Jan. 24, 1939. J. L. SHRODE 2,144,898

UNITARY EXPANSION VALVE AND DISTRIBUTOR MECHANISM

Filed April 7, 1938

Fig. 1.

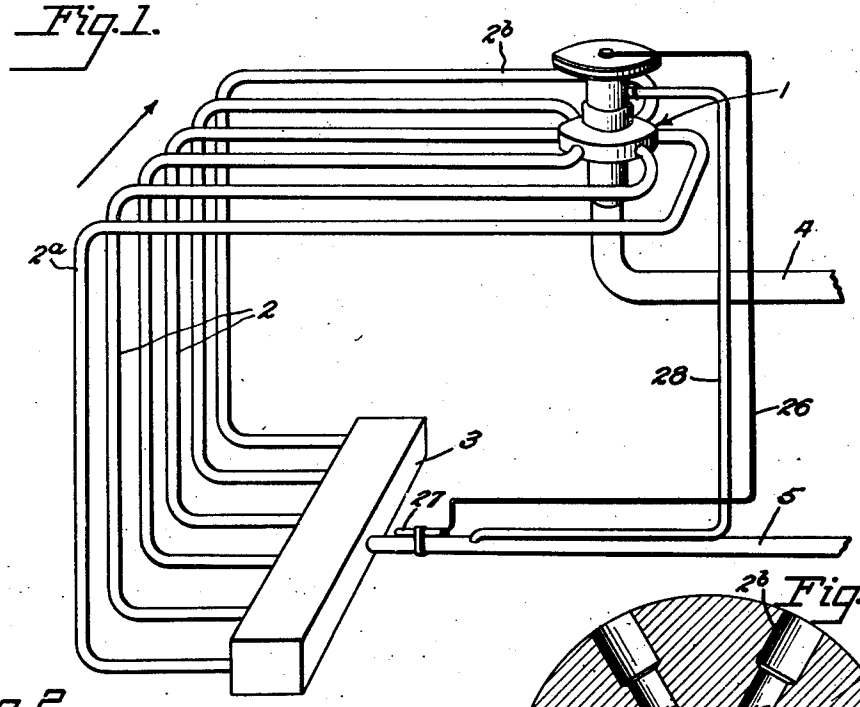


Fig. 3.

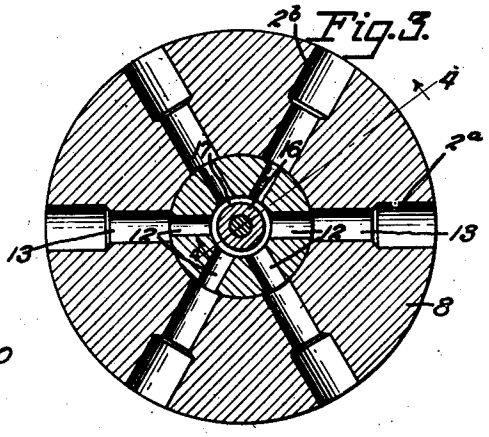


Fig. 2.

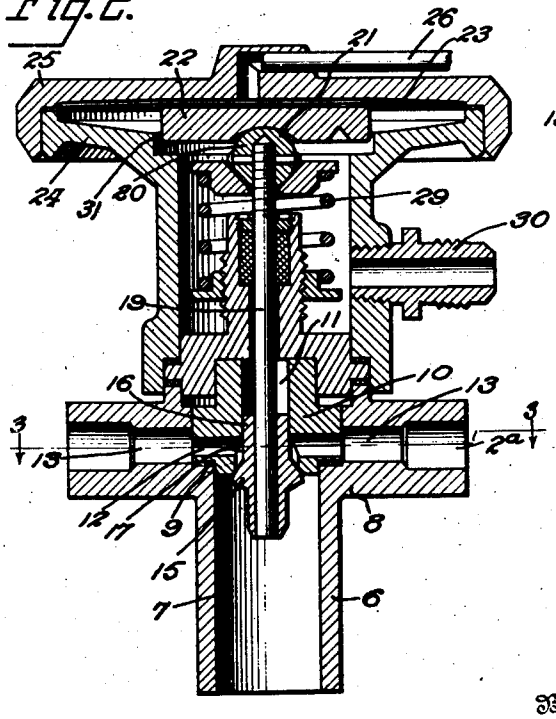
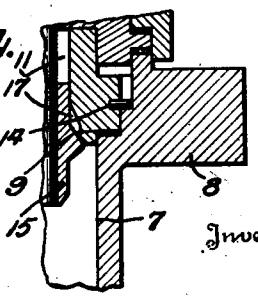


Fig. 4.



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UNITARY EXPANSION VALVE AND DISTRIBUTOR MECHANISM

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Application April 7, 1938, Serial No. 200,791

11 Claims. (Cl. 62—127)

This invention relates to refrigeration and has for its general object the provision of a unitary expansion valve and distributor mechanism, the purpose of which is to effect the distribution of liquid and gaseous refrigerant in homogeneous mixture proportionately to a plurality of similarly or differently loaded coil passes according to the needs of each and regardless of changes in the load or rate of flow of the refrigerant.

Up to the present invention an evaporator having a multiplicity of tubes and not intended for full flooded operation was usually supplied with refrigerant by one of three methods, one being to connect all the tubes in series and to supply the refrigerant through a single expansion valve. Another was to divide the evaporator into several multiple passes beginning and terminating in inlet and outlet headers, the refrigerant being supplied to the inlet header by one expansion valve. The third method was to supply refrigerant to each pass by a separate expansion valve, one to each pass.

None of these methods has proved entirely satisfactory. The first named method brought about an extreme pressure drop between the inlet and outlet ends of the evaporator resulting in loss in refrigerating capacity. The second named method involved the employment of several types of inlet headers, these being customarily classed either as centrifugal or gravity headers. The centrifugal header was theoretically arranged so that the velocity and volume of refrigerant entering the header would feed the required amount of refrigerant to each of the several passes connected to the header. With such an arrangement, reduction of refrigeration load which always occurs at times in any evaporator would cause the expansion valve to throttle and the flow of refrigerant entering the centrifugal header would decrease, the result being improper distribution and starvation of one or more passes.

The gravity header supplied theoretically equal feed to all passes due to the existence of a static liquid head in the header, but in the absence of a static liquid head, that pass offering the least resistance at the moment would receive the greater proportion of the refrigerant admitted to the header by the expansion valve.

The third named method overcame most of the objections to the first two, but since it involved a valve for each pass, the cost of installation is in general too great to make this method practicable.

It is therefore obvious that a single expansion valve so designed as to automatically supply the required proportion of refrigerant to each of the several passes regardless of total load changes and resultant changes in the rate of refrigerant flow, would eliminate the necessity of inlet headers as well as a multiplicity of valves, and would provide ideal distribution.

With this and other objects in view, the present invention will be readily understood by reference to the following specification and claims and to the drawing which accompanies and forms a part of the specification and in which:

Figure 1 is a perspective view of a multi-pass evaporator and expansion valve embodying the features of the invention;

Figure 2 is an axial section through the expansion valve and distributor mechanism;

Figure 3 is a cross section taken along the line 3—3 of Figure 2; and

Figure 4 is a section taken along the line 4—4 of Figure 3.

Referring now in detail to the several figures, the numeral 1 represents as a whole the unitary expansion valve and distributor mechanism into which the inlet ends of the passes 2 are connected, the opposite ends of said passes being shown connected to a suction header 3. The high pressure side of the system is represented by the pipe 4, the low pressure or suction side being designated by the pipe 5.

Referring to Figure 2 in which the details of the expansion valve and distributor mechanism are disclosed, the body 6 has a bore 7 to which the liquid refrigerant carrying pipe 4 is connected. The upper part of the body is expanded to form a flange 8 which is recessed as at 9 to form a seat for the distributor head 10. Said distributor head as shown is formed with an axial passage 11 and with a circumferential series of radial passages 12 communicating with the axial passage 11 and lying in the zone of the flange 8 of the body 6. Said flange is provided with a series of radial outlets 13 which register with the radial passages 12 in the distributor head, and a pin connection 14, shown in Figure 4, between the distributor head and the flange 8 prevents relative rotation between the distributor head and the body 6 and so keeps the passages 12 in registry with the outlets 13.

In general, the passages 12 may be of similar or different cross sectional diameter as shown in Figure 3 since proportionate distribution depends upon the sizes of these passages. The outlets 13 are of like or larger diameter than the diameters of the passages 12 so that the outlets 13

shall not have a throttling effect upon said passages and reduce the velocity of flow through said passages.

A reciprocatory valve 15 is seated at the lower edge of the axial passage 11, said valve as shown being provided with a cylindrical portion 16 which is slidably guided in that part of the axial passage 11 which is above the zone of the radial passages 12. The lower part of the axial passage 11, that is to say, that part which extends from the valve seat to the zone of the passages 12 is somewhat expanded forming a valve chamber 17.

It is, of course, a well known fact that as soon as an expansion valve opens, expansion takes place and the fluid immediately adjacent the low side of the expansion valve usually becomes a mixture of liquid and gaseous refrigerant. The distribution of this mixture proportionately through a plurality of passages is greatly simplified and materially enhanced by maintaining its liquid and gaseous constituents in homogeneous mixture during the course of its distribution.

According to the present invention, the conduit constituted by the cross section of the port of the valve 15 when said valve is open, the cross section of the annulus constituting the valve chamber and the cross sections of the several distributing passages 12 are so restricted relative to the velocity of flow of the refrigerant that its velocity is not checked and consequently a homogeneous mixture of liquid and gaseous refrigerant is delivered through the several passages 12 to the outlets 13 to which the several passes 2 of the evaporator are connected. The maintenance of this homogeneous liquid and gaseous mixture is fostered by the close adjacency of the passages 12 to the valve 15.

The rest of the structure illustrated in Figure 2 is common to known expansion valves. The valve 15 has a stem 19 with a ball end 20 which rests in a spherical seat 21 in a plate 22 contacting the center of a diaphragm 23 in a diaphragm chamber formed between the fitting 24 and the cap 25 between which fitting and cap the diaphragm edges are clamped or otherwise secured. The upper part of the diaphragm chamber is connected by means of the tube 26 with the thermostatic bulb 27 applied or inserted at the suction end of the evaporator. The lower part of the diaphragm chamber is connected by an external equalizer 28 directly with the interior of the system at the suction end of the evaporator, said equalizer being connected into the chamber of the fitting 24 by means of a nipple 30, and the chamber of the fitting 24 being in communication with the lower part of the diaphragm chamber through the annular opening 31. The valve 15 is normally kept closed by a spring 29 which presses upwardly against the ball end of the valve stem. Dominant differential pressure on opposite sides of the diaphragm opens the valve against the pressure of the spring 29.

While the present illustrative embodiment of the invention shows the valve-actuating means as being a diaphragm, it will be understood by those skilled in the art that the present invention does not particularly concern itself with the means for actuating the valve and that known and conventional equivalent actuating devices may be substituted for the diaphragm without transcending the spirit and scope of the invention. In this connection, it may be stated also that an internal equalizer may be substituted for the external equalizer if desired, and that any other device which is the equivalent of the thermostatic element, for creating or transmitting force to the opposite side of the diaphragm may be employed and still be within the scope of the invention.

Referring to Figure 1 of the drawing, it is assumed that the evaporator therein shown is employed for air conditioning and that the current of air is flowing in the direction of the arrow. It is obvious that the coil pass 2*a* carries the heaviest load, for the air is at its highest temperature when it impinges upon this pass while it has become progressively cooled as it flows from one pass to the other. It follows therefore that the pass 2*a* should receive the greatest amount of refrigerant. It is therefore connected as shown in Figure 3 to the passage 12 having the greatest diameter. Likewise, the coil 2*b* being at the rear of the coil, carries the least load and is therefore connected as shown in Figure 3 to the distributing passage 12 which has the smallest diameter. Although air is indicated in this discussion, the principle is applicable to any other fluid.

In this invention correct proportional distribution is assured not only when the main throttling valve is in its extreme open position, but also throughout the entire flow range of the valve. Throttling the valve 15 equally throttles the flow to each of the distributor passages, and because of the fixed position of the distributor passages with relation to the outlets 13 from the valve body, and because of the close proximity of each to the other and to the main throttling valve and because of the high jet velocity thus maintained, changes in flow through the valve 15 are correspondingly reflected in the flow to each outlet without interfering with the proportional distribution.

While I have in the above description disclosed what I believe to be a preferred and practical embodiment of the invention, it will be understood to those skilled in the art that the specific details of construction and arrangement of parts as illustrated and described are by way of example and not to be construed as limiting the scope of the invention as defined in the appended claims.

What I claim is:

1. Unitary expansion valve and distributor mechanism comprising a body having a bore one end of which is adapted to communicate with the condenser of a refrigeration system, an expansion valve member in said bore defining with the walls of said bore a valve chamber on the side of said valve member remote from said one end, said body being provided with lateral distributing passages opening into said valve chamber, adapted to be connected to the inlet ends of coil passes.

2. Unitary expansion valve and distributor mechanism comprising a body having a bore one end of which is adapted to communicate with the condenser of a refrigeration system, an expansion valve member in said bore defining with the walls of said bore a valve chamber on the side of said valve member remote from said one end, said body being provided with lateral distributing passages opening into said valve chamber adapted to be connected to the inlet ends of coil passes, the conduit constituted by the valve port when the valve is open, said valve chamber and said distributing passages being of cross-sectional area so restricted as to maintain such velocity of flow as to maintain the liquid and gaseous refrigerant

in homogeneous mixture until it reaches said passes.

3. Unitary expansion valve and distributor mechanism comprising a body having a bore one end of which is adapted to communicate with the condenser of a refrigeration system, an expansion valve member in said bore defining with the walls of said bore a valve chamber on the side of said valve member remote from said one end, said body being provided with lateral distributing passages opening into said chamber, terminating at their ends remote from said valve chamber in outlets of at least as great a diameter as that of said passages, adapted to be connected to the inlet ends of coil passes.

4. Unitary expansion valve and distributor mechanism comprising a body having a bore one end of which is adapted to communicate with the condenser of a refrigeration system, an expansion valve member in said bore defining with the walls of said bore a valve chamber on the side of said valve member remote from said one end, said body being provided with lateral distributing passages of different cross-sectional areas opening into said valve chamber, said passages terminating in outlets of at least as great a diameter as that of said passages, adapted to be connected to the inlet ends of coil passes.

5. Unitary expansion valve and distributor mechanism comprising a body having a bore one end of which is adapted to communicate with the condenser of a refrigeration system, an expansion valve member in said bore, said body being provided with radial distributing passages opening into said bore on the side of said valve member remote from said one end and closely adjacent thereto, said passages being adapted to be connected to the inlet ends of coil passes.

6. Unitary expansion valve and distributor mechanism comprising a body having a bore adapted to be connected to the condenser of a refrigeration system, said body including a distributor head seated within a recess in said body, said distributor head having a valve chamber communicating with said bore and a plurality of distributing passages opening radially into said valve chamber, a valve seating on said distributor head to control the passage of liquid refrigerant from said bore to said valve chamber, said body having outlet passages registering with the distributing passages of said distributor head and of at least as great a cross sectional area as that of said passages.

7. Unitary expansion valve and distributor mechanism comprising a body having a bore adapted to be connected to the condenser of a refrigeration system, the upper end of said body having a recess communicating with said bore and having radial outlets with their inner ends opening in the walls of said recess, a distributor head fitting in said recess having a valve chamber communicating with said bore and having radial distributing passages communicating with said valve chamber and with said outlets, said distributing passages being not larger in cross section than said outlets, a reciprocable valve seating on said distributor head and controlling communication between said bore and said valve chamber, and means for actuating said valve.

8. Unitary expansion valve and distributor mechanism comprising a body having a bore adapted to be connected at one end to the condenser of a refrigeration system, a distributor head carried by said body having a valve chamber communicating with said bore and having radial distributing passages communicating at their inner ends with said valve chamber, said body having radial outlets in registry with the outer ends of said distributing passages and of at least as large a diameter as that of said passages, a reciprocable valve member seating on said distributor head and controlling communication between said bore and said distributing passages, and means for actuating said valve member.

9. In an expansion valve mechanism of that type in which the control of the supply of liquid refrigerant to an evaporator in a refrigeration system is effected by a fluid pressure actuated valve responsive to refrigerative requirements of the evaporator, a body having a bore adapted to be connected to the condenser of said refrigeration system, an expansion valve member in said bore, said body being provided with radial distributing passages opening into said bore on the side of said valve member opposite said condenser and closely adjacent to said valve member, said passages being adapted to be connected to the inlet ends of the passes of such evaporator.

10. In an expansion valve mechanism of that type in which the control of the supply of liquid refrigerant to an evaporator in a refrigeration system is effected by a fluid pressure actuated valve responsive to refrigerative requirements of the evaporator, a body having a bore adapted to be connected to the condenser of said refrigeration system, a distributor head unitarily mounted with respect to said body having a valve chamber communicating with said bore and having radial distributing passages communicating with said valve chamber, said body having radial outlets registering with the outer ends of said distributing passages and being of at least as large cross-sectional area than the cross-sectional areas of said passages, said outlets being adapted to be connected to the inlet ends of the passes of said evaporator, and a reciprocable valve seating on said distributor head and controlling communication between said bore and said valve chamber.

11. Unitary expansion valve and distributor mechanism comprising a body having a bore adapted to be connected to the condenser of a refrigeration system, the upper end of said body having a recess communicating with said bore and having radial outlets with their inner ends opening in the walls of said recess, a distributor head fitting in said recess having a valve chamber communicating with said bore and having radial distributing passages communicating with said valve chamber and with said outlets, the latter being adapted to be connected to the inlet ends of the passes of an evaporator coil, said distributing passages being not larger in diameter than said outlets, a reciprocable valve seating on said distributor head and controlling communication between said bore and said valve chamber, means for actuating said valve, said distributor head being formed with a guide and said valve having a portion slidable in said guide.

JOHN L. SHRODE.