May 12, 1953 W. A. RAY 2,637,985

MULTIPORT VALVE

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Fig. 1

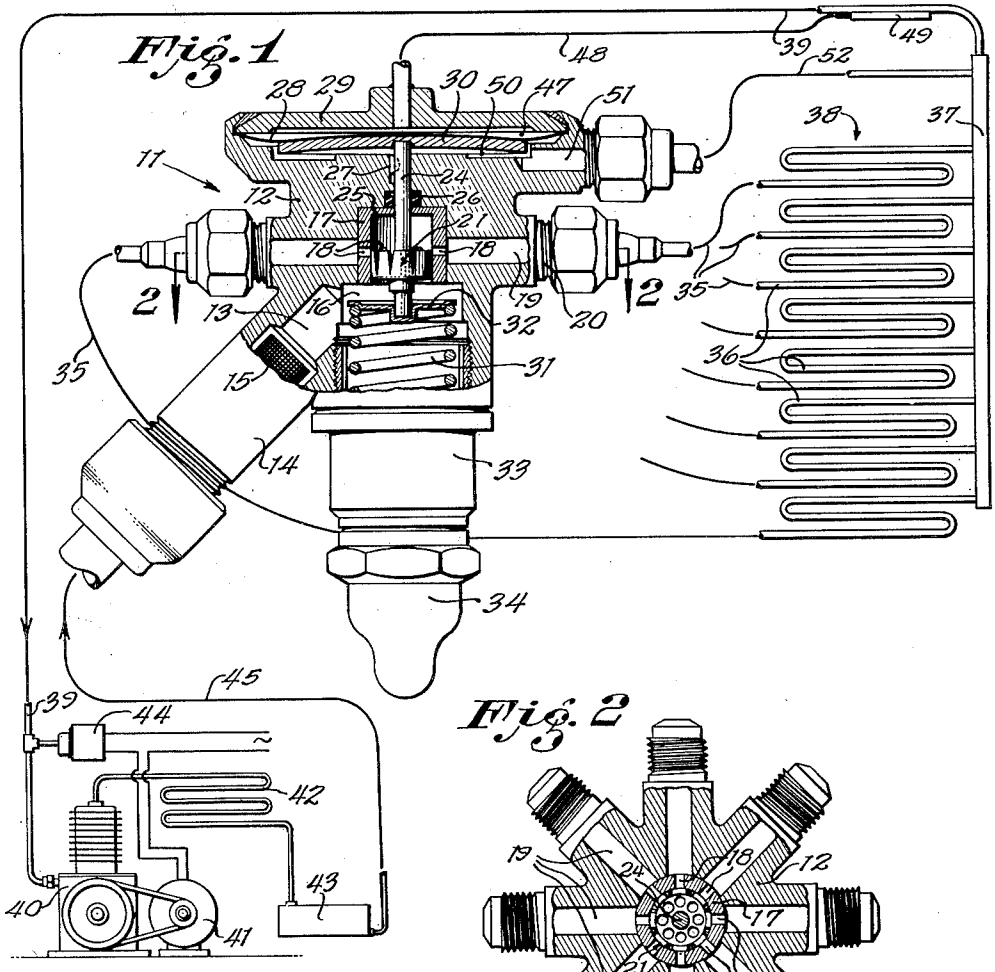
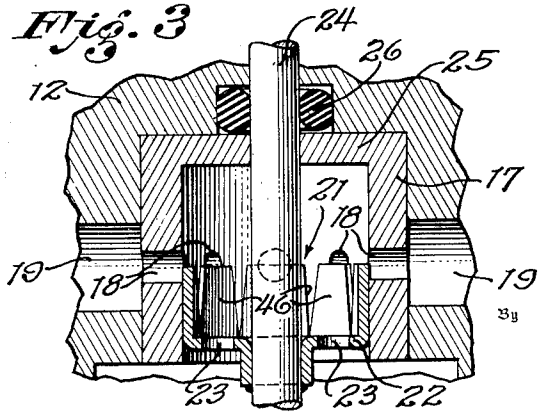


Fig. 2

Fig. 3



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Fig. 4

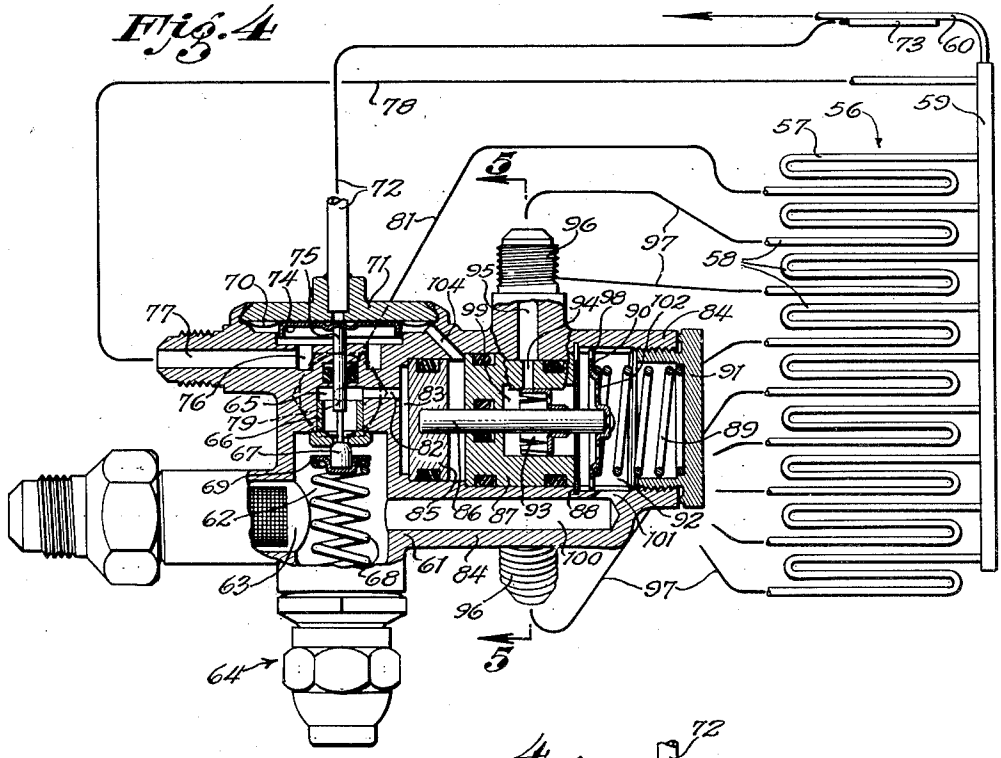
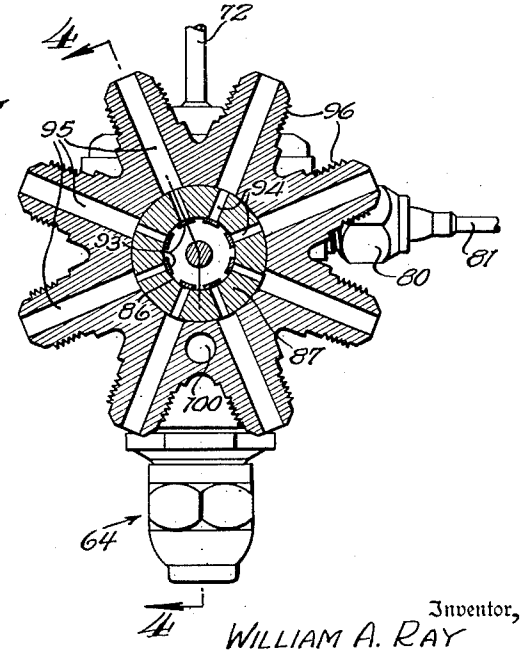


Fig. 5



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MULTIPORT VALVE

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Application January 22, 1951, Serial No. 207,222

6 Claims. (Cl. 62—127)

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My present invention relates to multiport valve structures, which, while obviously capable of other uses, are specially adapted for controlling flow of refrigerant to the individual units or passes of an evaporator of the multiple type, such as that shown in my Patent No. 2,491,905, issued December 20, 1949.

It is a general object of this invention to provide a valve structure of the character described whereby refrigerant can be distributed equally to a relatively large number of evaporator passes.

Another object is to provide a valve structure having a plurality of outlet ports, one for each pass of the evaporator, and a closure adapted to gradually uncover or cover all of the ports, equally and simultaneously, so as to throttle the flow of refrigerant.

Another object is to provide a multiport valve structure which includes motor means, operated by the pressure of refrigerant flowing to a single one of the evaporator passes, for actuating a closure controlling flow of refrigerant to the remaining ones of the passes.

For full understanding of the invention, and further appreciation of its objects and advantages, reference is to be had to the following detailed description and accompanying drawing, and to the appended claims.

In the drawing:

Figure 1 is a view, mainly in vertical section, of a refrigerant-control valve structure embodying this invention, and a schematic showing of a conventional refrigerating system which includes an evaporator of the multipass type;

Figure 2 is a transverse section taken along the line 2—2 of Fig. 1;

Figure 3 is an enlarged fragmentary view, in section, of the cup-like closure 21 and its environment;

Figure 4 is a sectional view of a modified form of valve structure according to this invention; a portion of the section being taken along the irregular line 4—4 of Fig. 5; and

Figure 5 is a section taken along the line 5—5 of Fig. 4.

Referring first more particularly to Figs. 1–3 of the drawing, the numeral 11 generally indicates a valve structure which comprises a casing 12 having an inlet 13. Ahead of the inlet, in a hollow lateral extension 14 of the casing, is the usual strainer or filter 15. The inlet 13 leads into a vetrical cylindrical opening or chamber 16 in the lower part of the casing; this opening being reduced in diameter at its upper end to tightly receive a hollow cylindrical liner 17 having through its side wall a row of equally-spaced radial ports 18. As can be seen in Fig. 2, the ports 18 communicate respectively with radial outlet passages 19 which extend through projections 20 to the exterior of the structure.

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Cooperable with the ports 18 is a hollow cylindrical closure 21, of thin metal, which is a close sliding fit in the liner 17. Through the bottom wall 22 (see Fig. 3) of closure 21 is a circular row of openings 23; and projecting through a central opening in wall 22, and secured thereto as by brazing, is a stem 24. The upper portion of stem 24 extends to the top of the casing through an opening therein and in the end wall 25 of liner 17; leakage past the stem being prevented by an O-ring 26 compressed in a recess around the stem. Rotation of stem 24, and consequently of closure 21, is prevented by a Woodruff key 27.

At the top of the structure is a fluid pressure motor, for actuating closure 21, which comprises a flexible diaphragm 28 in a shallow recess formed in the top of the casing and covered by a disk 29 secured, as by solder, to the casing with the margin of the diaphragm clamped therebetween. At the underside of diaphragm 28 is a pusher-plate 30 having a central recess for the tip of closure-stem 24; the stem being urged upward against the plate by the force of a compression spring 31 acting on the bottom of the stem through a washer 32; means (not shown) for adjusting the force of spring 31 being contained in the hollow lower section 33 of the casing which is closed by a cap 34.

The eight radial outlets 19—20 of the valve structure are connected respectively, by tubes 35, to eight coils 36 which, being connected in common at their outlet ends to a header 37, form the passes of a multiple evaporator or cooling unit generally indicated at 38. The header 37 is connected by suction line 39 to a conventional refrigerant-condensing unit which comprises a compressor 40 driven by an electric motor 41, a condenser 42, and a receiver 43. The operation of the compressor motor is controlled by a pressure switch 44 which, being connected to the suction line 39, is responsive to evaporator and crankcase pressure and acts to initiate the on-cycle of the system by starting the compressor when that pressure reaches a predetermined maximum due to rise of temperature of the evaporator, and to stop the compressor and thereby initiate the off-cycle when the pressure falls to a predetermined minimum. During the on-cycle, liquid refrigerant under pressure is sup-

plied through pipe 45 to the inlet 13 of the valve structure, whence the refrigerant may pass under the control of closure 21 to the evaporator passes 36.

As is better seen in Fig. 3, the thin annular wall of closure 21 is slit or notched to provide a series or row of eight forks 46 registering respectively with the eight ports 18. The purpose of notching the wall of the closure is so that the resilient forks can be sprung into tight engagement with the liner 17 and lapped to ensure a close fit. As shown in Figs. 1–3 the closure is in a position wherein all of the ports 18 are partially, and equally, uncovered so that refrigerant can flow into the ports from the inlet 13 and chamber 16 by way of the openings 23 in the bottom of the closure. With downward movement of the closure a greater area of each port is uncovered, and when the closure is raised to its full extent flow through the ports is obstructed by the top portions of the forks 46. The closure 21 thus functions to obstruct flow to the ports, or to throttle flow of liquid refrigerant equally to the individual ports, whence it flows to the individual passes or coils 36 of the evaporator.

By the valve arrangement described, distribution of refrigerant to a large number of evaporator coils can be effected; and since the refrigerant in chamber 16 and as it enters the ports is always in liquid state, it is distributed in equal amounts to the various coils regardless of its change of state after entering the ports. To limit flow of refrigerant to a maximum rate within the capacity of the evaporator, the necessary restrictions may be provided by the ports 18, or as by making a portion of each of the tubes 35 of small internal diameter.

The space 47 above the motor diaphragm 28 is connected by a capillary tube 48 to a thermostatic bulb 49 attached to the suction line 38 and responsive to the temperature at the outlet of the evaporator, so that the pressure of the thermally expansive fluid with which bulb 49 and space 47 are charged (preferably, refrigerant of the same type as that circulating in the system) is applied to the diaphragm in downward direction. The space 50 below the diaphragm is connected by a passage 51 and capillary tube 52 to the header 37 so that, when the refrigerating system is in operation, the pressure of the refrigerant at the outlet of the evaporator is applied to the diaphragm in upward direction.

The operational position of closure 21 is thus determined by the difference between the pressure above the diaphragm (which pressure is a function of the temperature of bulb 49, and the pressure below the diaphragm plus the force of spring 31 which is adjusted to determine the superheat setting of the evaporator; increase of temperature at the thermostatic bulb effecting movement of the closure in a downward or port-uncovering direction.

The modified valve structure of Figs. 4–5 may employ the same type of valve closure as is shown in Figs. 1–3, but in the arrangement of Figs. 4–5 the power for actuating that closure is derived from the pressure of refrigerant flowing to a single pass of the evaporator, indicated at 56, under the control of valve means actuated by a thermostatic motor of conventional construction but of relatively small size and capacity. The evaporator 55 is therefore shown as including an additional pass 57, there being nine passes in all. The outlet end of pass 57, as well as those ends of the remaining eight passes 58, are connected in common to a header 59 from which a suction line 60 leads to a condensing unit, not shown, but which may be the same as in Fig. 1.

The valve structure of Figs. 4–5 comprises a casing 61 which is bored to form an inlet chamber 62, communicating with the refrigerant inlet 63 and closed at its bottom by a fitting 64, and an outlet chamber 65. Pressed in the bore of chamber 65 is a hollow member 66 having an opening through its bottom with which the rounded tip of a valve member 67 cooperates; the valve member being urged toward seating position by the force of a compression spring 68 in chamber 62 and acting on the member through a cupped disk 69.

At the top of the structure is a fluid pressure motor which comprises a flexible diaphragm 70 in a shallow recess in the casing and clamped by its margin to the casing by a disk 71. The space above diaphragm 70 communicates by way of a capillary tube 72 with a thermostatic bulb 73 attached to suction line 60; this system being charged with the usual thermoexpansive fluid. At the underside of the diaphragm is a flanged pusher-plate 74 whereby movements of the diaphragm are transmitted to the valve member 67 through a rod 75 which sealingly extends through an opening in the top of the outlet chamber 65 and has a reduced lower portion engaging the valve member. The space below diaphragm 70 communicates by way of an annular recess 76, passage 77 and tube 78 with the evaporator header 59.

From the description so far, it is clear that with rise of temperature at the thermostatic bulb 73 the valve means 66—67 is opened and refrigerant flows from inlet 63 to the outlet chamber 65. From this chamber the refrigerant passes through an opening 79 in the back of the casing, and through a fitting 80 (Fig. 5) and tube 81 to the top pass 57 of the evaporator.

From the outlet chamber 65 another opening 82 leads to a cylindrical space 83 bored in a lateral projection 84 of the casing. Reciprocable in an extension of this space is a piston 85 having a stem 86 which passes through an opening in the end wall of a cupped member 87 in a further extension of space 83 and secured in place by a snap-ring 88. The piston 85 is urged toward its position as shown in the drawing by the force of a spring 89 compressed between a disk 90 secured to stem 86 and a cap 91 which closes the outer end 92 of the bore of extension 84.

Secured to the piston stem 86 is a cylindrical closure 93, of the same form as the closure 21 shown in Figs. 1–3, which has a close sliding fit with the cylindrical inner surface of the cupped member 87 and whose forks are registerable with ports 94 in the side wall of that member and communicating with outlet passages 95 in radial projections 96; the passages 95 leading through tubes 97 to the eight lower passes 58 of the evaporator. It is to be noted that, as seen in Fig. 4, this portion of the structure is cut along the irregular line 4—4 of Fig. 5. Rotation of disk 90, and thereby rotation of closure 93, is prevented by fingers 98 provided at the edge of the disk and cooperating with slots cut in the surface bounding bore 92. Sealing of the piston 85, its stem 86, and the cupped member 87, is ensured by conventional O-rings, as shown.

The chamber 99 bounded by the ported inner surface of cupped member 87 is constantly in communication with the inlet chamber 62 of the valve structure by way of a horizontal passage

100 in the lower part of extension 84, inclined passage 101, bore 92, openings 102 through disk 90, and the openings through the end wall of closure 93. The space between piston 85 and the end wall of cupped member 87 is connected by an inclined passage 104 with the space below diaphragm 70 to permit proper movement of the piston; the end wall of member 87 serving to isolate the piston or movable wall 85 from the pressure of refrigerant in chamber 99.

With the parts in the positions shown in Figs. 4–5 the valve member 67 is seated, and the piston 85 therefore in its spring-biased position wherein the outlet ports 94 are covered by the forks of closure 93. With rise of temperature at the thermostatic bulb 73 the pressure above diaphragm 70 effects unseating of valve member 67 so that refrigerant flows into chamber 65 and thence through opening 79 to the top pass 57 of the evaporator. The pressure of the refrigerant entering chamber 65 is applied, through opening 92, to the space 83 ahead of piston 85 so that the same is driven to the right; the corresponding movement of closure 93 effecting uncovering of ports 94 so that refrigerant flows also to the remaining passes 58 of the evaporator.

The multiport valve structure shown more particularly in Fig. 3 is claimed in my copending application Serial No. 337,182 which on February 16, 1953 was filed as a division of the present application.

The specific embodiments of my invention herein shown and described are obviously susceptible of modification without departing from the spirit of the invention, and I intend therefore to be limited only by the scope of the appended claims.

I claim as my invention:

1. In a valve structure for controlling flow of refrigerant to an evaporator of the multipass type: a casing having an inlet for liquid refrigerant and an outlet adapted to be connected to one of the passes of said evaporator, said casing including means defining a space in constant communication with said outlet; valve means for controlling flow of refrigerant from said inlet to said outlet and said space; means mounted on said casing for actuating said valve means; said casing also including means defining a chamber and means fluidly connecting the chamber to said inlet, there being a plurality of separate outlet ports leading from said chamber for connection respectively to the individual remaining ones of said evaporator passes; a movable closure cooperable with said ports and adapted in its movements to uncover and to cover all of said ports simultaneously; and means operated by the pressure of refrigerant in said space for actuating said closure so as to effect uncovering of said ports when said valve means is opened.

2. In a valve structure for controlling flow of refrigerant to an evaporator of the multipass type: a casing having an inlet for liquid refrigerant and an outlet adapted to be connected to one of the passes of said evaporator, said casing including means defining a space in constant communication with said outlet; said space-defining means including a wall subjected to the pressure of refrigerant in said space and movable in accordance with variations of said pressure; valve means for controlling flow of refrigerant from said inlet to said outlet and said space; means mounted on said casing for actuating said valve means; said casing also including means defining a chamber and means fluidly connecting the chamber to said inlet, there being a plurality of separate outlet ports leading from said chamber for connection respectively to the individual remaining ones of said evaporator passes; a movable closure cooperable with said ports and adapted in its movements to uncover and to cover all of said ports simultaneously; and means operatively interconnecting said closure and said movable wall, the arrangement being such that movement of the wall in response to increase of pressure in said space effects movement of the closure in port-uncovering direction.

3. A valve structure as defined in claim 2, and including means for isolating said movable wall from the pressure of refrigerant in said chamber.

4. In a valve structure for controlling flow of refrigerant to an evaporator of the multipass type: a casing having an inlet for liquid refrigerant and an outlet adapted to be connected to one of the passes of said evaporator, said casing including means defining a space in constant communication with said outlet; said space-defining means including a wall subjected to the pressure of refrigerant in said space and movable in accordance with variations of said pressure; valve means for controlling flow of refrigerant from said inlet to said outlet and said space; means mounted on said casing for actuating said valve means; said casing also including means defining a chamber and means fluidly connecting the chamber to said inlet, a portion of the wall of said chamber-defining means being cylindrical, there being a circumferential row of separate outlet ports leading from said portion-surface for connection respectively to the individual remaining ones of said evaporator passes; a movable cylindrical closure fitting said portion-surface and so cooperating with said ports in its movement relative thereto as to uncover or to cover all of the ports simultaneously; and means operatively interconnecting said closure and said movable wall, the arrangement being such that movement of the wall in response to increase of pressure in said space effects movement of the closure in port-uncovering direction.

5. A valve structure as defined in claim 4, and including means for isolating said movable wall from the pressure of refrigerant in said chamber.

6. A valve structure as defined in claim 4, and wherein said cylindrical closure is hollow and its side wall is formed to provide a plurality of independent resilient portions cooperable respectively with the individual remaining ones of said ports and urged into engagement with said portion-surface.

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