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REFRIGERANT FLOW CONTROL FOR IMPROVING LOW CAPACITY EFFICIENCY

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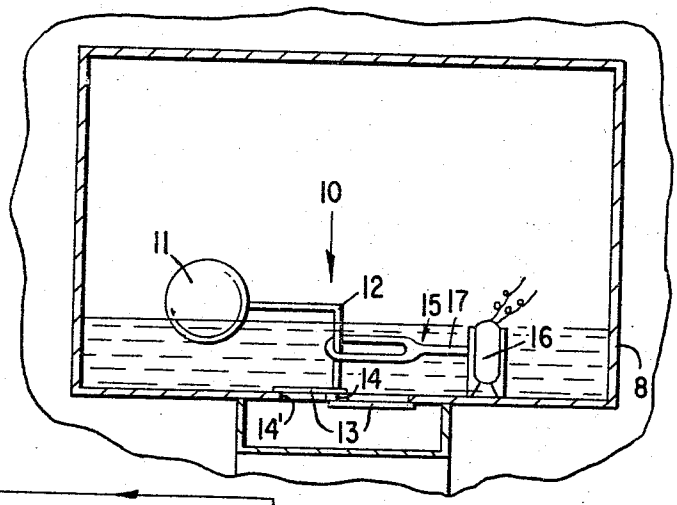

FIG. 2

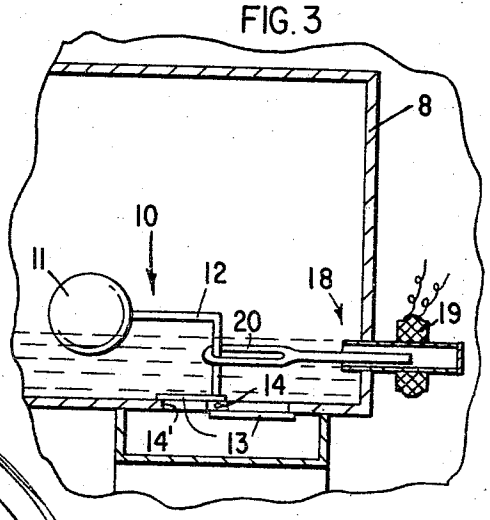

FIG. 3

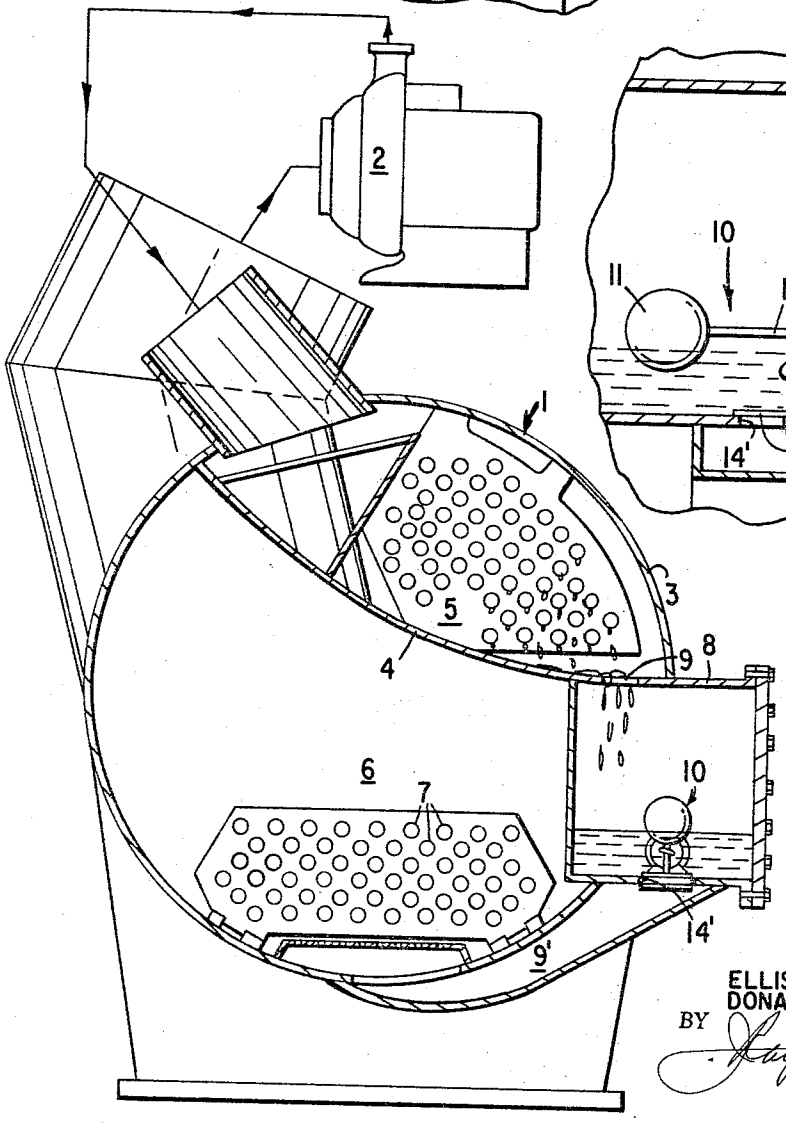

FIG. 1

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REFRIGERANT FLOW CONTROL FOR IMPROVING LOW CAPACITY EFFICIENCY

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ABSTRACT OF THE DISCLOSURE

A centrifugal refrigeration machine having a tube bundle in the evaporator section thereof for passage therethrough of the medium to be cooled. A float controlled metering valve, provided to regulate flow of refrigerant between the condenser and evaporator, is operably connected to a solenoid which holds the valve open under low load conditions to pass gaseous refrigerant to the evaporator to cause agitation of liquid refrigerant therein. The liquid agitation insures wetting of the evaporator tubes by liquid refrigerant for maximum evaporator efficiency.

This invention relates broadly to a refrigeration machine. More particularly, this invention relates to control of refrigerant flow in a refrigeration machine. Still more particularly, this invention relates to a liquid refrigerant metering device particularly equipped to pass 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 at low load.

In high tonnage refrigeration machines, a compressor is arranged to extract gaseous refrigerant from an evaporator, compress the refrigerant, and pump it to a condenser where it 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 and flow from the receiver is regulated by a float operated valve mechanism.

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 and receiver are disposed in the high pressure side and the evaporator in the low pressure side of the machine. Refrigerant flow from the high side 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. Float operated valve assemblies are designed to pass a predetermined amount of refrigerant in accordance with the level of refrigerant collected to maintain a liquid seal in the receiver.

The liquid from the receiver is passed through the float valve to the evaporator. The evaporator contains a multiplicity of tubes usually referred to as a tube bundle through which the medium to be cooled by the machine 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 particularly those in the upper rows of the bundle, 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 portion of the high pressure gaseous refrigerant from the condenser is passed through the pool of liquid refrigerant in the evaporator.

The chief object of this invention is to provide a simplified refrigerant flow control for passing both liquid and gaseous refrigerant to the evaporator under certain operating conditions. It is an additional object of this invention to provide a refrigerant control device which will maintain a liquid seal in the condenser 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.

These objects are attained by providing a float valve actuator to maintain the float valve open a desired amount at low load conditions regardless of the liquid level in the receiver. The actuator is operable in response to an operating characteristic of the refrigeration machine indicating low load such as guide vane position.

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

FIGURE 1 is a somewhat schematic view of a refrigeration machine, wherein the evaporator-condenser section is shown in sectional elevation, incorporating a control mechanism illustrating the invention.

FIGURE 2 is a fragmentary view of the receiver of a refrigeration machine illustrating a float valve and float valve actuator.

FIGURE 3 is a sectional view of the receiver portion of the refrigeration machine illustrating a second embodiment of our invention.

Referring more particularly to the drawing there is shown a centrifugal refrigeration machine **1** for cooling a large quantity of water or brine. Refrigeration machines of this type are employed to cool water or brine flowing within a closed circuit forming a part of an air conditioning installation. The machine **1**, having a refrigerant motor compressor **2**, includes shell **3** for housing the heat transfer units (evaporator and condenser) associated with the machine. The shell **3** has a partition **4** therein for separating the high pressure condenser section **5** from the low pressure evaporator section **6**. Tube bundle **7** in evaporator section **6** is provided for passing water to be chilled therethrough.

Refrigerant receiver, or float box **8**, is provided for receiving gaseous and liquid refrigerant from the condenser through opening **9** communicating therewith. Float valve assembly **10** in float box **8** is provided for metering refrigerant from the float box to the evaporator section **6** through passageway **9'**. The float valve assembly **10** comprises float ball **11**, float arm **12**, and throttle plates **13** rigidly connected to arm **12**. The float valve assembly is pivoted on pin **14** mounted in the sides of an opening **14'** formed in the receiver. Actuator assembly **15** consisting of solenoid **16** and actuator arm **17** is provided to hold float valve assembly **10** open when solenoid **16** is activated in a manner to be later explained.

FIGURE 3, illustrating a second embodiment of our invention, has an actuator assembly **18** consisting of solenoid **19** and actuator arm **20** to hold float valve assembly **10** open when solenoid **19** is activated. In this embodiment, the solenoid is located outside the receiver.

Considering the operation of the refrigerant control device illustrated in FIGURES 1 and 2, under normal operating conditions, float valve assembly **10** will maintain a

constant liquid refrigerant level in float box **8**. Under low load conditions, liquid refrigerant level will tend to build up in the evaporator. However, float valve assembly **10** will still operate to maintain a relatively constant liquid level in the float box **8**. In order to do so, float valve assembly **10** will be substantially closed and flow of refrigerant to the evaporator will be minimal. Under these conditions, the heat given off by the water being chilled will be insufficient to boil the collected refrigerant in the evaporator. The upper tubes of the tube bundle will not be wetted by the refrigerant and the capacity of the refrigeration machine will decrease.

To maintain the efficiency of the refrigeration machine at a high level, it is desirable to pass both liquid and gaseous refrigerant to the evaporator to cause agitation of the liquid therein to wet all the tubes of the tube bundle. To accomplish this, the float valve assembly **10** is opened to allow all of the liquid collected therein and gaseous refrigerant to pass through passageway **9'** into the evaporator. By actuating solenoid **16** in response to a machine operating characteristic indicative of low load such as compressor inlet guide vane position, float valve assembly **10** will be held open thereby breaking the liquid seal in float box **8** allowing liquid and gaseous refrigerant to pass therethrough to agitate the collected liquid refrigerant in evaporator **6**.

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 centrifugal refrigeration system, the combination of a high pressure side including a centrifugal compressor and a condenser;

a low pressure side including an evaporator having a tube bundle therein;

a refrigerant metering device comprising a float valve disposed in the high pressure side of the system to meter passage of refrigerant from the condenser to the low pressure side, said float valve being operable in response to liquid refrigerant level in the high pressure side to pass refrigerant to the evaporator to maintain a constant liquid level in the high pressure side under normal operating conditions; and

an actuating assembly for actuating said float valve, said assembly being responsive to an operating characteristic of the system at low load to hold said valve open irrespective of the refrigerant level in the high pressure side to pass gaseous refrigerant from the high pressure side to the evaporator to agitate liquid refrigerant in the evaporator thereby wetting substantially all the tubes of the bundle with liquid refrigerant to increase evaporator efficiency under low load conditions.

2. A centrifugal refrigeration system according to claim **1** wherein said actuator assembly comprises:

an actuator arm operably associated with said float valve to hold said float valve open when said arm is retracted, and

a solenoid operably connected to said actuator arm to retract said arm when said solenoid is energized.

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