PURGE MECHANISM FOR REFRIGERATION SYSTEM

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This invention relates to refrigeration systems. More particularly, this invention relates to an improved purging arrangement for use in refrigeration systems.

Purging apparatus is employed in conjunction with refrigeration systems for the purpose of removing non-condensibles which collect within the system and which, if permitted to remain, create pressure unbalances which materially affect the efficiency and effectiveness of the refrigeration system. The purging arrangement forming the subject of this invention includes a novel control arrangement which is operable to enable the purging arrangement to provide other important functions in the operation and maintenance of a machine employing the refrigeration system.

The purging system herein contemplated includes a chamber for the purpose of collecting non-condensibles from a portion of the refrigeration system where such accumulate. Located within the chamber is a heat transfer unit supplied with liquid refrigerant from a portion of the refrigeration machine forming the refrigeration system. The control system governing the operation of the pump includes a plurality of valves, at least one of which is operated by a solenoid connected in an electric circuit having control elements responsive to certain operating conditions within the refrigeration machine and/or the purge chamber. In addition, there is a number of manually operated valves which may be manipulated in a novel way so as to permit the pump to either automatically purge the system of non-condensibles, evacuate the entire machine, elevate the pressure within the machine above atmospheric for the purpose of determining the position of any leaks in the machine, or may be used to elevate the pressure within the purge chamber under circumstances where the pressure in that portion of the purging arrangement is below atmospheric and it is desired to drain condensed water from the chamber or apply condenser pressure to a part of the purge chamber to drain lubricant to the compressor.

The chief object of this invention is the provision of an improved purging arrangement wherein it is possible to employ the equipment normally used to achieve the purging action to accomplish other functions necessary for the proper operation of a refrigeration machine equipped with such a purge arrangement.

Another object of the invention is an improved method of purging a refrigeration machine.

A still further object of the invention is the provision of a control for a purging arrangement which includes novel piping and flow-regulating members which is operable under various patterns of operation to provide a number of different functions that may be accomplished by the purging mechanism.

These and other objects of the invention will be apparent upon a consideration of the ensuing specification and drawings in which:

FIGURE 1 is a diagrammatic view of the purging arrangement serving as the subject of this invention as it applies to certain of the components comprising the refrigeration machine;

FIGURE 2 is a schematic view of a part of the control circuit for use with the purging arrangement serving as the subject of this invention; and

FIGURE 3 is a partial view of a modification of the control for the purging arrangement.

Referring more particularly to the drawings, a refrigeration machine of the type to which the novel purging arrangement forming the subject of this invention is applicable includes a condenser 10 of the shell and tube type having a line 12 for conducting condensed refrigerant to an economizer 13. From the economizer, line 14 conducts liquid refrigerant at a lower pressure level to cooler 18. The cooler, more commonly known as an evaporator, is constructed in a manner similar to the manner of construction of the condenser. Line 20 provides a path of flow for gaseous refrigerant formed in the evaporator to a compressor 22 where the pressure of the refrigerant is elevated and discharged through line 22 to the condenser to complete the refrigeration cycle. Line 14 connects the economizer with the motor driving the compressor to supply economizer gas to cool the motor in the manner described in United States patent application, Serial No. 566,190, filed February 17, 1956, now issued as United States Letters Patent 2,921,445 in the names of Carlyle M. Ashley and Adolph Zulinke and assigned to the assignee of this invention. Line 15 provides a path for the flow of heated economizer gas to the compressor at an intermediate stage of compression.

The refrigeration machine of the kind described is useful in an air conditioning system wherein it is desired to chill water flowing in a closed circuit which includes the tubes in the evaporator as well as a number of coils in units strategically placed in an enclosure adapted to be supplied with air conditioning. As indicated above, non-condensible gases very often accumulate within the refrigeration machine, normally in the high pressure side at the top of the condenser. The non-condensibles include water vapor and portions of the refrigerant vapor which may eventually accumulate with the non-condensibles. The function of a purging system in a refrigeration machine of the kind described is to remove the collected gaseous material described above, liquify the condensable constituents of the removed gas in a purge chamber and evacuate the remaining non-condensibles. Those portions of the gas removed from the condenser which may be condensed are then recirculated through the purge chamber, as in the case of the refrigerant, or drained off to waste, as in the case of the water.

The purging system forming the subject of this invention includes a purging chamber 24 arranged to define a space 25 for the collection of the non-condensibles flowing from the condenser through line 45. The portions of the gas flowing through line 45 that may be condensed are then liquefied by passing them in heat transfer relation with liquid refrigerant flowing from the low pressure side of the refrigeration machine. The purge chamber includes headers 26 and 28 at opposite ends thereof connected by a plurality of tubular members 29 serving as passages for the liquid refrigerant. The liquid refrigerant present in the cooler is supplied to the header 26 through a line 30 having a check valve.
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32 at the end thereof received within header 26. The purge chamber may thus be considered a flooded evaporator. The purge chamber includes, in addition to the components described above, an area 33 and a space 34. The area 33 provides a location for the non-condensibles to collect for subsequent evacuation to the atmosphere. The space 34 serves to collect the liquid refrigerant and water which is condensed in the chamber 24. The header 28 receives any lubricant from the refrigeration system that may have been carried into the purge chamber by the flow of refrigerant thereto. Vaporization of refrigerant in the purge chamber increases the concentration of the lubricant. In addition, the header 28 communicates with line 48 for the purpose of providing a path for flow to the refrigerant vaporized by the heat transfer action in the purge chamber. Line 55 connects with line 48 and three-way valve 54 to permit the gaseous refrigerant formed in the purge chamber to be introduced into the cooler 18 from where it is returned to the refrigeration system.

As indicated above, the purge evaporator 24 is effective to remove from the gases introduced into the purge evaporator a substantial amount of the water vapor and refrigerant vapor included therewith. The liquid refrigerant and water collect in the space 34 with the water floating on top of the liquid refrigerant. Line 62 is formed in the shape of a U and provides passage for the liquid refrigerant to a receiver 64 having a float valve 66 operative to permit flow of the condensed refrigerant to the header 26 through line 68. Thus the liquid refrigerant recovered is recirculated to the purge evaporator. Line 62 is constructed so as to form a liquid seal which will permit only refrigerant to flow to chamber 64. A second line 70 communicates with the space 34 and provides a path for the flow of water once the valve 72 controlling such flow is opened. Portion 34 of the purge evaporator is provided with a sight glass 35 which permits one to determine by visual observation the amount of water and the level at which said water stands in the space.

In order to evacuate the non-condensibles which have been subjected to the heat transfer action in the purge evaporator and are still in the gaseous state, line 35 is provided connecting the space 33 with a pump 38 through line 36, and a manually operated valve 37. A branch line 23 connects to 36 and opens to the atmosphere. Valve 40 controls the flow through line 36. Valve 49 is interposed in line 36 for a purpose to be later explained.

Pump 38 includes a suction chamber 58 having a suction valve and a pump chamber 39, the capacity of which is determined through the movement of a diaphragm 40 under the influence of appropriate mechanical linkage 41 connected to motor 60. The pump chamber 39 connects with a discharge chamber 59 for the purpose of expelling gas to the atmosphere through line 41 and check valve 43. Manually operated valve 42 controls the flow of gas in line 41. Line 51 connects line 41 and line 45 and includes a manually operated valve 53 together with a connection 52 having a cap which normally closes said connection to the atmosphere. Line 48 connects three-way valve 54 to the line 45 upstream of check-valve 46 and orifice 47 located in the line 45. The line 48 includes a portion 50' serving as a fitting which is likewise provided with a cap closing the line to the atmosphere.

In order to remove lubricant from the header 28, there is provided a line 76 having a solenoid valve 78 controlling flow therein, connected to the lubrication system of the refrigeration machine. A pressure relief valve 82 is connected into the line 45.

Considering the operation of the purging arrangement, the pump 38 is included in an electrical control circuit including a differential pressure switch 84 as well as a differential pressure switch 86. During operation of the refrigeration machine, pump 38 functions to expel non-condensibles from the refrigeration system when the pressure differential switches energize a circuit containing motor 60, the valve 49 is closed and the valve 37 is opened. In addition, valves 40 and 53 are closed and valve 42 is opened. A circuit through the pump 38 is completed in response to the presence of a predetermined pressure differential between the purge chamber and the condenser. Differential pressure switch 84 includes connections to the purge evaporator and the condenser for detecting the pressure difference therebetween. In addition, differential pressure switch 86 is constructed so as to be normally closed under circumstances where a pressure difference between the condenser and cooler in the refrigeration machine exists. Thus energization of the motor controlling the pump 38 is prevented during the time the refrigeration machine is inactive and the pressure throughout the machine equalized. Actuation of the motor 60 provides a pumping action sufficient to remove the non-condensibles from the portion 33 of the purge evaporator and exhaust them to atmosphere through lines 35, 36 and 41. Once a predetermined pressure difference is established between the purge chamber and the condenser indicative of normal operating pressures, switch 84 opens the circuit through the motor to terminate the pumping action.

The purging arrangement described is likewise operative under circumstances where it is desired to test the machine prior to charging it with refrigerant to determine if leaks are present in the refrigerant flow path through the machine. To accomplish this, it is necessary to manually close valve 42 and valve 37 as well as valve 49 and 53 and open valve 40. At the same time a conduit, shown in dotted lines in FIGURE 1, may then be connected to the connections 52 and 59' so that the discharge of pump 38 is accomplished through line 41, line 51, the conduit line represented by the dotted line, and line 48 into the condenser 10. Air from the atmosphere is drawn into the pump 38 through the suction chamber 58, lines 36 and 39, the latter of which is open to the atmosphere.

The purging mechanism described herein is likewise sufficient to evacuate the entire system after it has been tested in the manner described above, and before the system is provided with a refrigerant charge. Under these circumstances valve 42 is opened, valve 40 is closed, valves 37 and 49 are opened so that air present in the refrigeration machine is exhausted therefrom through a path determined by lines 35 and 36 and expelled to the atmosphere through line 41.

A still further advantage present in the purging arrangement described herein involves the use of the purging system in a refrigeration machine wherein the normal operating pressures may be below atmospheric and the pressure differential between the high and low side of the machine is relatively small, as, for illustration, on the order of 10 pounds. It will be appreciated that withdrawal of water through the line 70 is impossible under those circumstances where the pressure within the purge evaporator 24 is below atmospheric. The purging arrangement forming the subject of this invention is operative to elevate the pressure within the purge evaporator temporarily so as to permit the removal of water through the valve 72. This is accomplished by closing valve 42 and opening valve 53. Under these circumstances, valve 37 should be closed. Pressure gauge 96 will indicate the presence of a pressure within the purge evaporator in excess of atmospheric so that the operator is advised from the portion 34 of the purge evaporator. Under these circumstances, the pump is operable to draw air from the atmosphere through line 39 and open valve 49 into the pump and expel it through lines 41 and 51 to line 45 which is in communication with the purge evaporator. The presence of a small amount of air in this system under these conditions is not objec-
tionable for the reason that it will be purged from the machine in the manner described above once the water has been drained and the purge mechanism restored to normal operation.

As pointed out above provision is made for draining of lubricant from the header 28. Valve 78 controlling flow of lubricant from the header 28 is responsive to the action of a float controlled switch 79 which in turn is operative in response to the specific density of the liquid on indication of the amount of lubricant in the mixture in header 28. Other arrangements capable of sensing a relatively high concentration of lubricant may be employed to effect drainage of header 28. Also, a time controlled switch may be used to energize the coil controlling valve 78. Drainage of lubricant from header 28 is expedited by subjecting the header to condenser pressure. This is accomplished by connecting the coil of three-way valve 54 in series with the switch controlling valve 78 which is under the influence of the float 77. In FIGURE 2, the coil controlling solenoid operated valve 78 is shown as 78' while the coil controlling rotation of three-way valve 54 is shown at 54'.

Another form of this invention is illustrated in FIGURE 3 and involves a simplification of the control for automatically operating the pump for evacuating non-condensibles from the purging chamber. In the embodiment described above, it is necessary that two differential pressure switches be employed in order to prevent operation of the purge pump during the time the machine is shutdown. The first differential pressure switch senses a difference in pressure between the condenser and the purging chamber, which pressures tend to equalize in response to a build-up of pressure within the purging chamber. Such a condition, of course, is also present during shutdown of the machine when the pressure within the two portions of the purging arrangement tend to equalize one another.

In the form of the invention illustrated in FIGURE 3, a single differential pressure switch 100 is arranged so as to sense the pressure within that part of the condenser wherein the pressure tends to rise due to the presence of non-condensible gas and water vapor. In addition, the switch 100 is connected through a capillary to a bulb located in the sump of the condenser where the condensed refrigerant normally accumulates. Under normal operating conditions the temperature within the condenser in the area where the gases accumulate and the temperature of the liquid are substantially equal. As the non-condensibles accumulate in the upper portion of the condenser, the temperature or pressure in that part tends to rise in relation to the pressure sensed by the bulb 102 within the sump of the condenser. When the difference in pressure reaches a predetermined value a circuit is completed through a pump motor and non-condensibles are evacuated in the same manner as described in connection with the description of the first embodiment of the invention.

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

We claim:

1. A purging arrangement for evacuating non-condensibles from a refrigeration system comprising means within said system for accumulating non-condensibles, pumping means for expelling the non-condensibles from the system, means connecting said pumping means with the means accumulating said non-condensibles, and control means operative to automatically expel non-condensibles from the system, said control means being effective to actuate said pumping means to elevate the pressure within the entire refrigeration system, or to evacuate the entire refrigeration system.

2. The invention set forth in claim 1 wherein means are provided for removing water and refrigerant after the constituents have been condensed from said non-condensibles.

3. The invention set forth in claim 2 wherein said control means are effective to elevate the pressure in the means for removing water so that the water may be removed by drainage from the system.

4. The invention set forth in claim 3 wherein said means for removing the water and refrigerant includes a heat transfer unit for condensing water vapor and refrigerant vapor carried over with said non-condensibles from the refrigeration system, said heat transfer unit being supplied by liquid refrigerant from the system for said purpose.

5. The invention set forth in claim 4 wherein means are provided for accumulation of lubricant employed in said system and said control means is effective to automatically return lubricant to said system.

6. A purging arrangement for expelling non-condensibles from a refrigeration system comprising means forming a flooded evaporator for condensing water vapor and refrigerant vapor that inadvertently accumulates with non-condensibles in the system by heat transfer with liquid refrigerant from the system, means for withdrawing the condensed refrigerant and water, pumping means for evacuating the non-condensibles from the flooded evaporator, means for connecting the pumping means and the flooded evaporator and control means associated with said pumping means for automatically expel non-condensibles from the flooded evaporator under a first pattern of operation and being effective under a second pattern of operation to purify the evaporator under circumstances where the operating pressure within said flooded evaporator is below atmospheric pressure thereby preventing withdrawal of the condensed water vapor.

7. In a refrigeration system including a condenser and an evaporator, apparatus for purging the system of non-condensible gases comprising means forming a chamber having a first opening communicating with a portion of the refrigeration system wherein non-condensible gases accumulate, a second opening communicating with a portion of the system accommodating liquid refrigerant, heat transfer means within said chamber to condense constituents of the non-condensibles by heat transfer with said liquid refrigerant, means for removing condensed constituents from said chamber, a motor-driven pump having the suction connection thereof connected to said chamber for evacuating said chamber of non-condensibles, means controlling the operation of said pumping means, said control means including a circuit for energizing said pump motor, said circuit including a switch responsive to a predetermined pressure differential between the chamber and a portion of the refrigeration system, said circuit further including a switch operative to open the circuit to the pump motor in response to a pressure differential within the system.

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