Oct. 6, 1936. L. A. PHILIPP 2,056,482

REFRIGERATING APPARATUS

Filed March 13, 1935

Fig. 1.

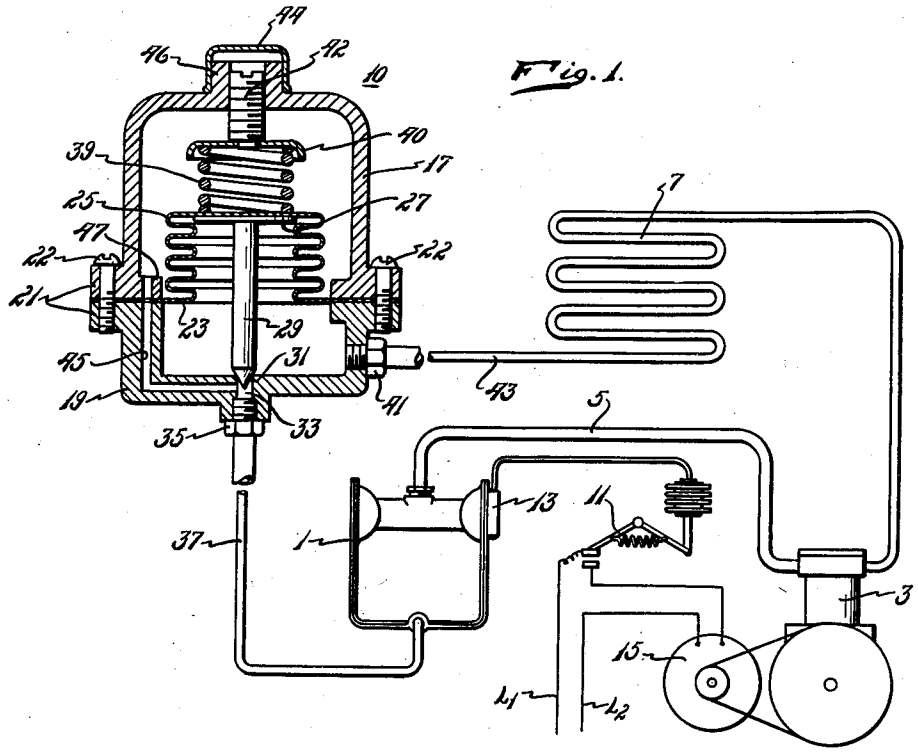


Fig. 2.

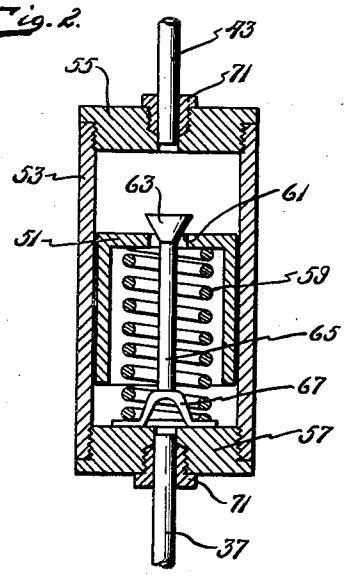
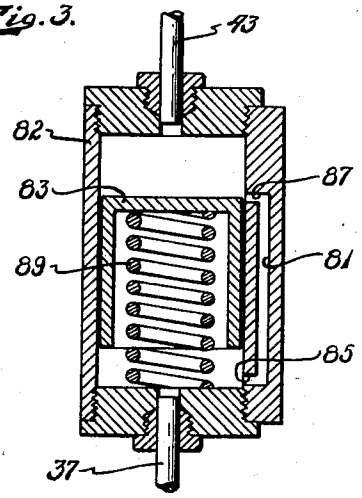


Fig. 3.



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REFRIGERATING APPARATUS

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8 Claims. (Cl. 62—3)

My invention pertains to feed controlling means for regulating the flow of refrigerant from the high side to the low side of expansion refrigerating systems, and more particularly to pressure differential actuated refrigerant feed valves.

It is an object of my invention to provide refrigerant regulating means between the high side and the low side of an expansion type refrigerating system to regulate the relation of the refrigerant therein comprising means for applying the pressure of the high side refrigerant to react upon a movable member in opposition to a biasing spring, means for applying the low side refrigerant pressure to react upon said movable member in aiding relation with the biasing spring and refrigerant flow controlling means arranged for passing refrigerant to the low side in accordance with the movements of said member and also for unloading the compressor for easy starting.

It is also an object of my invention to provide a refrigerant feed valve comprising a valve casing for receiving the high pressure liquid refrigerant to be regulated and applying its pressure to react upon a diaphragm like member having a flexible bellows portion and a refrigerant passing valve actuated thereby in conjunction with conduit means for applying the pressure set up by the passed refrigerant to aid in biasing spring in opposing the unregulated pressure.

It is a further object of my invention to provide a refrigerant regulating valve comprising a cylinder for receiving high pressure refrigerant in one end thereof for moving a piston in opposition to a biasing spring and in cooperative relation with a relatively movable valve member which opens to pass refrigerant through the piston to the other end of the cylinder where its pressure aids the biasing spring and from whence it is conveniently conducted to the low or regulated side of the system and arranged for unloading the compressor during off periods.

Another object of my invention is to provide a refrigerant regulating valve of the above type wherein the flow regulating arrangement comprises a recess extending through a side wall of the cylinder from one end of the cylinder to an aperture disposed in an intermediate portion of the side wall whereby it is covered or exposed to admit the refrigerant in accordance with the movements of the piston in response to opposing pressure differences to which it is subjected.

The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments, when read in conjunction with the accompanying drawing, in which

Fig. 1 is a view partly sectional and partly diagramatic showing an embodiment of my refrigerant feed valve arranged for controlling the flow of refrigerant from the high side to the low side of an expansion type refrigerating system; and

Figs. 2 and 3 are sectional views showing modifications of my feed valve structure.

Referring more particularly to Fig. 1 of the drawing, the apparatus comprises an evaporator 1 for absorbing heat by vaporizing a volatile liquid refrigerant which is supplied thereto from a suitable source. As illustratively represented the source of refrigerant may be a motor driven compressor 3 which withdraws the refrigerant vapor from the evaporator through a suction line 5, compressing it through suitable heat dissipating condenser coils 7 where its latent heat of vaporization is disbursed thereby recondensing it to a liquid. From the condenser 7 the liquefied refrigerant is supplied to the low side of the system through my automatic refrigerant feed valve 10 which is interconnected therebetween.

The compressor 3 is preferably controlled to operate and supply a suitable quantity of refrigerant to the system for maintaining a predetermined temperature adjacent the evaporator by means of a thermostat switch 11 which is controlled by a thermo-bulb 13 for intermittently energizing from the service lines L1 and L2 an electric motor 15 which drives the refrigerant compressor in a well known manner.

The refrigerant feed valve 10 which is interconnected by the high side and the low side of the refrigerating system for regulating the relations of the refrigerant therein, comprises a pair of valve casings 17 and 19 having abutting lateral flanges 21 which are clamped together by suitable bolts or screws 22 to clamp the edges of a flexible metallic diaphragm member 23 whereby the enclosure is hermetically sealed and divided into two compartments. The diaphragm comprises a flexible bellows portion 25 having a relatively rigid bellows head 27 which carries a valve stem 29. The valve stem is rigidly secured to the bellows head in any suitable manner, as by welding, and projects for cooperative engagement in a valve seat 31, which is disposed in a wall of the valve casing. From the valve seat 31 an aperture 33 extends through the bottom valve casing wall 19 which is provided with a suitable connecting

fixture 35 for conveniently connecting with the conduit 37 through which the refrigerant is supplied to the low side of the system. The valve 29 is normally biased towards flow obstructing position by a biasing spring 39 which is compressed between the bellows head 27 and an adjustable stop 40 in the opposite wall of the upper half of the valve casing 17. The adjustable stop 40 is pivotally mounted on the end of a threaded pin 42 which screws into a threaded aperture in the end wall of the valve casing. After the pin has been turned by a screw driver to adjust the biasing spring 39 for desirable operating characteristics in the system, a metallic cap 44 is hermetically sealed on shoulders 46 provided around the outside of the aperture to prevent leakage.

The lower valve casing wall 19 is also provided with a suitable pipe fitting 41 by which it may be readily connected with the conduit 43 for receiving the liquefied refrigerant from the high side of the system. From the upper compartment of the valve, a passage 45 extends through the diaphragm clamping shoulder 47 through the wall of the lower half of the valve casing to the outlet 33 leading from the valve seat 31 to the low side of the system. For convenient assembly the refrigerant feed valve 10 may preferably be positioned directly on the evaporator. The area of the bellows head and the tension of the biasing spring 39 are suitably selected to discharge high pressure impulses caused by the compressor drawing unusually large charges of refrigerant vapor from the vapor filled evaporator when starting. In this manner the abnormally high starting loads are avoided and a smaller motor may be used for driving the compressor.

In operation the thermostatic switch 11 starts the compressor in response to abnormally high temperature adjacent the evaporator 1. As the compressor operates, the liquefied refrigerant passing into the low compartment of feed valve creates a pressure which distorts the flexible bellows member 25 in opposition to the biasing spring 39. This moves the valve 29 away from the valve seat 31 and passes a quantity of refrigerant through the conduit 37 to the low side of the system. As the passed liquid refrigerant enters the evaporator, it is vaporized, thus absorbing heat and providing the desired refrigeration.

The vaporization of the liquid refrigerant in the evaporator produces an increasing pressure in the low side of the system including the refrigerant line 37 which is connected from the valve seat of the feed valve 10. As this pressure builds up it is also applied through the differential passage 45 in the valve casing wall into the upper compartment of the feed valve 10 where it aids the biasing spring 39 in opposing the pressure applied on the lower side of the diaphragm. As the pressure builds up on the low side of the system it eventually reaches such a value that the force applied by it on the upper side of the diaphragm added to the force applied thereon by the biasing spring 39 equals or slightly over balances the force exerted on the lower side of the diaphragm by the high pressure refrigerant, and the valve is then moved into engagement with the seat thereby restricting the flow of refrigerant from the high side to the low side of the system.

When the flow of refrigerant from the high side has been restricted by the above operation the refrigerant tends to build up a high pressure therein but in my arrangement this dangerous condition is eliminated because the increased pressure on the lower side of the diaphragm again overbalances the force of the biasing spring 39 and the refrigerant pressure applied on the upper side of the diaphragm thus opening the valve 29 and discharging sufficient of the high side liquid refrigerant to the low side of the system to regulate the pressure. In this manner my refrigerant feed valve operates to automatically regulate the refrigerant to maintain a predetermined pressure difference between the two sides of the system, and there is no danger of excessively high pressures accumulating on the high side before the thermostat switch 11 responds to the low temperature adjacent the evaporator 1 and stops the operation of the compressor 3.

When the temperature adjacent the evaporator unit 1 has been lowered to a predetermined value the thermostat switch 11 automatically operates to deenergize the electric motor and stop the operation of the compressor. The compressor now remains inactive for a period of time which depends upon the quantity of refrigerant in the low side of the system and the heat load thereon.

After the compressor has been stopped, the continued vaporization of the liquid refrigerant in the low side of the system gradually increases the pressure therein, and because this pressure is supplied to the upper compartment of the feed valve 10 in aiding relation with the biasing spring 39, the valve is thereby seated more firmly in flow restricting engagement with the valve seat. Since this condition tends to maintain the extremely high pressures which were created in the high side of the system by the compressor just before it stopped, and since the evaporator becomes heavily charged with vapor when the compressor is idle, the subsequent starting operation produces very high pressure pulsations in the system. By a suitable adjustment the selection of the bellows and biasing spring the valve releases the extreme high pressures and unloads the compressor, thereby avoiding an abnormally heavy starting load on the motor 15.

The flexible bellows diaphragm 23, 25 of my feed valve is suitably selected to function as a rupture diaphragm in case of a sticking valve whereby it safely releases the high pressure refrigerant from the high side to the low side without danger of releasing refrigerant from the system and also avoiding injury to other parts of the system.

The differential passage 45 extending through the wall of the refrigerant feed valve casing may be replaced by a small conduit externally connected from the upper compartment to the low side conduit 37 if desired.

In accordance with another embodiment of my invention the differential pressure responsive actuating member comprises a piston 51 which is slidably disposed in a suitable cylinder 53, as shown in Fig. 2 of the drawing. The open ends of the cylinder 53 are threaded for receiving cylinder heads 55 and 57 which are also screw threaded for engagement therein to close the open ends of the cylinder. The piston member 51 comprises a disc like portion having a depending cylindrical skirt. A compression spring 59 is concentrically disposed in the skirt portion of the piston to react between the piston and the lower cylinder head 57. An orifice 61 is provided through the piston 51 for discharging the refrigerant from one side to the other. The orifice comprises a valve seat which is adapted to cooperatively receive a valve 63 supported on the upper side of the piston on a valve stem 65 which extends through the orifice to a pedestal 67 rest-

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ing upon the lower cylinder head 57. The piston, the valve stem and the biasing spring are thus disposed in concentrical relation whereby the spring 59 tends to move the piston valve seat to cooperatively engage the valve 63 and restrict the flow of refrigerant therethrough. The upper cylinder head 55 is provided with a fitting 71 for conveniently connecting the conduit 43 from the high side of the system, and the bottom cylinder head 57 is provided with a similar pipe fitting 71 for convenient connection with the conduit 37 through which it passes refrigerant for supplying the low side of the system. The diameter of the piston 51 is so selected that an appreciable amount of leakage is provided whereby the high side pressures are gradually unloaded during the off periods to provide for easy starting.

In operation the high pressure refrigerant applies a force on the upper end of the piston 51 which tends to push the piston down thus carrying the valve seat away from the valve 63 and discharging refrigerant in the low side of the system. As the passed refrigerant vaporizes in the low side of the system it provides an increased pressure therein which, being also applied to the lower side of the piston, aids the biasing spring 59 in opposing the force applied by the high pressure refrigerant from the high side of the system. Thus, the sum of the forces acting on the low side of the piston 51 eventually overbalances the pressure on the upper side of the piston which then closes the valve and restricts the flow of refrigerant. An accumulation of excessive high pressure is avoided because the device operates as a constant pressure differential regulator and increasing pressure on the high side will reopen the valve to discharge refrigerant again into the low side. The operation of the compressor is thus safely continued until the thermostat control 11 has operated to stop the compressor.

The refrigerant flow controlling means which is actuated by the movements of the piston may comprise a recess 81 in the side wall of the cylinder 82, as shown in Fig. 3. The refrigerant controlling recess extends from the lower end of the cylinder to a point preferably adjacent the normal position of the piston 83 in the cylinder whereby its movement opens or closes the upper end of the recess to pass or restrict the flow of refrigerant. As shown the refrigerant controlling recess 83 may comprise a channel extending within the cylinder wall and terminating at opposite ends in orifices which open into the cylinder. As shown the lower orifice 85 opens adjacent the low end of the cylinder and the other orifice 87 is opened into the cylinder at an intermediate position where it will be covered or uncovered in accordance with the movements of the piston 83 in the cylinder. In this embodiment the end of the piston 83 is solid and the piston is of suitable size to provide a desirable amount of leakage for unloading the compressor. A compression spring 89 is provided in the piston for reacting in opposition to the high pressure refrigerant, as in the preceding modifications, and its connection and operation in the system is similar.

It will be seen that I have provided refrigerant feed controlling means of simple construction for regulating the flow of refrigerant from the high side to the low side of the expansion refrigerating systems and providing for easy starting of the compressor.

Aside from the specific embodiments of the invention herein shown and described, it will be understood that numerous details of the construction may be altered or omitted without departing from the spirit and scope of the invention as disclosed and claimed, and that I do not desire to limit the invention to the exact constructions herein set forth.

I claim as my invention:

1. A refrigerant feed valve comprising a flexible diaphragm like member, means for applying high pressure refrigerant from a refrigerant source to distort said member, refrigerant flow controlling means arranged for passing a portion of the high pressure refrigerant in accordance with the distortion of said member, and means for applying the pressure set up by the passed refrigerant to oppose the distortion of said member by the high pressure refrigerant.

2. A refrigerant feed valve comprising a valve casing, a metallic diaphragm like member having a flexible bellows portion, an aperture comprising a valve seat in a wall of said valve casing, a valve disposed from the movable head of said bellows for cooperative movement adjacent said valve seat in accordance with the distortion of the bellows, a biasing spring compressed between the movable end of said bellows and an opposite wall of said valve casing whereby the valve is biased to its closed position, and means for applying unregulated pressure on the side of said diaphragm adjacent said valve and regulated pressure on the opposite side whereby the valve operates to maintain a constant pressure differential.

3. A refrigerant feed valve comprising a cylinder, a piston slidably disposed therein, biasing means for urging said piston toward one end of said cylinder, an inlet for applying high pressure refrigerant from a refrigerant source to move said piston in opposition to said biasing means, refrigerant flow controlling means arranged for passing a portion of the high pressure refrigerant to the opposite side of the piston in accordance with the movements thereof in opposition to said biasing means, and an outlet from which refrigerant may be conducted to the low side of a refrigerating system.

4. A refrigerant feed valve comprising a cylinder having open threaded end portions, threaded cylinder heads for closing the open threaded end portions of said cylinder, a piston slidably disposed in said cylinder, said piston comprising a disc like portion having a depending cylindrical skirt, a compression spring concentrically disposed in the skirt portion of said piston to react between the piston and the adjacent cylinder-head, an inlet for applying high pressure refrigerant from a refrigerant source to move said piston in opposition to said spring, refrigerant flow controlling means arranged for passing a portion of the high pressure refrigerant to the opposite side of the piston in accordance with the movements thereof in opposition to said biasing means, and an outlet whereby the refrigerant passed to the other end of the cylinder may be conducted to the low side of a refrigerating system.

5. A refrigerant feed valve comprising a cylinder, a piston slidably disposed therein, cylinder heads for closing the ends of said cylinder, biasing means for urging said piston toward one end of said cylinder, an inlet in one of said cylinder heads for applying high pressure refrigerant from a refrigerant source to move said piston in opposition to said biasing means, refrigerant flow con-

trolling means comprising a recess in the side wall of the cylinder for passing a portion of the high pressure refrigerant to the opposite side of the piston in accordance with the movements thereof in opposition to said biasing means, and an outlet in the other cylinder head from which refrigerant may be conducted to the low side of a refrigerating system.

6. A refrigerant feed valve comprising a cylinder, a piston slidably disposed therein, cylinder heads for closing the ends of said cylinder, biasing means for urging said piston toward one end of said cylinder, an inlet in one of said cylinder heads for applying high pressure refrigerant from a refrigerant source to move said piston in opposition to said biasing means, refrigerant flow controlling means comprising a valve seat in the piston and a relatively movable valve member arranged for passing a portion of the high pressure refrigerant to the opposite side of the piston in accordance with the movements thereof in opposition to said biasing means, and an outlet in the other cylinder head from which refrigerant may be conducted to the low side of a refrigerating system.

7. In combination in a refrigerating system an evaporator for absorbing heat by vaporizing a volatile liquid refrigerant, an intermittently actuated compressor for supplying liquefied refrigerant thereto, and refrigerant feed regulating means connected therebetween comprising pressure reducing means to maintain a predetermined refrigerant relation between the low side and the high side of the system during running periods and said regulating means also including cooperating surfaces spaced for conducting high pressure refrigerant to the low pressure side to unload the compressor when the compressor is at rest.

8. In a refrigerating system, a high side comprising a source of volatile liquid refrigerant, a low side comprising an evaporator for absorbing heat by vaporizing the liquid refrigerant, and means responsive to the pressure difference between the high side and the low side for regulating the flow of refrigerant therebetween, comprising a movable member, a spring biasing said member, means for applying high pressure refrigerant from the high side of the system to move said member in opposition to said biasing spring, refrigerant flow controlling means arranged for passing a portion of the high pressure refrigerant in accordance with the movements of said member in opposition to the biasing spring and applying the passed refrigerant to the low side of the system and to aid said biasing spring on said member.

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