

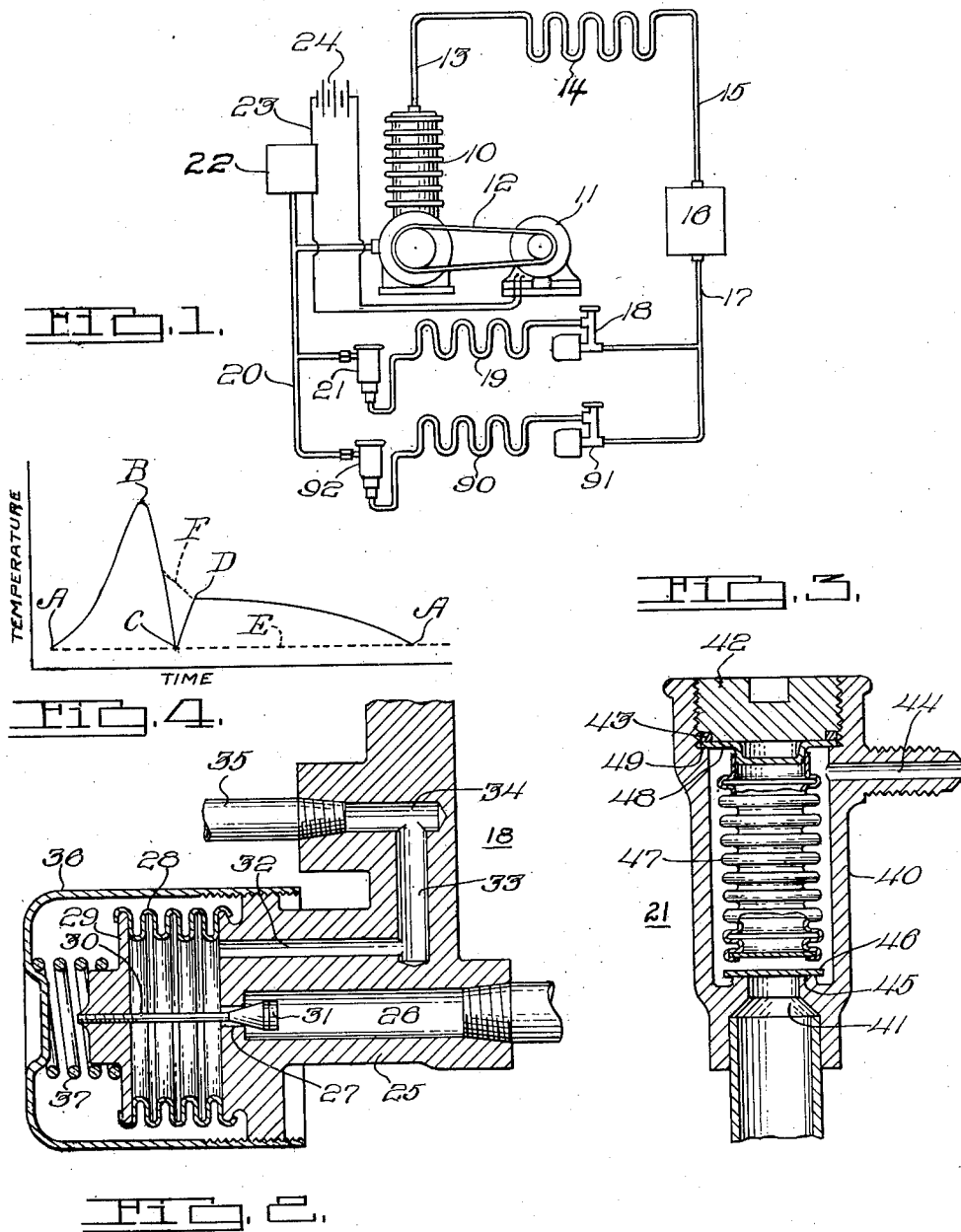
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CONTROL FOR REFRIGERATION SYSTEMS

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CONTROL FOR REFRIGERATION SYSTEMS

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5 Claims. (Cl. 62-4)

This invention relates to refrigerating mechanism, and particularly to the control of flow of refrigerant through the expansion chamber thereof, the principal object being the provision of a new and novel means for this purpose.

Another object is to provide a temperature controlled control device for a refrigerating system having a sufficient lag in the operation thereof as not to be affected by relatively temporary changes in the temperature of the member or medium whose temperature is depended upon to control its operation.

Another object is to provide a control valve for a refrigerating device comprising a housing through which the refrigerant is adapted to pass, the housing being provided with a metallic bellows therein cooperable with a valve to control the flow of refrigerant through the housing, the bellows enclosing a freezing solution adapted to expand upon freezing, and thereby act to close the valve.

Another object is to provide, in combination with a refrigerating system having an expansion element, a pressure actuated expansion valve for admitting refrigerant to the expansion element, and means on the suction side of the expansion element operating by a freezing solution for controlling the flow of refrigerant from the expansion element.

A further object is to provide a valve mechanism for refrigerating systems including a movable element dependent for its movement upon the change in volume of a freezing mixture.

The above being among the objects of the present invention, the same consists in certain novel features of construction and combinations of parts to be hereinafter described with reference to the accompanying drawing, and then claimed, having the above and other objects in view.

In the accompanying drawing which shows a suitable embodiment of the present invention, and in which like numerals refer to like parts throughout the several different views;

Fig. 1 is a more-or-less diagrammatic representation of a mechanical refrigerating system.

Fig. 2 is a sectional view taken centrally through an expansion valve for a refrigerating system such as is shown in Fig. 1.

Fig. 3 is a sectional view taken centrally through a control valve for a suction line of a refrigerating system such as is shown in Fig. 1.

Fig. 4 is a typical temperature-time curve for a refrigerating system such as is shown in Fig. 1.

The present invention relates to means for

controlling the operation of a mechanical refrigerating system of the compression expansion type, and particularly to a construction such as is disclosed in my application for United States Letters Patent for improvements in Control for refrigerating systems, filed December 31, 1928, Serial No. 329,396, and more particularly to an improved type of control valve for use in connection therewith.

The suction control valve in the above identified application included an actuating element comprising a metallic bellows enclosing a gasifying liquid. This gasified liquid, upon being cooled to a predetermined temperature, is sufficiently liquefied to contract the bellows and close the valve, and when its temperature is raised to a predetermined value sufficient liquid is gasified to expand the bellows and open the valve. However, due to certain characteristics of refrigerating systems of the type described, the action of this control valve is more sensitive than is desirable in all cases. This is explained by reference to Fig. 4 in the present drawing which illustrates a typical time-temperature curve for one complete refrigerating cycle of a system of the type described, the temperature being that of the expansion element.

Referring to Fig. 4, and considering the line E as the line of desired minimum temperature and the point A as the point where compression stops, it will be noted that the temperature of the gas in the outlet connection of the expansion element rises from the point A to a predetermined maximum temperature such as indicated by the point B, at which point the control mechanism is actuated to again start compression. As soon as compression is again started the temperature rapidly drops, due to the temporary excess of liquid in the expansion element. Theoretically the curve should drop from the point B and then gradually flatten out as along the dotted line F to the point D from which it gradually drops to the point A of desired minimum temperature at which point compression is stopped, thus allowing a relatively long period of operation of the compressor and a corresponding long period of compressor inactivity. Practically, however, the curve does not follow this theoretical path because at the time compression is started, as at the point B, an excess amount of liquid refrigerant is present in the expansion element, and this refrigerant is rapidly gasified upon the drop in pressure in the expansion element when the compressor is started. This gasifying of what may be termed as residual refrigerant causes the

temperature to drop rapidly from the point B to the point C which may be at or slightly above the line E, and thereafter, because of the small interval of time necessary to dispose of this residual refrigerant, it rises to the point D from which the desired usual conditions continue.

Where the temperature of the refrigerant in the suction passage is employed to control the operation of the compressor, as described in the above identified application, if the control means operated by the change in temperature is of a too sensitive nature, it will be evident that it may be caused to operate at the point C to stop the compressor, and in so doing the cycle of operation will be limited to between two points such as A and C, thereby resulting in an unsatisfactory condition. Such a condition is liable to occur in employing a bellows filled with a gasifying liquid as in the above referred to application, and the present application refers to a construction in which a lag in the operation of the suction control device is obtained, such that the interval of time between the points B and D is insufficient to cause operation of the device.

I show in Fig. 1 a refrigerating system comprising a compressor 10 which may be driven by an electric motor such as 11 by means of a belt 12. The discharge side of the compressor 10 is connected by a tube such as 13 to a condenser such as 14 which may be cooled either by air or water, and which is connected by a tube such as 15 to a conventional refrigerant receiver 16. The receiver 16 is connected by a tube 17 to an expansive valve, indicated generally as 18 in Fig. 1, and which in turn is connected to an expansion element 19 which may take the form of coiled tubes such as shown, or any other suitable construction such as sheet metal.

In conventional constructions the expansion element 19 is connected to the suction side of the compressor 10 by a pipe such as 20 without the interposition of further refrigerant flow control means. In the present case a control member, indicated generally as 21 in Fig. 1, is inserted in the suction line 20 to the compressor. The control member 21 may take the form shown in Fig. 3, or any other form constructed in accordance with the teachings thereof.

The operation of the electric motor 11 may be controlled by any suitable type of pressure actuated switch mechanism indicated generally as at 22 which is connected into the suction tube 20 and interposed in the electric circuit 23 between the motor 11 and a suitable source 24 of electrical energy.

The expansion valve 18 which is of the pressure controlled type is shown in detail in Fig. 2 and comprises a body 25 having an inlet passage 26 connected by a small opening 27 to the left hand face of the body 25, as shown in Fig. 2. This face of the body 25 is sealed by a metallic bellows 28 to the head 29 of which is secured a valve member 30 whose head 31 is positioned within the opening 26 and is adapted to close the opening 27 to the passage of the refrigerant upon expansion of the bellows 28. The interior of the bellows 28 is connected by the openings, 32, 33 and 34 within the tube 35 which may be a continuation of the expansion element 19 when made of coiled tubes, or may be a separate tube where the expansion element is of sheet metal or other construction.

It will be obvious that as the pressure builds up in the expansion element 19 such pressure will be transmitted through the passages 34, 33

and 32 to the interior of the bellows 28 and will cause the same to expand and move the head 31 of the valve member 30 to close the opening 27. The particular pressure necessary in the bellows 28 to cause the head 31 to close the opening 27 may be adjustably controlled by rotating the cap 36 threadably received on the body 25 and between the end of which and the head 29 of the bellows is positioned a coil spring 37 maintained under compression. Any other form of expansion valve or device adapted to be controlled by pressure within the expansion element to control the flow of refrigerant to the expansion element may be equally well employed in connection with the present invention.

Contrary to conventional practice, I insert in the suction line between the expansion element and the compressor 10 a control valve, indicated generally as 21 in Fig. 1, which may take the form indicated in Fig. 3, and which comprises a housing 40 having an inlet passage 41 adapted to be connected to receive refrigerant from the expansion element 19, and which is closed at the other end by a cap member 42 which may threadably engage the same and may be sealed against leakage by a gasket such as 43 or other suitable means. The casing 40 is provided with a discharge passage 44 through which the refrigerant is adapted to flow to the suction side of the compressor. The casing 40 adjacent the inlet passage 41 is formed to provide a seat 45 for a valve, shown in the drawing in the form of a disc valve 46. Positioned in the casing 40 between the valve seat 45 and the cap 42 is a metallic bellows 47 supported in place by an outwardly flanged end member 48 the margins of which are clamped between the shoulder 49 and cap 42. The interior of the bellows 47 is filled with a freezing mixture such as water, water and alcohol, or any other mixture which is adapted to expand and freeze at a predetermined desired temperature. The relation between the length of the bellows 47 and the valve seat 45 is such that upon freezing of the mixture within the bellows 47 and consequent expansion of the bellows, the free end of the bellows moves to force the valve 46 against the seat 45 and thereby stops circulation of refrigerant through the member 40. The valve 46 in the construction shown in Fig. 3, is shown as being free of the bellows 47 in order that it may also act as a check valve to prevent reversal of flow of refrigerant through the casing 40, but it will be apparent that if desired a valve member may be rigidly or otherwise secured to the end of the bellows 47 so as to be directly movable therewith, and a separate check valve be employed to effect the same result as is acquired by the construction shown.

The operation of the above device will be apparent. Considering that the valve 46 is in open position and the compressor 10 is operating, refrigerant from the receiver 16 passes through the expansion valve 18 and enters the expansion element 19 where it turns to gas and then passes through the control valve 21 through the tube 20 to the suction side of the compressor, which acts to reduce the pressure within the expansion element 19. As this action continues, the expansion element begins to collect liquid refrigerant therein and the gasified refrigerant passing through the housing 40 decreases in temperature, and some liquid refrigerant may find its way into the housing 40 and become gasified therein until enough of the mixture within the bellows 47 is frozen to cause sufficient expansion of the

bellows 47 to force the valve 46 down against the seat 45. As soon as this happens the pressure in the expansion element 19 builds up and causes the expansion valve 18 to close and thus shut off the flow of refrigerant to the expansion element 19. At the same time the pressure in the suction tube 20 drops, and this drop in pressure is transmitted to the control device 22 which is thereby actuated to break the circuit 23 between the motor 11 and source of electrical energy 24.

When a sufficient amount of the refrigerant in the expansion element 19 has been gasified and its temperature rises, a corresponding but delayed rise in temperature will also occur in the mixture in the bellows 47, which will accordingly cause the frozen mixture therein to melt and cause the length of the bellows 47 to decrease, permitting the valve 46 to be lifted off the seat 45 by the pressure in the expansion element 19, thereby raising the pressure in the suction passage 20 and causing the pressure switch 22 to be actuated to start the motor 11, thus starting another cycle of operation.

It will be apparent that more than a momentary drop in temperature will be necessary to freeze sufficient of the mixture in the bellows 47 to shut the valve 46, this because the act of freezing mixture consumes a relatively long time when compared to the length of time necessary to liquefy a gasifying liquid such as employed in the construction described in my above identified previous application. In fact, I have found that in no case is the interval of time necessary to freeze sufficient of the freezing mixture to allow actuation of the valve 46 small enough to permit the momentary depression of the temperature, as at C in Fig. 4, to close the valve and cause stopping of the compressor. It is also to be noted that a corresponding long period of time will be necessary to melt sufficient of the mixture when frozen, to allow the valve to open.

It will of course be obvious that the particular temperature at which the mixture within the bellows 47 freezes may be readily controlled by introducing into the bellows any substance or a mixture of any two elements whose freezing point corresponds with the temperature at which it is described to limit the operation of the device.

It will also be apparent that in operation the control device shown in Fig. 3 effects the same result as effected by the similarly located control devices shown and described in my previous patent application above identified.

It will also be apparent that this control device may be employed in positions and for purposes other than herein specifically described, and it is also equally applicable to constructions in which a single motor compressor unit is employed in conjunction with a plurality of expansion elements adapted for maintenance at different temperatures, as in the case of my previously described patent application. In the last mentioned case, a second expansion element such as 90 having an expansion valve indicated generally as at 91, and a suction control valve indicated generally as at 92 is inserted between the tubes 17 and 20 in parallel to the expansion element 19.

Any number of expansion elements may, of course, be connected in parallel as shown, each with its individual expansion valve and individual suction control valve. The expansion valve 91 may of course be of the same construction as the expansion valve 18 shown in detail in Fig. 2, and the suction control valve 92 the same as the suction control valve 21, except that in the use of the

multiple expansion elements it is preferable that the suction control valves all be equipped with a check valve, or at least all of the suction control valves except that or those which are employed on that expansion element regulated to obtain the highest minimum temperature of the entire number of expansion elements employed. Such suction control valves may, of course, be provided with check valves in accordance with the teachings of the construction shown in Fig. 3.

Where one or more expansion elements such as the elements 18 and 91 thus described are employed in parallel, it is often desirable that the minimum temperature which is desired in connection with one of the elements is different from the minimum temperature desired in the other of the elements, and it is also necessary for satisfactory operation that the compressor or compressing device be started in operation as soon as the rise in temperature in any of the expansion elements has reached a predetermined value. It is also desirable that should any one of the expansion elements be in condition not to require the introduction of additional liquid refrigerant at the same time that another one of the elements does require the introduction of such refrigerant, that the operation of the compressor should not affect the former. All of these points are taken care of in the construction shown.

For the purpose of illustration, it may be assumed that the expansion valve 18 is set to produce a lower minimum temperature in the expansion element 19 than the expansion valve 91 for the expansion element 90. Considering that the motor 11 and compressor 10 are operating and both expansion valves 18 and 91 are open so as to deliver liquid refrigerant to the expansion elements 19 and 90 respectively, it will be apparent that the expansion element 90 will be the first to reach its minimum temperature, at which time both the suction control valve 92 and the expansion valve 91 will close, but the compressor 10 will continue to operate until the expansion element 19 has reached its minimum temperature, at which time valve 21 and then valve 18 will close and a sufficiently low pressure will be produced in the suction tube 20 to cause operation of the control unit 22 to open the circuit 23 for the motor 11. In this manner the compressor may be caused to operate until each of the units 19 and 90 reaches its desired minimum temperature. Inasmuch as each of the suction control valves is provided with a check valve, the gas from one expansion element whose suction control valve has been opened, is prevented from flowing into any of the other expansion elements because of the check valve in the suction control valve for such other elements. In this manner any number of expansion elements may be connected in parallel and each regulated to produce a different minimum temperature in such a manner that each will operate as though it alone were connected to the compressor, and will result in the same satisfactory operation as though such were the case.

Formal changes may be made in the specific embodiment of the invention described without departing from the spirit or substance of the broad invention, the scope of which is commensurate with the appended claims.

What I claim is:

1. In a refrigerating system, in combination, an evaporator, means for supplying refrigerant

to said evaporator, a suction line leading from said evaporator, a valve in said suction line for controlling the flow of refrigerant therethrough, and thermally responsive means actuated by a freezing solution contained therein for closing said valve at a predetermined low temperature in said suction line.

2. In a refrigerating system, in combination, an evaporator, means for supplying refrigerant to said evaporator, a suction passage leading from said evaporator, a valve in said passage for controlling the flow of refrigerant therethrough, and an element in said passage containing a freezing solution for closing said valve when the temperature in said passage is maintained at or below a predetermined low value for an appreciable length of time.

3. In a refrigerating system, in combination, an evaporator, means for supplying refrigerant to said evaporator, a suction line leading from said evaporator, a valve in said suction line, and expansible and contractible means in said suction line and actuated by a freezing solution contained therein for moving said valve to control the flow of refrigerant through said line.

4. In a refrigerating system, in combination, an evaporator, means for supplying refrigerant to said evaporator including a compressor, a suction line leading from said evaporator, pressure actuated means connected with said suction line for controlling the operation of said compressor, a valve in said suction line between said pressure actuated means and said evaporator, and a delayed action temperature actuated means in said suction line for controlling said valve, the last mentioned means comprising an expansible member enclosing a normally liquid material adapted to freeze and to expand after the extraction therefrom of the sensible heat contained therein to close said valve.

5. In a refrigerating system, in combination, an evaporator, means for supplying refrigerant to said evaporator, a suction line leading from said evaporator, a valve in said suction line for controlling the flow of refrigerant therethrough, and freezable liquid in the suction line for operating the valve, whereby said valve is affected by said liquid only after the absorption therefrom of the sensible heat contained therein.

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