Aug. 12, 1941.

W. L. McGRATH

2,252,300

REFRIGERATION SYSTEM

Filed May 7, 1938

Fig. 1

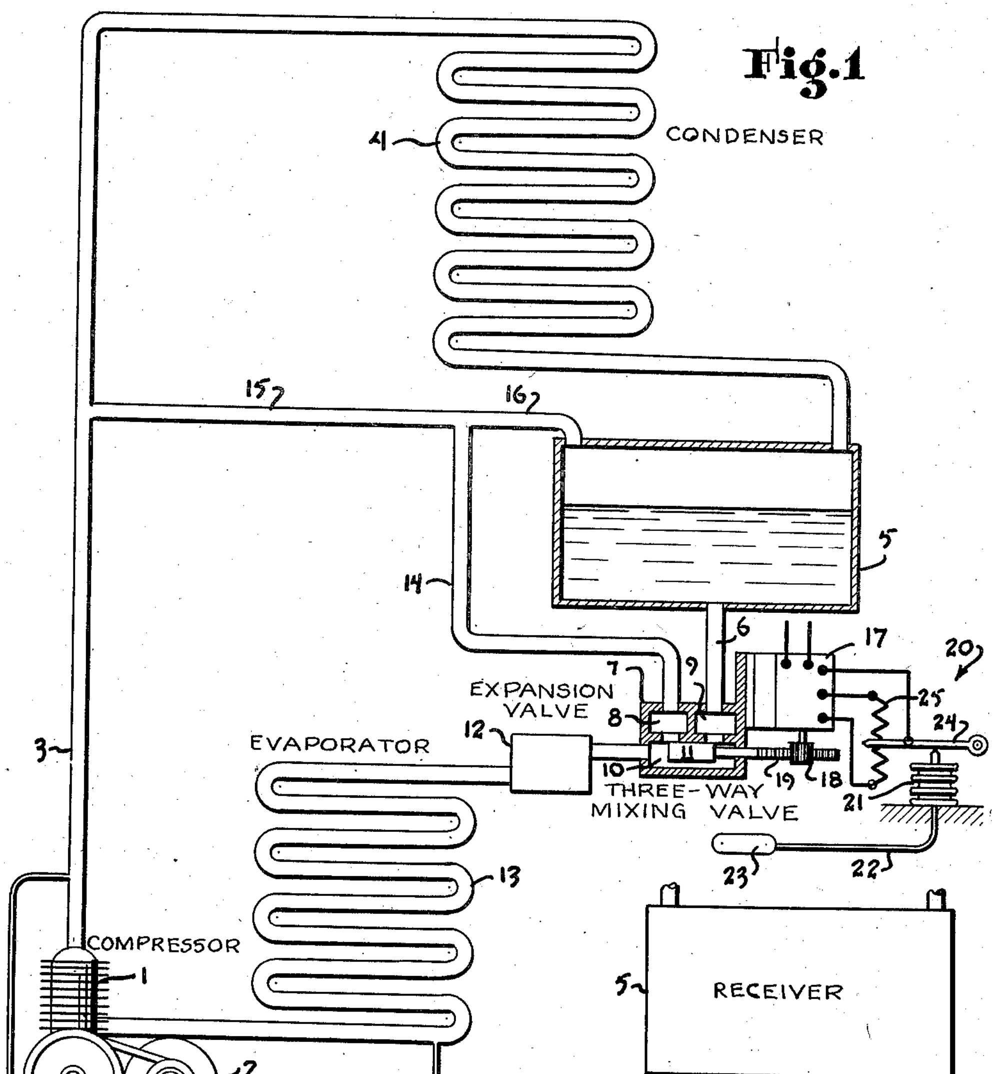
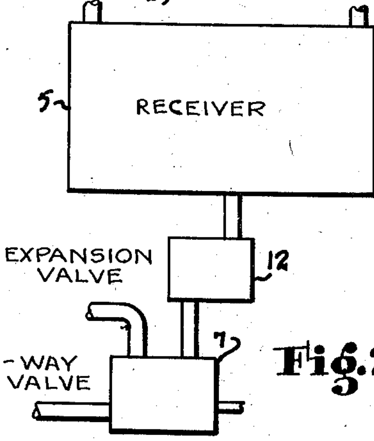


Fig. 2



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UNITED STATES PATENT OFFICE

2,252,300

REFRIGERATION SYSTEM

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8 Claims. (Cl. 62—3)

This invention relates in general to refrigeration and is more particularly concerned with automatic control means therefor.

In the refrigeration art it has been proposed to control the output of a refrigeration system by controlling the compressor with a suction pressure controller, and by varying the flow of refrigerant into the evaporator in accordance with the load upon the system. Thus as the load on the system decreases, the flow of refrigerant into the evaporator is decreased thereby decreasing the cooling effect of the evaporator. Control systems of this type, however, are not entirely satisfactory for the reason that as the flow of refrigerant into the evaporator is reduced, the compressor will pump down the low side pressure more quickly, thus stopping and starting the compressor frequently when the load on the system is light. This frequent starting and stopping of the compressor wastes a considerable portion of power and also increases the wear and tear upon the compressor motor and controls.

It is an object of my invention to provide a refrigeration system which avoids this undesirable result and which permits the reduction in flow of refrigerant to the evaporator while at the same time avoiding the necessity of frequent starting and stopping of the compressor. In accordance with one form of my invention, this result may be obtained by the passing of gaseous refrigerant or other fluid into the evaporator along with the liquid refrigerant, this gaseous refrigerant having the result of increasing the pressure within the evaporator and thus prolonging the periods of operation of the compressor.

Another object of my invention, therefore, is the provision of a refrigeration system having an automatic control arrangement for varying the proportions of liquid refrigerant and gaseous refrigerant or other medium passed into the evaporator in accordance with the load on the system.

Other objects of this invention will become apparent from the following detailed description and from the appended claims.

For a full disclosure of my invention reference is made to the following description and the accompanying drawing, in which

Figure 1 illustrates diagrammatically a refrigeration system embodying the features of my invention, and

Figure 2 shows a modified arrangement for the expansion valve and mixing valve of the system shown in Figure 1.

Referring to Figure 1, reference character 1 indicates a compressor which may be driven by means of an electric motor 2. The discharge of the compressor 1 is connected to a discharge line 3 leading to a condenser 4 which in turn discharges into the receiver 5. The outlet of the receiver 5 is connected by a liquid line 6 to one inlet of the three-way mixing valve 7. This three-way mixing valve may be of any suitable type and is diagrammatically illustrated herein as comprising inlet chambers 8 and 9 which communicate through the valve ports shown with a mixing chamber 10 containing a valve member 11 which is adapted to selectively cover and uncover the valve ports in a manner to vary the proportions of fluid passed from chambers 8 and 9 into the chamber 10. The outlet or mixing chamber 10 of the three-way mixing valve 7 is connected to an expansion valve 12 which in turn is connected to an evaporating coil 13. This evaporator coil 13 is connected to the inlet or suction side of the compressor 1 as shown. The inlet chamber 8 of the three-way mixing valve 7 is connected to a pipe 14 which in turn may be connected to pipe 15 leading from discharge line 3, or may be connected by a pipe 16 leading from the top of the receiver 5, or both. By an arrangement of this type it will be apparent that gaseous or uncondensed refrigerant will be passed into the inlet chamber of the three-way mixing valve 7. Thus movement of the valve member 11 will vary the proportions of liquid and gaseous refrigerant passed into the evaporator 13.

In Figure 1, the expansion valve is shown as being connected to the outlet of the three-way mixing valve 7. If desired the expansion valve 12 may be connected between the receiver 5 and the liquid refrigerant inlet of the three-way mixing valve 7 as shown in Figure 2. The arrangement shown in Figure 2 obviates the necessity of passing the gaseous refrigerant through the expansion valve and consequently permits the use of a smaller expansion valve than would be necessary in the arrangement of Figure 1.

Referring again to the three-way mixing valve 7, the valve member 11 thereof may be actuated by means of a proportioning motor 17, this motor being illustrated as actuating the valve member 11 through the medium of a pinion 18 driven by the motor 17, and a rack 19 which is attached to the valve member 11. The motor 17 may be of any desired type and preferably may be of the type shown and described in Patent No. 2,028,110 issued on January 14, 1936, to Daniel G. Taylor. This type of proportioning motor is adapted to be controlled by means of a potentiometer controller, and will assume a position corresponding to the position of a potentiometer slider upon its resistance. In accordance with my invention, this motor 17 may be controlled according to the load upon the system by means of a potentiometer type temperature controller 20. The temperature controller or thermostat 20 may be of any suitable type and is for illustrative purposes indicated as comprising a bellows 21 which is connected by a capillary tube 22 to a control bulb 23. The bellows, tube and bulb are charged with a suitable volatile fill for causing the pressure within bellows 21 to vary with changes in temperature at the bulb 23. The bellows 21 in turn may actuate a slider 24 which cooperates with a resistance 25 to form a control potentiometer for the motor 17. By the arrangement just described, when the temperature at bulb 23 increases, the bellows 21 will expand thus moving slider 24 upwardly across resistance 25, and this will cause the proportioning motor 17 to shift the valve member 11 to the left, thus increasing the flow of liquid refrigerant into the evaporator while simultaneously decreasing the flow of gaseous refrigerant, thus increasing the cooling effect of the evaporator 13. Upon fall in temperature at the bulb 23, the opposite action will take place and thereby decreasing the cooling effect of the system.

Referring to the compressor control, the compressor may be controlled by means of a low pressure cut-out or suction pressure controller 26, and by a high pressure cut-out 27. The suction pressure controller 26 may be of any suitable type and may comprise a bellows 28 which is connected by a tube 29 to the outlet of the evaporator. This bellows is shown as actuating a pivoted mercury switch carrier 30 which carries a mercury switch 31. This instrument may be designed and adjusted in a manner to maintain the mercury switch 31 in closed position when the evaporator or suction pressure is above a predetermined value, while tilting the switch to open position when the suction pressure falls to a lower value.

Referring to the high pressure cut-out 27, this controller may comprise a bellows 32, which is connected by a tube 33 to the discharge line 3 of the compressor. This bellows actuates a mercury switch 34 in a manner to cause tilting of this switch to open position whenever the head pressure becomes excessive. This controller is primarily a safety device for stopping the compressor in the event of the head pressure becoming excessive, thereby preventing damage to the compressor and other apparatus. The mercury switches 31 and 34, it will be noted, are connected in series in the compressor control circuit. Consequently when either the head pressure becomes excessive or the suction pressure is reduced to a predetermined low value the compressor 1 will be placed out of operation.

Operation

With the parts in the positions shown, the head pressure is not excessive and the suction pressure is not too low, as indicated by the mercury switches 31 and 34 being closed. The compressor 1 is therefore in operation. Also the temperature at the control bulb 23 is at an intermediate value as indicated by the slider 24 of thermostat 20 engaging the center of resistance 25. This has caused the motor 17 to place the valve member 11 of the three-way mixing valve 7 in an intermediate position for allowing a portion of liquid refrigerant and a portion of gaseous refrigerant to enter the evaporator. If the temperature at bulb 23 increases, thus indicating an increased load upon the system, the slider 24 of thermostat 20 will move upwardly thus causing motor 17 to shift the valve member 11 to the left an amount proportionate to the travel of slider 24 on resistance 25. This will reduce the amount of gaseous refrigerant passing into the evaporator and will increase the amount of liquid refrigerant passing into said evaporator. Due to this increased supply of liquid refrigerant to the evaporator, the cooling effect of the evaporator will be increased. When the load upon the refrigeration system rises to a maximum the slider 24 will engage the upper end of resistance 25 and this will cause the valve 11 to be moved to its left-hand limit of motion, thereby completely cutting off the flow of gaseous refrigerant into the evaporator while increasing the flow of liquid refrigerant thereinto to a maximum. At this time the system will act in the same manner as a conventional refrigeration system, the suction pressure controller 26 stopping the compressor whenever the suction pressure falls below a predetermined value, thus preventing the evaporator temperature from being lowered beyond a predetermined value.

As the load upon the system decreases, the slider 24 of thermostat 20 will move downwardly across resistance 25 for causing movement of the valve member 11 to the right. This will decrease the flow of liquid refrigerant into the evaporator and consequently reduce the cooling effect of the evaporator. At the same time, the flow of gaseous refrigerant into the evaporator will be increased. This flow of gaseous refrigerant into the evaporator has two functions. One function of this gaseous refrigerant is to increase the pressure within the evaporator or, put another way, to prevent the compressor from reducing the evaporator pressure as rapidly as would occur if the gaseous refrigerant were not passed thereinto. This will have the result of preventing the suction pressure controller 26 from stopping the compressor as frequently as would occur if the gaseous refrigerant were not passed into the evaporator. Also this flow of gaseous refrigerant through the evaporator will increase the velocity of the refrigerant in the evaporator, thereby obtaining better heat exchange between the refrigerant and the evaporator surface.

From the foregoing description it will be apparent that I have provided a control system for a refrigeration system which will graduatingly vary the output of the system in accordance with the load on the system, this result being obtained by the introduction of gaseous refrigerant into the evaporator along with liquid refrigerant, and by varying the proportions of the liquid and gaseous refrigerant passed into the evaporator. It will also be apparent that my invention provides a refrigeration control system which will vary the system output without causing the compressor to frequently start and stop under the control of a suction pressure controller.

While my novel control system is of especial utility in systems wherein the compressor is controlled by a suction pressure controller, my invention is not limited to systems of this type as it will provide for variation in the system output even in systems where the compressor runs constantly. Also, while I have shown a thermostat for controlling the position of the mixing valve, it will be understood that any suitable type of controller may be utilized depending upon the particular application of the refrigeration system. For instance, if the system is applied to air conditioning, a humidity controller or other desired type of controller may be substituted in place of the thermostat 23. As many other modifications and adaptations of my invention will occur to those skilled in the art, I desire to be limited only by the scope of the appended claims.

I claim as my invention:

1. In a refrigeration system having an evaporator, a receiver for liquid refrigerant, means for passing said liquid refrigerant from said receiver into said evaporator, means including valve means for adding gaseous refrigerant to said liquid refrigerant being passed into said evaporator and for controlling the proportions of liquid and gaseous refrigerant being passed into said evaporator, and means responsive to the load on said evaporator for controlling said valve means.

2. In a refrigeration system, in combination, an evaporator, back pressure reducing means for withdrawing evaporated refrigerant from said evaporator, a condenser for condensing said evaporated refrigerant, means for passing condensed refrigerant from said condenser to said evaporator, means including valve means for mixing uncondensed refrigerant with the condensed refrigerant passing to said evaporator and for controlling the proportions of condensed and uncondensed refrigerant passed to said evaporator, and means responsive to the load on said evaporator for controlling said valve means.

3. In a refrigeration system, in combination, an evaporator, back pressure reducing means for withdrawing evaporated refrigerant from said evaporator, a condenser for condensing said evaporated refrigerant, means for passing condensed refrigerant from said condenser to said evaporator, means including valve means for mixing uncondensed refrigerant with the condensed refrigerant passing to said evaporator and for controlling the proportions of condensed and uncondensed refrigerant passed to said evaporator, load condition responsive means for controlling said valve means, and means for controlling said back pressure reducing means in accordance with the pressure of the refrigerant in said evaporator.

4. In a refrigeration system having an evaporator, a receiver for liquid refrigerant, a source of fluid having characteristics differing from said liquid refrigerant, means for passing said liquid refrigerant into said evaporator, means including valve means for adding said fluid to said liquid refrigerant being passed to said evaporator and for controlling the proportions of the fluid and said liquid refrigerant being passed into said evaporator, and means responsive to the load on said evaporator for controlling said last mentioned means.

5. In a refrigeration system having an evaporator, a receiver for liquid refrigerant, a source of fluid having characteristics differing from said liquid refrigerant, mixing valve means having an outlet connected to said evaporator and a pair of inlets, one of said inlets being connected to said receiver and the other of said inlets being connected to said source, and load responsive means for adjusting said mixing valve means for thereby varying the proportions of liquid refrigerant and fluid passed into said evaporator.

6. In a refrigeration system, in combination, an evaporator having an inlet and an outlet, back pressure reducing means connected to said outlet for withdrawing evaporated refrigerant therefrom, an expansion valve connected to said inlet, a receiver for liquid refrigerant, a source of fluid having characteristics differing from said liquid refrigerant, means for connecting said source and said receiver to the expansion valve for delivering a mixture of liquid refrigerant and fluid to said expansion valve and for varying the proportions of the mixture, and load conditions responsive means for controlling said last mentioned means.

7. In a refrigeration system, in combination, a compressor, a condenser, a high pressure line for conveying gaseous refrigerant from the compressor to the condenser, an evaporator, a liquid line for conveying liquid refrigerant from the condenser to the evaporator, an expansion valve in said liquid line, a by-pass line for conveying refrigerant directly from the high pressure line to said liquid line ahead of the expansion valve for adding gaseous refrigerant to the liquid refrigerant passing to the expansion valve, valve means for controlling the proportions of gaseous and liquid refrigerant passed to the expansion valve, and load responsive means for controlling said valve means.

8. In a refrigeration system, in combination, a compressor, a condenser, a high pressure line for conveying gaseous refrigerant from the compressor to the condenser, an evaporator, a liquid line for conveying liquid refrigerant from the condenser to the evaporator, an expansion valve in said liquid line, a by-pass line for conveying refrigerant directly from the high pressure line to said liquid line downstream of said expansion valve for adding gaseous refrigerant to the refrigerant passing from the expansion valve into said evaporator, means for varying the proportions of the mixture of liquid and gaseous refrigerant, and load responsive means for controlling said last mentioned means.

WILLIAM L. McGRATH.