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REVERSIBLE REFRIGERATING SYSTEM

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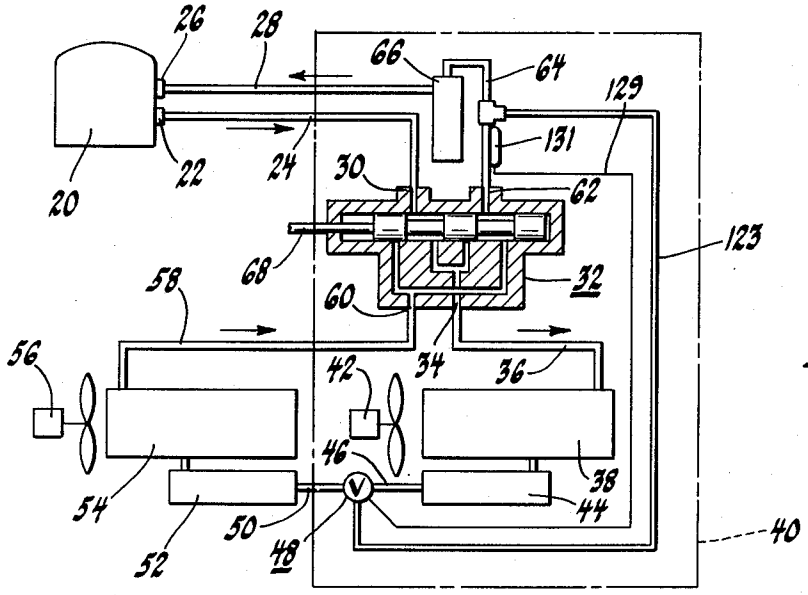


Fig. 1

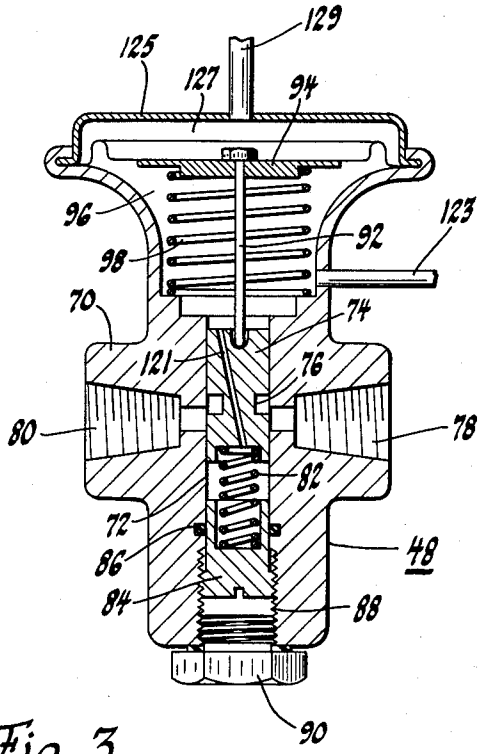


Fig. 3

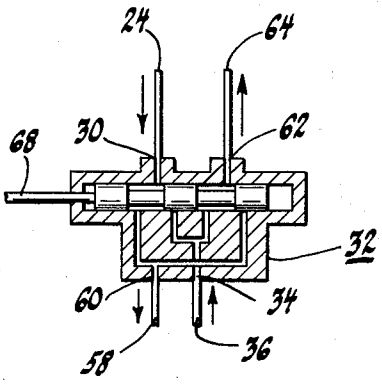


Fig. 2

INVENTOR.
Richard L. Merrell
BY
Edwin S. Dybnig
HIS ATTORNEY

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REVERSIBLE REFRIGERATING SYSTEM

Richard L. Merrell, Royal Oak, Mich., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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This invention relates to refrigerating apparatus and more particularly to refrigerating systems arranged for cooling and also provided with a reversing valve for providing reverse cycle refrigeration for heating.

The control of refrigerant flow in a reverse cycle refrigerating system has been a perplexing problem. There are a number of reasons for this. In a conventional system expansion valves are built for flow only in one direction. In a reverse cycle system, to obtain maximum efficiency from the heat transfer units, it is necessary to provide an arrangement whereby whichever unit becomes the evaporator it will be kept substantially filled with liquid refrigerant. Yet the return of liquid refrigerant to the compressor must be prevented at all times. Since the outside heat transfer unit is larger and since the temperature conditions for heating and cooling are different, the refrigerant flow must be greater during the cooling cycle than during the heating cycle. This has lead to the use of various combinations of pressure responsive valves, check valves and restrictors.

It is an object of this invention to provide a refrigerating system with a single simple temperature responsive valve arranged to keep whichever heat transfer unit is serving as the evaporator substantially filled with liquid refrigerant without returning any liquid refrigerant to the compressor.

It is another object of this invention to provide a refrigerating system with a single simple temperature responsive valve so arranged that its thermostatic bulb is always responsive to the temperature of the refrigerant flow out of the heat transfer unit serving as the evaporator regardless of whether a system is on the heating cycle or the cooling cycle so that the system will be kept at its maximum efficiency.

These and other objects are attained in the form of the invention shown in the drawings in which a two-way piston-type thermostatic expansion valve is connected between the indoor and outdoor heat transfer units. A reversing valve is connected in between these two heat transfer units and the compressor intake and discharge ports. The thermostatic bulb and the pressure equalizer connection of the valve are connected to the suction line between the reversing valve and the compressor.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Figure 1 is a diagrammatic view of a refrigerating system embodying one form of my invention with the reversing valve arranged for heating;

Figure 2 is a fragmentary view showing the reversing valve in position for cooling; and

Figure 3 is a vertical sectional view through one form of thermostatic expansion valve as shown in Figure 1.

Referring to the drawings more particularly to Figure 1 there is shown a sealed motor compressor unit 20 provided with a discharge outlet 22 and a discharge conduit 24. The compressor also is provided with a suction port 26 and a suction conduit 28. The discharge conduit 24 connects to the inlet 30 of the reversing valve 32. The reversing valve has a central passage 34 connected by the conduit 36 with one terminal of the indoor heat transfer unit 38. The heat transfer unit 38 as well as the reversing valve 32 may be located in a room or other space to be cooled indicated by the dot-dash enclosure 40. The air from the room or enclosure may be circulated in heat transfer relationship with the heat transfer unit 38 by the electric motor driven fan 42.

The heat transfer unit 38 may be connected to a receiver 44 which in turn is connected through the conduit 46 to one side of the thermostatic automatic expansion valve 48. The opposite side of the valve 48 is connected by the conduit 50 to a receiver 52 connected to and located beneath the outdoor heat transfer unit 54 which is located outside the room or compartment 40. An electric motor driven fan 56 is provided for circulating air outside the enclosure 40 into heat transfer relationship with the heat transfer unit 54. The heat transfer unit 54 has its second terminal connected by the conduit 58 with the outer passage 60 of the reversing valve 32. The reversing valve 32 also has a return port 62 connected by the conduit 64 to the top of a liquid trap 66. The side of this liquid trap 66 connects directly to the suction conduit 28. The reversing valve 32 may take any desired form but in Figure 1 it is shown as a piston-type valve with three sealing pistons connected in spaced relation upon the piston rod 68. When the pistons are in the right position shown in Figure 1 the inlet 30 connects through the space between the left pistons to the left center port connecting with the passage 34. The passage 60 connects through the right port between the two pistons on the right providing a connection with the return port 62. When the valve is in position for cooling as shown in Figure 2 the piston rod 68 is moved to the left so that the inlet port 30 connects between the center and left pistons through the left port to the passage 60 while the return port 62 connects between the center and right pistons through the right center port to the passage 34.

The expansion valve 48 includes a valve body 70 provided with a vertical cylinder bore 72 containing a piston 74. This piston 74 is provided with an annular groove 76 providing a passage between the right conduit connection 78 and the left conduit connection 80. The piston 74 is recessed at the bottom so as to retain the upper end of a compression spring 82. The lower end of the compression spring 82 is supported by an adjustable threaded plug 84 sealed by the synthetic rubber ring 86 located in an annular recess in the valve body provided in the vertical cylindrical bore 72. The threaded plug 84 is adjustably located in an enlarged threaded bore 88 coaxially aligned with the cylindrical bore 72. The threaded bore 88 is sealed by a cap screw 90 having a gasket under its head.

The upper end of the piston 74 is provided with a small recess receiving the lower end of a push pin 92. The upper end of this push pin 92 is connected to the diaphragm 94. The diaphragm 94 extends across and is sealed to the upper rim of the valve body 70. Between the diaphragm 94 and the piston 74 is provided a pressure chamber 96 containing a valve spring 98 which tends to urge the diaphragm 94 upwardly. The piston 74 may contain an equalizer passage 121 extending from the top to the bottom of the piston 74 to connect the chambers above and below the piston 74. The pressure chamber 96 is connected by an equalizer tube 123 with the suction conduit port 64 located between the liquid separator 66 and the valve 32. Above the diaphragm 94 there is

provided a cap enclosure 125 likewise sealed to the valve body 70 and forming a sealed chamber 127 between the diaphragm 94 and the cap 125. This chamber is connected by the capillary tube 129 to the thermostat bulb 131 which is clamped to the conduit 64 between the liquid separator 66 and the reversing valve 32.

With the valve 48 and the system so arranged, the sealed motor compressor unit will pump compressed refrigerant through the conduit 24, the port 30, the passage 34, the conduit 36 to the heat transfer unit 38 which in the heating arrangement shown in Figure 1 will act as a condenser. The fan 42 will circulate the air from the room or compartment 40 into heat transfer relation with the indoor heat transfer unit 38 so as to heat the air in the room or compartment 40 and condense the refrigerant in the unit 38. The condensed refrigerant will be collected in the receiver 44. This condensed refrigerant will flow through the conduit 46 to the conduit connection 78 and through the passage 76 of the valve 48 to the conduit connection 80. The conduit connection 80 will connect through the conduit 50 to the receiver 52. The valve 48 will restrict the flow of liquid refrigerant which will evaporate under reduced pressure within the heat transfer unit 54. The air from the outside will be circulated by the fan into heat transfer relationship with the heat transfer unit 54 so as to heat and evaporate the liquid refrigerant.

The evaporated refrigerant will then flow through the conduit 58, the passage 60 in the valve 32 to the return port 62. From the port 62 this refrigerant will flow into heat transfer relationship with the thermostat bulb 131. This thermostat bulb 131 will control the valve 48 so as to keep the heat transfer unit 54 substantially filled with liquid refrigerant but which will throttle the valve 48 sufficiently when liquid refrigerant approaches the bulb 131 to prevent refrigerant in liquid form from coming nearer to the motor compressor unit 20. The evaporated refrigerant will flow through the conduit 64 into the top of the liquid refrigerant separator 66. Should any liquid refrigerant be swept by the evaporated refrigerant through the conduit 64 it will be collected in the separator 66 where it will evaporate before it flows through the suction conduit 28 to the sealed motor compressor unit 20.

When the system is used for cooling and the valve arranged as in Figure 2, the discharge conduit 24 now connects through the port 30 and the passage 60 with the conduit 58 to deliver the compressed refrigerant to the outside heat transfer unit 54. The fan 56 will circulate the air in heat transfer relationship with the unit 54 to condense the refrigerant. The condensed refrigerant will flow into the receiver 52 and through the conduit 50 to the valve 48. The valve 48 will control the flow of liquid refrigerant according to the temperature of the bulb 131 through the conduit 46 into the receiver 44 and the heat transfer unit 38 so as to keep the unit 38 substantially filled. The liquid refrigerant will evaporate in the unit 38 under reduced pressure and flow through the conduit 36 connected by the valve 32 through the passage 34 and return port 62 to the conduit 64 where it flows into heat transfer relationship with the bulb 131. The evaporated refrigerant returns through the separator 66 and the conduit 88 to the suction port 26 of the motor compressor unit 20.

The equalizer tube 123 applies the pressure prevailing in the conduit 64 adjacent the bulb 131 to the bottom of the diaphragm 94 while the pressure within the chamber 127 on top of the diaphragm 94 is responsive to the temperature of the bulb 131. This makes it possible to adjust the screw 84 so as to maintain a desired amount of the super heat at the point of the bulb 131 so as to keep the heat transfer units 54 and 38 substantially filled whenever either is operating as the evaporator in the system. In this way a simple thermostatic expansion valve is arranged so as to control the flow of refrigerant efficiently in both directions so as to automatically provide the proper flow to keep either of the units substantially filled with liquid refrigerant when it serves as the evaporator.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. Refrigerating apparatus including a motor compressor unit having a suction inlet and a discharge outlet, first and second heat transfer units each having two fluid terminals, a two-way thermostatic refrigerant expansion valve connecting in a single series circuit one terminal of each of the heat transfer units to provide a single series connection for flow in either direction between said heat transfer units, a reversing valve providing alternate connections between the other terminals of said heat transfer units and said inlet and outlet of said compressor unit, said expansion valve including a thermostatic bulb mounted in heat exchange relation with the connection between said reversing valve and said compressor inlet.

2. Refrigerating apparatus including a motor compressor unit having a suction inlet and a discharge outlet, first and second heat transfer units each having two fluid terminals, a two-way thermostatic refrigerant expansion valve connecting in a single series circuit one terminal of each of the heat transfer units to provide a single series connection for flow in either direction between said heat transfer units, a reversing valve providing alternate connections between the other terminals of said heat transfer units and said inlet and outlet of said compressor unit, said expansion valve including a thermostatic bulb mounted in heat exchange relation with the connection between said reversing valve and said compressor inlet, said expansion valve also including a sealed diaphragm chamber and an equalizer tube extending from said sealed chamber and connecting to the interior of said connection between said reversing valve and said compressor inlet.

3. Refrigerating apparatus including a motor compressor unit having a suction inlet and a discharge outlet, first and second heat transfer units each having two fluid terminals, a two-way thermostatic refrigerant expansion valve connecting in a single series circuit one terminal of each of the heat transfer units to provide a single series connection for flow in either direction between said heat transfer units, a reversing valve providing alternate connections between the other terminals of said heat transfer units and said inlet and outlet of said compressor unit, said expansion valve including a thermostatic bulb mounted in heat exchange relation with the connection between said reversing valve and said compressor inlet, said expansion valve also including a piston-type valve element capable of controlling the flow of refrigerant in either direction.

References Cited in the file of this patent

UNITED STATES PATENTS

2,139,297	Bergdoll	Dec. 6, 1938
2,182,718	Anderson et al.	Dec. 5, 1939
2,276,814	Zwickl	Mar. 17, 1942
2,353,240	Huggins	July 11, 1944
2,637,985	Ray	May 12, 1953
2,774,220	Heym	Dec. 18, 1956