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MEANS FOR PURGING REFRIGERATION SYSTEMS

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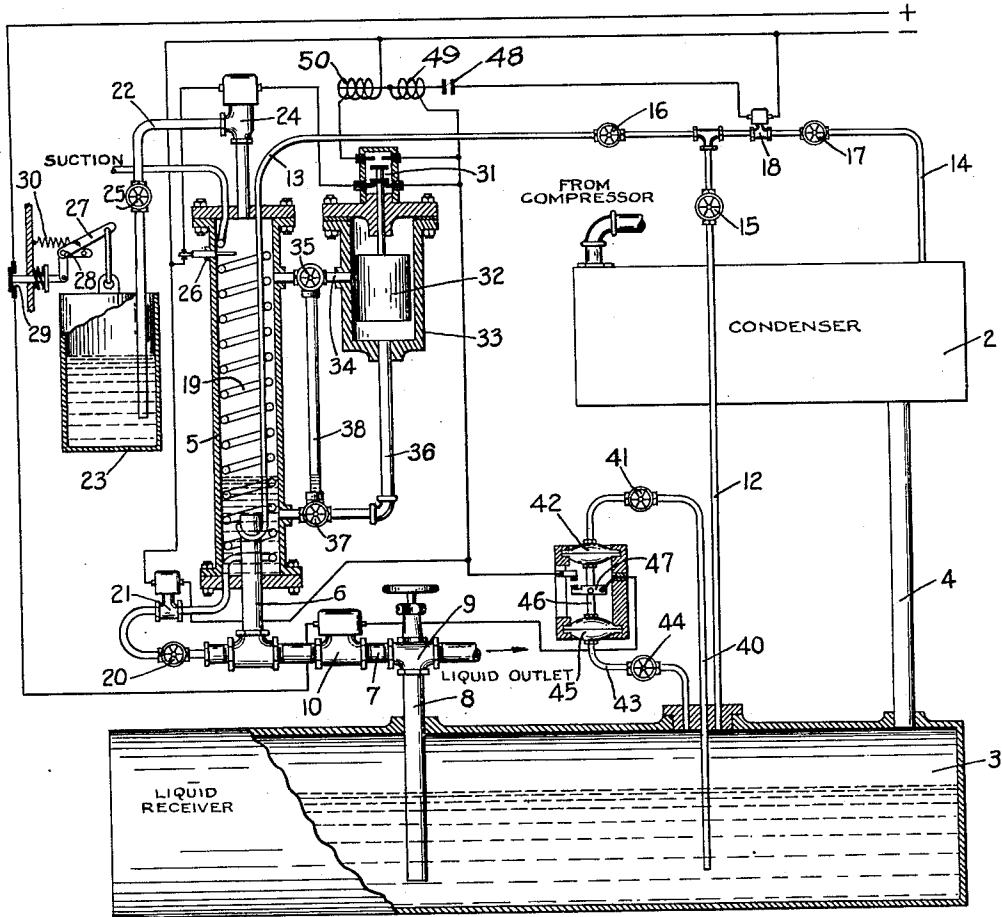
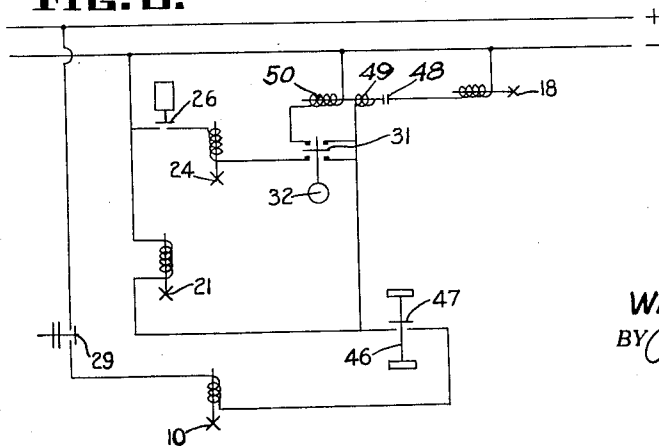


FIG. 1.

FIG. 2.



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MEANS FOR PURGING REFRIGERATION SYSTEMS

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4 Claims. (Cl. 62—3)

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This invention relates to refrigerating systems, and particularly to a means for and method of purging such systems.

In refrigerating systems employing a refrigerating medium of ammonia or similar fluid, it is well known that foul or foreign gases, such as air, and other non-condensable gases, accumulate in such systems after a period of use thereby reducing considerably the capacity of the condenser and the efficiency of the system. Various purging systems have been heretofore suggested and used for disposing of these non-condensable gases, but they have not been entirely satisfactory. In the first place, most of them were manually controlled and, consequently, required constant attention. While automatic purgers have been heretofore suggested and used, they were not entirely satisfactory for the reason that their operation depended alone on the changes of pressure and temperature in the system, and not on the amount of foreign or non-condensable gases present therein.

It is well known that in the law of partial pressures of gases that the total pressure of a vessel containing a mixture of gases is the sum of the partial pressure in each. In a refrigerating system where a considerable amount of vapor is used as the refrigerant, such as ammonia, the vapor pressure bears a certain relation to the temperature of the liquid and any excess pressure is due to the pressure of foul gases in the system. In a refrigerating system, the operating conditions thereof vary with seasonal and cooling water temperatures, and the system should not depend on pressure and temperature differentials alone to set the purging system into operation, but should depend also on the amount of non-condensable gases present in the system which the present invention does take into consideration.

Accordingly, it is one of the primary objects of this invention to provide improved means for and method of controlling the purging of refrigerating systems by balancing the pressure of the refrigerant in its pure state against the pressure of that in the system, both being at substantially the same temperature.

It is another object of the invention to provide an improved means for purging a refrigerating system of foreign or non-condensable gases without interfering with or interrupting the operation of the system.

It is a further object of this invention to provide an improved purging means for refrigerating systems which is fully automatic in its operation and one which will remove all non-con-

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densable gases without the waste of an excessive amount of the refrigerant.

It is still another object of the present invention to provide an improved purging system which is simple and inexpensive in its construction and, at the same time, efficient and effective in its operation.

Various other objects and advantages of this invention will be more apparent in the course of the following specification, and will be particularly pointed out in the appended claims.

In the accompanying drawings, there is shown for the purpose of illustration, an embodiment which my invention may assume in practice.

In these drawings:

Fig. 1 is a diagrammatic view, partly in section, of a refrigerating system showing my improved automatic purging means incorporated therewith; and

Fig. 2 is a wiring diagram of the electrical system for operating the purging system of the present invention.

The construction and operation of a refrigerating system with which my invention is shown are well known and, accordingly, the general details of such a system will not be described. The fluid most commonly employed in such a system is ammonia, but it will be understood that my purging system will operate satisfactorily with any system in which a condensable vapor is employed.

Referring now more particularly to the drawing, there is shown in Fig. 1, a suitable condenser 2 which is connected to a liquid refrigerant receiver 3 by means of an outlet pipe 4 through which the liquid refrigerant flows from the condenser to the receiver. There is arranged above the receiver 3, a pressure-tight purge chamber or drum 5 which is connected to the receiver by means of refrigerant outlet piping 6, 7, and 8 with the pipe 6 extending up into and through the bottom of the purge chamber and terminating preferably a short distance above the bottom thereof. The pipe 8 extends down into the receiver terminating at a point adjacent the bottom thereof, and there is arranged between the pipes 7 and 8 a manually controlled valve 9 for shutting the purging system completely out of the refrigerating system when desired, such as when the entire system is shut down. There is also arranged in the line 7, a solenoid actuated valve 10 for controlling the flow of the liquid refrigerant and accumulated gases from the receiver to the purge chamber in a manner hereinafter to be explained.

A bleeder pipe 12 extends from an opening in

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the top of the receiver 3 to a pipe 13 which extends down into purge chamber 5 terminating adjacent the bottom thereof preferably at a point immediately below the opening in the upper end of the pipe 6 so that the open end of the pipe 13 will always be submerged in the sub-cooled liquid in the bottom of the purge chamber. The pipe 12 is connected also to a pipe 14 which in turn is connected to the condenser 2. There is arranged in the lines 12, 13, and 14, manually controlled valves 15, 16, and 17, respectively, for controlling the flow of refrigerant through the system. There is also arranged in the line 14, a solenoid actuated valve 18 for controlling the flow of gases from the condenser to the purge chamber, as will be later described.

Within the purge chamber 5, there is arranged an evaporating or expansion coil 19 the lower end of which is connected to the line 7 through a manually operated expansion valve 20 and a solenoid actuated valve 21. The upper or discharge end of the coil 19 is connected to the suction or low pressure side of the system and may be equipped with suitable valves (not shown) to insure a positive shut-off when desired. The coil acts as a refrigerating coil to chill the mixture of gases in the purge chamber thereby liquifying the ammonia or refrigerant gas while leaving the foreign gases in their gaseous state. In the top of the purge chamber 5, there is connected thereto a pipe 22 which extends into a liquid contained preferably in a suspended vessel 23 into which the non-condensable gases are purged. There is arranged in the line 22, a solenoid actuated valve 24 and a manually operated valve 25. In the side wall of the purge chamber 5, there is arranged a temperature controlled switch 26 which controls the actuation of the valve 24 in a manner to be described.

The vessel 23 is suspended on the outer end of a lever arm 27 which is pivotally supported, as at 28, with the opposite end of the arm 27 connected to a plunger type switch 29. There is provided a tension spring 30 for moving the arm 27 in a counter-clockwise direction so as to maintain the vessel 23 in its uppermost position with the switch normally in its closed position.

To one side of the purge chamber 5, there is arranged a double-acting float actuated switch 31 having two sets of contacts with the float 32 being housed in the cylindrical vessel 33. The vessel 33 is connected centrally thereof to the purge chamber 5 adjacent the top thereof by means of a pipe 34 having a manually actuated valve 35 arranged therein. The bottom of the vessel 33 is connected to the purge chamber adjacent the bottom thereof by means of a pipe 36 which also has a manually actuated T-valve 37 arranged therein. There is provided a gage glass 38 which extends between the valves 35 and 37 for observing the height of the liquid refrigerant in the purge chamber for the purpose of making adjustments and checking the operations of the system.

There is arranged in the receiver 3 and extending down through an opening in the top thereof to a point adjacent the bottom of the receiver, a cartridge 40 which is sealed at the bottom end thereof and which contains a quantity of the refrigerant used in the system in its pure state. Sufficient liquid must be contained therein to insure the presence of liquid in it at all temperatures normally encountered in the operation of the system. That is to say, this cartridge must contain the liquid refrigerant, as well as its vapor,

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at all times so that its temperature and pressure will bear a definite relation. This condition exists up to the critical temperature of the liquid refrigerant which is the temperature at which the liquid refrigerant no longer exists at any pressure. The opposite end of the cartridge 40 is connected through a manually controlled valve 41 to a diaphragm chamber 42.

There is also connected to the top of the receiver 3, a pipe 43 which is connected through a valve 44 to another diaphragm chamber 45 positioned diametrically opposite the diaphragm 42.

The diaphragms 42 and 45 are connected by a rigid connection 46 which carries centrally thereof, a contact arm 47 which constitutes a pressure differential switch for controlling the purging system. The pressure differential control switch is arranged in an electrical circuit in which the various solenoid actuated valves are arranged, and is the master switch for controlling the purging system and one of the important aspects of the present invention.

The operation of my purging system is as follows:

It will be assumed that the refrigerating system is in normal operation and that foreign or non-condensable gases have accumulated in the system. When such gases accumulate in the system, they collect generally in the condenser or receiver and the pressure in the system increases to the extent of the partial pressure of the gases, i. e., the pressure rises above that which would exist in the system if only the liquid refrigerant and its vapor were present therein. In the present instance, when this excess pressure due to the presence of foreign gases in the receiver reaches a certain predetermined amount, the pressure in the receiver 3 will be that much greater than that in the cartridge 40 containing the refrigerant in its pure state. When this condition exists, the pressure differences, i. e., the pressure between that in receiver 3 and that in cartridge 40, will close switch 47 and the electrical circuit in which it is arranged, as more clearly shown in Fig. 2, setting up a sequence of operations, the first of which is to energize the solenoid arranged with the valve 21, thus opening this valve and permitting the refrigerant to flow into the coil 19 in the purge chamber or drum 5 thereby sub-cooling the purge chamber, and to energize the solenoid arranged with the valve 10 thereby opening this valve, permitting the liquid refrigerant to pass from the receiver 3 through lines 6, 7, and 8 into the bottom of the purge chamber. The condensation of the refrigerant in the coil 19 reduces the temperature and pressure in the chamber or drum 5. The amount of reduction in pressure and, consequently, the height of the liquid that can be contained in the drum 5 is dependent upon the amount the valve 16 is throttled.

It will be understood that pressure in the receiver 3 exists in the system up to the throttling point which is the expansion valve. This pressure is reduced in the chamber or drum 5 when the purger is in operation by a slight amount due to the fact that lines 6, 7, and 8 have a liquid seal in the receiver and line 13 is throttled at valve 16. The condensation of refrigerant vapor causes the pressure to drop, and as the purge chamber fills with non-condensable gases its pressure will increase slightly. Accordingly, the regulation of the valve 16 is important for the reason that without throttling by means of this valve, there

would be no liquid refrigerant in chamber 5 to operate the float 32.

Assuming that foreign gases are not present in drum 5, the drum when chilled will first fill with the liquid refrigerant due to the pressure drop. As the amount of liquid refrigerant in the purge drum 5 fills and approaches the top of the drum 5, it comes in contact with float 32 thereby moving the switch 31 out of contact with the lower contacts thereof and into contacts with the upper contacts, breaking one electrical circuit and closing another. Depending on the conditions within the system, the closing of this second circuit will set forth a sequence of operations which will be later described.

As the pressure drops in the purge chamber or drum 5, gases will also flow from the top of the receiver 3, where they have accumulated, through the lines 12 and 13, and possibly through the lines 14 and 13 from the condenser into the drum 5. As the gases pass up through the sub-cooled liquid refrigerant in the drum 5, the refrigerant or condensable gas will be condensed and the foreign or non-condensable gases will continue up through the liquid and collect in the top of the drum 5. As the foreign gases accumulate in the top of the drum, the liquid refrigerant will be displaced therein and the level thereof will be forced downwardly until the float 32 moves to its lowermost position thereby again permitting switch 31 to contact the lower contacts thereof. As the foul or non-condensable gases accumulate in the top of the chamber or drum 5, the temperature in the drum gradually decreases, and when the temperature reaches a predetermined point the solenoid of the valve 24 is energized thereby opening this valve.

The foul gases then pass slowly from the top of the purge chamber through the valve 24 and the line 22 into the vessel 23 and up through the liquid (water) therein to the atmosphere. Should the foul gas be trapped in the chamber 5 when purging pressure is reached, then, any large amount of the liquid refrigerant will not be drawn into the purge chamber and switch 31 remains closed. Switch 26 is then operable being in the same circuit as soon as the predetermined low temperature is reached in the chamber. This system of controlling the action of switch 26 by switch 31 is to prevent the liquid refrigerant from passing out through the valve 24 and the line 22. At times, a certain amount of the refrigerant will escape along with the foul gases to the vessel 23, and that is the reason for providing the liquid-filled vessel so as to absorb the vapor thereby preventing it from contaminating the atmosphere. The amount of refrigerant vapor escaping from the chamber depends on various operating conditions, for example, the temperature in the chamber, the shape of the drum or chamber, and the extent to which it is allowed to purge.

The switch 29 may be operated by a thermal, gravitational, or chemical action but it is thought that gravitational operation, as shown in the present instance, is the most satisfactory, especially where the refrigerant is soluble in water as in the case of ammonia. In such a case, the water will dissolve better than 30 per cent of its weight of ammonia at about 100 degrees F. In the apparatus as shown in the drawing, when the moment of the vessel 23 about its pivotal point 28 due to the absorption of the refrigerant by the water exceeds that caused by the action of the spring, 30, the vessel 23 will move downwardly

moving the lever 27 in a clockwise direction thereby opening the switch 29 so as to break all circuits in the electrical system except the opening of switch 47, thereby permitting all of the valves to close as they are all spring loaded.

The controlling of the valve 24 by means of two switches, namely, switches 31 and 26, is for reasons of safety. It will be understood that conditions vary in a refrigerating system, and there might be some conditions encountered to cause valve 24 to open when the purge chamber 23 is full of the liquid refrigerant. This is prevented by float 32 and the switch 31. The switch 31, however, has another more important function. As described hereinbefore, this switch has two sets of contacts and the switch is always in contact with one set of points according to the position of the float 32. When the float is in its uppermost position due to the upper level of the liquid refrigerant in the chamber 5, the circuit with the lower set will be broken and the upper set will close so as to close the circuit in another part of the electrical system and close the contactor 48 which controls the solenoid actuated valve 18. The contactor 48 is closed by a shunt coil 49 and kept closed by a series coil 50 until the master switch 47 has been opened. When the valve 18 is opened, some other portion of the system will be bled into the purge chamber through the lines 13 and 14, providing that the pressures on switch 47 have not been equalized sufficiently to cause it to open thereby breaking the circuit. This other portion of the system generally will be the top of the condenser, but it may be any point in the system where foul gas tends to accumulate. After all parts of the system have been purged of foul gases and the pressures are equalized in the receiver 3 and the cartridge 40, the switch 47 will again maintain a neutral position breaking contact and opening the circuit closing all solenoid actuated valves, and the system is in readiness for the next purging operation which will occur when a certain predetermined amount of foul gases collect in the system and the pressures in the receiver 3 and the cartridge 40 are unequal.

The valves 15, 16, and 17 are provided for regulating manually the operation of the system, and the valves 15 and 17 may also be used for cutting out, if desired, the purging system from the refrigerating system for maintenance or for other reasons. The valve 25 is provided merely for regulation and shut-off of the purging system to the atmosphere. The valves 9 and 20 are provided for cutting off and regulating the flow of the liquid refrigerant and gases to the purge chamber. The other manually operated valves in the system are provided for similar reasons.

As a result of my invention, it will be seen that there is provided an improved purging system which is fully automatic so as to require little or no attention during its operation. It will be seen also that the system functions substantially continuously to purge the foreign gases from the receiver or the condenser so that the system is substantially free of foreign gases at all times thereby increasing materially the efficiency thereof. Also, it will be noted that the system is so arranged that the foreign gases are localized so as to eliminate any danger of purging an excessive amount of the refrigerant from the system thereby keeping such loss to a minimum.

While I have shown and described an embodiment which my invention may assume in practice, it will be understood that this embodiment

is merely for the purpose of illustration and description, and that other forms may be devised within the scope of my invention as defined in the appended claims.

What I claim as my invention is:

1. In a refrigerating system containing a volatile refrigerant and including a condenser and a receiver, means for purging the system of non-condensable gases including a purge chamber interposed in said system and arranged so as to permit the liquid refrigerant to flow thereinto, an electrical circuit, a pressure differential control switch arranged in said circuit for controlling the purging system, said switch connected to said receiver and controlled by the pressure differentials existing therein, means connecting said receiver with said purge chamber through which the liquid refrigerant passes from said receiver into said purge chamber, a solenoid actuated valve arranged in said connecting means, said solenoid being controlled by said pressure differential control switch, another solenoid actuated valve arranged in a connection for venting the purge chamber, and means arranged in said electrical circuit which is controlled by the level of the liquid refrigerant in said purge chamber and the pressure differential control switch for controlling the energization of said last mentioned solenoid valve.

2. The combination, as defined in claim 1, including a coil arranged in the purge chamber for cooling the refrigerant therein, means connecting said coil with the receiver, a solenoid actuated valve arranged in the last mentioned connecting means for controlling the flow of the refrigerant from the receiver into and through said coil with the solenoid of said valve arranged in said electrical circuit and controlled by said pressure differential control switch.

3. The combination, as defined in claim 1,

wherein the means arranged in the electrical circuit which is controlled by the level of the liquid refrigerant in the purge chamber for controlling the energization of the solenoid venting valve consists of a float actuated switch with which there is arranged two sets of poles, said switch being arranged in said electrical circuit and adapted to contact one set of poles when the level of the refrigerant in said purge chamber drops below a predetermined low level so as to energize said venting solenoid valve to open the valve whereby the non-condensable gases are permitted to escape from the purge chamber.

4. The combination, as defined in claim 3, including means connecting the purge chamber with the condenser, a solenoid actuated valve arranged in said connecting means, said float actuated switch adapted to contact the other set of poles thereof when the level of the refrigerant in the purge chamber rises to a predetermined upper level so as to energize the last mentioned solenoid valve and opening the same so as to permit non-condensable gases to escape from the condenser and the system other than the receiver to said purge chamber.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,612,963	Bergdoll	Jan. 4, 1927
1,636,512	Hilger	July 19, 1927
1,652,163	Carrier	Dec. 13, 1927
1,911,464	Pearson	May 30, 1933
2,062,697	Buehler	Dec. 1, 1936
2,321,964	Zieber	June 15, 1943
2,464,631	Zwickl	Mar. 15, 1949