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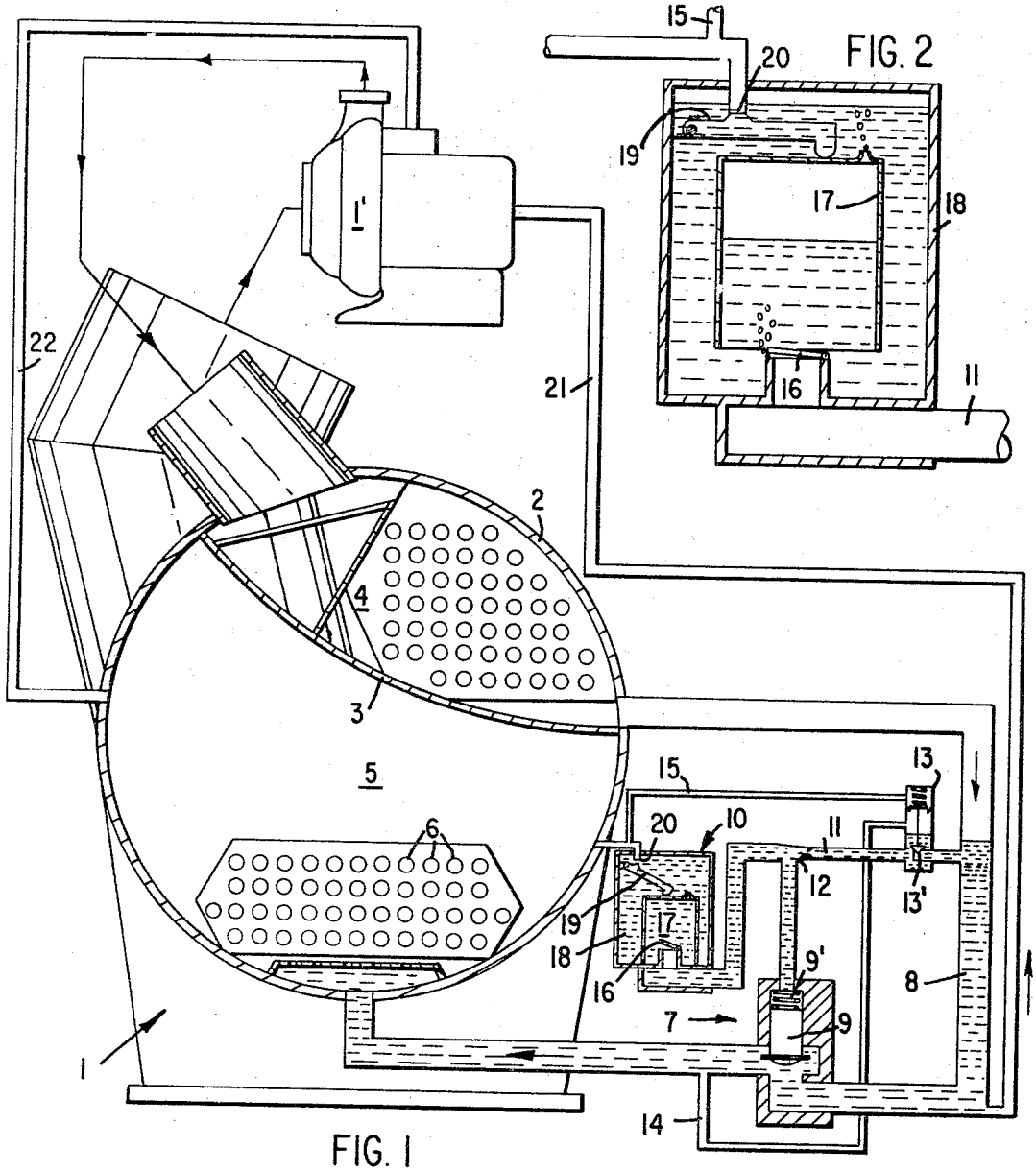


FIG. 1

FIG. 2

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APPARATUS AND METHOD FOR CONTROLLING REFRIGERANT FLOW IN A REFRIGERATION MACHINE

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9 Claims. (Cl. 62—115)

This invention relates broadly to a refrigeration machine. More particularly, this invention relates to the control of refrigerant flow in a refrigeration machine. Still more particularly, this invention relates to a liquid refrigerant metering device particularly equipped to provide a minimum head within the refrigeration machine under abnormal conditions and in addition, provide for passage of a mixture of liquid and gaseous refrigerant to the evaporator of a refrigeration machine at low load conditions to improve the efficiency of the evaporator.

In high tonnage refrigeration machines, a compressor is arranged to extract gaseous refrigerant from an evaporator and pump the compressed refrigerant to a condenser where the refrigerant is cooled and condensed. In communication with the condenser, there is normally provided a receiver for collecting liquid refrigerant formed in the condenser prior to its passage to the evaporator. The receiver usually contains refrigerant both in the liquid and gaseous phases. In some machines, a portion of the liquid refrigerant is utilized to cool the motor driving the refrigerant compressor. To insure sufficient refrigerant flow to the motor being cooled, a minimum refrigerant pressure differential between the receiver and motor casing is required.

To maintain a liquid seal in the receiver, a metering device is employed to regulate refrigerant flow from the condenser to the evaporator.

Under normal operating conditions, the level of the liquid refrigerant collected in the receiver is a function of the pressure difference between the high pressure side of the machine and the low pressure side of the machine and the load on the machine, it being understood the condenser is disposed in the high pressure side and the evaporator in the low pressure side of the machine. Refrigerant flow from the condenser to the evaporator occurs in an amount related to the loading on the machine and automatic controls such as suction guide vanes are provided for the purpose of maintaining flow rates corresponding to machine loading. Refrigerant metering devices are designed to pass a predetermined amount of refrigerant in accordance with the level of liquid refrigerant collected to maintain a liquid seal in the receiver.

The liquid from the receiver is passed through the metering device to the evaporator. The evaporator contains a multiplicity of tubes usually referred to as a tube bundle through which the medium to be cooled is passed in heat transfer relation with the refrigerant in the evaporator. Under normal operating conditions, the heat supplied to the refrigerant from the medium being cooled is sufficient to cause the liquid refrigerant in the evaporator to boil vigorously. The boiling refrigerant thus wets all the tubes in the evaporator, providing optimum heat transfer between the medium and the refrigerant. However, at low loads a relatively small quantity of heat is given off by the medium. The refrigerant, under these conditions, does not boil vigorously enough to wet all the tubes, causing the efficiency of the evaporator to decrease. Therefore, to maintain evaporator efficiency at low load, the liquid refrigerant therein must be agitated. To accomplish this, a part of the high pressure gaseous refrigerant from the condenser is passed through the liquid in the evaporator.

Under abnormal conditions, such as start up, there is usually insufficient pressure on the system to force liquid refrigerant to the refrigerant compressor motor. It is, therefore, desirable to provide a rapid build up of pressure in the high pressure side (receiver) when the machine is started and to maintain a minimum pressure difference in the machine under abnormal conditions.

The chief object of this invention is to provide an improved refrigerant flow control device. It is an additional object of this invention to provide a refrigerant control device which will maintain a constant level of liquid refrigerant in the receiver under normal operating conditions. A further object of this invention is to provide a control for passing liquid and gaseous refrigerant to the evaporator to provide agitation of the liquid refrigerant therein under low load conditions. A still further object of this invention is to provide a refrigerant control device which will provide for rapid build up of pressure in the machine at start up and maintain a minimum pressure therein under abnormal operating conditions. Another object of this invention is to provide an improved method for controlling refrigerant flow in a refrigeration machine between the high pressure and the low pressure sides thereof.

These objects are attained by providing a spring loaded or weighted metering valve in the refrigerant line between the condenser and evaporator to regulate the refrigerant flow therethrough. The spring or weight is selected so as to prevent the metering valve from opening until the desired minimum pressure difference between the high pressure and low pressure sides of the machine has been attained, or stated another way, until a preselected minimum pressure is developed in the condenser and receiver. When the refrigeration machine is operating above this minimum pressure requirement, a pilot trap is operable to modulate the metering valve in response to liquid level in the receiver line to maintain a seal therein under changes encountered in normal operating conditions. A pilot trap control line valve is operable in response to machine characteristics indicative of low load conditions to reduce refrigerant flow to the pilot trap, reducing pressure therein which in turn opens the metering valve, allowing liquid and gaseous refrigerant to flow to the evaporator under low load conditions to provide agitation of the liquid-refrigerant collected in the evaporator.

Other objects and features of this invention will be apparent upon a consideration of the ensuing specification and drawing in which:

FIGURE 1 is a schematic view of a refrigeration machine incorporating the preferred embodiment of the refrigerant flow control mechanism forming the subject of this invention.

FIGURE 2 is a sectional view of the pilot trap utilized in the control mechanism of the invention showing the pilot trap closed.

Referring more particularly to the drawing there is shown a refrigeration machine **1** for cooling a large quantity of water such as may be employed in air conditioning installation. The machine **1** having a refrigerant motor-compressor **1'** includes a shell **2** for housing the heat transfer units associated with the machine. The shell **2** has a partition **3** therein for separating the high pressure condenser section **4** from the low pressure evaporator section **5**. Tube bundle **6** in evaporator section **5** is provided for passing the water to be chilled therethrough.

A refrigerant metering control mechanism **7** is provided to control refrigerant flow through receiver line **8** from the condenser section **4** to the evaporator section **5**.

Refrigerant metering valve **9** which is biased toward a closed position by minimum head spring **9'** controls the flow of refrigerant through line **8**. The pilot trap assembly **10**, under normal operating conditions, maintains a constant refrigerant level in line **8** by varying the pressure on valve **9**. The pilot trap assembly communicates with receiver line **8** through line **11** which has an orifice **12** therein.

Motor cooling is accomplished by providing the motor compressor **1'** with liquid refrigerant from the receiver line **8** through motor refrigerant line **21**. The refrigerant is then routed to the low pressure side of the refrigeration machine through return line **22**.

Under low load conditions a pilot trap valve **13'** operable in response to changes in pressure across a cooler refrigerant distribution means restricts flow of refrigerant through line **11** to override pilot trap assembly **10** and allow metering valve **9** to pass liquid and gaseous refrigerant therethrough. This agitates the liquid refrigerant in the evaporator **5** under low load conditions. A cooler distribution means of the kind contemplated is described in detail in United States Patent application Ser. No. 281,400 filed May 20, 1963, and assigned to the assignee of this application.

Considering the operation of this control system, at start up, spring **9'** will maintain metering valve **9** closed until sufficient pressure is built up in the high side of the refrigeration machine and applied via line **8** to the underside of valve **9** to override the spring force. When the machine has reached its normal operating range, cooler refrigerant distribution pressure drop is relatively constant. This pressure difference which is communicated to pressure differential control **13** on pilot trap valve **13'** through lines **14** and **15** maintains valve **13'** open. Gaseous refrigerant flowing through line **11** into the pilot trap assembly **10** through poppet valve **16** collects under the bucket **17** causing it to rise in the chamber **18** which has liquid refrigerant therein. The bucket **17** pushes lever **19** upward, closing pilot trap orifice **20** communicating with the evaporator. As liquid level in line **8** rises in response to changes in operating conditions, liquid refrigerant will flow through line **11** into the pilot trap. Since gaseous refrigerant is no longer provided under bucket **17**, it will start to sink, opening pilot trap orifice **20**. Since pilot trap orifice **20** is larger than orifice **12**, pressure in line **11** downstream from orifice **12** will decrease opening metering valve **9** to a greater extent to pass sufficient refrigerant therethrough to lower the liquid level in line **8** below the junction of lines **11** and **8**. Thus, a substantially constant liquid level and seal is maintained within the machine operating range.

Under low capacity conditions, distribution pressure drop decreases. This modulates pilot trap valve **13'** to restrict flow of refrigerant through line **11** which causes valve **9** to open and pass liquid and gaseous refrigerant therethrough to agitate the collected liquid refrigerant in evaporator **5**.

It is to be understood that the pilot trap valve **13'** could be actuated manually or by a solenoid rather than pressure drop as described above as well as by any other combination of system operating characteristics indicative of low capacity conditions.

While we have described a preferred embodiment of our invention, it is to be understood that the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

We claim:

1. In a refrigeration machine having a high pressure side and a low pressure side and including a condenser in the high pressure side of the system for liquifying gaseous refrigerant and an evaporator in the low pressure side of the system receiving liquid refrigerant from the condenser, a refrigerant metering device for regulating flow of refrigerant from the condenser to the evaporator comprising:

a metering valve between the condenser and evaporator for metering the flow of refrigerant therethrough,

means for actuating said metering valve in response to the level of liquid refrigerant in the high pressure side of the refrigeration machine under normal operating conditions to maintain a liquid seal at said metering valve, and

means responsive to an operating characteristic of the machine indicative of low load conditions to hold said metering valve open irrespective of the liquid level in the high side of the machine to pass liquid and gaseous refrigerant to the low pressure side of the machine.

2. In a refrigeration machine having a high pressure side and a low pressure side and including a condenser in the high pressure side of the system for liquifying gaseous refrigerant and an evaporator in the low pressure side of the system receiving liquid refrigerant from the condenser, a refrigerant metering device for regulating flow of refrigerant from the condenser to the evaporator comprising:

a metering valve between the condenser and evaporator for metering the flow of refrigerant therethrough,

a pilot trap having an inlet communicating with the high pressure refrigerant from said condenser upstream from said metering valve and an outlet communicating with the low pressure side of the refrigeration system; and

a control line from said pilot trap communicating with said metering valve, the refrigerant pressure in said pilot trap actuating said metering valve.

3. A refrigerant metering device according to claim **2** further including:

a pilot trap valve disposed between the high pressure side of the system and the pilot trap inlet, to regulate the flow of refrigerant to said pilot trap.

4. A refrigerant metering device according to claim **3** wherein said pilot trap valve is actuated by a pressure differential control responsive to cooler refrigerant distribution pressure drop.

5. A refrigerant metering device according to claim **2** further including:

biasing means operably associated with said metering valve to maintain said metering valve closed until the desired minimum refrigerant pressure is built up in the machine.

6. A refrigerant metering device according to claim **5** wherein said biasing means is a spring.

7. A refrigerant metering device according to claim **2** further including:

a pilot trap valve disposed between the high pressure side of the system and the pilot trap inlet operable in response to predetermined demand on the refrigeration machine to regulate the flow of refrigerant to said pilot trap, and

biasing means operably associated with said metering valve to maintain said metering valve closed until the desired minimum refrigerant pressure is built up in the machine.

8. A refrigerant metering device according to claim **2** further including:

a pilot trap valve disposed between the high pressure side of the system and the pilot trap inlet,

a pressure differential control, responsive to cooler refrigerant distribution pressure drop, operably associated with said pilot trap valve to regulate the flow of refrigerant to said pilot trap, and

a spring operably associated with said metering valve to maintain said metering valve closed until the desired minimum refrigerant pressure is built up in the machine.

9. A method of controlling refrigerant flow in a refrigeration machine which consists in the steps of:

regulating the passage of liquid refrigerant from the

high pressure side of the machine to the low pressure side of the machine by a mechanism operable in response to the level of liquid refrigerant collected in the high pressure side of the machine, and

overriding the action of said mechanism at a predetermined load on the machine so that a mixture of gaseous and liquid refrigerant from the high pressure side may pass to the low pressure side unimpeded by the action of the mechanism.

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