Aug. 3, 1943. F. Y. CARTER 2,326,093

REFRIGERATING SYSTEM

Filed May 29, 1940

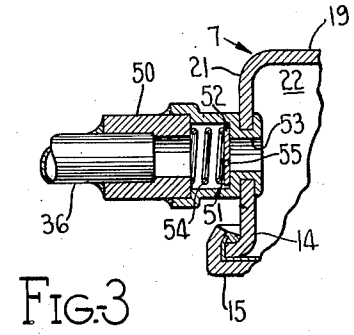


FIG.-3

FIG.-2

FIG.-1

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Patented Aug. 3, 1943

2,326,093

UNITED STATES PATENT OFFICE

2,326,093

REFRIGERATING SYSTEM

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Application May 29, 1940, Serial No. 337,886

12 Claims. (Cl. 62—8)

This invention relates generally to refrigerating systems and more particularly to a capillary tube type of system in which there is incorporated a means for controlling the flow of refrigerant.

One object of the invention is to provide a system in which the high temperature vaporous refrigerant is prevented from entering the evaporator during the "off" period of the condensing unit.

Another object is to provide a system in which the high temperature vaporous refrigerant is bypassed around the evaporator each "off" period of the condensing unit.

Another object is to provide automatic operation for the by-pass means.

The invention consists in the new apparatus and the novel arrangement of parts and the construction thereof, to be more fully described hereinafter and the novelty of which will be particularly pointed out and distinctly claimed.

In the accompanying drawing, to be taken as a part of this specification, I have fully and clearly illustrated a preferred embodiment of the invention, in which drawing:

Figure 1 is a diagrammatic view of a capillary tube refrigerating system embodying the invention;

Fig. 2 is a partial view of a capillary tube refrigerating system embodying a modified form of the invention, and

Fig. 3 is a partial view of a modified portion of the flow controlling means of Fig. 1.

Referring to the drawing by characters of reference, the numeral 1 represents a refrigerating compressor driven by means of a motor 2 through a belt drive 3. The compressor 1 pumps the refrigerant into the condenser 4 where it radiates heat to the surrounding cooling medium. The condensed refrigerant then flows through the capillary tube device 5 to the inlet 6 of a flow controlling valve means 7. Refrigerant flows from the means 7 into an evaporator 8 and back to the means 7 and therefrom back to the compressor 1 through conduit 9. An automatically operable switch 10 is controlled by means of a temperature sensitive bulb 11 responsive to the temperature of the evaporator 8 and is operable to control the electrical circuit through lead wires 12 and 13 to the motor 2. Switch 10 is operable to complete the electrical circuit at a predetermined high temperature of bulb 11 and to break the circuit at a predetermined low temperature of the bulb 11.

The flow controlling valve means 7 in this instance comprises an upper cup-shaped member 14 and a lower cup-shaped member 15 having their open edges or lip portions in abutting relation. The member 14 has a lip 16 and the member 15 has a flanged lip 17 which receives the lip 16 and which after jointure of the members 14 and 15 and after the placing of a diaphragm member 18 therebetween is rolled so that the lip 17 is bent to clamp the members 14 and 15 together and the diaphragm member 18 tightly therebetween. To insure a fluid-tight joint, the annular groove formed between the flanged lip 17 and the member 14 is filled with solder to intimately seal the members 14, 15 and 18 together. When so assembled, the means 7 has a top wall 19, a bottom wall 20 and a side wall 21 and is separated by the diaphragm member 18 into an upper chamber 22 and a lower chamber 23. The top wall 19 has a central aperture therethrough in which is secured a seat member 24. The seat member 24 has a longitudinal aperture 25 therethrough, the upper end of which receives, in fluid-tight relation, the outlet end of the capillary device 5. The lower end wall of the member 24, through which the aperture 25 extends, is positioned within the chamber 22. An annular groove in the lower end wall surrounding the opening of aperture 25 receives an annular seat member 26 which may be of any desired material and which may be held therein as by peening an adjoining edge portion of the end wall of member 24.

The diaphragm member 18 has a central aperture therethrough which is concentric with the aperture through the top wall 19 and which receives a movable valve member 27 which has a small diameter bore 28 therethrough opening centrally through the upper and lower end walls of member 27. Surrounding the openings but having as small a diameter as possible and extending from the upper and lower end walls of member 27 are annular seating portions 29, 30 respectively. By making the diameters of the portions 29 and 30 as small as possible the effect of any refrigerant pressure in the aperture 25 is rendered smaller and the diaphragm member 18 acts more nearly in direct response to the differences in pressure between chambers 22 and 23. The portion 29 acts upon upward movement of the valve member 27 to seat against the seat member 26 thereby to prevent flow of refrigerant from the aperture 25 of member 24 into chamber 22 but by means of the bore 28 connects the aperture 25 directly to the chamber 23. The side wall 21 of means 7, adjacent chamber 23, and more

particularly the side wall of the cup-shaped member 15 has a shoulder 31 which positions a plate-like supporting member 32 within the chamber 23. The member 32 is preferably held against the shoulder 31, due to the press fit with the inside surface of the side wall 21, and has a plurality of apertures 32a therethrough to allow for free passage of fluid past the member 32. A central aperture of the supporting member 32 has secured therein, as by peening, a stationary seat member 33 which extends therefrom and which has a recess concentric with the central aperture of the diaphragm member 18 and the bore 28 in its upper end wall for the reception of a seat member packing 34 which may be held within the recess in any convenient manner. The seat member packing 34 is engaged by the portion 30 of the movable valve member 27 upon downward movement of the diaphragm member 18 so that flow of fluid through bore 28 into the chamber 23 is prevented. It can now be seen that the movable valve member 27 cooperates with the seat members 24 and 33 to form a three way valve which is operable in one position to direct fluid flow solely to the chamber 23 and in another position to direct fluid flow solely to the chamber 22. Movement of the valve member 27 is accomplished by the diaphragm member 18 and which member 18 also serves to form a seal between and separate chambers 22 and 23. A spring 35 is placed concentric with and surrounding the seat member 33 and is positioned with one end against the diaphragm member 18 and the other end against the supporting member 32 so that the spring 35 is held under compression and acts to urge the diaphragm member 18 upward so that seating portion 29 is urged into engagement with the seat member 26 to prevent fluid flow into chamber 22 and allow for flow to chamber 23.

The evaporator 8 may be of any of the standard designs and for simplicity is here shown as a continuous coil type having an inlet 36 and an outlet 37. The inlet 36 is sealed in fluid-tight relationship to a connecting member 38, secured in fluid-tight relation to the side wall 21 of means 7, and acts to connect, for fluid flow, the interior of chamber 22 to the evaporator inlet 36. The connecting member 38 is constructed with an orifice 39 through which the refrigerant must flow in its movement to the evaporator 8 and the orifice 39 is so proportioned relative to the flow of refrigerant that during operation of the compressor 1, the chamber 22 is maintained at a pressure somewhat greater than the pressure within the evaporator 8. The outlet 37 of evaporator 8 is sealed in fluid-tight relationship to a connecting member 40 which in turn is secured in fluid-tight relation to the side wall 21 of the means 7 and acts to connect, for fluid flow, the outlet 37 to the chamber 23. Positioned within the connecting member 40 is a check valve means 41 having a movable plate means 42 held against a valve port 43 by means of a helical coil spring 44. The spring 44 has one end against the plate means 42 and its other end against a shoulder 45 in the passageway through member 40. The spring 44 and plate means 42 are so proportioned relative to the port 43 that the minimum possible differential in pressure between that in the chamber 23 and that in the evaporator outlet 37 is necessary to open the port 43 to fluid flow. During operation of the compressor 1, the pressure within the chamber 23 is maintained appreciably lower than the pressure within chamber 22 so that the diaphragm member 18 is flexed downward thereby compressing the spring 35 and holding the seating portion 30 tightly against packing 34 to prevent flow of fluid refrigerant through the bore 28 to chamber 23. Preferably the valve means 7 is positioned with its longitudinal axes horizontal and with the connecting members 38 and 40 facing downward so that any liquid in the chamber 22 will tend to flow by gravity through the member 38 into the evaporator 8. The difference in pressure within chamber 22 and 23 is due primarily to the drop in pressure as the refrigerant flows through the orifice 39 of the connecting member 38 because the drop in pressure through the evaporator 8 and the connecting member 40 is maintained by design, familiar to those skilled in the art, as low as possible to maintain the efficiency of the refrigerating system as high as possible. It may be desirable under some circumstances to increase the force exerted by the spring 44 so that a pressure drop is created across the check valve means 41 even though some loss in efficiency of the compressor 1 results. This loss in efficiency is due to the fact that the compressor 1 operates at a suction pressure less than the pressure of the evaporator 8.

An outlet member 45a extends through an aperture in the bottom wall 20 of the means 7 and projects into the interior of chamber 23 away from the inner surface of wall 20. The member 45a is sealed in fluid-tight relation to the wall 20 and the conduit 9 is sealed in fluid-tight relation to the outer end of member 45a. The conduit 9 opens into a longitudinal aperture 46 which extends through the member 45a and affords communication between the conduit 9 and interior of the chamber 23. The inner end of member 45a, through which the longitudinal aperture 46 opens, is spaced from the wall 20 so that if the valve means 7 were positioned with the longitudinal axes vertical any liquid, whether it be refrigerant or oil from the compressor 1, will not flow as a stream into the conduit 9 to the compressor 1. Such liquid as does become caught or trapped in the bottom of chamber 23 will eventually evaporate if it is refrigerant or if oil become entrained with refrigerant vapor and finally be carried, a little at a time, through the conduit 9 to the compressor 1. With the valve means 7 in the preferred horizontal position, the passage of the refrigerant vapor up through any entrapped oil in the chamber 23, will cause a more rapid entrainment of the oil or vaporization of entrapped refrigerant.

In Fig. 2 there is shown a modified form of the invention in which the valve means 7 is placed adjacent the outlet of the condenser 4 and a portion of the capillary tube feed device 5, adjacent the condenser 4, is placed in heat exchange relation with the bottom chamber 23. By so placing the chamber 23 in heat exchange with the hot refrigerant from the condenser 4, the rate of vaporization of any liquid refrigerant which may be in the chamber 23 is increased. With such a modified form, it is desirable that the upper chamber 22 be heat insulated, as at 46a, from the ambient temperature to conserve refrigeration as well as an insulated refrigerant inlet conduit 47 which carries the low pressure liquid refrigerant to an evaporator 48 positioned in heat exchange relation with the space to be refrigerated. An outlet conduit 49 carries the low pressure refrigerant vapor from the evapora-

tor 48 to the connecting member 40 of the valve means 7.

In Fig. 3 there is shown a connecting member 50 which is a modified form of the connecting member 38 and which has one end portion secured in fluid-tight relationship to the side wall 21 and opens into the chamber 22. The inlet 36 of the evaporator 8 is secured to the other end of the member 50, as by solder, so that the evaporator is communicatively connected to the chamber 22. A check valve means 51 comprises a disk member 52 which is cooperable with a port 53 and which is held thereagainst by a spring 54. The spring 54 and the disk member 52 are so interrelated that a differential in pressure between the chamber 22 and evaporator 8 must be maintained in order for the valve means 51 to allow flow of refrigerant into the evaporator 8. The disk member 52 has a small aperture or bleed hole 55 therethrough which has no function during the operation of the compressor 1 but which during the "off" period of the compressor 1 allows the pressure in the evaporator 8 to bleed into the chamber 22 so that at the start of the compressor operation, the pressure within chamber 22 is equal to that in the evaporator 8. The flow capacity of bleed hole 55 is so small relative to the capacity of the compressor 1 that its effect during the operation of compressor 1 is negligible as stated.

The operation of the refrigerating apparatus is as follows: High pressure, hot refrigerant vapor is discharged from the compressor 1 into the condenser 4 where it is liquified due to the heat transfer from the condenser 4 to the surrounding medium. The liquid, high pressure refrigerant then flows through the capillary tube feed device 5 into the aperture 25 and therefrom into chamber 22, the valve member 27 being in its downward position, and through connecting member 38 into the evaporator 8. Due to the restriction to flow of orifice 39 in the connecting member 38, the pressure in the inlet 36 of the evaporator 8 will be lower than the pressure within chamber 22. The liquid refrigerant evaporates in the evaporator 8 to lower the evaporator temperature thereby cooling the space and the vapor flows to the outlet 37, past the check valve means 41, into chamber 23 and through the conduit 9 to the compressor 1. The pressure within the conduit 9 and chamber 23 is substantially the same as that within the evaporator 8 and which is appreciably lower than the pressure in chamber 22 so that the pressure difference acting on the diaphragm member 18 will compress the spring 35 and hold the valve member 27 against its lower seat member 33.

As the compressor 1 continues to operate, the temperature of the evaporator and the bulb 11 associated therewith is lowered and at a predetermined low temperature of the bulb 11, the switch 10 acts to open the circuit through lead wires 12 and 13 and deenergize the motor 2. The flow of refrigerant through the orifice of the connecting member 38 decreases so that the pressure within chamber 22, evaporator 8 and chamber 23 soon approach each other and the spring 35 moves the diaphragm upward so that the movable valve member 27 moves against the upper seat member 24 to prevent flow of refrigerant from the aperture 25 into chamber 22. By means of bore 28 this refrigerant flow is directed into the chamber 23. Under ideal conditions, the refrigerant directed through bore 28 will be substantially entirely vapor and, because the compressor 1 is not operating, the pressure in the chamber 23 and the conduit 9 will increase above that in chamber 22 and which pressure differential then aids the spring 35 in holding the movable valve member 27 in its upper position. The increased pressure within chamber 22 is not transmitted to the evaporator 8 because of the closed check valve means 41.

When the temperature of the bulb 11 again increases to a predetermined high temperature, the switch 10 will close the circuit through lead wires 12 and 13 to motor 2, and the compressor 1 will again discharge high pressure vaporous refrigerant into the condenser 4. The pumping capacity of the compressor 1 is greater than the rate of flow of refrigerant through the bore 28 and soon the pressure within chamber 23 is brought below that of chamber 22 due to the effect of moving fluids in the evaporator 8 and chambers 22 and 23. Once the valve member 27 has moved away from the seat member 26 and additional refrigerant flows from the feeding device 5 to the chamber 22 and the evaporator 8, additional pressure drop will occur and the differential in pressure between chambers 22 and 23 is increased to firmly hold the valve member 27 against the seat member 33 and the refrigerating system continues as described hereinbefore.

In a capillary tube refrigerating system, the high side liquid line or location of the point where solely liquid is found varies in any given unit with the ambient or condenser temperature. If the temperature is just at the design point, there should be no point of solely liquid in the condenser 4 but at the inlet to the capillary device 5 there should be solely liquid. With high condensing temperature the liquid line moves into the device 5 and with lower temperatures the liquid line moves into the condenser 4. If lower condensing temperatures are experienced, there may be a tendency for liquid to flow through the bore 28 into chamber 23. Some of the liquid will evaporate during the "off" cycle but some may remain there at the start of the "on" cycle. In such an event, the heat exchanger of Fig. 2 is operative and acts to rapidly evaporate the refrigerant in chamber 23 so that it does not lie there and render the system unbalanced nor can it gradually accumulate so that it flows as liquid through the conduit 9 into the compressor 1 to cause slugging or other harm thereto.

The operation of the flow restricting check valve means 51 of Fig. 3 is substantially like that of the flow restricting orifice 39 in that each maintains a difference in pressure thereacross during operation of the compressor 1 and during its "off" period substantially equal pressures will be maintained in chamber 22 and the evaporator 8. The chief advantage in the means 51 over the orifice 39 is that at the start of operation of the compressor 1 a greater restriction to flow from chamber 22 to evaporator 8 may be had with a consequent quicker movement of the movable valve member 27 to its lower position.

By utilizing a refrigerating system embodying this invention, it is possible to prevent the high pressure vaporous refrigerant from entering and heating the evaporator. This acts to increase the "off" cycle to cause more infrequent cycling and consequently less loss in efficiency due to the unloading effect of the capillary feed device. By utilizing the above device it is also possible to use systems in which there is an appreciably greater volume in the condenser 4 than would otherwise be possible without an undue loss in efficiency

because it is not necessary to reduce the pressure in chamber 23 and conduit 9 to evaporator pressure.

What I claim and desire to secure by Letters Patent of the United States is:

1. In a refrigerating system, an evaporator having an inlet and an outlet, means connecting said inlet and said outlet, means for supplying refrigerant to said connecting means, valve means in said connecting means and operable to direct the flow solely to said inlet or to said outlet, and means for heating said connecting means thereby to vaporize any liquid refrigerant therein.

2. In a refrigerating system, an evaporator having an inlet and an outlet, a refrigerating condensing unit, conduit means connected to said unit, flow restricting means for supplying refrigerant to said evaporator from said unit, a chambered member having a pair of chambers separated by a diaphragm member, one of said chambers being connected to said flow restricting means and to said evaporator inlet, the other of said chambers being connected to said conduit means and to said evaporator outlet, valve means carried by said diaphragm member and operable to direct flow of the refrigerant solely to said one chamber or to said other chamber, flow restricting means interposed intermediate said one chamber and said evaporator inlet, and check valve means interposed intermediate said evaporator outlet and said other chamber and operable to allow flow of refrigerant solely from said evaporator to said other chamber.

3. In a refrigerating system, an evaporator having an inlet and an outlet, a refrigerating condensing unit, conduit means connected to said unit, flow restricting means for supplying refrigerant to said evaporator from said unit, a chambered member comprising a pair of cup-shaped casings having their open ends sealed together in opposed facing relation, a diaphragm member sealed between and extending across the open ends of said casings thereby to form a pair of chambers, one of said chambers being connected to said flow restricting means and to said evaporator inlet, the other of said chambers being connected to said conduit means and to said evaporator outlet, valve means carried by said diaphragm member and operable to direct flow of the refrigerant solely to said one chamber or to said other chamber, flow restricting means at the evaporator inlet from said one chamber, check valve means at said evaporator outlet to said other chamber and operable to allow flow of refrigerant solely from said evaporator to said other chamber, and means urging said first-named valve means into a position to direct flow of fluid solely into said other chamber.

4. In a refrigerating system, an evaporator having an inlet and an outlet, a condensing unit having an inlet and an outlet, flow restricting means connected to said unit outlet, valve means connecting said flow means to said evaporator inlet and normally operable to prevent flow of refrigerant therebetween, means connecting said evaporator outlet to said unit inlet, said valve means having a flow passageway therethrough of predetermined restriction to refrigerant flow communicatively connected to said unit inlet for restricted flow of refrigerant from said flow means to said unit inlet, means responsive to a predetermined pressure in said connecting means below that in said evaporator inlet for actuation of said valve means thereby to allow flow of refrigerant from said flow means to said evaporator inlet, and means operable upon actuation of said valve means for closing said flow passageway to flow of refrigerant.

5. In a refrigerating system, an evaporator having an inlet and an outlet, a condensing unit having an inlet communicatively connected to said outlet and having an outlet communicatively connected to said inlet, means for refrigerant flow in by-passing relation to said evaporator, means for controlling the rate of refrigerant flow from said unit outlet to said evaporator inlet, means operable to render said by-passing means ineffective upon starting operation of said condensing unit, and means to close off communication between said condensing unit outlet and said evaporator inlet and to render said by-passing means effective upon stopping operation of said condensing unit.

6. In a refrigerating system, an evaporator having an inlet and an outlet, a condensing unit having an inlet communicatively connected to said outlet and having an outlet communicatively connected to said inlet, means for refrigerant flow in by-passing relation to said evaporator, means for controlling the rate of refrigerant flow from said unit outlet to said evaporator inlet, means operable to render said by-passing means ineffective upon starting operation of said condensing unit, means to close off communication between said condensing unit outlet and said evaporator inlet and to render said by-passing means effective upon stopping operation of said condensing unit, and a check valve operable to close off flow to said evaporator outlet from said by-passing means.

7. In a refrigerating system, an evaporator having an inlet and an outlet, a condensing unit having an inlet communicatively connected to said outlet and having an outlet communicatively connected to said inlet, means adjacent to and restricting flow through said evaporator inlet, means for refrigerant flow in by-passing relation to said evaporator, means for controlling the rate of refrigerant flow from said unit outlet to said evaporator inlet, means operable to render said by-passing means ineffective upon starting operation of said condensing unit, and means to close off communication between said condensing unit outlet and said evaporator inlet and to render said by-passing means effective upon stopping operation of said condensing unit.

8. In a refrigerating system, a condensing unit, an evaporator having its inlet communicatively connected to the outlet of said unit, means for controlling the rate of admission of refrigerant from said condensing unit to said evaporator, a valve operable to close off flow from said condensing unit to the inlet of said evaporator, means urging said valve to closed position, means communicatively connecting the outlet of said evaporator to the inlet of said condensing unit, said valve having a by-pass passageway operable when said valve is closed to establish communication from said condensing unit outlet to said connecting means, and means operatively connected to said valve and operable to overcome said urging means and open said valve upon starting operation of said condensing unit thereby to establish communication from the outlet of said condensing unit to the inlet of said evaporator.

9. In a refrigerating system, a condensing unit, an evaporator having its inlet communicatively connected to the outlet of said unit, means for controlling the rate of admission of refrigerant

from said condensing unit to said evaporator, a valve operable to close off flow from said condensing unit to the inlet of said evaporator, means urging said valve to closed position, means communicatively connecting the outlet of said evaporator to the inlet of said condensing unit, said valve having a by-pass passageway operable when said valve is closed to establish communication from said condensing unit outlet to said connecting means, means operatively connected to said valve and operable to overcome said urging means and open said valve upon starting operation of said condensing unit thereby to establish communication from the outlet of said condensing unit to the inlet of said evaporator, and a second valve operatively connected to said last-named means and operable thereby to close said by-pass passageway upon movement of said first-named valve to open position.

10. A refrigerating apparatus, comprising an evaporator having an inlet and an outlet, a hollow casing having an inlet passageway and an outlet passageway, a pressure responsive member separating said passageways and dividing said casing internally into separate chambers, means connecting one of said chambers to said inlet, means connecting the other of said chambers to said outlet, oppositely directed valve members carried by said responsive member and positioned one in each of said chambers, said inlet passageway having a valve seat engageable by one of said valve members to close off flow from said inlet passageway to said one of said chambers, said valve members having a restricted passageway therethrough operable to establish communication between said inlet passageway and said other of said chambers when said one of said valve members is engaged with said valve seat, a valve seat member in said other of said chambers and engageable by said other of said valve members to close off communication between said restricted passageway and said outlet passageway when said one of said valve members is in open position, and means acting to hold said responsive member against movement upon reduction of pressure in said other of said chambers and in position to maintain said one of said valve members in engagement with said valve seat.

11. A refrigerating apparatus, comprising an evaporator having an inlet and an outlet, a hollow casing having an outlet connected to said inlet and having an inlet connected to said outlet, a pressure responsive member separating said casing outlet and casing inlet and dividing said casing internally into an inlet chamber and an outlet chamber, a thrust member extending through and sealed in said responsive member and terminating at its opposite ends in valve members, said thrust member having a restricted passageway extending therethrough and opening at its ends concentrically with said valve members, an inlet member carried by said casing and having an inlet passageway opening into said inlet chamber concentrically with said restricted passageway, a valve seat member surrounding the chamber end of said inlet passageway and engageable by one of said valve members, a supporting member carried within said outlet chamber by said casing, a valve closure member carried by said supporting member in alignment with said restricted passageway and engageable by the other of said valve members to close said restricted passageway, said casing having an outlet passageway leading from said outlet chamber, and a coil spring surrounding said closure member and acting on said thrust member to urge said one of said valve members toward said valve seat member.

12. In a refrigerating system, an evaporator having an inlet and an outlet, means connecting said inlet and said outlet, a conduit for supplying refrigerant to said connecting means, and valve means controlling refrigerant flow through said connecting means and operable in one position to direct refrigerant flow to said inlet and in another position to direct refrigerant flow to said outlet, said conduit having part of its length in heat exchange relation to said connecting means.

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