REFRIGERANT FLOW CONTROL

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This invention relates to a refrigeration machine. More particularly, this invention relates to refrigerant flow in a refrigeration machine. Still more particularly, this invention relates to a refrigeration machine having means therein to control the flow of refrigerant from the high side to the low side thereof.

In high tonnage refrigeration machines, a compressor is arranged to extract gaseous refrigerant from an evaporator and deliver it at a higher pressure to a condenser where the refrigerant is cooled and condensed.

To increase the efficiency of the machine, it is desirable to cool the condensed refrigerant to a temperature below condensing temperature before it is passed to the evaporator. This can be accomplished by providing a tube bundle in the bottom of the condenser or in a separate enclosure located so that condensed refrigerant can be passed over the tubes in heat transfer relation with cooling water passing therethrough. To obtain maximum sub-cooling as this action is called, sufficient liquid refrigerant must be maintained in the subcooler to completely cover the tube bundle.

The subcooled refrigerant is passed from the subcooler through a metering device to the evaporator. The evaporator contains 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 causes the liquid refrigerant in the evaporator to boil vigorously. The boiling refrigerant wets all the tubes in the evaporator, providing optimum heat transfer between the medium and the refrigerant. At low loads, when there is insufficient heat in the medium being cooled to cause vigorous boiling of the refrigerant in the evaporator, efficiency drops as the number of heat exchange tubes wetted by the refrigerant is reduced. To counteract this, it is desirable to agitate the liquid refrigerant in the evaporator by passing gaseous refrigerant therethrough, the violent action induced thereby causing all the heat exchange tubes to be wetted by liquid refrigerant.

If a motor is employed to drive the compressor of the refrigeration machine, sufficient pressure must be maintained in the system to lift a portion of the refrigerant to the motor housing, refrigerant cooling commonly being used to maintain safe motor operating temperatures. By preventing flow of refrigerant from the high side to the low side, required high side pressure may be rapidly built up.

It is therefore the chief object of this invention to provide a novel method to control refrigerant flow in a refrigeration machine.

It is a further object of this invention to provide a refrigerant metering device for passing refrigerant from the condenser to the evaporator of a refrigeration machine which will maintain a desired liquid level on the high side of the machine.

It is a further object of this invention to provide a metering device having provisions therein for agitating the refrigerant in the evaporator at a low load operating condition.

Still another object of this invention is to provide a refrigerant metering device having provisions therein for maintaining a minimum pressure differential across the machine.

The objects of this invention are attained by providing a control chamber between the high and low sides of the refrigeration machine, means being provided in the chamber responsive to the refrigerant level therein to actuate a metering device to pass refrigerant from the high side to the low side, said chamber having a refrigerant supply line communicating with the high side of the machine and a drain line communicating with the low side thereof, the level of refrigerant in the chamber being determined by the relative refrigerant flow rates through said lines.

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 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 fragmentary view, partially in perspective, and partially in a perspective of a portion of the evaporator-condenser illustrating important details of the flow control mechanism.

FIGURE 3 is a perspective view, partially in section, of the evaporator-condenser showing portions of the flow control mechanism.

Referring more particularly to the drawings, there is shown a refrigeration machine 1 having a condenser 3, an evaporator 5 and a motor-compressor 7. The evaporator-condenser is formed by a shell 9 having a partition 11 therein separating condenser 3 from evaporator 5. A subcooler chamber 13 is defined, on the top by partition 11, on the bottom by bottom plate 14, on one side by upstanding wall 15, and on the other side by a section of shell 9. Tube bundles 4, 6 and 12 disposed in condenser 3, evaporator 5 and subcooler 13 respectively, are provided for passing heat transfer fluids therethrough, 4 and 12 being a circuit separate from the circuit including bundle 6.

A float box or control chamber 17 is provided for regulating refrigerant flow from the high side to the low side of the machine. The float box 17 has a top plate 19, a bottom plate 21, side plates 23 and 25, and cover plate 27. Shell 9 provides a back wall for the control chamber. An upstanding partition 29 divides the control chamber 17 into a float compartment 31 and a metering compartment 33, metering compartment 33 being divided by horizontal partition 35. A shaft 37, extending through compartments 31 and 33, has a float 34 attached thereto by means of an arm 39 in compartment 31 and a throttle plate 41 attached thereto in compartment 33, both elements having pivotal movement relative to the shaft. An opening 43 is provided in partition 35, throttle plate 41 being aligned therewith to form a valve.

An opening 45 is provided in partition 11 at one end thereof to allow refrigerant from the condenser to pass to the subcooler. A conduit 47 communicating between the other end of the subcooler at the bottom thereof and the top of metering compartment 33 provides a passage.
way for refrigerant between the subcooler and the metering compartment. A conduit 50 between the bottom section of compartment 33 and evaporator 5 provides a passageway for refrigerant therewith. Thus, refrigerant can pass from condenser 3, through opening 45, subcooler 13, conduit 47, opening 43 (if throttle plate 41 is not positioned so as to obstruct flow therethrough), conduit 50 and into evaporator 5.

A control chamber supply tube 52 is utilized to supply refrigerant from condenser 3 to float compartment 31. A control chamber drain tube 54, preferably smaller than tube 52, is provided to drain refrigerant from float compartment 31 to evaporator 5. Supply tube 52 communicates with condenser 3 at a location corresponding to the desired collected refrigerant level therein so that an excess of collected refrigerant is present in the condenser, a portion thereof will flow through tube 52 into chamber 31. A secondary supply tube 56 communicates between float chamber 31 and the high pressure side of the machine at the bottom of subcooler 13. Valves 53, 55 and 57 are provided in lines 52, 54 and 56 respectively.

Considering the operation of the refrigerating metering device under normal operating conditions, valves 53 and 55 are opened and valve 57 is closed. If an excess of refrigerant is collected in condenser 3, a portion thereof will flow through tube 52, into chamber 31. Due to the fact that drain tube 54 is smaller than line 52, refrigerant will not drain from chamber 31 as fast as if it is supplied thereto, the refrigerant build-up in chamber 31 raising float 34 which causes throttle plate 41 to open further to pass more refrigerant therethrough, reducing the amount of refrigerant in condenser 3. If the liquid refrigerant in condenser 3 is below the desired level, no liquid refrigerant will flow through tube 52, chamber 31 will drain, lowering float 34, closing throttle plate 41 so less refrigerant is passed therethrough until the refrigerant in the condenser reaches the desired level.

It should be understood that under normal operating conditions, this system will reach an equilibrium whereby a sufficient amount of refrigerant will pass through tube 52 to maintain a level in chamber 31 which will hold throttle plate 41 in such a position that the refrigerant level in condenser 3 will be maintained constant at the desired point.

Under low load conditions, when it is desirable to agitate the collected refrigerant in the evaporator for reasons set forth heretofore, the level of refrigerant in the condenser would ordinarily be less than that to which the condenser would be emptied, and throttle plate 41 would be closed. For agitation therefor, valve 55 is closed and valve 57 is opened. This causes liquid refrigerant from the high side of the machine to enter chamber 31 and remain there, raising float 34 to the top of the chamber and opening throttle plate 41 to the fullest extent. This rapidly drains any liquid refrigerant from the high side of the machine and then allows high pressure gas to pass to the evaporator to agitate the liquid refrigerant therein.

Under abnormal operating conditions, such as start-up, when it is desirable to maintain or obtain a minimum pressure differential between the high and low sides of the machine, valves 53 and 57 may be closed and valve 55 opened, causing chamber 31 to drain, lowering the float and closing throttle plate 41. This allows high side pressure to build up more rapidly than would be the case if the throttle plate were positioned as explained heretofore under normal operating conditions.

It is to be understood that this invention is not limited to a refrigeration system as described having a subcooler therein but is applicable to any system when it is desirable to maintain a predetermined refrigerant level in the high side thereof and to obtain forced feed of refrigerant through any device between the high and low sides of the system.

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

We claim:

1. A method of controlling the flow of refrigerant from the high pressure side of a refrigeration machine to the low pressure side of the machine which consists in the steps of collecting liquid refrigerant in the high pressure side of the machine, continuously supplying a portion of liquid refrigerant in excess of a predetermined amount of the collected refrigerant to a control chamber, utilizing the level of refrigerant in said control chamber to regulate passage of liquid refrigerant from the high pressure side of the machine to the low pressure side of the machine and thereby vary the accumulation of collected liquid refrigerant, continuously draining the liquid refrigerant from the control chamber to the low pressure side of the machine while supplying said excess refrigerant thereto, the rate of drainage being related to the rate of supply, as governed by the variation in accumulation, so that passage of liquid refrigerant from the high side to the low side is regulated in accordance with the load on the machine throughout the normal operating range of the machine.

2. The method set forth in claim 1 including the step of passing a portion of the collected liquid refrigerant directly to the control chamber while preventing drainage therefrom during operation of said machine at a predetermined load thereby establishing continuous communication between the high pressure side and the low pressure side of the machine.

3. The method set forth in claim 1 including the step of draining the liquid refrigerant from the control chamber to the low pressure side of the machine while preventing flow of refrigerant thereto from the high side at a predetermined low head condition thereby sealing the high pressure side from the low pressure side of the machine.

4. A refrigerant flow control device for maintaining a predetermined level of collected refrigerant on the high side of a refrigeration machine under normal operating conditions comprising a control chamber, means mounted in said chamber responsive to the refrigerant level therein, a metering valve, operably associated with said means, said metering valve being disposed between the high and low sides of the refrigeration machine to regulate refrigerant flow to the low side thereof, a conduit line for passage of refrigerant between the chamber and said control chamber, the high side end of said control line being disposed at a location corresponding to the predetermined level of collected refrigerant therein, a control chamber drain line having a flow capacity less than said control line, said drain line communicating between the low side of the refrigeration machine and said control chamber so that a portion of the refrigerant in excess of the predetermined collected refrigerant will flow into said control chamber faster than it can drain therefrom, opening said metering valve and draining the excess refrigerant to the low side of the machine to establish said predetermined level.

5. A refrigerant flow control device according to claim 4 further including a second control line for passage of refrigerant between the high side of the machine and said control chamber, the high side end of said second control line being disposed at a location below said control line, first valve means for preventing fluid flow through said second control line under normal operating conditions and second valve means for preventing fluid flow through said drain line so that under low load conditions, said first valve means can be opened and said second valve means can be closed simultaneously to flood said control chamber, open said metering valve and pass gaseous refrigerant to the low side of the machine to agitate the liquid refrigerant therein.
6. A refrigerant flow control device according to claim 5 further including third valve means for preventing flow of refrigerant through said control line under low head conditions so that by maintaining said first and third valve means closed and said second valve means open, said control chambers will drain, closing said metering valve, causing an increase in the pressure differential between the high and low sides of the refrigeration machine.

References Cited
UNITED STATES PATENTS

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