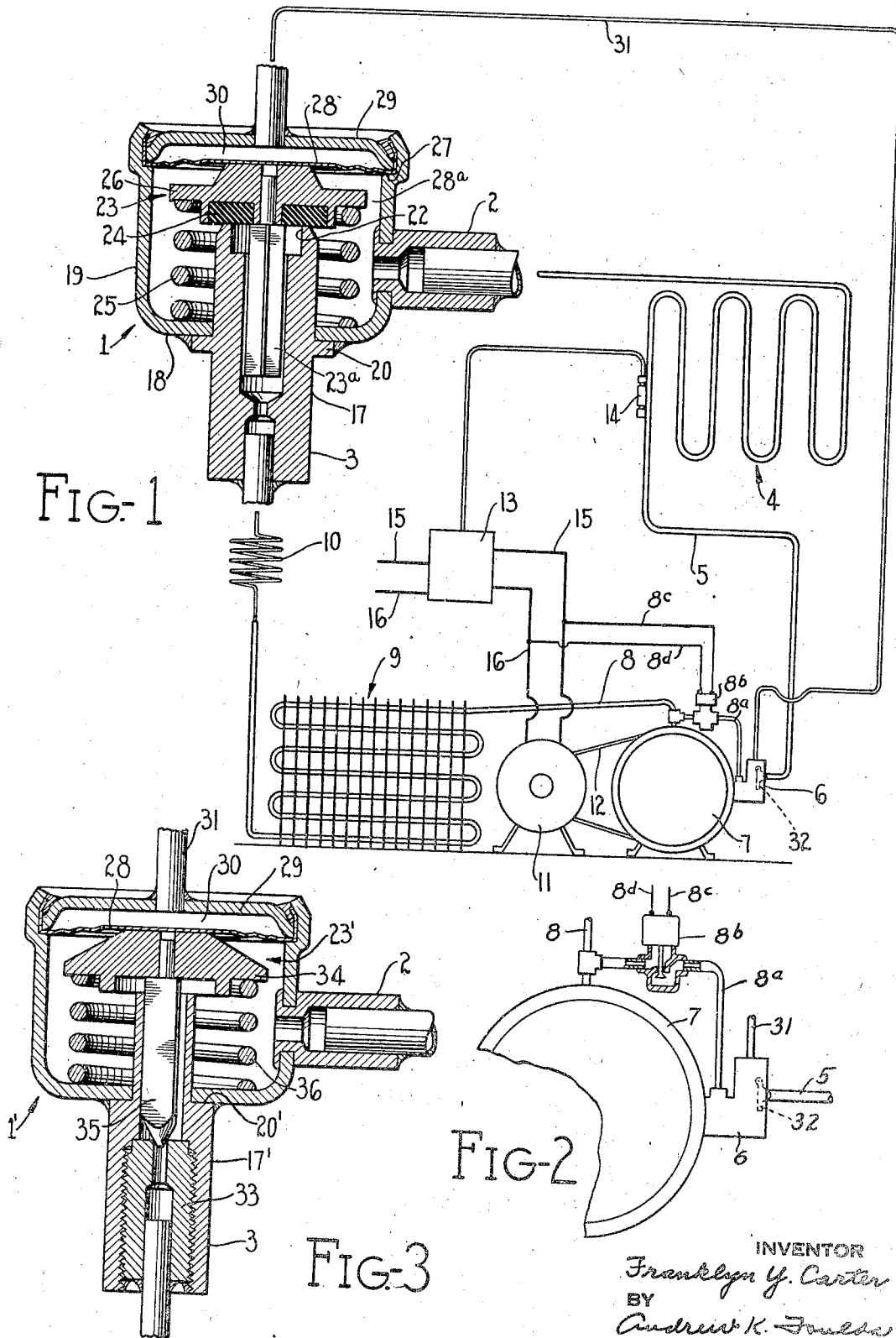


Oct. 5, 1943.

F. Y. CARTER
REFRIGERATING SYSTEM
Filed May 17, 1940

2,331,264



INVENTOR
Franklyn Y. Carter
BY
Andrew K. Foulds
his Attorney

UNITED STATES PATENT OFFICE

2,331,264

REFRIGERATING SYSTEM

Franklyn X. Carter, Detroit, Mich., assignor to
Detroit Lubricator Company, Detroit, Mich., a
corporation of Michigan

Application May 17, 1940, Serial No. 335,846

4 Claims. (Cl. 62—8)

This invention relates generally to refrigerating systems and more particularly to systems using a capillary tube feeding device.

One object of the invention is to increase the efficiency of a refrigerating unit by providing means for preventing the passage of high pressure refrigerant vapor into the evaporator during "off" periods of the compressor.

Another object is to provide an automatic means for operating the flow preventing means.

Another object is to utilize the unloader of the compressor as the automatic means.

The invention consists in the improved construction and combination of parts, 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 my invention in which drawing:

Figure 1 is a diagrammatic view of a refrigerating system including the control valve which is shown in central vertical section,

Fig. 2 is an enlarged detail view partly in section and showing one form of compressor unloading means, and

Fig. 3 is a partial view in central vertical section of a modified form of the valve member.

Referring to the drawing by characters of reference the numeral 1 designates generally a valve means having an outlet 2 and an inlet 3. The outlet 2 is connected to the inlet of an evaporator 4 which may be of any desired type and which is shown as a continuous coil type having its outlet connected by means of a conduit 5 to the inlet 6 of a compressor 7 having unloading means for equalizing the inlet and outlet pressures upon stopping of the compressor. This pressure equalizing or unloading means may be any of the conventional devices for accomplishing this purpose. In some rotary compressors this means is inherent in that there is sufficient clearance for leakage back through the vanes or blades to equalize quickly the outlet and inlet pressures on stopping of the compressor. In other compressor types or constructions additional means must be employed for pressure equalization, such for example as a solenoid valve which is energized to closed position when the compressor motor is energized. The compressor 7 has its outlet connected by means of a conduit 8 to the inlet of a condenser or radiator 9. With a solenoid valve type of unloader, the inlet 6 is connected to the outlet conduit 8 by a bypass pipe

8^a in which is intercalated a normally open, when deenergized, solenoid valve 8^b having its coil or winding connected in parallel or multiple with the compressor motor 11 by lead wires 8^c, 8^d connected respectively to the lead wires 15, 16 on the motor side of the switch 13. The condenser outlet is connected to the inlet 3 of the valve means 1 by a capillary tube refrigerant feed device 10 which regulates the flow of the liquid refrigerant to the evaporator in the well known manner of the prior art. The compressor 7 is driven by an electric motor 11 as by means of a belt 12. Operation of the motor 11 is controlled by means of an automatic switch 13 operated by a temperature sensitive bulb means 14 secured to the evaporator adjacent its outlet or placed wherever it is desired to control the temperature. The switch controls the circuit from the source of electrical supply through lead wires 15 and 16 and upon closure of the switch 13 the motor 11 is started to drive the compressor 7.

The valve means 1 comprises a tubular member 17 having a central longitudinal aperture therethrough. The lower end portion of the member 17 is the inlet 3 and is adapted to receive one end of the capillary tube device 10 which substantially fits the central aperture and is held in fluid-tight relationship therewith as by means of solder. The member 17 extends through a central aperture in the bottom wall 18 of a cup-shaped casing member 19 and an outwardly extending shoulder 20 which is located substantially midway between the ends of the member 17 is positioned against and soldered to the wall 18. The upper end portion is within the interior of the casing 19 and has at its end surface a valve port 22 which is controlled by means of a valve member 23. The member 23 has a polygonal extending portion 23^a which is reciprocal within and is guided by the longitudinal aperture of the member 17 thereby to maintain the valve member 23 in correct relationship to the port 22. The polygonal faces cooperate with the wall of the aperture of member 17 to provide flow passageways for flow of fluid refrigerant from the inlet 3 to the valve port 22. Packing or seating material 24 is carried in an annular recess in the lower end wall of the member 23 so that upon closure of the valve port 22 by the member 23 the material 24 engages the upper end wall of the member 17 and prevents flow of fluid through the port 22. A helical coil spring 25 is positioned concentric with the member 17 and has its lower end portion engaging the bottom wall 18. The upper end portion of the spring 25 engages an

outwardly extending flange 26 of the valve member 23 and due to the expanding force, of the spring 25, the valve member 23 is urged toward open position.

Adjacent to but spaced from its top end, the member 19 has a shoulder 27 against which a diaphragm member 28 is positioned. The member 28 acts to seal the open end of the casing member 19 to form a chamber 28^a and also acts to position the valve member 23 relative to the port 22. The valve member 23 is constructed with a flat top surface portion which is substantially in the plane of the shoulder 27 when the valve member 23 is seated. The outlet 2 opens through the side wall of the member 19 and forms a fluid flow path from the chamber 28^a to the evaporator 4.

A cap member 29 has its peripheral portion held against the peripheral portion of the diaphragm member 28 and has its central portion spaced from the central portion of the diaphragm member 28 and cooperates therewith to form a pressure sensitive expansible-contractible chamber 30. The end portions of the side walls of member 19, which extend beyond the shoulder 27, are bent inwardly to clamp the peripheral portion of cap member 29 and diaphragm member 28 tightly against the shoulder 27. As an additional means of securing the members together in fluid-tight relation, solder is placed in the channel formed at the intersection of the members 28, 29 and 19.

The cap member 29 has a central aperture therethrough in which one end of a capillary tube 31 is sealed in fluid-tight relation, as by solder. The other end of the tube 31 is secured to the inlet 6 of the compressor 7 on the compressor side of a check valve 32 which valve is positioned within inlet 6 and is operable to prevent flow of fluid from the compressor 7 to the evaporator 4.

The valve means 1' of Fig. 2 differs from the valve means 1 chiefly by the construction of the tubular member 17' and the valve member 23'. The member 17' comprises a tubular member having a larger diameter portion and a smaller diameter portion forming at their intersection a shoulder 20' which seats against the lower or bottom wall of the casing 19 and is held in fluid-tight relation therewith as by solder. The tubular member 17' has its larger diameter portion external of the casing 19 and has its longitudinal aperture internally screw-threaded for reception of a seat member 33 which has a central longitudinally extending aperture therethrough, the outer end of which receives the outlet end of the capillary tube means 10. Solder is utilized around the joint between the means 10 and member 33 and in the joint between the member 33 and lower end of the member 17' to prevent any leakage of fluid from the interior of the member 17' to atmosphere. The inner end of the seat member 33 forms a valve seat which is controlled by means of a valve member 23'. The valve member 23' has a head portion 34 which engages the underside of the diaphragm member 28 and has a polygonal portion 35 reciprocal within the upper end of the central aperture of member 17'. The lower end portion of the polygonal portion 35 is conical in shape and cooperates with the aperture through the seat member 33 to control flow of fluid therethrough. The head portion 34 is urged upward into engagement with the diaphragm member 28 by a spring 36 which has one end engageable with the por-

tion 34 and has its other end engaging the lower end wall of the member 19.

Because the valve means 1 is intended to be primarily operative during the "off" periods of a normally cycling capillary tube refrigerating system, the operation of the system in which the valve means 1 is incorporated can best be described by referring to the system when it is already maintaining the evaporator between the given predetermined temperature limits as determined by the bulb means 14. The switch 13, controlled by the bulb means 14, is of the type for operating a refrigerating system according to temperature change and which is well known to those skilled in the art. The evaporator temperature is assumed to be midway between the said predetermined temperature limits with the compressor 7 being operated by the motor 11 through the belt 12. High pressure gaseous refrigerant is being discharged by the compressor 7 through conduit 8 into the condenser 9 where heat is radiated therefrom to the ambient air so that the gaseous refrigerant can condense to liquid form so that substantially only liquid refrigerant flows from the capillary tube feeding means 10 to the valve means 1 and the evaporator 4. The exact place of complete condensation of the refrigerant to liquid phase varies somewhat depending upon the pressure maintained in the evaporator 4 and the ambient temperature surrounding the condenser 9 which is reflected as refrigerant pressure within the condenser 9. If the ambient temperature is high the pressure drop across the capillary tube means 10 is great and more refrigerant can flow therethrough so that the point of complete liquid phase may be within the means 10 or in extreme conditions may never occur. With low ambient temperatures the point of complete liquid phase may be within the condenser 9 because the refrigerant pressure therein is low and the pressure drop across the capillary means 10 is correspondingly low and the liquid does not flow therethrough as rapidly. By the backing up into the condenser 9 of the liquid refrigerant, the radiating surface thereof is made smaller with an effective increase in refrigerant pressure therein so that the rate of flow through capillary means 10 equals the rate of inflow to the condenser 9 by the compressor 7. The ideal location of the point of complete liquid phase is intermediate the capillary tube means 10 and condenser 9 as this gives most economical operation.

The evaporating refrigerant in the evaporator 4 is removed by the compressor 7 and discharged to condenser 9, the solenoid valve 8^b, if employed, being energized and closed. This lowers the temperature of the evaporator 4. When the minimum predetermined temperature of evaporator 4 is reached, the switch 13 controlled by bulb means 14, will open the circuit through lead wires 15, 16 to the motor 11 to stop operation of the compressor 7. Immediately upon stopping of the compressor 7, due to the unloader means included therein, pressure from the condenser 9 finds its way back through the blade clearance or the opened bypass conduit of the compressor 7 to the inlet 6 where a check valve 32 is positioned which closes and prevents the passage or flow of refrigerant from compressor 7 through conduit 5 to evaporator 4. The capillary tube 31 is, however, open to the compressor 7 between it and the check valve 32 positioned in inlet 6 and the refrigerant pressure is transmitted thereby and therethrough to the pressure chamber 30 and

acts on the top side face of the diaphragm member 28 to compress the spring 25 and to force the valve member 23 against the port 22 to prevent further flow of refrigerant from the capillary means 10 to the evaporator 4. The lower side face of the diaphragm member 28 is subjected to the pressures within the chamber 28^a and which due to its constant communication with the evaporator 4 is always at evaporator pressure which is a relatively low pressure so that the high pressure in chamber 30 can seat the valve member 23.

Under the prior art systems and those omitting the valve means 1, the capillary tube means 10 continues to supply liquid refrigerant to the evaporator 4 after the compressor 7 has been stopped. This is quite satisfactory as far as operation is concerned, but soon the liquid in means 10 and condenser 9 is all gone and only hot, high pressure refrigerant vapor remains. When this enters the evaporator 4, the gaseous refrigerant is condensed therein with a consequent rise in temperature of evaporator 4 due to the increased heat content thereof. This means that the temperature sensitive switch will again call for compressor operation sooner than it otherwise would. Before any useful refrigeration work can be done the by-passed vapor or gas must be again pumped by the compressor 7 to the condenser 9 to raise the pressure therein to a suitably high point so that the heat of vaporization of the refrigerant may be radiated and thrown off to the medium surrounding condenser 9. A motor driven fan may be utilized to increase the radiating effect of the condenser 9 if desired and which fan may be controlled in synchronism with motor 11 or the fan may even be driven by the motor 11. By the inclusion of the valve means 1, flow through the capillary tube means 10 subsequent to stopping of the compressor 9 is prevented so that the uncondensed high pressure gaseous refrigerant within condenser 9 is kept from flowing into the evaporator. In a system in which the compressor is designed to run continuously the valve means 1 would be without function, but in many modern refrigerators now being built with capillary tube feed devices the compressor is designed to start and to stop or cycle anywhere from 6 to 12 or more times per hour. In such a system the efficiency by incorporating the valve means 1 would be increased substantially, or in the neighborhood of 15% or more, depending upon the volume within the "high side" or condenser 9 and conduit 8 and varying in direct proportion therewith.

When the predetermined high temperature of the evaporator 4 has been reached, switch 13 will again energize the motor 11 and start operation of the compressor 7. The first operation is to lower the pressure within the compressor 7 on its inlet side intermediate the outlet thereof and the check valve 32 within inlet 6. This will also lower the pressure within chamber 30 so that the valve member 23 will be moved by the spring 25 to open position. When this said pressure has been reduced to or slightly below the pressure within the evaporator 4, the check valve in the inlet 6 will open and the system will act as does a normally operating capillary tube refrigerating system after equilibrium conditions have occurred, and as described hereinbefore.

Operation of the modified valve means 1' as shown in Fig. 2 is substantially the same as that of the valve means 1 of Fig. 1, the difference between the two valve means 1 and 1' being not in

operation but in the details of construction as hereinbefore pointed out.

It may now be seen that by utilizing the herein described invention the efficiency of the cycling capillary tube refrigerating systems is increased in a simple, novel and new manner, and one which is automatic and positive in its operation.

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

1. In a refrigerating system, evaporating means, means for supplying refrigerant to said means, means for intermittently extracting refrigerant from said evaporating means and discharging the extracted refrigerant into said supplying means, pressure sensitive means interposed between said supplying means and said evaporating means, and means for supplying a pressure to said pressure sensitive means greater than the pressure in said evaporating means upon cessation of said extracting means thereby to cause said sensitive means to stop further flow of refrigerant from said supplying means to said evaporating means.

2. In a refrigerating system, an evaporating means having an inlet and an outlet, a condensing means having an inlet and an outlet, flow restricting means connecting said condensing means outlet to said evaporating means inlet, means including a check valve connecting said evaporating means outlet to said condensing means inlet, valve means having a pressure operated power element interposed between said flow restricting means and said evaporating means inlet and operable upon a predetermined pressure within said element to stop flow of refrigerant to said evaporating means, and pressure conducting means connected to said condensing means and operable to supply a pressure at least as great as said predetermined pressure to said element upon cessation of operation of said condensing means.

3. In a refrigerating system, an evaporator, a compressor for extracting vaporized refrigerant from said evaporator, conduit means connecting said compressor and said evaporator, condensing means for liquefying the vaporized refrigerant discharged from said compressor, capillary tube means for regulating the flow of refrigerant from said condensing means to said evaporator, valve means interposed between said capillary tube means and said evaporator, pressure sensitive means for moving said valve means to closed position, unloader means cooperable with said compressor upon cessation of operation thereof to allow the high pressure discharged refrigerant to pass to the inlet of said compressor, check valve means interposed between said compressor and said evaporator and operable to prevent back flow of refrigerant to said evaporator through said conduit means, and conduit means for conveying the high pressure refrigerant passed by said unloader means to said pressure sensitive means so that during periods of cessation of operation of said compressor said first-named valve means acts to stop flow of refrigerant to said evaporator.

4. In a refrigerating system, an evaporator, a compressor for extracting vaporized refrigerant from said evaporator, conduit means connecting said compressor and said evaporator, condensing means for liquefying the refrigerant discharged from said compressor, capillary tube means for regulating the flow of refrigerant from said condensing means to said evaporator, valve means interposed between said capillary tube means and said evaporator, spring means urging said valve means toward open position, pressure sensitive

means for moving said valve means to closed position in opposition to said urging means, unloader means cooperable with said compressor upon cessation of operation thereof to allow the high pressure discharged refrigerant to pass to the inlet of said compressor, check valve means interposed between said compressor and said evaporator and operable to prevent back flow of

refrigerant to said evaporator through said conduit means, and conduit means for conveying the high pressure refrigerant passed by said unloader means to said pressure sensitive means so that during periods of cessation of operation of said compressor said first-named valve means acts to stop flow of refrigerant to said evaporator.

FRANKLYN Y. CARTER.