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REFRIGERATION SYSTEM

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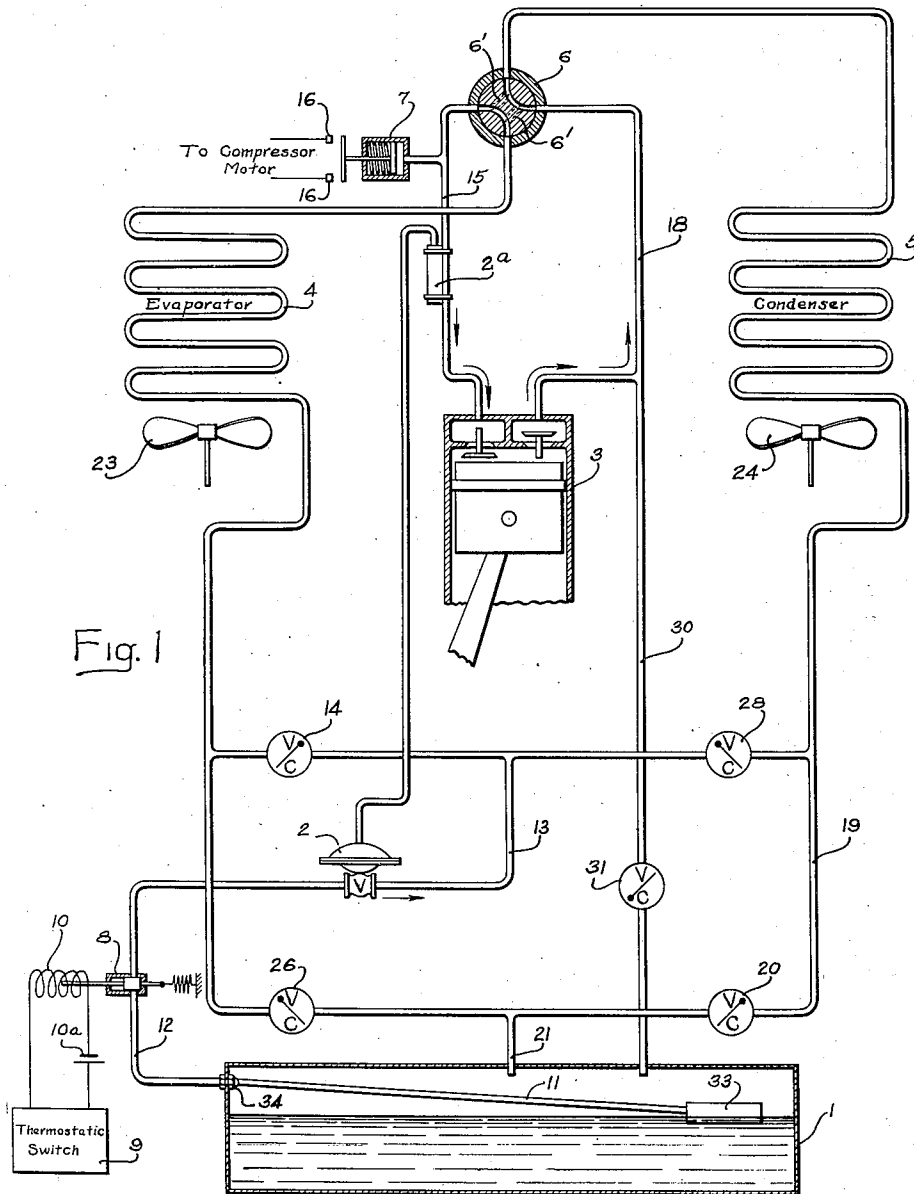


Fig. 1

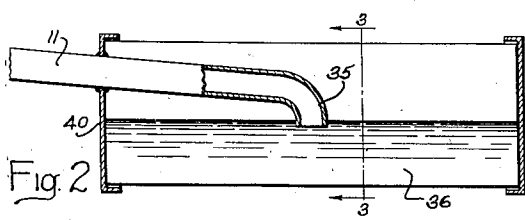


Fig. 2

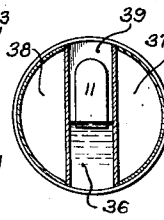


Fig. 3
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REFRIGERATION SYSTEM

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7 Claims. (Cl. 62—115)

This invention relates generally to a refrigeration system, more particularly of the reverse cycle type.

It is an object of my invention to provide an improved reverse cycle refrigerating system, wherein a single expansion valve may be effectively employed for either a heating or cooling cycle. A further object is to provide an improved reverse cycle refrigerating system having a single expansion valve mechanism that is coordinated in an improved manner with the suction side of the compressor and with various valve elements so as to insure maximum effectiveness and flexibility of operation with minimum manual operation of any control elements employed.

Another object is to provide an improved reverse cycle refrigerating system in which the compressor encounters minimum resistance during starting regardless of whether the system is utilized for a heating or cooling cycle.

A still further object is to provide an improved reverse cycle refrigerating system in which a stable balance between a refrigerant and lubricant is maintained in the system so as to avoid excessive accumulation of the lubricant in a receiver.

In the specific aspect of the invention, I accomplish the foregoing and other objects of my invention by providing a combination of a single thermostatic expansion valve with proper check valves whereby for both cycles the refrigerant always flows in the same direction through the expansion valve and consequently the pressure diaphragm of the expansion valve is never exposed to the high pressure side of the system which otherwise would be the case if two thermostatic expansion valves were used.

Other objects and advantages will be more apparent to those skilled in the art from the accompanying drawing in which:

Fig. 1 is a diagrammatic outline of my improved refrigerating system and the elements employed therewith.

Fig. 2 is an enlarged longitudinal section through my improved float; and

Fig. 3 is a transverse section taken on line 3—3 of Fig. 2.

Referring to the drawing, my improved system includes generally a receiver 1, a thermostatic expansion valve 2, a compressor 3, complementary heat exchange elements 4 and 5, a reversing valve 6, a high pressure-low pressure switch mechanism 7 and a magnetic liquid shut-off valve 8 controlled by a thermostat 9 which

is placed in a room or other suitable enclosure whose air is being conditioned. The thermostat 9 is of the summer-winter type so that it closes its contacts on a rise of temperature during the cooling season and on a fall of temperature during the heating season.

Cooling cycle operation.—When the room temperature rises above a predetermined value, the thermostat 9 closes thereby energizing solenoid 10, by current from a source diagrammatically indicated as a battery 10a, to cause valve 8 to open. Liquid refrigerant then flows from receiver 1 through pipes 11 and 12, thermostatic expansion valve 2, pipe 13, check valve 14 and to the evaporator 4, refrigerant vapor from the evaporator 4 flows through reversing valve 6 and suction line 15 to the inlet side of compressor 3. The compressor is not yet running and therefore the pressure in pipe 15 continuously increases. When the refrigerant pressure reaches a predetermined value it causes pressure switch 7 to close contacts 16 thereby starting in any usual manner a conventional compressor motor (not shown). When the compressor is running, it draws refrigerant vapor through the evaporator and discharges the same through a pipe 18, reversing valve 6 and thence through condenser 5, pipe 19, check valve 20 and pipe 21 which leads to the upper part of receiver 1. To maintain a certain predetermined superheat in the suction pipe 15 the cycle is regulated by means of the thermostatic expansion valve 2 and its power element 2a (which as is usual is attached to the suction pipe 15 leading to the compressor) thereby serving the purpose of controlling the volume of liquid refrigerant flowing from the receiver through pipes 12 and 13 to the evaporator and as a result maintaining a constant superheat in the suction pipe so as to prevent the slapping over of liquid from the evaporator into the compressor.

When the room temperature has fallen to a predetermined value (assuming that the refrigeration system is being used to cool the enclosure air), solenoid 10 will be deenergized to allow closure of valve 8. However, compressor 3 will continue to run thereby reducing pressure in the suction line 15. When the suction pressure falls to a predetermined low value, the switch mechanism 7 will open thereby stopping the compressor. It will be understood that the switch mechanism 7 is a well-known device per se adapted to close contact 16 upon occurrence of a predetermined high pressure and to open said contacts only when a predetermined lower pres-

sure is obtained. As a result of continuing the operation of the compressor after closure of valve 8, the evaporator pressure will be reduced to a minimum so that the compressor can be easily restarted. If the compressor did not continue to operate in the above manner, then the remaining liquid refrigerant in evaporator 4 would continue to build up vapor pressure in the suction line 15. This would create considerable back pressure against which the compressor would have to work when initially started which is avoided in my invention. It will also be understood that enclosure air is circulated over heat exchange element 4 by any suitable blower diagrammatically indicated at 23 while heat exchange element 5 is cooled by any suitable medium, preferably air from outside the enclosure circulated by a blower diagrammatically indicated at 24.

Heating cycle operation.—To utilize my improved system and apparatus for heating the enclosure air, the evaporator and condenser functions of heat exchange elements 4 and 5 are interchanged or reversed whereby element 4 now serves as a condenser and element 5 as an evaporator. Hence the room air which is circulated over condenser 4 will be heated by the condensing action while the element 5 now serving as an evaporator will absorb heat from the outside atmosphere or other medium circulated over the element 5. To effect said reversal a usual reversing valve 6 is rotated 90° whereby suction pipe 15 is connected to heat exchange element 5 and compressor discharge pipe 18 is connected to heat exchange element 4 as generally indicated by dotted lines 6'. The heat exchange element 4 (now a condenser) will be connected through a check valve 26 to receiver inlet pipe 21 while the heat exchange element 5 (now an evaporator) will receive liquid refrigerant from pipe 13 by way of valve 8 and check valve 28, valve 8 being opened by operation of thermostat 9 on a demand for heating. The corresponding check valves 14 and 20, which were previously operative during the cooling cycle, will be closed automatically merely upon adjustment of the reversing valve 6 to its heating position, or vice versa when the valve 6 is adjusted to its cooling operation. Since the heat exchange elements are cross-connected through the check valves, as just described, it is possible to utilize a single expansion valve 2 for either heating or cooling and to accomplish all the desirable operating characteristics above described regardless of whether the system is being used for heating or cooling. In each cycle the power element 2a of the thermostatic expansion valve 2 is connected to the pipe 15 which serves as a suction pipe that is common to either the heating or cooling cycle. The low pressure switch mechanism for controlling the compressor is also connected to the pipe 15, and, therefore, maintains its control of the compressor in accordance with the evaporator function simultaneously with the reversal of the cycle.

To prevent vapor pressure building up in receiver 1 and thereby insure free flow from pipe 21 into the receiver, there is provided a vent pipe 30 connecting receiver 1 with the discharge pipe 18. A check valve 31 is inserted in line 30 thereby insuring that vapor shall always be relieved in a direction away from receiver 1. The pipe 30 by being in communication with the discharge pipe 18 and with inlet pipe 21 functions as an equalizing pipe between the same to insure free flow of liquid from the condenser element to the receiver

without back pressure. This equalizing pipe functions during either cycle.

When utilizing a refrigerant such as "Freon" together with a lubricant such as castor oil, it is desirable to prevent an excessive accumulation of castor oil in the receiver, it being understood that the oil will float on top of the heavier liquid Freon. Hence I have provided an improved combination of a float 33 and outlet pipe 11. Pipe 11 is flexibly connected to pipe 12 in any suitable or usual manner such as through a flexible gas tight joint, say, the ball and socket type diagrammatically indicated at 34. The inner end of pipe 11 is turned down as at 35, Fig. 2 to terminate just slightly below the normal level of the liquid refrigerant 36. The pipe is rigidly connected to float 33 by extending between two semi-circular buoyant chambers 37 and 38 spaced apart to provide a longitudinal vertical slot or passageway 39, this passageway communicating freely at its top and bottom with the receiver 1. The two buoyant chambers 37 and 38 are rigidly connected together at their ends by suitable flanged end plates 40 and 41. If lubricating oil should tend to accumulate excessively in receiver 1, float 33 will rise with the oil thereby causing outlet pipe 11 to have direct communication with the oil which will thereupon flow out through pipe 11 and into the refrigerating system. In normal operation, however, the float will maintain a substantially stable balance between the amount of oil and refrigerant which flows out through pipe 11 and hence an excessive amount of oil will not normally accumulate in the receiver.

From the foregoing disclosure it is seen that I have provided an improved reverse cycle refrigerating system that allows maximum simplicity of expansion valve mechanism and which has maximum efficiency and flexibility of operation regardless of whether the refrigerating system is operating on a cooling or heating cycle. The various check valves 14 and 20 or the check valves 26 and 28 will automatically function in response to adjustment of the main reversing valve 6 thereby to coordinate the high and low pressure with respect to each other and to the heat exchange elements depending upon whether such elements are performing condenser or evaporator functions.

It will of course be understood that various changes in details of construction and arrangements of parts may be made by those skilled in the art without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. A reverse cycle refrigerating system comprising, in combination, a compressor having a suction line, condenser and evaporator heat exchange elements connected in a refrigerant circuit with said compressor, means for reversing the condenser and evaporator functions of said heat exchange elements, and a single thermostatic expansion valve having a power element connected to said suction line for controlling flow of liquid refrigerant to whichever one of said heat exchange elements is functioning as an evaporator.

2. A reverse cycle refrigerating system comprising, in combination, a compressor having a suction line, condenser and evaporator heat exchange elements connected in a refrigerant circuit with said compressor, means for reversing the condenser and evaporator functions, and a single expansion valve having a power element connected to said suction line and operative to control flow of liquid refrigerant to whichever one

of said heat exchange elements is functioning as an evaporator automatically in accordance with the operation of said reversing means.

3. A reverse cycle refrigerating system comprising, in combination, a compressor-condenser-evaporator circuit having complementary heat exchange elements performing respectively condenser and evaporator functions, means for reversing the condenser and evaporator functions of said heat exchange elements and a thermostatic expansion valve for controlling the flow of liquid refrigerant to whichever one of said heat exchange elements is functioning as an evaporator, said expansion valve having operative connection to the suction side of said compressor between the compressor and reversing means.

4. The combination set forth in claim 3 further characterized in that the heat exchange elements are cross-connected by two passages one of which has a pair of check valves opening away from each other and the other of which has a pair of check valves opening toward each other and said expansion valve is connected to said first pipe in which the check valves open away from each other and the second passage in which the check valves open toward each other connects with a liquid refrigerant receiver, whereby during one cycle of operation one of said connecting passages is open to communication to the evaporator and the other connecting passage is open to communication to the condenser or vice versa for a reverse cycle operation.

5. A refrigerating system comprising, in combination, a compressor-condenser-evaporator circuit, a thermostatically controlled valve for shutting off flow of liquid refrigerant to the evaporator automatically when a predetermined low temperature is obtained, means for continuing the compressor in operation after said valve shuts off flow of refrigerant to the evaporator until a predetermined condition is reached, and means for reversing the condenser and evaporator functions while still controlling said valve in accordance with a predetermined low pressure on the evaporator side.

6. A refrigerating system comprising, in combination, a condenser-compressor-evaporator circuit, a thermostatically controlled shut off valve for controlling flow of liquid refrigerant to the evaporator, means for starting said compressor automatically only after a predetermined refrigerant vapor pressure has been built up in the evaporator, and means for reversing the condenser and evaporator functions while still controlling said valve in accordance with a predetermined low pressure on the evaporator side.

7. The combination set forth in claim 6 further characterized by the provision of means for reversing the functions of the condenser and evaporator and for simultaneously maintaining the control of the compressor in accordance with the evaporator function.

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