Aug. 8, 1939. W. A. GRANT 2,168,404

REFRIGERANT DISTRIBUTION

Filed May 23, 1935 2 Sheets-Sheet 1

Fig. 1.

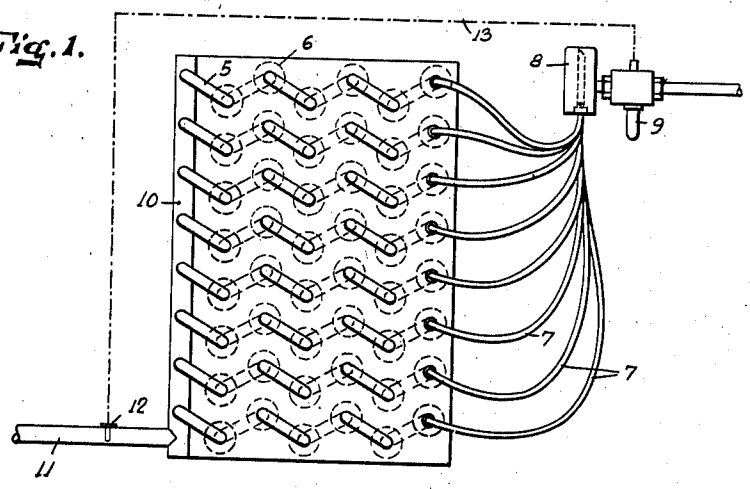


Fig. 2.

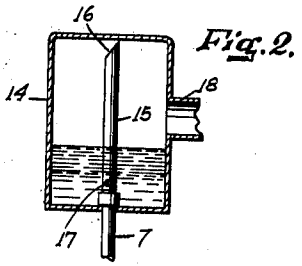


Fig. 3.

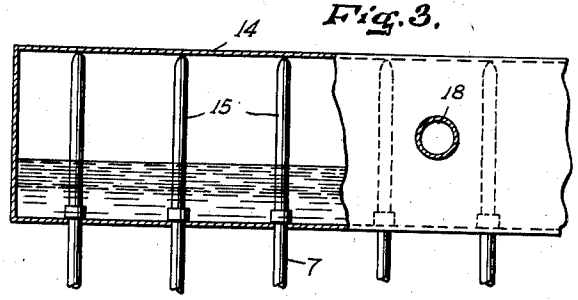


Fig. 4.

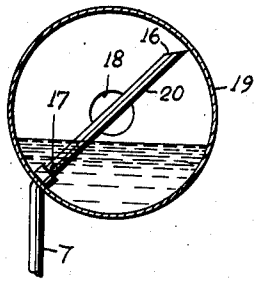
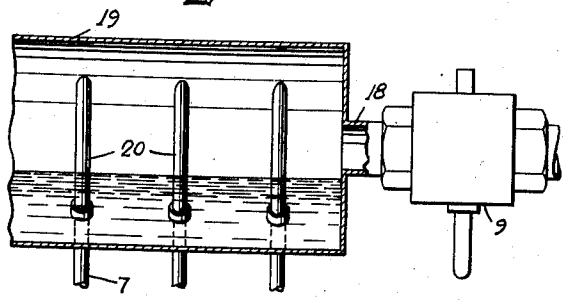


Fig. 5.



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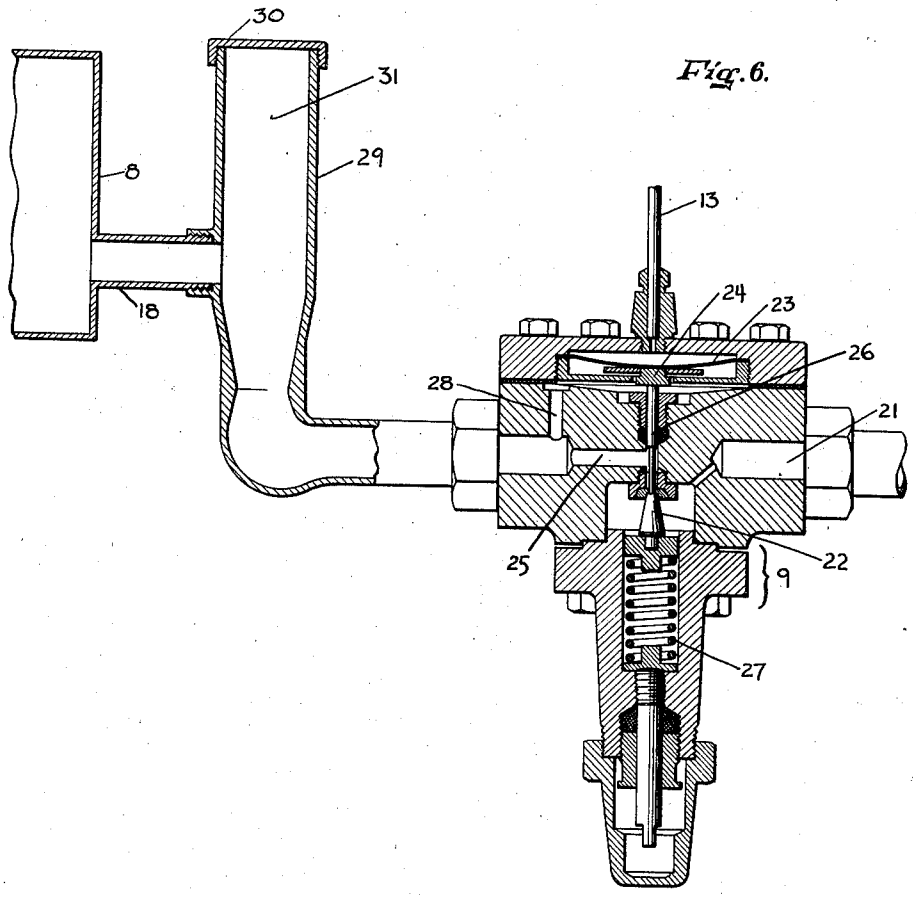

Fig. 6.

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REFRIGERANT DISTRIBUTION

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Application May 23, 1935, Serial No. 22,949

3 Claims. (Cl. 62—126)

This invention relates to expansion valves and distributor heads for refrigeration evaporators, and relates more particularly to expansion valves and distributor heads for use with refrigeration evaporator coils used as air cooling coils in air conditioning systems.

With the advent of non-toxic refrigerants, it has become common practise to expand such refrigerants directly in extended surface air cooling coils for air cooling purposes, in air conditioning systems. In order, however, to obtain sufficient surface in contact with the air being cooled, it is necessary to provide not only extended surface on the coils, but to provide a large number of separate coils extended crossways the air stream, and also a large number of coils in multiple or parallel relationship. Where so many coils are used, it has been found that the ordinary expansion valve is not suitable for expanding refrigerant into cooling coils because of the problems of unequal distribution.

According to the present invention, an expansion valve is provided with a distributor head. The distributor head is provided with a series of small orifices, each connecting with a row of air cooling evaporator coils.

An object of this invention is to regulate the flow of refrigerant through a single expansion valve and to apportion it equally to each of a plurality of rows of evaporator coils.

Another object of the invention is to supply to each of a plurality of rows of evaporator coils an equal quantity of liquid refrigerant.

It is another object of the invention to provide a refrigerant distributor adapted to function in a plurality of positions.

It is another object of the invention to provide a refrigerant distributor which is relatively simple, inexpensive, reliable and efficient.

A feature of the invention resides in the provision of a header having an inlet opening on the low pressure side of an expansion valve, and a plurality of pipes, having openings above the level of liquid refrigerant in the header and orifices below the liquid level, the pipes being in communication wtih a plurality of evaporator tubes.

Another feature of the invention resides in the provision of a header and a plurality of pipes within the header, the pipes being inclined at an angle to the horizontal.

Another feature of the invention resides in the provision of an evaporator in combination with a header, and a plurality of pipes in the header, said pipes being inclined at a predetermined angle to the horizontal when the evaporator and header are in each of a plurality of positions.

Another feature of the invention resides in the provision of a distributor header and an expansion valve, and means for reducing the velocity of refrigerant passing from the expansion valve to the header, said means serving also to separate gaseous and liquid refrigerant.

Other objects and features will be apparent from the following description, to be read in connection with the accompanying drawings in which:

Fig. 1 is a side view of an assembly of extended surface evaporator coils, with each horizontal row of coils attached to a separate tube leading to the distributor head;

Fig. 2 is an end view, partly in section, of the distributor header of Fig. 1;

Fig. 3 is a fragmentary elevational view, partly in section, of the distributor header;

Fig. 4 is an end view, partly in section, of another form of the invention, showing applicant's inclined header pipes;

Fig. 5 is a fragmentary elevational view, partly in section, of the embodiment of Fig. 4, showing the expansion valve and refrigerant supply arrangement; and

Fig. 6 is an elevational view, partly in section, illustrating applicant's expansion valve and velocity reduction and separator means, in combination with the distributor header.

The evaporator coil assembly of Fig. 1 comprises the rows of coils 5, which are provided with the extended surfaces 6, and which are arranged in a plurality of horizontal and vertical rows. Each horizontal row of coils is supplied with expanded refrigerant through an individual tube 7, leading from the distributor head 8 of the expansion valve indicated generally by 9. Each horizontal row of coils discharges into the common header 10, from which the pipe 11 conducts the low pressure gas after the complete evaporation of the refrigerant in the coils. The pipe 11 contains the ordinary thermostat element 12, connected by tube 13 to the valve mechanism in the expansion valve 9, this control serving, as is well known, to control the rate of flow of the refrigerant in accordance with the superheat of the low pressure gas leaving the coils. Details of this control will be discussed in connection with the description of Fig. 6 of the drawings.

The header 8 comprises a casing 14, illustrated as being rectangular in cross-section, in which are positioned a plurality of pipes 15. Each pipe is provided with an opening 16 in its upper

portion, preferably at its upper extremity, and with an orifice 17 at a point proximate its lower extremity. In operation, a mixture of refrigerant gas and refrigerant liquid is supplied to the casing 14 from expansion valve 9 by a channel 18, which opens into the casing 14 at a point in the side of the casing well above the bottom thereof. The refrigerant liquid fills the bottom of casing 14 to a level above that of the orifices 17. The liquid flows through orifices 17 into pipes 15, whence it passes to the tubes 7 and the evaporator coils 5. Refrigerant gas from the upper part of the casing is drawn into pipes 15 through the openings 16, and passes into the tubes 7 and evaporator coils 5 with the liquid refrigerant.

Due to the admission of refrigerant into the casing, the liquid refrigerant in casing 14 is constantly in a state of turbulence. Since the orifices 17 are below the liquid level, however, flow through the orifices is but slightly affected by such turbulence. The liquid head on each orifice remains substantially the same, and thus, each orifice delivers to the evaporator coils a substantially equal quantity of refrigerant liquid. Since the pressure drop between the distributor header inlet and the compressor side of the evaporator is the same for each row of evaporator coils, each row of coils will receive a substantially equal amount of refrigerant gas.

Figs. 4 and 5 illustrate a modified form of the invention, in which a casing 19 is preferably cylindrical. It is to be understood, however, that a casing of any desired shape may be utilized. The casing 19 receives refrigerant from channel 18, which in this case opens into the end of the casing. Pipes 20 are equipped with openings 16 and orifices 17, communicate with the evaporator coils and function in precisely the same manner as the pipes 15. Instead of being substantially vertical, however, pipes 20 are inclined at an angle to the horizontal, and are so positioned within the casing as to pass through the axis thereof. In this arrangement, the distributor header will operate in identical fashion whether in the position shown or rotated 90 degrees counterclockwise about the longitudinal axis of the casing, since in each case the liquid head on the orifices and other operating factors will be exactly the same. Thus, the apparatus may form an integral part of an evaporator coil assembly, adapted to be used in either horizontal or vertical position.

In the operation of the expansion valve illustrated in Fig. 6, liquid refrigerant under high pressure is forced into the expansion valve 9 through the high pressure inlet 21. The expansion valve 22 is moved under the control of thermostat element 12 (Fig. 1). As temperature variations take place in the outlet pipe 11, evaporation or condensation of suitable liquid in the bulb 12, takes place, and the resultant change in pressure causes movement of the diaphragm 23. The member 24, in contact with the low portion of diaphragm 23, is actuated by movement of the diaphragm to move the expansion valve piston 22 from its seat, to permit refrigerant entering the expansion valve to pass from the passage 21 into the passage 25. Movement of the member 24 is communicated to the valve piston 22 through the intermediate rod 26. Movement of the valve piston 22 is opposed by the action of spring 27, and by the evaporator pressure of refrigerant gas transmitted to the lower side of diaphragm 23 through passage 28.

To reduce turbulence in the header 8, applicant discharges refrigerant from the expansion valve into the bottom of a short pipe 29, which is preferably vertically mounted. The upper end of pipe 29 is closed by member 30. Channel 18 opens into the pipe 29 below the top thereof. There is thus provided a dead-end chamber 31. When refrigerant is discharged into pipe 29 its velocity is largely absorbed by turbulence in chamber 31. The refrigerant then passes to the header 8 at reduced velocity through channel 18, the liquid refrigerant tending to separate from the mixture of gaseous and liquid refrigerant and to flow along the bottom of channel 18. Reduction of the velocity of the refrigerant mixture entering the header and partial separation of liquid and gaseous refrigerant reduce turbulence in the header and thus make for equal distribution of refrigerant to each of the evaporator circuits.

In the foregoing, each of a plurality of rows of evaporator coils have been described as being provided, according to this invention, with an equal quantity of gas and liquid. This represents, however, ideal conditions where each row of coils is under equal load. In some cases, however, the air load may be definitely less on some individual coils, due to their location with respect to entering and leaving air, or to other reasons, and to prevent flooding of the coils with the lesser load, the orifices 17 leading to such coils may be reduced in size. In this way, there may be a variety of sizes of orifices in any one distributor to adjust the amount of gas and liquid fed to individual coils in accordance with load distribution.

Since certain changes in carrying out the above method of operation and in the constructions set forth, which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. In an apparatus of the character described, a distributor head, an evaporator, a plurality of pipes in said head, a plurality of openings in said pipes, said pipes being inclined at an angle to the horizontal and passing through the axis of said head, whereby said head may be rotated about its axis through an angle of 90 degrees without changing the height of said openings above a datum level, and means for drawing refrigerant from said head into said evaporator through said openings and said pipes.

2. In an apparatus of the character described, a refrigerant supply header, a plurality of conduits extending within said header, an evaporator comprising a plurality of refrigerant circuits, and means connecting different of said conduits with different of said evaporator circuits, said conduits being each provided with a plurality of openings therein within said header, said conduits being inclined at an angle of approximately 45 degrees to the horizontal when said header is in a first predetermined operating position, whereby said header may be rotated 90 degrees to a second predetermined operating position without affecting the distribution of refrigerant to said circuits by said header and said conduits.

3. A refrigerant distributor comprising a refrigerant supply header and a plurality of conduits extending within said header, each of said conduits being adapted to supply refrigerant from within the header to a different evaporator

circuit without the header, each conduit being provided with a plurality of openings therein within said header, and each of said conduits being inclined at an angle of approximately forty-five degrees to the horizontal when said header is in a first predetermined operating position, whereby said header may be rotated ninety degrees to a second predetermined operating position without changing the height of said openings above a datum level and without affecting the distribution of refrigerant to said different evaporator circuits.

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