Feb. 24, 1942. A. B. NEWTON 2,274,615

AIR CONDITIONING SYSTEM

Original Filed May 6, 1938

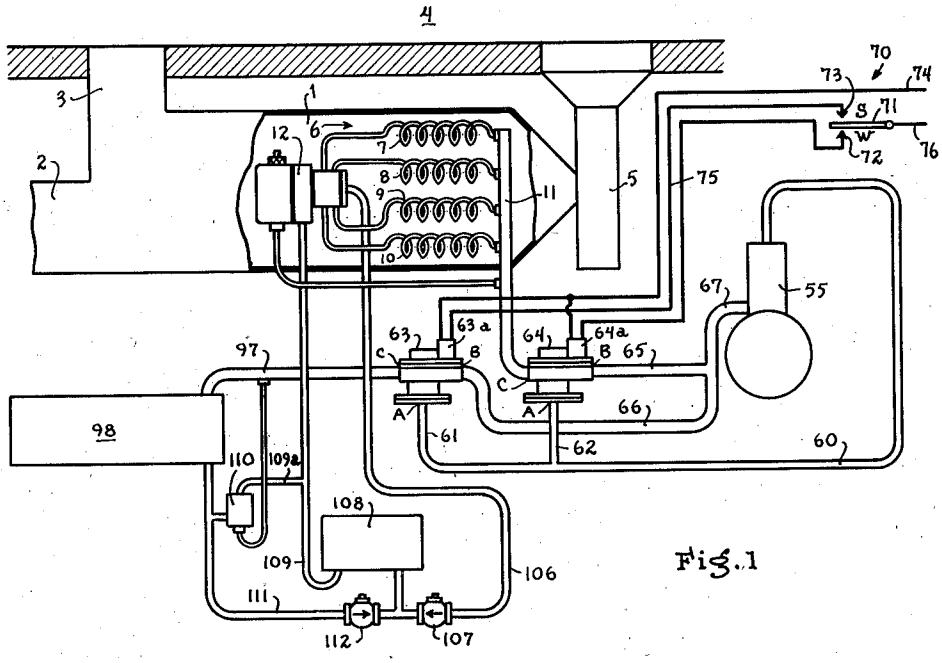


Fig. 1

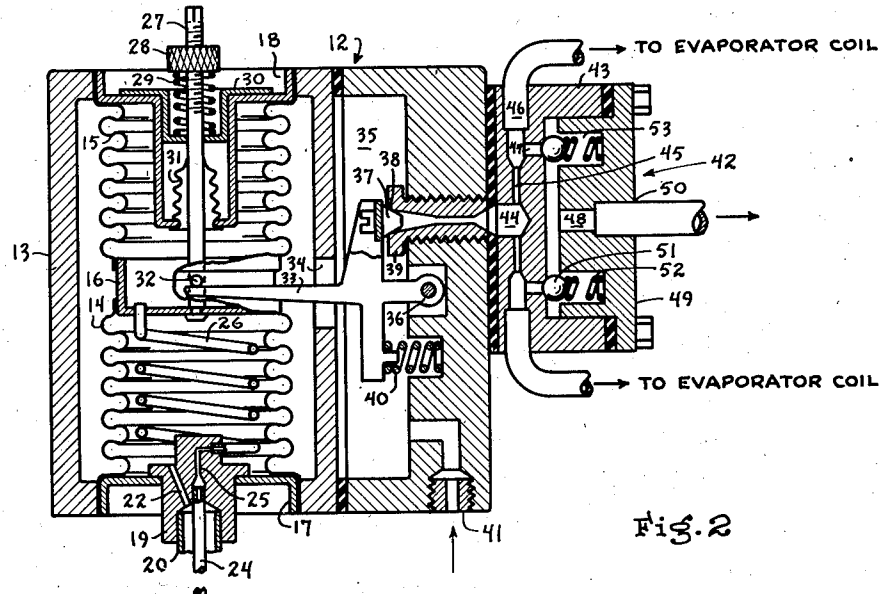
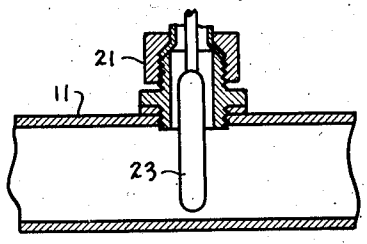


Fig. 2



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AIR CONDITIONING SYSTEM

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3 Claims. (Cl. 62—8)

This application is a division of my application Serial No. 206,411, filed May 6, 1938, for "Air conditioning system."

This invention relates in general to air conditioning or refrigeration and is particularly concerned with the provision of an expansion valve arrangement for an evaporator of the type employing a plurality of parallel passes.

In the air conditioning art it is desirable to utilize direct expansion cooling coils in a conditioner for cooling the air being passed to the space, as these coils are very compact and efficient. In larger systems it is desirable to utilize instead of a single cooling coil a direct expansion type heat exchanger which is formed of a plurality of parallel passes, for thereby decreasing the pressure drop. Direct expansion coils of this type present a problem of distributing the liquid refrigerant equally to the various passes, for if the refrigerant is not equally distributed, either some of the passes will become flooded, and permit the flow of liquid refrigerant to the compressor, or the expansion valve will become closed for preventing flow of refrigerant to all of the passes. In order to distribute refrigerant equally to the various passes it has become common to utilize distributor devices consisting of restricted inlet orifices for each pass. This arrangement is quite satisfactory for coils which operate only as evaporators. In reversible cycle systems it is desirable to use a single heat exchanger in the air stream as an evaporator during the cooling cycle and as a condenser during the heating cycle. When the heat exchanger is operating as a condenser, the restrictors used for distributing the liquid refrigerant when the heat exchanger operates as an evaporator are unnecessary, and in fact are undesirable as they create an additional pressure drop within the system.

It is an object of this invention to provide a distributor device for a multiple pass heat exchanger which acts to distribute properly the liquid refrigerant to the various passes when the heat exchanger is operating as an evaporator, and which automatically permits by-passing of refrigerant around the distributor restrictions when the heat exchanger is operating as a condenser.

Another object is the provision of a distributor device for a multiple pass unit which utilizes the velocity of the liquid refrigerant leaving the expansion valve for aiding in the distribution of the liquid refrigerant to the various passes.

Other objects of the invention will become apparent from the following description and the appended claims.

For a full disclosure of this invention reference is made to the following detailed description and to the accompanying drawing, in which:

Fig. 1 is a diagrammatic illustration of a reversible cycle refrigeration system utilizing a multiple pass heat exchanger in a conditioning chamber, and provided with the expansion valve and distributor arrangement of the present invention, and

Fig. 2 is an elevation in section showing the expansion valve and distributor arrangement for the direct expansion coils.

Referring to Fig. 1, reference character 1 indicates an air conditioning chamber having a fresh air inlet 2, and a return air inlet 3 which communicates with a space to be conditioned 4. The discharge end of the chamber 1 is connected to a fan 5 which acts to draw air through the chamber 1 and discharge it through suitable duct means into the space 4. Located within the chamber 1 is a heat exchange device generally indicated as 6, this heat exchange device being adapted to operate as an evaporator for cooling the space, or as a condenser for heating the space. The heat exchange device 6 preferably is formed of a plurality of separate cooling coils or refrigerant passes 7, 8, 9, and 10. The right-hand ends of these coils are connected to a suitable header 11 while the left-hand ends of these coils are connected to a combined expansion valve and distributor device indicated as 12.

Referring now to Fig. 2, this figure indicates the construction of the combined expansion valve and distributor device 12. Referring to the expansion valve portion of this device, this valve may be of the same type shown in my copending application Serial No. 192,818, filed Feb. 26, 1938. This expansion valve may comprise a diaphragm casing 13 which houses a diaphragm structure formed of diaphragms 14 and 15 and a connecting member 16. The diaphragm or bellows 14 is sealed to the lower surface of the diaphragm casing 13 and the lower end thereof is closed by means of a cup member 17. The bellows 15 is similarly sealed to the upper end of casing 13, and its open end is closed by means of a cup member 18. Both the bellows 14 and the bellows 15 are sealed as by soldering to the member 16 so as to provide a unitary fluid tight device. The cup member 17 is provided with a fitting 19 which is connected by a pipe 20 to a fitting 21 located on the header 11. A passage 22 is provided within the fitting 19 for placing the interior of the

bellows 14 into communication with the interior of the header 11. The pressure within bellows 14 is therefore equal to the pressure within this header. Also located within the fitting 21 is a thermostatic bulb 23 which is connected to a capillary tube 24 located within the pipe 20, this tube 24 being attached to the fitting 19 in a manner to communicate with a passage 25 in this fitting. This passage 25 is connected by means of a coiled tube 26 located within the bellows 14 to the interior of the bellows 15. The bulb 23 contains a suitable volatile fill which preferably is the same as the refrigerant used in the system. The arrangement just described therefore will cause a pressure to exist within the bellows 15 which is indicative of the temperature in the header 11, while the pressure within the bellows 14 is equal to the pressure within said header.

Connected to the member 16 is a rod 27 which extends upwardly through the cup member 18, this rod being threaded at its upper end as shown and carrying a nut 28 engaging a spring 29 which is supported by means of a spring retainer 30. A sealing bellows 31 is provided for preventing the escape of vapor from the bellows 15. With the arrangement just described it will be apparent that upon an increase in pressure within the header 11 the bellows 14 will expand and the bellows 15 will contract, while upon an increase in temperature at bulb 23 the pressure within bellows 15 will increase thereby causing expansion of this bellows and contraction of the bellows 14. The bellows 14 and 15 therefore act in opposition and the vertical position assumed by the connecting member 16 is an indication of the degree of superheat of the refrigerant at the fitting 21.

The member 16 is provided with a pin 32 which cooperates with a lever arm 33 extending through an opening 34 into the valve chamber 35. This lever is pivoted to the valve chamber casing at 36 and carries a valve member 37 cooperating with a valve port 38 located in a nipple 39. A spring 40 is provided for urging the lever 33 in a direction tending to maintain the valve member 37 against the valve port 38. In operation, liquid refrigerant enters at 41 and passes through port 38 to the distributor device 42. If the amount of superheat of the refrigerant leaving the coils 7, 8, 9, and 10 should increase, the pressure within bellows 15 will increase, this causing downward movement of the member 16, and due to engagement of pin 32 with lever 33 the valve member 37 will be moved away from port 38 to increase the supply of liquid refrigerant to the coils. Conversely, upon decrease in the amount of superheat, the member 16 will move downwardly, thereby permitting valve member 37 to approach port 38 under the action of spring 40. By adjusting the nut 28 any desired degree of superheat may be maintained.

Referring now to the distributor device 42, this device consists of a member 43 having a chamber 44, this device being secured to the valve casing in a manner to cause the chamber 44 to register with the opening in nipple 39. The member 43 is also provided with a plurality of restricted radial passages 45 which lead from the chamber 44 to openings 46 which are adapted for connection with the coils of the heat exchange device 6. It will be understood that a restricted passage 45 and connection 46 is provided for each of the coils of the heat exchange device. It will be noted that the nipple 39 is formed to provide a venturi and that the chamber 44 is in direct alignment with the valve port 38, so that the stream of liquid passing through the valve is discharged into the chamber 44 at high velocity. This high velocity discharge of refrigerant into the chamber 44 causes the liquid refrigerant to become a homogeneous mixture of liquid and gas within this chamber and to pass through the restricted passages 45 into the coils 7, 8, 9, and 10. Due to this action of refrigerant within the chamber 44, both the gaseous and liquid refrigerant will be divided equally between the various coils. This arrangement therefore provides for the passing of the proper amount of liquid refrigerant to each coil and thereby prevents the flooding of one coil and the starving of another.

Each of the passages or connections 46 communicates through a passage 47 with a chamber 48 formed between the member 43 and a cap member 49. This chamber 48 is connected to a discharge connection 50. Each of these passages 47 is also provided with a ball valve member 51 which is urged against its seat by means of a spring 52 located within a recess 53 located within the cover member 49. The purpose of the passages 47 and the valve members 51 is to permit the passage of refrigerant from the coils 7, 8, 9 and 10 into the outlet connection 50 when the coils 7, 8, 9 and 10 are acting as condensers. This arrangement avoids the necessity of passing the liquid refrigerant through the restricted passages 45 when the system is operating as a heating system. The operation of the distributor device 42 will become apparent as this description proceeds.

Referring now to the remainder of the refrigeration system, reference character 55 indicates a compressor which is connected by a discharge line 60 and branch lines 61 and 62 with three-way changeover valves 63 and 64. These three-way valves are each provided with pipe connections A, B, and C and are controlled electrically by means of solenoid pilot valves. The solenoid pilot valve 63*a* of valve 63 and the solenoid pilot valve 64*a* of valve 64 are controlled by means of a summer-winter switch 70. This switch includes a switch arm 71 cooperating with contacts 72 and 73. During the summer the switch arm 71 is moved into engagement with contact 73 which completes a circuit from the line wire 74 to the solenoid 63*a* and through wire 75, contact 73, and switch arm 71 to line wire 76. At this time, the switch arm 71 is out of engagement with contact 72 and therefore the solenoid 64*a* is deenergized. This position of the switch 70 causes the valve 63 to place its connections A and C into communication while blocking off connection B, and also causes valve 64 to place its connections B and C into communication while blocking off its connection A. During the winter, the switch arm 71 is moved into engagement with the switch arm 72 which deenergizes the solenoid 63*a* and energizes the solenoid 64*a*. This causes the three-way valves 63 and 64 to assume their opposite positions.

Assuming now that switch 70 is in the summer position, that is, switch arm 71 engages contact 73, the solenoid 63*a* will be energized while the solenoid 64*a* is deenergized. With the valves in the positions caused by this position of switch 70, compressed refrigerant flowing from the compressor through the line 60 will pass through pipe 61 into the three-way valve 63, leaving this valve through connection C and passing through line 97 into the heat exchanger 98 which now acts as a condenser. At this time, the port A of valve 64 is closed which prevents entry of compressed refrigerant into this valve, and also the connection

B of valve 63 is closed which prevents refrigerant leaving this valve through this connection. The refrigerant in flowing through condenser 98 will become liquefied and the liquid refrigerant will flow through line 111 and check valve 112 into the receiver 108. From this receiver, the refrigerant will flow through line 109 into the casing of expansion valve 12. The refrigerant will then flow past the valve member 37 and as the flow area at this point is restricted, the jet of refrigerant leaving valve member 37 will flow at very high velocity through the passage 39 into the chamber 44 of the distributor 42. This high velocity jet of refrigerant upon striking the walls of chamber 44 will form a homogeneous mixture of liquid and evaporated refrigerant due to the turbulence created by the impact of the high velocity jet. This now thoroughly mixed mixture of liquid and gaseous refrigerant will now flow through the radial passages 45 to the respective cooling coil passes and will flow from these passes into header 11. The refrigerant in passing through the cooling coil passes becomes evaporated, the evaporated refrigerant being collected by header 11 and flowing into the valve 64 through its connection C. The refrigerant will then flow from this valve through connection B and through pipes 65 and 67 to the inlet of the compressor.

When the switch 70 is actuated so that the switch arm 71 engages contact 72, the three-way valves 63 and 64 will change in position for reversing the flow of refrigerant through the system. Now compressed refrigerant flowing from the compressor through line 60 will pass through pipe 62 into the valve 64 through connection A and will leave this valve through connection C passing into the header 11. The compressed gaseous refrigerant will flow from the header 11 into passes 7, 8, 9 and 10 wherein it condenses to liquid. The liquid refrigerant will now flow from the passes into the distributor device 42. However, instead of passing through the restricted passages 45 of this device, the refrigerant will by-pass these restricted passages, flowing through the passages 44 past the check valves 51 into the chamber 48. The liquid refrigerant will flow from this point through the pipe 106 and check valve 107 into the receiver 108. From this receiver the refrigerant will flow through lines 109 and 109a into the expansion valve 110 and from this expansion valve into the heat exchanger 98 which now acts as an evaporator. The refrigerant will now evaporate in the heat exchanger 98 and the evaporated refrigerant will flow through pipe 97 to the connection C of the three-way valve 63 and will flow from this valve 63 through connection C and pass through pipes 66 and 67 to the inlet of compressor 55.

From the foregoing description, it will be apparent that the present invention provides an improved distributor device for multi-pass evaporators which acts to utilize the velocity of the refrigerant resulting from its passing through the expansion valve for mixing the refrigerant into a homogeneous mass and which distributes the refrigerant to the evaporator passes from this homogeneous turbulent mass thereby insuring that each pass of the evaporator receives its share of liquid and gaseous refrigerant. It will also be apparent from the foregoing description that the present invention additionally provides an improved distributor device for reversible cycle systems which acts to cause by-passing by the refrigerant of the restricted passages in the distributor when the system is operating on the heating cycle.

While the invention has been shown in a system in which only one heat exchanger is of the air cooled multi-pass type, it will be obvious that the invention is equally applicable to systems in which both heat exchangers are of this type. In such case each heat exchanger would be provided with a distributor device as disclosed herein.

While I have shown and described a preferred form of the invention, it will be apparent that many modifications can be made without departing from the scope of the invention. It is desired therefore to be limited only by the scope of the appended claims.

I claim as my invention:

1. In a refrigeration system, in combination, an evaporator comprising a plurality of parallel passages for refrigerant, an expansion valve, a distributor device associated with said expansion valve, said distributor device comprising a relatively small chamber, means forming a venturi for conveying refrigerant from said expansion valve into said chamber, said venturi increasing the velocity of the refrigerant so as to discharge it into the chamber in a manner to create turbulence in said chamber sufficiently to prevent segregation of gaseous and liquid refrigerant in said chamber and means for providing communication between said passes and said chamber.

2. In a refrigeration system, in combination, an evaporator comprising a plurality of parallel passages for refrigerant, an expansion valve, a distributor device associated with said expansion valve, said distributor device comprising a relatively small chamber, means forming a venturi for conveying refrigerant from said expansion valve into said chamber, said venturi increasing the velocity of the refrigerant so as to discharge it into the chamber in a manner to create turbulence in said chamber sufficiently to prevent segregation of gaseous and liquid refrigerant in said chamber, and means for providing communication between said passes and said chamber, said last means comprising a plurality of restricted channels communicating with said chamber.

3. In apparatus of the character described, in combination, means forming a valve chamber, means forming a fluid distributing chamber associated therewith, means forming a valve port communicating with said first chamber and having a restricted throat connecting said port directly with said second chamber, the connection between said port and second chamber being relatively short and straight.

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