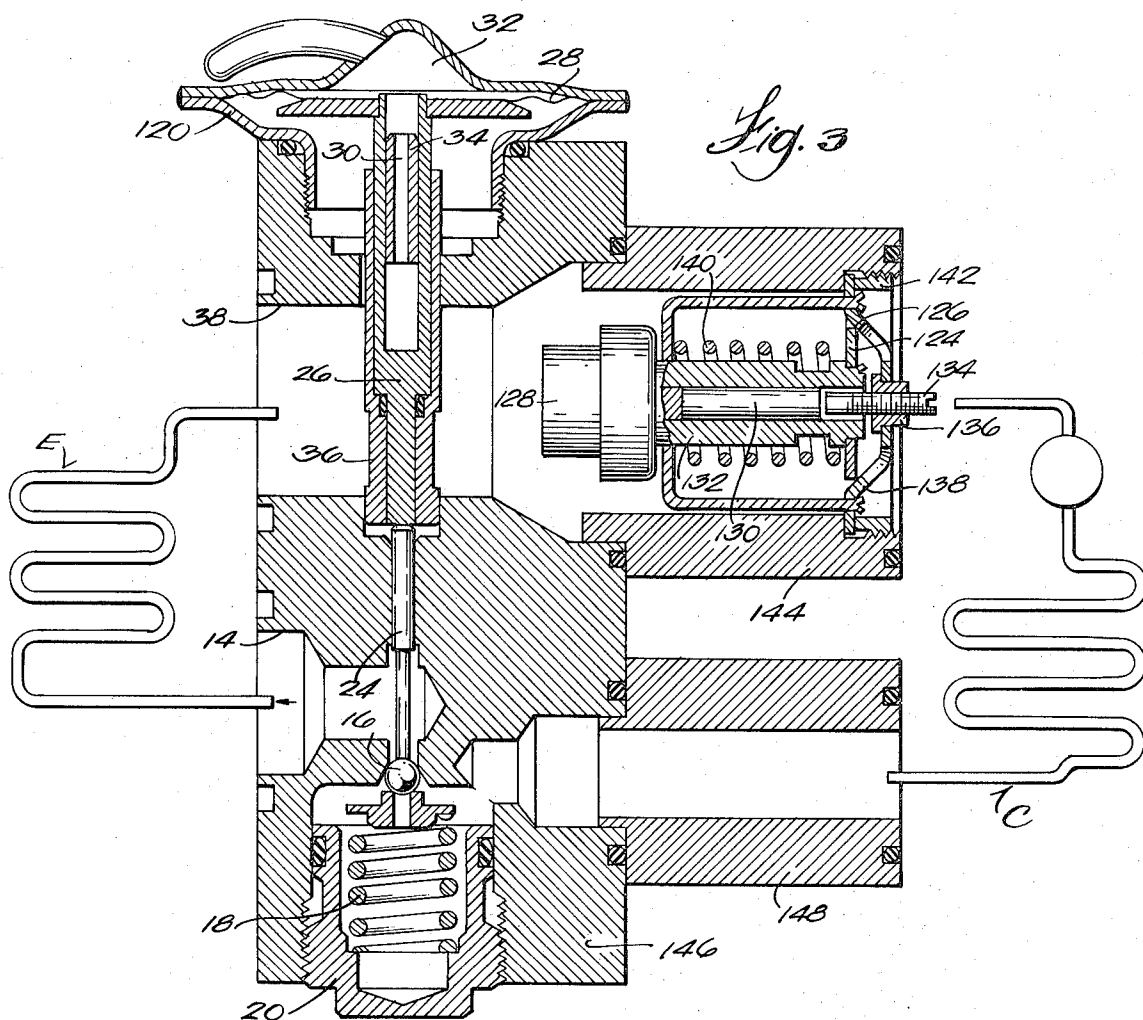
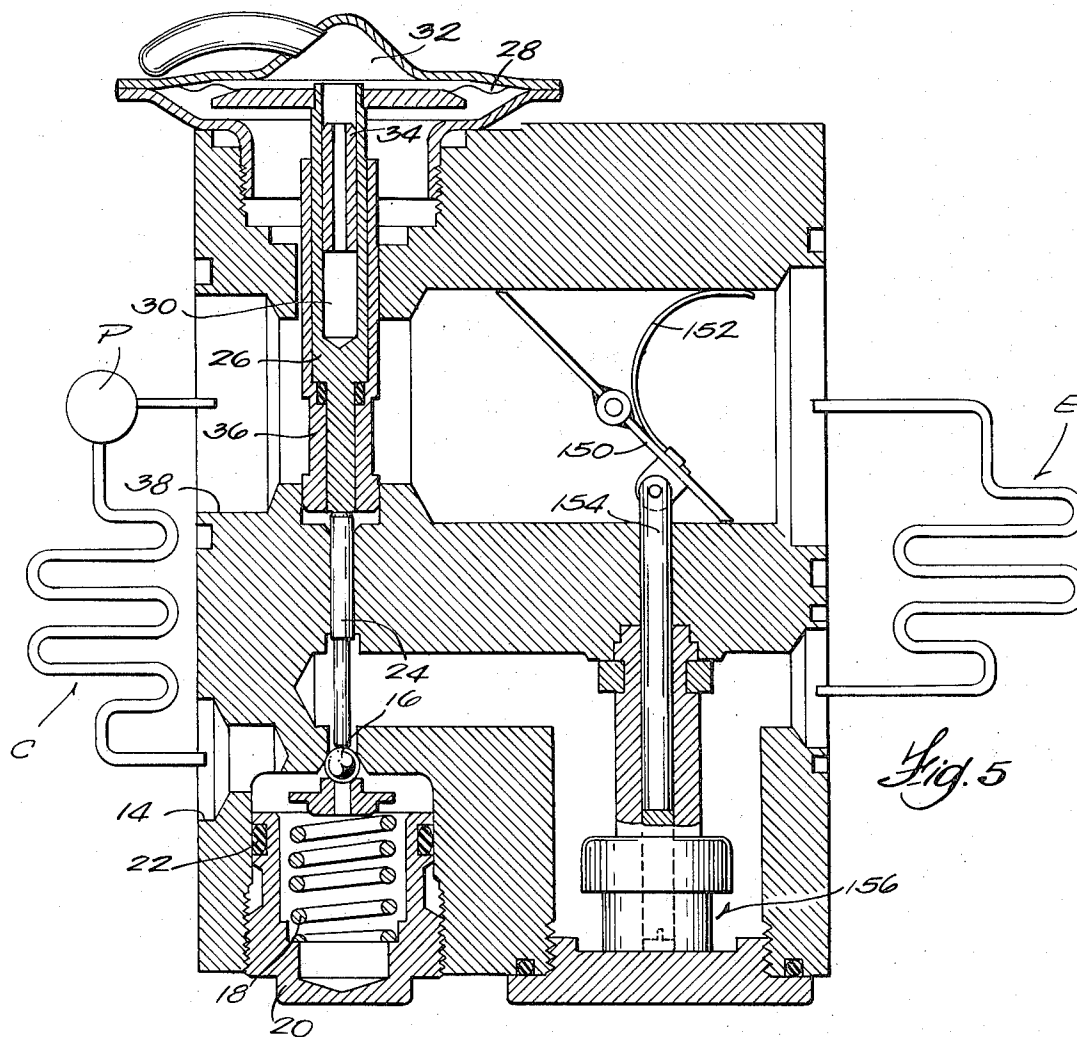
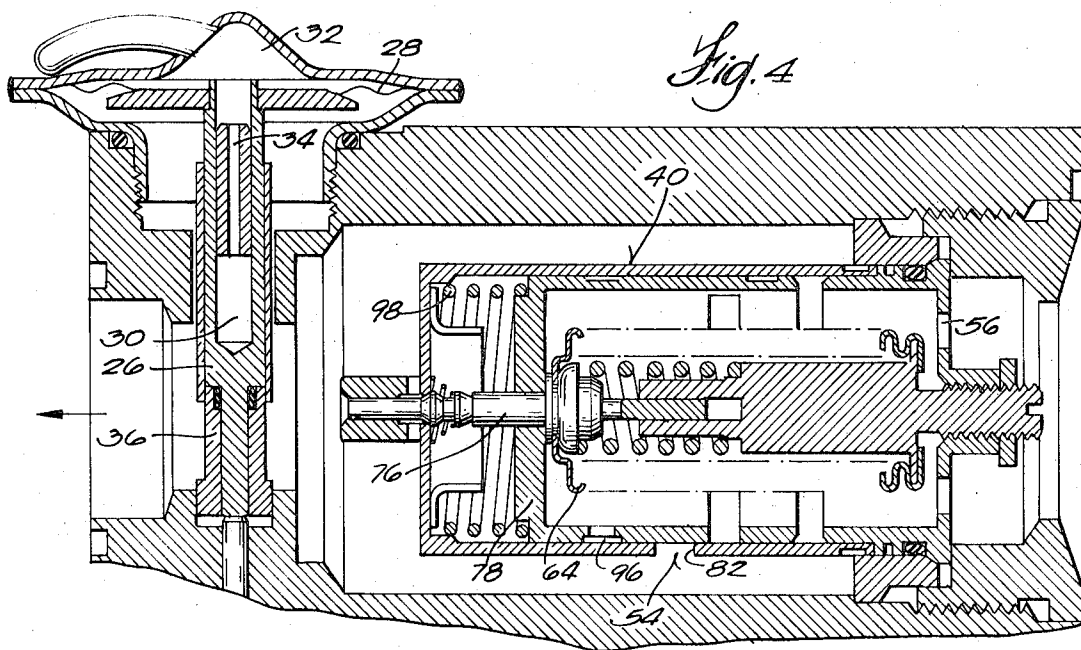
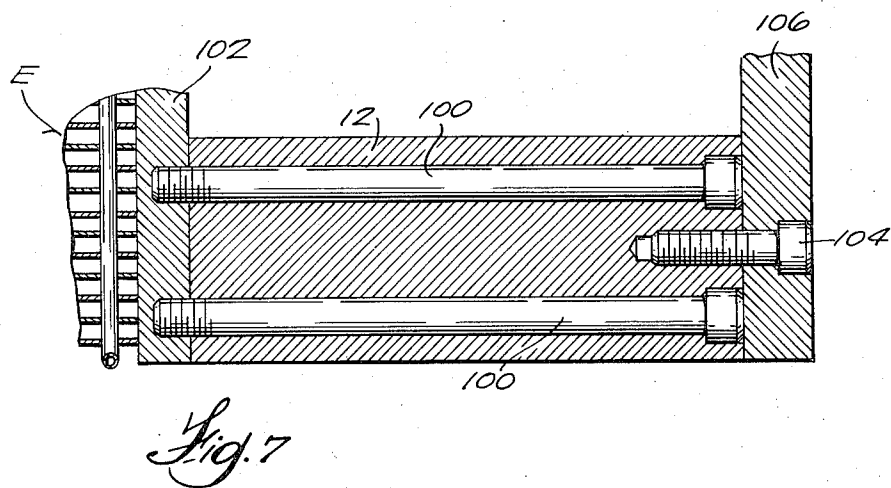
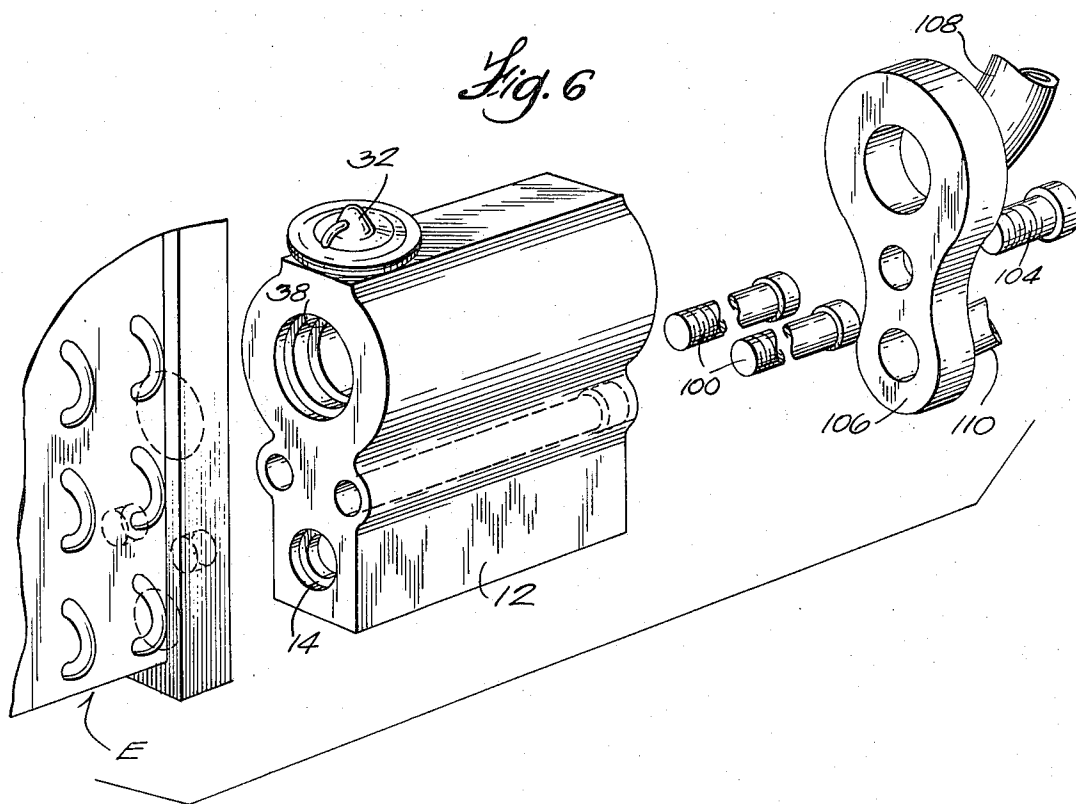


Fig. 1









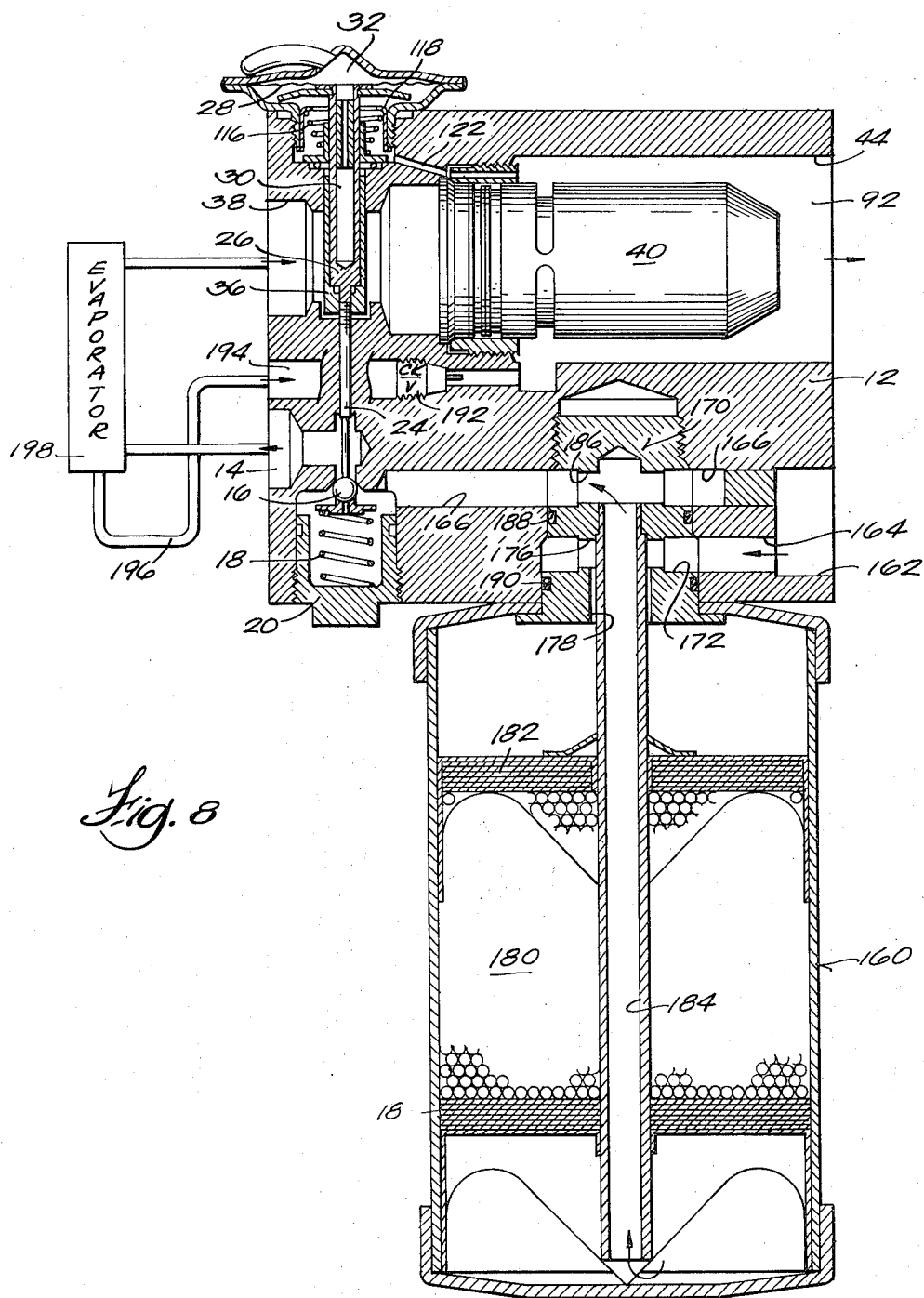


Fig. 8

REFRIGERATION VALVE

CROSS-REFERENCES TO RELATED APPLICATIONS

An improved version of the evaporator pressure regulating valve is shown in U.S. application Ser. No. 308,029, filed Nov. 20, 1972. The (wax element) suction temperature responsive valve (FIG. 3) is claimed in application Ser. No. 354,234, filed Apr. 25, 1973.

BACKGROUND OF THE INVENTION

This invention primarily relates to automotive air conditioning but is applicable to other air conditioning applications. Systems using thermostatic expansion valves (TXV) and an evaporator pressure regulator valve (EPR) or a suction temperature responsive valve (STV) have required numerous connections in final assembly of the system. This is costly and increases chances of foreign matter getting into the system. Physical separation of the control valves detracts from the maximum efficiency of the system.

Prior Art

The thermostatic expansion valve portion of the present design is shown in U.S. Pat. No. 3,537,645 and the evaporator pressure regulator valve is shown in U.S. Pat. No. 3,614,966.

SUMMARY OF THE INVENTION

The construction described in the Abstract reduces assembly into the system to the simplest form while bringing the control points close to maximize system efficiency. While a number of variations are illustrated, others are possible. The design has been directed to achieving maximum flexibility in that the EPR valve and wax element valve may be interchanged in the body. The flange mounting approach enables use of O-ring seals and avoids soldered connections. While the TXV and EPR appear in the prior art, there has been no suggestion as to how they might be combined in a single body with consequent increase in efficiency of the system nor has there been any teaching as to how the TXV can be simply "externally equalized" by an internal connection when the TXV is combined with the EPR in a single body.

The construction shown in FIG. 5 is unique in that the temperature sensing wax element is in the TXV outlet to the evaporator and "feels" boiling refrigerant so the response temperature can be selected to correspond to saturation pressure. Thus the temperature responsive wax element actuator is actually controlling pressure.

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a vertical section through the combination valve and includes a schematic representation of the complete air conditioning system.

FIG. 2 is a fragmentary section of the construction shown in FIG. 1 but modified to "externally equalize" the valve internally for use in flooded systems.

FIG. 3 is generally comparable to FIG. 1 but shows the manner in which a temperature actuated (wax element) valve may be utilized in lieu of an evaporator pressure regulator valve and the manner in which the wax element valve can be incorporated in a separate body.

FIG. 4 is a fragmentary section similar to FIG. 1 but shows the evaporator pressure regulator valve reversed in the body and the temperature sensing point of the thermostatic expansion valve downstream of the evaporator pressure regulator valve.

FIG. 5 is another variation in which the butterfly valve in the return line is regulated by a wax element actuator positioned in the boiling refrigerant on the outlet of the thermostatic expansion valve whereby the valve functions as an evaporator pressure regulator valve notwithstanding the fact it is temperature responsive.

FIG. 6 is an exploded perspective showing the manner in which the preferred valve body can be simply mounted into a system by three screws.

FIG. 7 is a fragmentary section showing the body mounted in the system.

FIG. 8 shows a valve of the type provided with a receiver-drier which may be serviced or changed without disturbing other system connections. The valve also has a relief controlled bypass line insuring compressor lubrication.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 the compressor P delivers hot, compressed refrigerant to the condenser C and the liquid refrigerant leaving the condenser may optionally go to a receiver but eventually goes into conduit 10 in the valve body 12. Flow from inlet 10 to outlet 14 is regulated by the thermostatic expansion valve which in this case comprises the ball-type valve 16 biased in the closing direction by spring 18 supported in the closure member 20 which is threaded into the body and is sealed by means of O-ring 22. The valve is moved in the opening direction by push pin 24 which is actuated by the rider pin 26 actuated by diaphragm 28. The rider pin is hollow so that the space 30 can communicate with the charged space 32 above the diaphragm. Thus the sensing for the chamber above the diaphragm is the temperature in space 30 inside the rider pin 26. The restrictor 34 minimizes migration of liquid slugs from the space 30 to the diaphragm chamber 32 even if the valve is inverted. The rider pin 26 is partially insulated by the plastic sleeve 36 to reduce hunting effects in the valve operation.

The body outlet 14 is connected to the inlet of the evaporator E and the refrigerant leaving the evaporator enters port 38 and passes over the hollow rider pin. Thus the temperature sensed by the hollow rider pin and the charge therein is the temperature in the return flow line and the outlet of the evaporator E. The pressure at this point can communicate with the underside of the diaphragm 28 and thus the actuation of valve 16 is influenced by the temperature and pressure surrounding the rider pin. Complete details of construction of this type of valve may be found in U.S. Pat. No. 3,537,645.

Valve 40 is an evaporator pressure regulator valve (EPR) and functions to control the pressure in the evaporator E. The EPR 40 includes a sleeve 42 fixed in the return conduit 44 by the retaining ring 46 which also captures the O-ring 48 to seal against flow around sleeve 42. Sleeve 50 is welded to sleeve 42 at 52. This construction facilitates mounting the inside parts but results in what amounts to a single sleeve in which piston 54 is mounted. The left end of the fixed sleeve is

provided with inlet ports 56 and has a central internally threaded boss 58 through which the threaded stem 60 of the bellows support 62 extends. The bellows support has a bellows 64 secured thereto with the other end of the bellows passing over seat 66 which serves as a seat for spring 68 inside the bellows. The seat has a guide stem 70 which is received in the blind hole 72 in the bellows support member. The space inside the bellows is at atmospheric pressure when it is sealed. Thus the pressure on the outside of the bellows is resisted by the atmospheric pressure within the bellows as well as by spring 68. The degree of compression of the spring (thus the response pressure) is determined by turing the threaded stem 60 relative to the boss 58. At the conclusion of the adjustment, the threaded boss 58 may be crimped into the thread and the lock nut 74 is turned down tight.

The bellows assembly acts against the head of the actuating pin 76 passes through the head 78 of the piston 54. The fit between the piston and the sleeve must be carefully controlled since this determines the leak rate allowed through the valve when the valve is closed. Too much leakage would cause the evaporator coil to freeze up while too little would not permit adequate oil circulation through the compressor and would cause the compressor suction pressure to run below atmospheric.

In the illustrated position the ports 80 through the piston skirt are blanked by the cylindrical housing and cannot register with the outlet ports 82 in the sleeve. When the pressure surrounding the bellows exceeds the adjusted value, it overcomes the atmospheric pressure and spring inside the bellows and the force of spring 68 to move the bellows to the left, thus relieving the force on the actuating pin 76. The large head 84 on the pin 76 avoids damage to the bellows by reason of localized force. When the bellows moves to the left and the force on the pin 76 is relieved, the forces are relieved from the pilot valve 86 so that the spring 88 compressed between the head of the sleeve and valve 86 can move the valve 86 to the left away from the cooperating seat and allow flow from the pilot chamber 90 past the valve 86 to the outlet 92. This drops the pressure in the pilot chamber 90 since flow from the chamber now exceeds the rate of flow permitted by the small port 94 communicating with the peripheral groove 96 around the right end of the piston. With reduced pressure in the pilot chamber the higher pressure acting on the left of the piston head can overcome the return spring 98 to move the piston to the right to bring the piston ports into registry with the sleeve ports to allow full flow through the regulator valve. When the pressure surrounding the bellows drops below the desired value, the bellows starts to expand and this will act through the actuating pin and valve 86 to close the pilot valve 86 whereupon the pressure in the pilot chamber will rise and allow spring 98 to move the piston to the left to close the main valve. When pilot valve 86 is closed, the bellows pin valve assembly is solid and spring 98 can return the piston to the left only until the piston head abuts the large head 84 of pin 76.

Flow from the outlet 92, of course, goes to the compressor P. It will be noted that outlet 92 as well as all the other body ports are surrounded by O-ring grooves. This permits sealing by simply clamping the valve body 12 in its final assembled relationship. This is illustrated in FIGS. 6 and 7. Here the two cap screws 100, 100

pass through the body 12 and are secured directly into the plate 102 on the evaporator coil assembly E. This, then, secures the body to the evaporator with O-rings captured in the grooves surrounding ports 14 and 38 and thus seals the body relative to the evaporator. Now, then, it is simply a matter of connecting one more fitting to the right side of the body and this is done by means of cap screw 104 which passes through the fitting 106 and is threaded into the body. This seals fitting 106 relative to the body. It will be understood that the fitting 106 has a line 108 leading to the compressor and another line 110 leading from the coil C.

Going back now to FIG. 1, it will be seen that the evaporator pressure regulator valve in this embodiment regulates the pressure immediately to the left of the evaporator pressure regulator valve and, hence, in the region of the rider pin which is the temperature sensing point. This, then, gives a fine correlation between the pressure regulation occasioned by the evaporator pressure regulator valve and the pressure sensed by the thermostatic expansion valve. If it is desired to provide the thermostatic expansion valve with the EPR downstream and have it function in the manner of an externally equalized valve, the rider pin 26 is sealed to minimize leakage past the pin to the underside of the diaphragm 28. For this purpose the flange member 112 (FIG. 2) is snugly fitted over the pin in the chamber under the diaphragm and is held down against the O-ring 114 (to seal at that point) by spring 116 compressed against the retainer 118 captured under the threaded end of the diaphragm cup 120. A port 122 is drilled from the chamber under diaphragm 28 into the chamber in which the evaporator pressure regulator valve is mounted but entering that chamber on the low pressure or suction side of the vaporator pressure regulator valve. Now, then, this simple port 122 functions as an external equalizer and yet requires no external capillary connection as heretofore required.

In the embodiment of FIG. 3 the evaporator pressure regulator valve described in connection with FIGS. 1 and 2 has been replaced by a wax element temperature responsive valve which functions to regulate movement of valve 124 relative to seat 126 in accordance with the temperature sensed around the wax element power head 128. The details of this wax element valve are claimed in a copending application as indicated above. For these purposes suffice it to say that expansion and contraction of wax within the housing 128 results in moving the plunger 130 relative to the sleeve 132 or vice versa. In this instance the plunger 130 is not movable, that is it abuts the adjusting screw 134 threaded in boss 136 carried by spider 138 acting against valve 124 carried on the right end of sleeve 132. Contraction of wax acts to move the valve against seat 126 while expansion of the wax in housing 128 will function to push the housing and sleeve 132 to the left and move valve 124 off seat 126 simply because there is expansion taking place in the chamber 128 and the only way the device can "make room" is to move away from the plunger 130. As the wax solidifies and contracts, the spring 140 returns the valve 124 to the closed position. In this embodiment the valve 124 in the return line is regulated in accordance with temperature surrounding element 128 which is virtually the same as the temperature surrounding the hollow rider pin of the thermostatic expansion valve. Since temperature and pressure are related, the functional result is much the same as

when using an evaporator pressure valve. It will be noted in this instance that the wax element valve is retained by threaded ring 142 in a sleeve 144 which functions as a separate housing. This permits this particular wax element valve to be sold as a separate item or adapted to the combination valve concept. In any event, it will be noted that since the sleeve 144 projects beyond the valve body 146 of the thermostatic expansion valve, an adapter inlet sleeve 148 is used to come out flush with the outboard end of sleeve 144 to permit a single flat flange to be utilized in mounting. However, a stepped flange could be used if desired although maintenance of the dimensional requirements would be rather difficult. It will be understood also that this arrangement can be adapted to the type of body utilized in the embodiment of FIG. 1. It is also to be observed that, if desired, the wax element valve can be mounted in a sleeve which is, in turn, mounted in the return line downstream of the TXV rider pin and spaced from the return line (except where sealed to the line) to permit equalization by an equalizer port from the space under the diaphragm to a point downstream of the wax element valve just as in the case of the equalized arrangement with the evaporator pressure regulator valve.

In the embodiment of FIG. 4 the flow in the return line is reversed, that is in FIG. 4 the flow goes from right to left. This occasions reversing the position of the evaporator pressure regulator valve 40 which in all other respects is the same as the evaporator pressure regulator valve illustrated in FIG. 1. This arrangement permits, in effect, regulating the pressure to the right of the evaporator pressure regulator valve and having the temperature and pressure sensing point of the thermostatic expansion valve located immediately downstream of the evaporator pressure regulator valve and in the suction line. There is a small gain in capacity by locating the thermostatic expansion valve sensing points downstream of the evaporator pressure regulator valve because the boiling liquid in the evaporator is brought closer to the end of the evaporator coil and, therefore, utilizes the coil a little more fully.

FIG. 5 also places the TXV sensing points (temperature and pressure) downstream (it could be upstream but would require complicated actuation of valve 150) of the regulating valve 150 in the return or suction line. The valve 150 is biased by spring 152 in a clockwise direction pushing the actuating pin 154 downwardly. When the wax in chamber 156 expands, it will push the pin upwardly to open the valve and the position of the butterfly valve 150 will be determined by the temperature at the wax element chamber 156. This is immediately downstream of the TXV and always feels boiling refrigerant. This means that the temperature always corresponds to the saturation pressure at this point and, therefore, it can be said that the wax element is actually or at least effectively controlling by pressure. In effect, therefore, this is the equivalent of an EPR valve rather than being strictly a temperature actuated valve. Since EPR valves have advantages over temperature actuated regulating valves, this arrangement takes advantage of the low cost of a wax element valve while achieving the functional virtues of the more costly EPR valve.

The valve shown in FIG. 8 is provided with a drier-receiver 160 mounted on the body 12. The body 12 is drilled in the same location as the inlet in FIG. 1, for example, but only to a shallow depth to provide a cavity or chamber 162. Two parallel holes 164, 166 are then

drilled with plug 168 being placed in hole 166 adjacent cavity 162. A cross hole is drilled to intersect holes 164 and 166 and the drier-receiver 160 is screwed into the cross hole with adapter fitting 170 threaded into the body so the groove 172 is aligned with hole 164 and groove 174 is aligned with inlet hole 166. Groove 172 communicates through holes 176 with the annular space 178 leading into the top of the receiver-drier cartridge. The cartridge contains deliquescent pellets 180 between filters 182. The refrigerant passes to the bottom of the cartridge and enters tube 184 which leads into the adapter to holes 186 and then into the inlet 166 to flow to valve 16. With this arrangement the system can be provided with a receiver-drier combined with the combination valve so the system can be completed with no additional connections in final assembly. The cartridge can be replaced simply by unscrewing the old one and screwing in a new one. It will be noted the adapter is provided with O-ring seals 188, 190 to respectively prevent flow from hole 164 directly to hole 166 (short circuiting the drier) and to prevent flow from hole 164 to atmosphere.

The valve in FIG. 8 is "externally equalized" as in FIG. 2 and operates as described relative to FIG. 2. The valve is also provided with a bypass around evaporator pressure regulator valve 40. Thus a pressure relief valve 192 is mounted in conduit 194 which is generally parallel to the suction conduit leading from the left hand face of the body to the outlet 92 downstream of the EPR 40. As previously noted in connection with FIG. 2, the fit in the EPR 40 must be carefully controlled to prevent evaporator freeze-up or inadequate lubrication when the valve is closed. With the FIG. 8 arrangement the relief valve is set to open at a desired pressure differential to permit a controlled leakage (thus avoiding fit problems in the EPR to achieve a controlled leakage) which can be taken from a low point in the evaporator (where lubricant tends to collect) and thus insure proper lubrication of the compressor. Thus conduit 196 can lead from the low point of evaporator 198 to the bypass conduit 194. The flange mounting capability is retained.

From the foregoing it can be seen this concept permits an extremely versatile approach to the system control with extreme simplicity in mounting the control in the system. Maximum use of parts and interchangeability to achieve various functions are assured. This, in turn, minimizes tooling and inventory problems.

I claim:

1. A control for a refrigeration system of the type having a compressor, condenser, and evaporator, the control comprising,

a valve body having a supply conduit and a suction conduit therethrough, the conduits being generally parallel,

a valve in the supply conduit to regulate flow to the evaporator,

means controlling said valve in accordance with temperature and pressure in the suction conduit,

a valve in the suction conduit regulating flow from the evaporator,

means controlling the valve in the suction conduit in accordance with a condition of refrigerant in said body at a location upstream of the suction conduit valve and which is directly related to the condition of refrigerant in the evaporator,

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said body being provided with two parallel faces and each conduit passes from one face to the other so connection in the system is simplified by having the connections to each face planar.

2. Apparatus according to claim 1 in which a receiver-drier means is mounted on the body and includes conduit means intersecting the supply conduit upstream of the valve in the supply conduit and operative to divert flow into the receiver-drier and return it to the supply conduit after passage through the receiver-drier.

3. Apparatus according to claim 2 in which the receiver-drier means is threadably mounted on the body for removal and mounting without disturbing other system connections.

4. Apparatus according to claim 2 including a bypass conduit in the body leading from one face to the suction conduit downstream of the valve in the suction conduit,

and a valve in the bypass conduit operative to open in response to a predetermined pressure differential thereacross.

5. A control for a refrigeration system of the type having a compressor, condenser, and evaporator, the control comprising,

a valve body having a supply conduit and a suction conduit therethrough, the conduits being generally parallel,

a valve in the supply conduit to regulate flow to the evaporator,

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means controlling said valve in accordance with temperature and pressure in the suction conduit, a valve in the suction conduit regulating flow from the evaporator,

means controlling the valve in the suction conduit in accordance with a condition of refrigerant in said body at a location upstream of the suction conduit valve and which is directly related to the condition of refrigerant in the evaporator,

said means controlling the valve in the supply conduit being responsive to temperature upstream of the suction valve and to pressure downstream of the suction valve.

6. Apparatus according to claim 5 in which the means controlling the valve in the supply conduit includes a diaphragm having one side exposed to pressure in a chamber,

a conduit located wholly within the valve body and leading from the chamber to a point in the suction conduit downstream of the valve in the suction conduit.

7. Apparatus according to claim 6 including a bypass conduit in the body leading from one face to the suction conduit downstream of the valve in the suction conduit,

and a valve in the bypass conduit operative to open in response to a predetermined pressure differential thereacross.

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