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PURGING APPARATUS FOR REFRIGERATION SYSTEM

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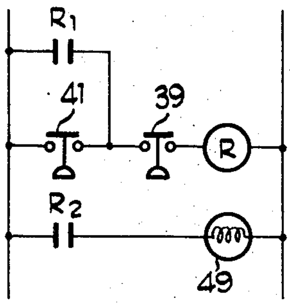
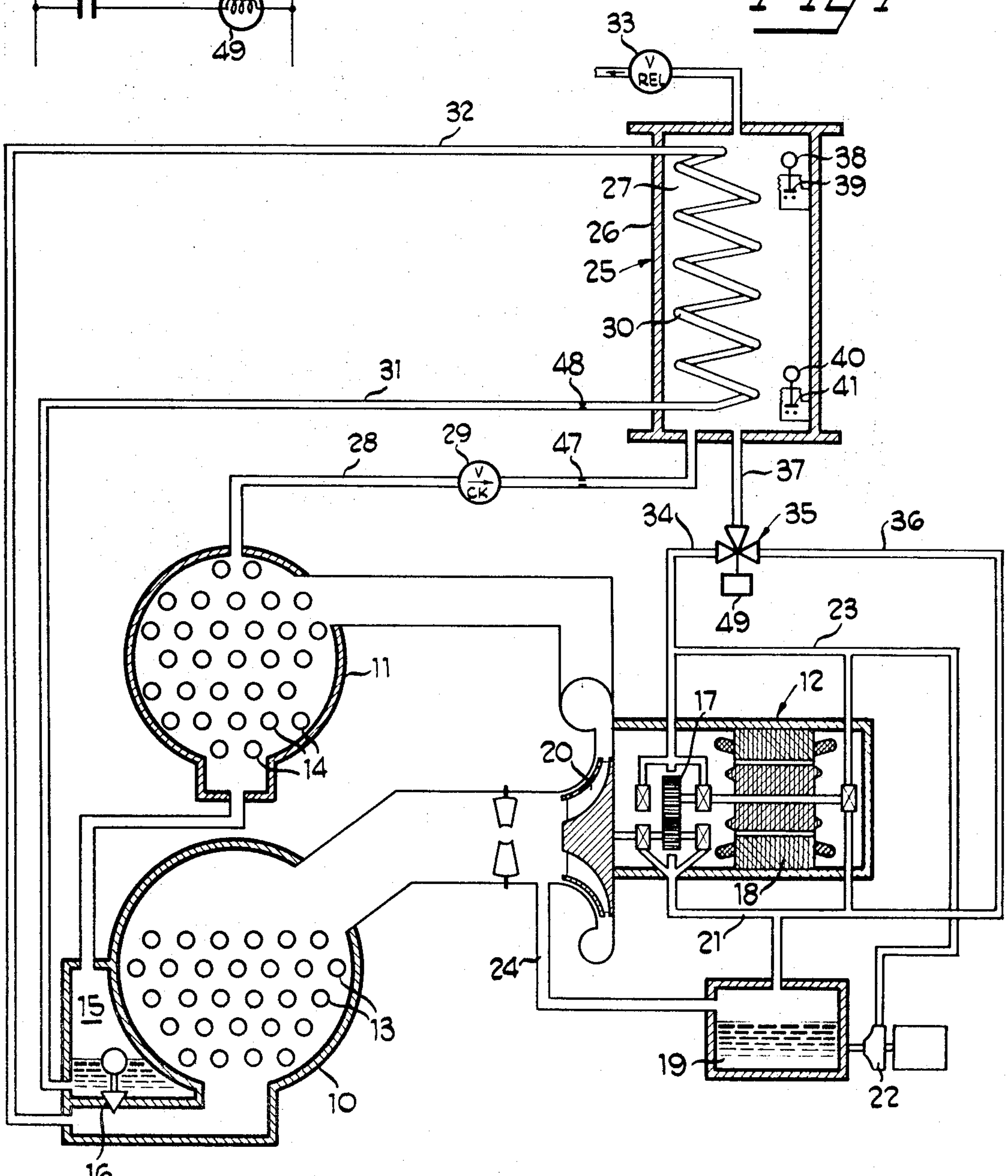


Fig 2

Fig 1



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PURGING APPARATUS FOR REFRIGERATION SYSTEM

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ABSTRACT OF THE DISCLOSURE

An apparatus for purging non-condensible gases from a refrigeration system and having a chamber receiving a mixture of condensible refrigerant vapor and non-condensible gases from the condenser of the system, a cooling coil in the chamber and using refrigerant from the system to condense the refrigerant vapor, and a compressor lubricant pump connected to the chamber and supplying oil under pressure to the chamber and providing a liquid piston effective to force the non-condensible gases from the chamber through a relief valve to the atmosphere and also providing means effective to draw the condensed liquid refrigerant and cooled oil mixture into the compressor lubricant reservoir and return of the refrigerant to the system.

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to apparatus for purging non-condensible gases from a vapor-cycle refrigeration system.

In a refrigeration machine, the presence of unwanted, relatively non-condensible, gases in the system may cause a considerable decrease in effectiveness of the condenser heat transfer surface, thus degrading the performance of the entire machine. These unwanted gases may also cause destructive corrosion within the machine.

While non-condensible gases are undesirable in any vapor-cycle refrigeration system, they are of greatest concern in systems which operate with sub-atmospheric pressures, for in such systems, a leak will introduce ambient air to the system.

It thus becomes important to remove any non-condensibles from a refrigerant system. While removing these unwanted gases, it is important to remove as little refrigerant as possible from the system, since a given quantity is required for proper system performance.

Various means have been suggested for purging non-condensibles from refrigeration systems. Most of them make use of the physical laws which dictate that by increasing the pressure and decreasing the temperature of a mixture of refrigerant vapor and non-condensibles, the refrigerant condenses out, leaving a smaller fraction of refrigerant in the mixture. This mixture of gases can then be purged to the atmosphere with minimum waste of refrigerant, while the condensed liquid refrigerant is returned to the system.

Most of the means suggested to date for purging employ a motor-driven purge compressor or mechanical piston force device to produce the desired high pressure. Such devices are complicated and expensive and subject to failure.

It is an object of the invention to provide an improved apparatus for purging non-condensible gases from a refrigeration machine.

A further object of the invention is to provide a refrigeration system purge apparatus utilizing a conventional compressor lubricant pump to provide lubricant under pressure to compress mixtures of refrigerant vapor and non-condensibles, and to purge the non-condensible gases from the system.

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Another object of the invention is to provide an improved apparatus for purging non-condensible gases from a refrigeration system while condensing refrigerant vapors to liquid form and mixture of the liquid with the lubricant for the compressor of the system and return of the mixture to the lube sump where the refrigerant is vaporized and returned to the system.

Another object of the invention is to provide a refrigeration system purge apparatus which operates automatically as needed, without operator attention, and can be utilized in different systems without change, modification or redesign of the system.

Other objects of the invention will be apparent upon consideration of apparatus embodying features of the invention described in the specification and illustrated in the accompanying drawings in which:

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic illustration of a conventional type refrigeration machine showing the improved apparatus of the present invention associated therewith, parts being shown in section; and

FIG. 2 is a schematic diagram of the electrical control circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown a refrigeration machine having an evaporator **10**, a condenser **11**, and a motor-compressor **12**. A tube bundle **13** in evaporator **10** is provided for passing the medium to be cooled therethrough while tube bundle **14** in condenser **11** is provided for passing cooling water from a suitable source through the condenser to cool the compressed refrigerant and cause it to condense therein. The condensed refrigerant is collected in a chamber **15**. A restrictor **16** regulates the flow of liquid refrigerant from chamber **15** to evaporator **10**. The motor-compressor unit **12** is provided with a drive motor **18**, drive gearing **17**, (if necessary) and a compressor **20**.

A pump **22**, associated with lubricant sump **19**, provides lubricant to the bearings in compressor **20**, drive motor **18** and to gearing **17** through a lubricant supply circuit **23**. Lubricant drain circuit **21** returns oil to the sump. A vent line **24** between sump and the compressor inlet or any portion of the machine below condenser pressure is provided to vent gaseous refrigerant to the compressor.

The present invention is more particularly directed to a purge unit or apparatus **25** designed to purge non-condensible gases, such as air, from the refrigeration system while condensing refrigerant vapors to liquid form and mixture of the liquid refrigerant with the lubricant for the compressor, the mixture of oil and refrigerant then returning to the sump **19**, the refrigerant then being vaporized and returned to the system. The apparatus **25** includes an upright heat exchanger shell **26** having a chamber **27** connected to condenser **11** by a small line **28** for flow of non-condensible gases and refrigerant vapor from condenser **11** to chamber **27**. A check valve **29** is provided in line **28** to prevent back-flow to the condenser. Orifice **47** meters the flow rate of gas entering shell **26**.

A heat exchange coil **30** is arranged within the shell **26** and positioned in a manner that the coil surface occupies a substantial portion of the chamber **27** and is disposed along the length thereof. Accordingly, oil, refrigerant and gases within chamber **27** must traverse the coil surfaces.

Liquid refrigerant from chamber **15** flows through a metering orifice **48**, through heat exchanger coil **30**, and returns to evaporator **10** by way of line **32**. Because of the orifice, the pressure in coil **30** is substantially that of the evaporator, so the coil is cooled to approximately evaporator temperature whenever the machine is running.

The compressor lubricant pump **22** is operative to force lubricant oil from sump **19** through line **34** in supply circuit **23** to a three way solenoid valve **35**. The valve, in one position thereof, connects line **34** to line **37** in order to supply oil to chamber **27**. In a second position of the valve, the valve is effective to disconnect line **37** from line **34** and connect line **37** with line **36** to drain the chamber back to the lube sump **19**. The solenoid operator, **49**, connected to valve **35**, is energizable to change the valve from its first to its second position. Upon de-energizing the solenoid, a spring returns the valve to its first position.

Mounted within chamber **27** are two float devices, **38**, and **40**, each arranged to actuate hermetically enclosed switches, **39** and **41** respectively. Float-switch **38, 39** is located near the top of the chamber and float-switch **40, 41** is located near the bottom of the chamber. Switches **39** and **41** and solenoid operator **49** are connected in an electrical circuit, illustrated in FIG. 2, such that upon drop of a liquid level to float **40**, the operator is energized, allowing oil to flow into chamber **27**. Upon rise of a liquid level to float **38**, the valve is de-energized, allowing liquid in the chamber to drain into sump **19**. Thus the solenoid valve and float switches will operate cyclically to fill and drain chamber **27** of oil.

A pressure operated relief valve **33** is connected to the top of shell **26** and communicates with chamber **27**. The valve is responsive to pressure in chamber **27** such that it opens upon a rise of pressure above a preset value and closes upon a decrease of pressure below tht preset value.

Operation

When the refrigeration machine is operating, refrigerant vapor and non-condensible gases from condenser **11** may enter the bottom of chamber **27**. The vapor and gas will bubble upward through the oil in the chamber. Refrigerant vapor will tend to dissolve in the oil, or condense on the cold coil above the oil and drain down into the oil. Any non-condensible gas will tend to be trapped in the chamber above the oil.

When valve **35** is in the second setting, and oil is filling chamber **27**, any non-condensible gas trapped above the oil is being decreased in volume. This will cause the pressure in chamber **27** to rise. When the pressure in chamber **27** equals that of condenser **11**, flow of vapor and gas into the chamber ceases and check valve **29** closes. Continued flow of oil into the chamber compresses non-condensible gas above the oil in chamber **27**. If the pressure in chamber **27** exceeds the setting value of relief valve **33**, it opens and allows the non-condensible gas to flow out to the atmosphere. (Relief valve **33** is set at a pressure slightly lower than oil supply pressure.) The oil rises nearly to the top of the chamber, expelling most of the non-condensible gas, actuates float-switch **38, 39** which opens the circuit (FIG. 2) through relay R, opens switches R_1 and R_2, and changes the setting of valve **35** to its first setting, to stop supplying oil and start draining the oil-refrigerant solution from chamber **27** to sump **19**.

As the liquid level in chamber **19** recedes, switch **39** will close, the pressure will decrease with expansion of the small amount of remaining trapped gas. When the pressure in chamber **27** drops below that of condenser **11**, flow of vapor and gas from the condenser to chamber **27** once again begins. The draining of oil-refrigerant solution continues, however, because the pressure in the sump **19** is lower than in the condenser. The refrigerant in solution in the oil drained from the purge unit back to sump **19** vaporizes rapidly when reaching the sump, because the sump operates at a high temperature. The vaporized refrigerant passes through vent line **24** back to the refrigeration system. Draining of the liquid from chamber **27** continues until float-switch **40, 41** is tripped, closing the circuit through R, closing switches R_1 and R_2, and returning the position of solenoid valve **35** to its second setting, whereupon the cycle repeats itself. Upon initial rise of the level, switch **41** will again open, but the relay is still held through closed switch **39**.

The cyclic operation continues as long as the machine is operating. If no non-condensible gases are present in the system, only refrigerant vapor will enter chamber **27** through line **28**, and this vapor will not build up pressure above the oil because it will condense as its volume is decreased. Thus relief valve **33** will not open. But the filling and draining of the oil in chamber **27** will proceed as described earlier.

The purging of non-condensibles from this device is done with a minimum loss of regrigerant from the system because the gas is expelled from chamber **27** at high pressure and low temperature. These are the criteria which must be met to minimize the mass fraction of refrigerant in the expelled gas.

The described cycle continues during the operation of the refrigeration machine. When the refrigeration machine, including the lubricant pump, stops, the purging apparatus **25** automatically discontinues operation as oil pressure is non-existent.

While this invention has been described in connection with a certain specific embodiment thereof, it is to be understood that this is by way of illustration and not by way of limitation; and the scope of the appended claims should be construed as broadly as the prior art will permit.

What is claimed is:

1. In combination with a closed circuit refrigeration system having an evaporator, condenser, and driven compressor interconnected in refrigerant flow relationship; means for supplying lubricant under ressure to said compressor including a lubricant circuit; and means for purging said system of non-condensible gases including means defining a chamber having an inlet in its lower portion to receive refrigerant vapors and non-condensible gases from the system, a liquid passage in its lower portion and a gas outlet in its upper portion; means, including a heat exchange coil in said chamber, for circulating system refrigerant through said chamber to condense refrigerant vapor flowing from said inlet; means controlling lubricant flow through said circuit and operable to divert lubricant under pressure from said lubricant circuit through said liquid passage to said chamber to compress the non-condensible gases in said chamber; and means controlling evacuation of said compressed gas through said gas outlet to the atmosphere.

2. The combination as defined in claim **1** in which said gas evacuation control means comprises means responsive to the compression of said gases by said lubricant under pressure.

3. The combination as defined in claim **1** in which said responsive means is a relief valve normally closing said gas outlet and operable by a predetermined pressure of the compressed gases in said chamber.

4. The combination as defined in claim **1** in which the lubricant flow controlling means includes a valve in said fluid circuit, and means controlling operation of said valve in response to changes in the volume of lubricant in said chamber.

5. The combination as defined in claim **1** in which the lubricant flow controlling means is a valve in said fluid circuit and having a first operative position to divert lubricant under pressure from said circuit to said chamber and having a second operative position to provide lubricant flow through said circuit and thereby drawing of the condensed refrigerant and cooled lubricant mixture from said chamber into said circuit; and means for returning the condensed refrigerant in said circuit to the system.

6. The combination as defined in claim **5** including control means for said valve and responsive to the level of the condensed refrigerant and lubricant mixture in said

chamber for controlling operation of said valve to its first or second position.

7. The combination as defined in claim **6** in which said valve control means includes a solenoid operatively connected to said valve.

8. The combination as defined in claim **6** in which said valve control means includes a solenoid operatively connected to said valve, an electric circuit for said solenoid and including a switch controlling energization of said solenoid, and float means in said chamber and controlling actuation of said switch in response to different levels of the mixture in said chamber.

9. The combination as defined in claim **6** in which said valve control means includes a solenoid for operating said valve, an electric circuit for said solenoid and including a switch and float means in said chamber and operating said switch to energize said solenoid to move said valve to said first position when the level of said mixture in said chamber rises to a predetermined upper level, and to move said valve to said second position when the level of said mixture in said chamber drops to a predetermined low level.

10. The combination as defined in claim **5** including a housing for said compressor; and said lubricant circuit includes a lubricant sump in said housing, a lubricant pump, a first conduit connecting said pump to said compressor for circulating lubricant under pressure from said sump to said compressor and return to said sump; and said refrigerant-returning means includes a second conduit connecting said housing and compressor inlet to vent refrigerant vapors in said housing to the compressor.

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