April 27, 1965 R. M. HENDERSON 3,180,347

MULTIPORT REVERSING VALVES

Original Filed Dec. 7, 1955 4 Sheets-Sheet 1

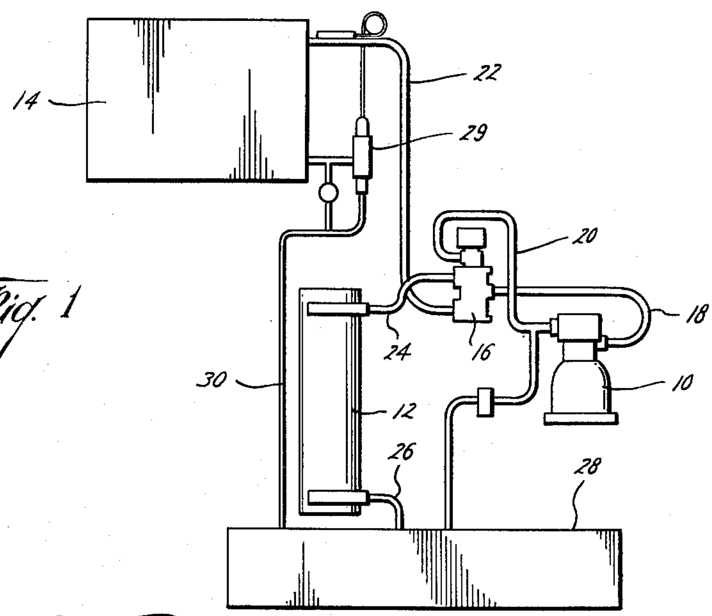

Fig. 1

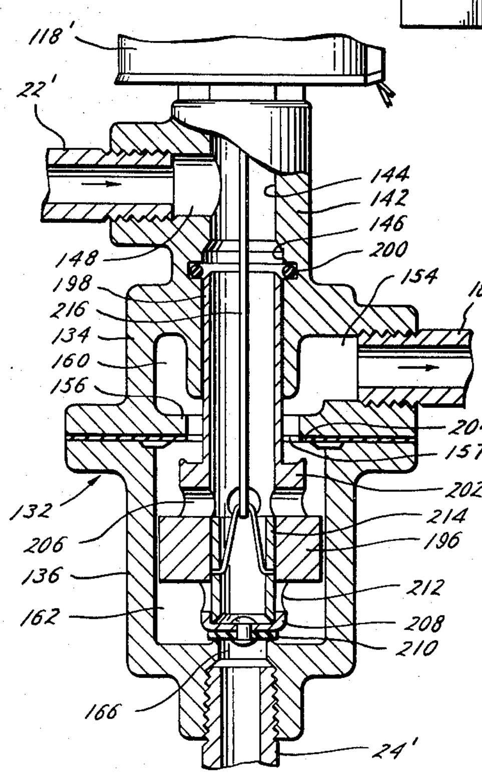

Fig. 4

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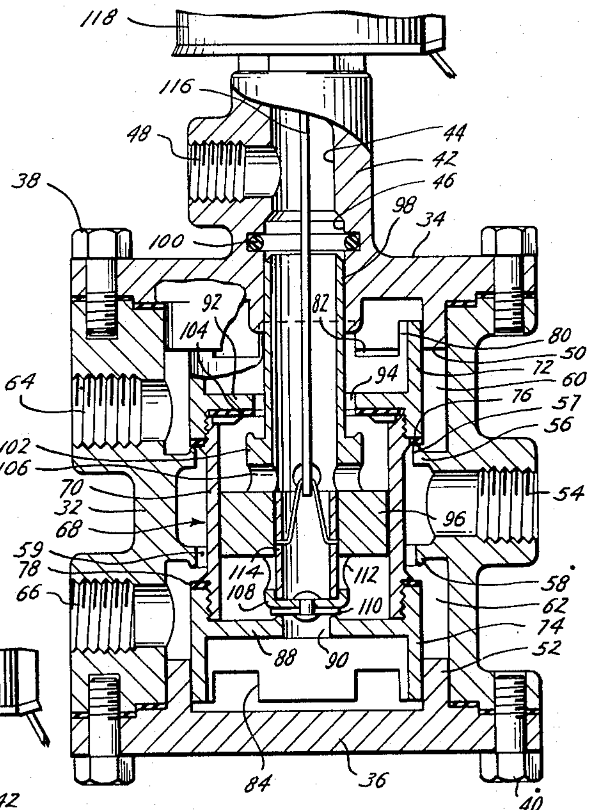

Fig. 2

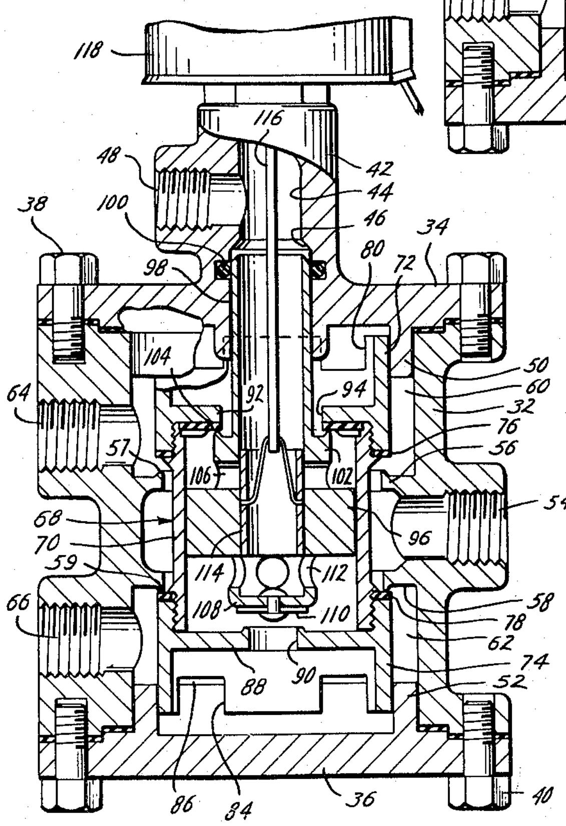

Fig. 3

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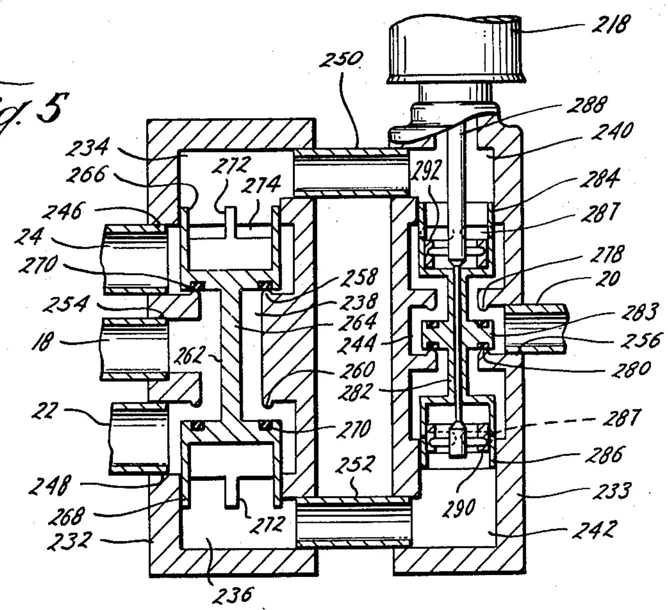
Fig. 5



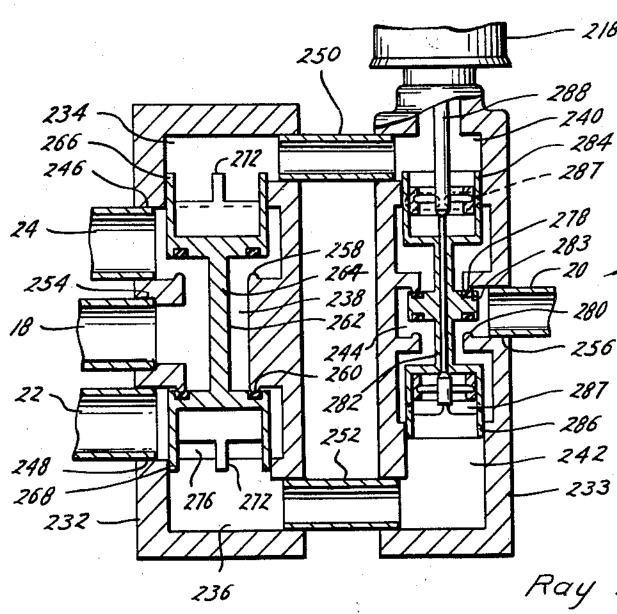


Fig. 6

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Fig. 7

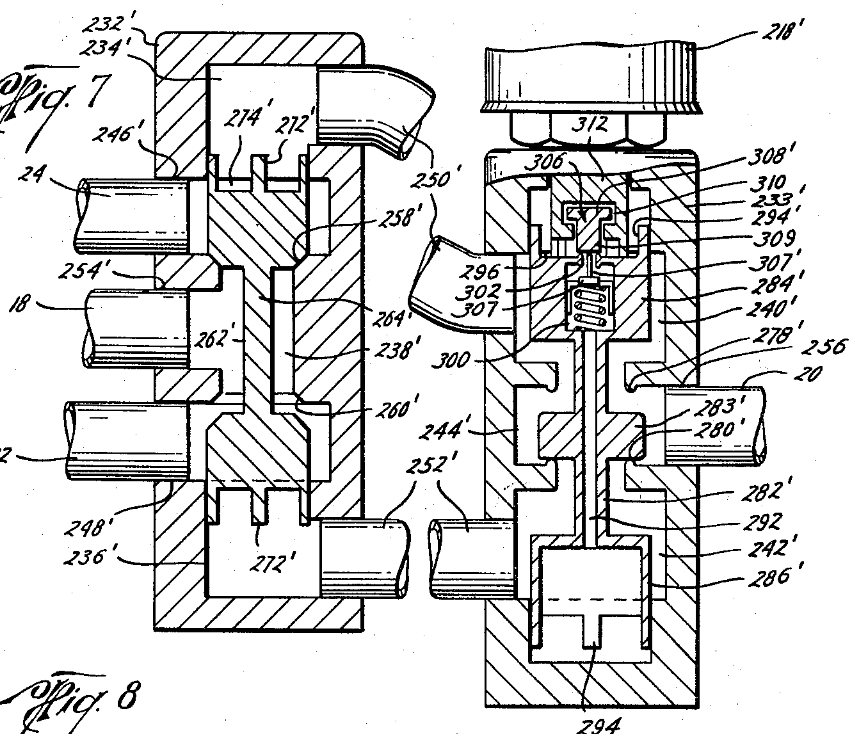


Fig. 8

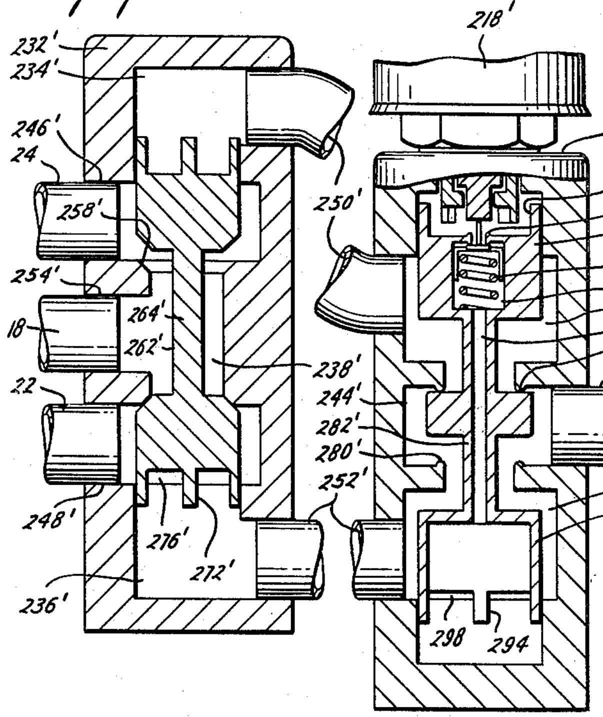
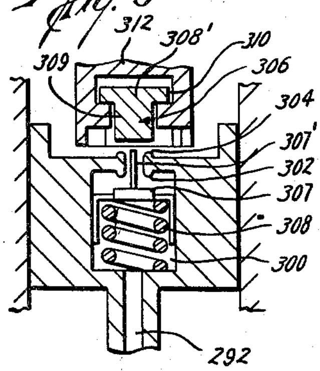


Fig. 9



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MULTIPORT REVERSING VALVES

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Continuation of applications Ser. No. 551,612, Dec. 7, 1955, and Ser. No. 25,310, Apr. 28, 1960. This application Sept. 19, 1963, Ser. No. 310,168
3 Claims. (Cl. 137—119)

This invention relates to multiport valves for directing, diverting or controlling the flow of fluids.

This application is a continuation of my copending U.S. application Serial No. 551,612 filed December 7, 1955, now abandoned, and application Serial No. 25,310 filed April 28, 1960, now abandoned.

An important application of this valve structure is in connection with reverse cycle operation of refrigeration systems to provide both heating and cooling by a heat-exchanger employed in the system.

The valve structure in accordance with this invention is especially adaptable to low temperature refrigeration systems wherein reverse cycle operation of the system is provided for the purpose of supplying heat to the evaporator for defrosting.

It is generally understood by those who are familiar with the problems of hot gas defrosting for refrigeration systems that the pressures encountered in the various stages of operation of both the refrigeration and defrost cycle are very erratic and instable. This instability is caused by the wide variation of temperatures at which refrigerant gas is condensed during the two different cycles. This variation of condensing temperatures not only affects the heat pressure of the compressor, but also the back pressure on the suction side of the compressor.

Because it is desirable to provide automatic control of such systems, it is obvious that automatic operation of the valve for reversing the operation of the system from one cycle to the other is essential.

It is further understood by those who are familiar with valve structure and operation that direct solenoid operation of large orifice valves for controlling high pressure fluids is not practical unless the pressure resistance from the seated side of the valve can be overcome or at least substantially equalized by pressure or force from the opposite direction. Therefore, diversion of pressure from one direction to another against effective pressure areas of movable parts of the valve is obviously a practical method for accomplishing automatic operation of such valves.

In common practice, three way pilot valves are usually used in combination with multiport valves to alternately direct high and low pressure from the system to the motive power element of the valve.

These pilot valves are usually used in combination with a cylinder and piston structure built into the valve, the piston being connected to the movable parts of the valve and arranged to move the valve parts between one relative position and another in response to changes in pressure provided by the pilot valve.

There are several types of valves used in connection with this type of piston and pilot valve combination including the ordinary valve stem disk and seat type and the sliding or sleeve type, all of which because of their complicated structure and the necessity of using the separate pilot valve are quite cumbersome and expensive to manufacture.

In the art of multiple port valve design, the principal difficulty encountered is the seating of two or more valve disks on their respective seats at the same time. In multiport valves that have more than two closable orifices for alternate opening and closing it is obvious that at least two of said orifices will necessarily be closed at the same

time and with the same movement of parts within the valve structure. This simultaneous seating of two or more valves within the valve structure is obviously difficult of accomplishment and because of these difficulties encountered in providing multiport valves with the conventional valve seats and valve stem closures, many types of slide valves and sleeve valves are used.

These so called slide or sleeve valves overcome the difficulties encountered in the multiple seat valves and tend to simplify and facilitate the movement of the valve from one operating position to another; however, because these valves depend upon close tolerance fit between sliding parts, their efficiency is soon dissipated by wear between these parts which causes leaks therebetween.

It is obvious that sleeve structure for diverting the flow of fluid is easier to operate because the pressure resistance encountered in the movement of seated valve plates is not present in the movement of a sleeve or hollow cylinder that is exposed to the same pressure on all sides and ends. It is further obvious that a tight closing seated valve is more effective in preventing leaks from one side of the valve to the other.

It is, therefore, an object of this invention to provide valve structure which incorporates sleeve structure to effect ease of movement and tight closing seated valve structure for holding pressure and preventing leaks after said movement has been accomplished.

It is a further object of this invention to provide sleeve structure for diverting pressure within the valve from one direction to another to effect movement of seating components from one seated position to another.

It is another object to provide valve structure for multiple port valves wherein the various ports are opened and closed in consecutive order rather than simultaneously and in which the closing of one port cannot interfere with the closing of another in the same directional movement.

Another object is to provide valve structure that is easily adapted to various types of automatically operated multiport valves.

It is another object to provide valve structure that is operable by diverting pressure from one direction to another within said structure and means within said structure for providing said diversion of pressure.

Another object is to provide structure for a multiport valve wherein various moving parts are movable in sequence and wherein the movement of each part diverts pressure from one place to another to impart movement to another part in the order of said sequence, until all moving parts of said valve have been moved from one operating position to another.

It is another object of this invention to provide a multiport valve for reversing the flow of refrigerant gas in a refrigeration system for the purpose of defrosting the evaporator of said system and which will not be adversely affected by the wide variations of pressure encountered in such systems.

Another object is to provide valve structure adaptable to valves for handling fluids in which two or more closable orifices are employed.

Another object is to provide valve structure for multiport valves that is easily adaptable to either manual or automatic operation.

Another object is to provide valve structure that is simple in design and versatile in application.

Other and more specific objects and advantages will become more readily apparent from the following detailed description and accompanying drawings.

In the drawings:

FIG. 1 is a schematic view illustrating a conventional refrigeration system embodying a multiport valve positioned with conduit connections in the system for providing reverse cycle operation for defrosting.

FIG. 2 is a cross-sectional view of a multiport valve taken on its longitudinal axis showing structural detail and connections, the valve being shown in normal operation position;

FIG. 3 is the same cross-sectional view of the valve as that of FIG. 2 except that the movable parts of the valve are shown in alternate operation position;

FIG. 4 is a cross-sectional view similar to that of FIG. 2 of another embodiment of the invention showing a three way valve having only two orifices that are closable by seated closing means;

FIG. 5 is a vertical, central, cross-sectional view illustrating a further embodiment of the invention showing the moving parts in the normal operating condition of the system;

FIG. 6 is a view similar to that of FIG. 5 showing the parts in the reverse cycle operation of the system;

FIG. 7 is a vertical, central, cross-sectional view of a still further embodiment of the invention with the moving parts shown in the positions which they occupy under normal operating conditions of the system;

FIG. 8 is a view similar to that of FIG. 7, the parts being shown in positions which they occupy during reverse cycle operation of the system; and

FIG. 9 is a fragmentary cross-sectional view on an enlarged scale illustrating an intermediate position of the embodiment of FIGS. 7 and 8 during the movement of the parts from normal operating condition of the system to reverse cycle operation of the same.

Referring now to the drawings in greater detail, the invention is illustrated herein in connection with its application to a refrigeration system of usual construction such as that shown in FIG. 1 having a compressor **10**, condenser **12**, and evaporator **14**, the multiport valve of the invention being shown at **16** connected into the system.

The compressor **10** has a suction line **18** and a discharge line **20** connected to the valve **16**, and in the normal position of the valve, the suction line is in communication through the valve with a pipe **22** leading from the evaporator **14**, while the discharge line is in communication through the valve with a pipe **24** leading to the condenser **12**. A pipe **30** leads to the evaporator from an accumulator **28** which is connected by a pipe **26** to the condenser. A pressure reducing valve **29** of any suitable and convention design is interposed in pipe **30**.

In the normal operation of the system fluid is withdrawn by the compressor from the evaporator through pipe **22**, valve **16** and suction line **18** and delivered to the condenser through discharge line **20**, valve **16** and pipe **24** from whence the fluid flows through pipe **26** to the accumulator **28** and back to the evaporator through pipe **30** and valve **29**.

To accomplish reverse cycling of the system, the valve **16** is moved to its alternate position and operates in a manner to be more fully described hereinafter to establish communication between suction line **18** and pipe **24** and between discharge line **20** and pipe **22** to permit the compressor to withdraw fluid from the condenser and deliver it to the evaporator.

FIGS. 2 and 3 illustrate a four way valve in accordance with one embodiment of the invention which comprises the generally tubular hollow body **32**, closed at one end by a bonnet **34** and at the opposite end by an end plate **36**, the bonnet **34** and end plate **36** being removably secured to the ends of the body **32** by any suitable means such as capscrews **38** and **40**, respectively. The bonnet **34** is formed centrally thereof with an outwardly extending neck **42** provided with a longitudinal bore **44** whose lower end opens into an enlarged counterbore **46** opening into the interior of the body. The neck **42** has an inlet opening **48** leading into the bore **44** for the connection thereto of the compressor discharge line **20**. The bonnet **34** is also provided with a downwardly extending annular flange **50** which fits into the upper end of the body **32** for a purpose hereinafter explained.

The end plate **36** has an upwardly extending annular flange **52** similar to the flange **50** which fits into the lower end of the body **32**.

The body **32** is provided with an outlet port **52** to which the suction line **18** of the compressor **10** is connected and is formed with internal, annular flanges **56** and **58** above and below the outlet port **54**. The upper flange **56** defines the lower end of an upper chamber **60** within the body **32** while the lower flange **58** defines the upper end of similar chamber **62** therein, the flanges also having central openings **57** and **59**, respectively, therethrough forming valve seats through which fluid may flow from the upper and lower chambers to the outlet **54**. The body has a port **64** in communication with the upper chamber **60** and to which, in the present illustration, the pipe **24** is connected, while a port **66** is provided in communication with the lower chamber **62** to which the pipe **22** is connected.

A sleeve valve assembly **68** of cylindrical formation is positioned in the body **32** for axial movement therein, which member has a central cylindrical section **70** extending through openings **57** and **59** in the internal flanges **56** and **58** in radially inwardly spaced relation thereto into the chambers **60** and **62** and carries at its upper and lower ends cylindrical extensions **72** and **74**, respectively, whose external diameters are somewhat larger than the external diameter of the section **70**. The upper extension **72** is slidably fitted into the annular flange **50** of bonnet **34** to guide the valve member and hold the same centralized within the body. The lower end of the extension **72** carries an annular seat element **76** positioned to engage the seat **57** to close the same when the valve assembly **68** reaches its lowermost position and the upper end of the extension **74** has a similar annular seat element **78** positioned to engage the seat **59** to close the same when the valve member reaches its uppermost position. At its upper end the extension **72** is formed with end notches **80** which form with the annular flange **50** passageways **82** when the valve member is in its lower position to provide communication between the interior of the valve assembly **68** and the chamber **60** and which passageways are closed when the valve member is in its upper position. Similarly, the lower extension **74** is provided with end notches **84** at its lower end which form with the annular flange **52** passageways **86** when the valve assembly is in its upper position to provide communication between the interior of the valve member and chamber **62** and which are closed when the valve assembly moves downwardly to its lower position.

The lower extension **74** has an internal web **88** which is provided with a central opening **90** forming a valve seat, and the upper extension **72** also has an internal web **92** provided with a central opening **94**.

A hollow plunger or valve member **96** is movably positioned within the section **70** of the valve member **68** and is provided with a hollow stem **98** extending upwardly through the opening **94** and is slidably fitted into the counterbore **46** of the bonnet **34**. Sealing means, such as an O-ring **100** is provided within the counterbore **46** within an internal groove provided to receive the same with which the stem **98** is engageable when the plunger is in its uppermost position to form a fluid tight seal between the stem and bonnet.

The stem **98** has an externally enlarged portion **102** adjacent the plunger **96** which is engageable with an annular sealing element **104** surrounding the opening **94** to close the opening when the plunger reaches its upper position. The enlargement **102** is also provided with one or more openings **206** which are in communication with the interior of the stem and which lead to the exterior of the same.

The plunger **96** has a hollow, downwardly extending portion **108** which carries a sealing element **110** positioned for engagement with the web 88 of the extension 74 about the opening 90 to close the opening when the plunger reaches its lower position. This downward extension 108 also has one or more openings 112 which are in communication with the interior of the stem and with the interior of the cylindrical section above the opening 90.

An internal pilot sleeve 114 is slidably fitted into the plunger 96 for axial movement to an upper position, extending into the enlargement 102, to close off communication through the openings 106 between the interior of the stem and the interior of the cylindrical section 70 above the plunger, while establishing communication through openings 112 between the interior of the stem and the interior of the section 70 below the plunger and to a lower position extending into the extension 108 to cut off communication through openings 112 between the interior of the stem and the interior of the section 70 beneath the plunger, while establishing communication through openings 106 between the interior of the stem and the interior of the section 70 above the plunger.

An operating rod 116 is connected at its lower end to the sleeve 114 and extends upwardly through the stem and bonnet 34 into suitable means, such as the solenoid coil mechanism, indicated at 118 by which the rod may be moved upwardly to move the sleeve 114 to its upper postion from which the sleeve may return downwardly to its lower position.

In the operation of the invention, constructed as described above, the valve is in the position illustrated in FIG. 2 with the solenoid mechanism 118 deenergized and the valve assembly 68, plunger 96 and sleeve 114 in their lowermost positions.

In this position of the valve, the annular flange 52 is in closing relation to the end notches 84 of the extension 74, closing the passageways 84 and the opening 90 is also closed by the plunger extension 108. The chamber 62 will, however, be in communication with the outlet 54 through opening 59 so that fluid may flow from the evaporator 14 through pipe 22 and suction line 18 to the compressor 10.

The interior of the hollow stem 98 will also be in communication with the interior of the valve assembly 68 through openings 106, and the interior of the valve assembly 68 will be in communication with the upper chamber 60 through opening 94 and passageways 82, which are open, so that fluid may flow from the compressor through discharge line 20, inlet 48 through stem 98, openings 106, opening 94 and chamber 60 to the port 64 and through pipe 24 to the condenser. It will be observed that the relatively high pressure of the fluid discharged from the compressor, while following this course, will be exerted against the upwardly facing pressure areas of all the movable parts of the valve. In this manner, the high pressure fluid is directed to hold the closed valve ports in a tightly sealed condition, the effectiveness of the sealing increasing as the pressure difference between the suction and discharge lines becomes greater.

To accomplish a reverse cycling of the apparatus, the movable parts of the valve are moved from the position of FIG. 2 to that shown in FIG. 3, such movement being initiated by energizing the solenoid mechanism 118 to lift the sleeve 114 to its uppermost position. This upward movement of the sleeve relative to the plunger 96 results in uncovering the lower openings 112 and closing the upper openings 106. The sleeve 114 being open at both ends, does not encounter pressure resistance in movement, and because it need not provide a tight seal for the openings, but may have a comparatively loose fit in the plunger requires only a small force for its operation so that the solenoid may be very small. When the sleeve reaches its upper position, the pressure of fluid discharged from the compressor will be diverted from its course as seen in FIG. 2 to that illustrated in FIG. 3, through the lower openings 112 into the valve assembly 68 beneath the plunger 96, whereupon the plunger will be moved upwardly to its upper position. This upward movement of the plunger establishes communication between the interior of the valve assembly 68 and the lower chamber 62 through opening 90 so that pressure builds up beneath the valve assembly 68 to move the same upwardly closing passageways 82 and opening passageways 86. Such upward movement of the valve assembly 68 also tightly closes the opening 59 and opening 94 while opening 57 is opened.

In this position of the valve fluid may then flow from the compressor discharge line 20 through inlet 48, stem 98, opening 90, passageways 86, chamber 62, port 66 and pipe 22 to the evaporator, and fluid will also be withdrawn from the condenser through pipe 24, port 64, chamber 60, opening 57, outlet 54 and suction line 18 to the compressor.

From the foregoing, it will be observed that the movement of each movable part is accomplished separately and consecutively, and by the movement of one part, pressure is directed to another portion of the valve to cause the next movement until all of the movements have been accomplished and the valve is in its alternate operating position.

The movement of the valve parts back to the normal operating position of the valve is accomplished in the same manner as described above except that the pressure is diverted and directed to cause the valve parts to move downwardly. This movement is initiated by deenergization of the solenoid mechanism 118 to cause the sleeve 114 to drop to its lower position over the openings 112 and to uncover the openings 106 to direct pressures into the valve assembly 68 above the plunger 96 thereby forcing the plunger downwardly and permitting pressure to build up in the upper chamber 60 to move the valve assembly 68 downwardly.

In FIG. 4, there is illustrated a somewhat different form of the invention in which the valve is of the three-way type having a hollow body 132 formed in two parts 134 and 136. The upper part 134 has an upwardly extending neck portion 142 provided with a bore 144 whose lower end opens into a downwardly opening counterbore 146, opening into an upper chamber 160. The upper part 134 also has an outlet 154 leading from the chamber 160 for the connection thereto of a suction line 18′ and an inlet 148 leading into the bore 144 for the connection thereto of a discharge 22′. An internal annular flange 156 is formed in the lower end portion of the upper part 134, which flange has a central opening 157 therethrough to provide a valve seat.

The lower part 136 has a chamber 162 and is provided with a port 166 leading into the chamber 162 for the connection thereto of a pipe 24′.

Within the chamber 162 a hollow plunger or valve member 196 is positioned for axial movement therein and which has a hollow stem 198 extending upwardly therefrom through the opening 157 in radially inwardly spaced relation to the flange 156 and which is slidably fitted at its upper end into the counterbore 146. Suitable sealing means, such as the O-ring 200 is provided, which is disposed in an internal groove in the counterbore 146 in position to form a fluid tight seal between the stem 198 and the upper part when the plunger is in its uppermost position.

The stem 198 has an externally enlarged portion 202 adjacent the upper side of the plunger and which is provided with one or more openings 206 therein which are in communication with the interior of the stem and the chamber 162 above the plunger. This enlargement 202 is shaped to seat on a suitable sealing element 204 on the flange 156 surrounding the opening 157 to close the opening when the plunger reaches its upper position.

The plunger 196 also has a downward extension 208 which carries a sealing element 210 in position to close the port 166 when the plunger reaches its lower position in the chamber 162. This downward extension 208 is provided with openings 212 in communication with the interior of the plunger and the chamber 162 beneath the plunger.

Within the plunger 196 an internal pilot sleeve 214 is movably positioned for downward movement to a lower position to cover the openings 212 while uncovering the openings 206 and to an upper position to uncover openings 212 and cover openings 206. An operating rod 216 is connected at its lower end to the sleeve 214 which rod extends upwardly through the hollow stem 198 and upper part 142 and into the solenoid mechanism 118' by which the rod may be moved upwardly upon energization of the solenoid mechanism to move the sleeve 214 to its upper position.

The upper and lower parts 134 and 136 may be secured together in any suitable manner, as by bolts, not shown.

In the operation of the above-described three-way valve, it will be apparent that the pilot sleeve 214 may be moved from one of its positions to the other to divert pressure from one side of the plunger 196 to the other side thereof to move the plunger from one to the other of its positions whereby the flow of fluid entering the valve through the line 22' may be diverted through the outlet 154 or through the port 166.

With the pilot sleeve in the position shown in FIG. 4, the openings 212 are covered while openings 206 are uncovered, permitting fluid from the inlet 148 to pass downwardly through stem 198 into the chamber 162 above the plunger through openings 206, from whence the fluid may pass out through opening 157 and the outlet 154. This course of the fluid causes pressure to be built up above the plunger 196 to move the plunger downwardly to close the port 166.

Upon energization of the solenoid mechanism 118' the pilot sleeve 214 will be moved upwardly by rod 216 to its upper position uncovering the lower openings 212 and covering the upper openings 206, whereupon fluid may flow downwardly through the stem into the chamber 162 beneath the plunger to raise the plunger and open the port 166. When the plunger reaches its upper position the enlargement 202 closes the opening 157 and the outflow of fluid through the outlet 154 is effectively shut off.

A further embodiment of the invention is illustrated in FIGS. 5 and 6, wherein the internal moving parts of the valve are separately located for independent movement relative to each other. In this embodiment of the invention the valve casing may be made up of two generally tubular hollow bodies or valve casing parts 232 and 233. The body 232 has upper and lower chambers 234 and 236, respectively, therein which are in communication through an intermediate bore 238, while the body 233 is formed with upper and lower chambers 240 and 242 which are in communication through an intermediate chamber 244. The body 232 has an opening 246 leading into the upper chamber 234 into which the pipe 24 leading to the condenser 12 is connected, while an opening 248 is provided leading into the chamber 236 into which the pipe 22 leading to the evaporator 14 is connected. The upper chamber 234 is connected with the upper chamber 240 by a pipe 250 and the lower chamber 236 is similarly connected in communication with the lower chamber 242 by a pipe 252.

The body 232 also has an opening 254 leading into the bore 238 and into which the suction line 18 of the compressor 10 is connected, and the body 233 has an opening 256 leading into the intermediate chamber 244 and into which the discharge line 20 of the compressor 10 is connected.

The body 232 is provided with internal annular valve seats 258 and 260, at the opposite ends of the bore 238, positioned to be engaged by a valve element 262 movably disposed in the body for movement therein to one position to close the seat 258 to shut off communication between the bore and the upper chamber 234 while opening the seat 260 to establish communication between the

bore and the lower chamber 236, or to another position to close the seat 260 to shut off communication between the bore and the lower chamber while establishing communication between the bore and the upper chamber.

The valve element 262 has a stem 264 extending through the bore 238 and is provided at one end with a sleeve-like head 266 located in chamber 234 and at the other end with a similar head 268 in chamber 236. Suitable sealing elements 270 may be provided on each of the heads 266 and 268 positioned for engagement with the seats 258 and 260, respectively, to close the seats. The sleeve-like heads are each formed with end notches 272 positioned to provide passageways 274 to establish communication with the pipes 24 and 250 when the valve 262 moves downwardly, as seen in FIG. 5, and passageways 276 to establish communication between pipes 22 and 252 when the valve element 262 moves upwardly, as seen in FIG. 6.

The body 233 is provided with internal annular valve seats 278 and 280 at the opposite ends of the intermediate chamber 244 and within the body a movable valve member 282 is disposed having an externally enlarged portion 283 intermediate its ends positioned for movement in one direction to close the seat 278 while opening the seat 280 and in the other direction to close seat 280 and open seat 278. This valve member 282 extends through the chamber 244 and has a sleeve-like upper end head 284 in the chamber 240 and a sleeve-like lower end head 286 in the lower chamber 242. Each of the heads 284 and 286 is provided with one or more openings 287 therein which are positioned to establish communication between the compressor discharge line 20 and pipe 250 when the valve member 282 is in position to open the seat 278 and close seat 280, and between the discharge line 20 and pipe 252 when the valve member is in position to close seat 278 and open seat 280.

A central stem 288 is slidably extended longitudinally through the member 282 and carries a piston 290 slidably positioned in the head 286 and a piston 292 slidably positioned in the head 284. The stem 288 extends upwardly through the top of the body for vertical movement relative thereto and the upper end of the stem extends within a solenoid device 218 whereby the stem will be moved upwardly upon energization of the solenoid device.

In the operation of the embodiment of the invention illustrated in FIGS. 5 and 6, assuming that the valve elements 262 and 282 are in the positions shown in FIG. 5 for normal operation of the system, with the suction line 18 of the compressor in communication with the pipe 22 through the lower chamber 236 and bore 238 and the discharge line 20 in communication with pipe 24 through seat 278, upper chamber 240, pipe 250, upper chamber 234 and passageways 274, and it is desired to place the system in condition for reverse cycle operation, then the solenoid device 218 is energized to move the stem 288 upwardly, whereupon the pistons 290 and 292 will be moved upwardly to close the openings 287 in head 284 and uncover the openings 287 of the head 286, thus cutting off the flow of pressure from the discharge line 20 to upper chamber 234. The pressure of the fluid from discharge line 20 then operates against the head 284 to move the valve member 282 upwardly to close the seat 278 and open the seat 280, whereupon pressure from the discharge line 20 may pass into the lower chamber 236 to act upon the lower head 268 of valve member 262 to move valve member 262 upwardly to the position of FIG. 6 to close seat 260 and open seat 268 to permit reverse cycle flow of fluid through the system.

It is to be noted that the end notches 272 of the sleeve-like heads of the valve member 262 are of such depth that the passageways 274 provided by the upper head 266 will remain partly open upon upward movement of the valve member until the passageways 276 provided by the lower head 268 have been opened substantially, so that upward movement of the valve member will not be resisted by downward pressure of fluid on the upper head 266.

The system can be restored to normal operating condition by de-energization of the solenoid device 218 to allow the stem 288 to move downwardly to move pistons 290 and 292 downwardly, whereupon pressure from discharge line 20 will be cut off from the lower chamber 236 and valve member 282 will be actuated to permit the application of pressure to the upper head 266 to move valve member 262 downwardly to the position of FIG. 5 to close seat 258 and open seat 260.

A still further embodiment of the invention is illustrated in FIGURES 7, 8 and 9, wherein the valve mechanism includes valve casings or bodies 232′ and 233′ of similar construction to the bodies 232 and 233 of the embodiment illustrated in FIGURES 5 and 6, the valve element 262′ being similar to the element 262 previously described, and the general arrangement of the system being the same. In this embodiment of the invention the valve member 282′ is of somewhat different construction to the member 282, having a central longitudinal passageway 292 therethrough which opens at its opposite ends into the chambers 240′ and 242′ at points beyond the sleeve-like heads 284′ and 286′. The heads 284′ and 286′ are also formed with end notches 294 which are positioned to provide passageways 296 through which fluid may flow between the upper chamber 240′ and the passageway 292 when the member 282′ is in its lower position, shown in FIGURE 7, and passageways 298 through which fluid may flow between the lower chamber 242′ and passageway 292 when the member in its upper position, shown in FIGURE 8.

The passageway 292 has an internal enlargement 300 intermediate its ends in which an internal seat 302 is provided on the head 284′, surrounding the passageway, there being also an external seat 304 on the head 284′ surrounding the upper end of the passageway.

An auxiliary valve 306 includes a disk-shaped valve element 307 having a stem 307′ which extends upwardly through the seats 302 and 304 and bears at its lower end on one end of a coil spring 308 whose other end is seated on the bottom of the internal enlargement 300 and which yieldingly urges the valve element upwardly relative to the valve member 283′. The valve element 307 is shaped to engage the seat 302 upon upward movement and the upper end of stem 307′ is adapted to engage the lower end of a small plunger 309 which forms a valve element adapted to engage the seat 304 upon downward movement of the plunger to close the passageway 292. Plunger 309 has at its upper end a head 308′ of T-shape which fits into a T-slot 310 in the lower end of a stem 312 which is slidably extended through the upper end of the body 233′. The T-head 308′ is of somewhat smaller size than the T-slot 310, so that the auxiliary valve element 307 and plunger 309 may move vertically a small distance relative to the stem 312. The stem 312 extends upwardly into a solenoid device 218′, in a manner to be moved upwardly upon energization of the solenoid device, and to descent by its own weight when the solenoid is de-energized.

In the normal operation of the system, employing this embodiment of the invention, the parts will be in the positions illustrated in FIGURE 7, the discharge line 20 of the compressor being in communication with the pipe 24 through the seat 278′, chamber 240′, pipe 250′ chamber 234′ and passageways 274′, and the suction line 18 being in communication with the pipe 22 through chamber 236′, seat 260′ and bore 238′. In this condition of the apparatus the solenoid 218′ is de-energized and the plunger 309 of auxiliary valve 306 is in engagement with the seat 304 to close the passageway 292 against the flow of fluid therethrough from the upper chamber 240′ into the lower chamber 242′ beneath the lower head 286′.

When it is desired to place the system in condition for reverse cycle operation the solenoid 218′ is energized, to move the stem 312 upwardly, whereupon the auxiliary valve 306 follows the stem upwardly under the influence of the coil spring 308 to an intermediate position, illustrated in FIGURE 9, to open both the seats 302 and 304 to permit the flow of fluid from the upper chamber 240′ through the passageway 292 into the lower chamber 242′ beneath the lower head 286′ to cause the valve member 282′ to be moved upwardly to the position illustrated in FIGURE 8, wherein the seat 278′ is closed, and the seat 280′ is open. As soon as the valve member 282′ reaches the position illustrated in FIGURE 8 to close the seat 278′ and open the seat 280′ the auxiliary valve element 307 will be in engagement with the seat 302 under the influence of the spring 308, to close the passageway 292. In this condition of the mechanism the passageway 298 of the lower head 286′ will be open, so that pressure from the discharge line 20 may also flow through the pipe 252′ to chamber 236′ to move the valve member 262′ to its upper position, whereupon fluid from the discharge line may flow to the pipe 22 and the suction line 18 will be in communication with the pipe 24 through the seat 258′.

The system may be returned to normal operation by de-energization of the solenoid 218′, whereupon the auxiliary valve 306 will be moved downwardly to the intermediate position of FIGURE 9 under the influence of the weight of the stem 312 to permit the flow of fluid from the lower chamber 242′ through passageway 292 into the upper chamber 249′ above the upper head 284′, so that the pressure above and beneath the valve member 282′ will be balanced, to permit the valve member to move downwardly to the position of FIGURE 7.

It will, of course, be appreciated that the valve bodies or casings 232 and 233 may be made as separate parts, as illustrated in the drawings, or as a single unit having the necessary passageways corresponding to the pipes 250 and 252.

From the foregoing it will be apparent that wide variations in the difference of pressure, between the high and low sides of a refrigeration system or any other pressure fluid system, will not materially affect the operation of the valve of the invention, because the novel structure of the invention provides pressure actuated moving parts in which the pressure actuating the parts cannot be affected by interchange of pressure within the valve until after the movement has been completed.

While the invention has been disclosed herein in connection with certain specific embodiments of the same, it will be understood that these are intended by way of illustration only, and that numerous changes can be made in the construction and arrangement of the various parts without departing from the spirit of the invention and within the scope of the appended claims.

What is claimed is:

1. A multiport valve comprising, a body having a hollow interior and an inlet port to said hollow interior and at least two additional ports in communication with said hollow interior, valve means longitudinally movable in said body for controlling fluid flow between said inlet port and said additional ports, said valve means having a first poppet valve surface and a second valve surface longitudinally spaced from each other, said body having a first poppet valve seat adapted to be contacted by said first valve surface to close fluid flow from said inlet port to a first one of said additional ports, said body also having a second valve seat adapted to be contacted by said second valve surface to close fluid flow from said inlet port to a second one of said additional ports, flow channel means in said valve means having longitudinally spaced outlet openings, said body having passage means in said hollow interior for directing fluid under pressure from said inlet port through said flow channel means and out of one of said outlet openings, pilot valve means for alternately opening and closing said outlet openings of said flow channel means, said body having additional passage means for directing the fluid under pressure from the

one of said outlet openings which is open to one of said additional ports in said body, and said valve means having a pressure surface adapted to be contacted by the fluid under pressure when one of said outlet openings is open and also another pressure surface adapted to be contacted by the fluid under pressure when the other of said outlet openings is open for alternately moving said valve means longitudinally in said body.

2. A multiport valve including, a body having a flow passage therethrough, conduit means communicating with the opposite ends of said passage for reversibly directing fluid into said opposite ends, a pair of annular valve seats positioned at longitudinally spaced points in said passage, flow ports communicating with said passage at points between said seats and the points of connection of said condiut means to the passage, and outlet port communicating with the passage between said seats, a valve member reversibly movable longitudinally in said flow passage, said valve member carrying longitudinally spaced closure elements and actuatable by the fluid flow from said conduit means to alternately engage said seats in accordance with the direction of said fluid flow, whereby to alternately establish communication between said outlet port and one of the flow ports, while simultaneously closing communication between said one of the flow ports and the conduit means, said valve member having throttling means therewith for gradually releasing fluid pressure at one end of said body between one of said annular valve seats and said one of said flow ports, said throttling means including longitudinally extending fingers having notches therebetween through which fluid may flow from the conduit means to said one of said flow ports, and the notches being gradually movable into the bore of the body to gradually close such flow to said one of said flow ports and prevent chattering of the valve member during such closure.

3. A multiport valve including, a body having a flow passage therethrough, conduit means communicating with the opposite ends of said passage for reversibly directing fluid into said opposite ends, a pair of annular valve seats positioned at longitudinally spaced points in said passage, flow ports communicating with said passage at points between said seats and the points of connection of said conduit means to the passage, an outlet port communicating with the passage between said seats, a valve member reversibly movable longitudinally in said flow passage, said valve member carrying longitudinally spaced closure elements and actuatable by the fluid flow from said conduit means to alternately engage said seats in accordance with the direction of said fluid flow, whereby to alternately establish communication between said outlet port and one of the flow ports, while simultaneously closing communication between said one of the flow ports and the conduit means, said valve member having throttling means therewith for gradually releasing fluid pressure at one end of said body between one of said annular valve seats and one of said flow ports, said valve member also having an additional throttling means therewith for gradually developing a pressure in the other end of said body as the pressure is gradually released from said one end of said body, said throttling means including longitudinally extending fingers having notches therebetween through which fluid may flow from the conduit means to said one of said flow ports, the notches being gradually movable into the bore of the body to gradually close such flow to said one of said flow ports and prevent chattering of the valve member during such closure, said additional throttling means including longitudinally extending fingers having notches therebetween through which fluid may flow from the conduit means to the other of said flow ports, and the notches thereof being gradually movable into the bore of the body to gradually close the flow to the other of said flow ports and prevent chattering of the valve member during such closure.

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