Nov. 28, 1939. G. S. McCLOY 2,181,855

REFRIGERATION METHOD

Original Filed April 30, 1937

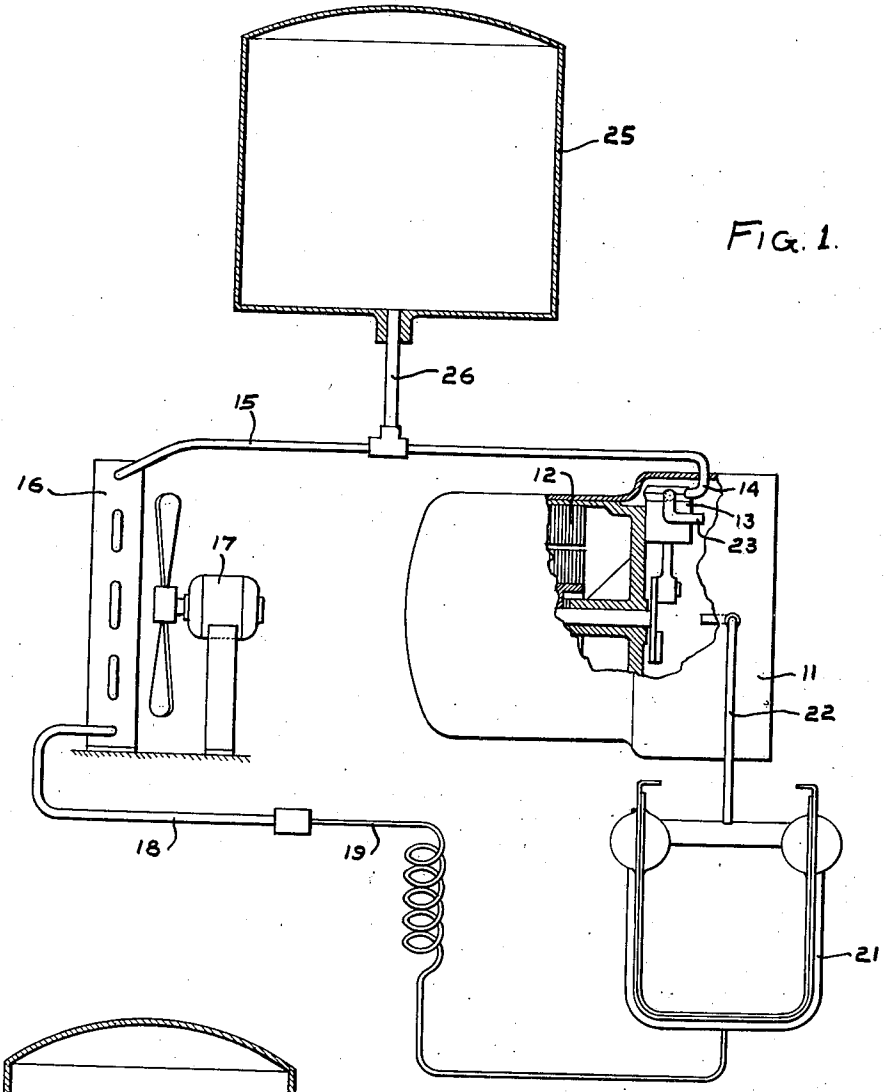


FIG. 1.

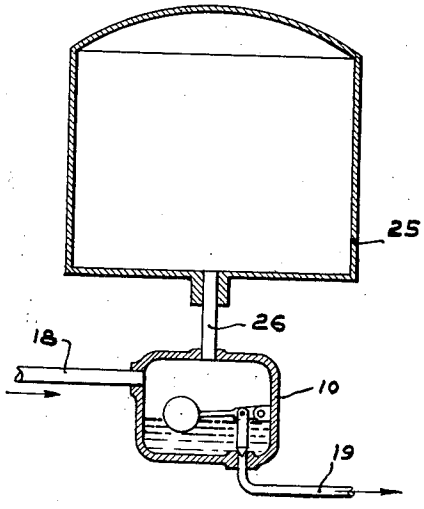


FIG. 2.

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REFRIGERATION METHOD

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6 Claims. (Cl. 62—170)

My invention relates to refrigeration apparatus and to a method of refrigeration and particularly to the removal of air or other non-condensable gases from a refrigerating system.

In the charging of a refrigerating system and particularly of a refrigerating system of the compression type, it is necessary to remove air and other non-condensable gases from the system for various reasons. The air and non-condensable gases must be removed because they will collect in the high pressure side of the system and cause unduly high head pressures. Furthermore, the presence of air or other non-condensable gases will sometimes cause oxidation of parts of the refrigerating system. In addition, in compression refrigeration apparatus particularly of the hermetically sealed type wherein the motor and compressor are contained within the sealed casing and the motor windings are subjected to an atmosphere of refrigerant and lubricant, any air or other non-condensable gases which are present in the system may themselves attack the windings or may combine with the refrigerant or lubricant to form moisture which will in turn attack the windings or freeze up in some part of the system.

It has, therefore, been necessary, before charging refrigerating systems with lubricant and refrigerant, to evacuate the systems in some manner. The method used for evacuating the systems has been to pump the air out of the system before charging. Such a method has two main defects. First, it is practically impossible to pump a sufficiently high vacuum to completely remove all the air and non-condensable gases from the system. Secondly, the equipment required for pulling a high vacuum on refrigerating systems is necessarily expensive, cumbersome and slow in operation. Furthermore, air and non-condensable vapors which are contained in the refrigerant and oil are not removed by such evacuating equipment.

It is therefore an object of my invention to provide improved apparatus and an improved method for removing air and non-condensable gases from a refrigerating system.

It is another object of my invention to provide a method of removing air and non-condensable gases from a refrigerating system wherein the compressor of the refrigerating system performs the work of removing the aforesaid non-condensable gases and expensive and cumbersome evacuating apparatus is, therefore, dispensed with.

It is another object of my invention to provide a means and method of removing non-condensable gases from a refrigerating system which may be readily set up in any convenient location and which may be used in servicing refrigerating systems in the field.

It is still another object of my invention to provide an improved means and method for removing non-condensable gases from a refrigerating machine of the hermetically sealed type and also from refrigerating machines wherein a capillary tube or similar constant restriction device is utilized to control the flow of refrigerant from the high to the low pressure side of the system.

It is a further object of my invention to remove the air or other non-condensable gases which are present in the refrigerant and lubricant with which the system is charged.

These and other objects are effected by my invention as will be apparent from the following description and claims taken in connection with the accompanying drawing, forming a part of this application, in whch:

Fig. 1 diagrammatically shows a refrigerating system of the compression type in which a hermetically sealed motor compressor unit is utilized and illustrates an application of my invention to this type of refrigerating system; and

Fig. 2 shows my invention applied to a float valve machine.

Referring specifically to the drawing for a detailed description of my invention, numeral 11 designates a hermetically sealed casing which encloses a motor 12 which drives a reciprocating compressor 13. Gas is discharged at high pressure from the compressor through the conduit 14 which extends through the sealed casing 11 and joins a conduit 15 which conveys high pressure refrigerant gas to a condenser 16. Refrigerant gas is cooled and condensed in the condenser 16, a motor driven fan 17 serving to force cool air over the condenser for this purpose. Condensed liquid refrigerant then passes through a conduit 18 to an open tube 19 of restricted diameter and considerable length, sometimes referred to as a "capillary tube". The capillary tube controls the flow of liquid refrigerant from the condenser 16 to a flooded evaporator 21 and permits the circulation of some gaseous fluid therethrough. The flooded evaporator 21 is connected to the interior of the hermetically sealed casing 11 which is subjected to the low pressure of the compressor by a conduit 22. Refrigerant is, therefore, vaporized in the evaporator 21 and returned to the interior of the casing 11, whereby the vaporized refrigerant cools the evaporator 21. The compressor 13 is provided with a port 23

opening into the interior of the hermetically sealed casing and refrigerant gas at substantially suction pressure is therefore present within the sealed casing. Refrigerant gas is admitted through the port 23 to the compressor and the cycle is then repeated. Suitable control mechanisms may be provided for controlling the operation of the motor and compressor in response to temperature of the evaporator. Since these control devices are well known in the art, no description thereof is deemed necessary.

In accordance with my invention, a container 25 is connected into the high pressure conduit 15 by a conduit 26 in such a manner that the container 25 is disposed above the conduit 15 containing high pressure refrigerant vapor.

The refrigerating system is first charged with refrigerant and lubricant, the exact amount to be charged being very carefully measured and placed in the system. The system at this time also contains air and other gases which are not readily condensable at ordinary temperatures. The motor 12 is then started and the compressor 13 pumps both refrigerant vapor and non-condensable gases into the conduit 15. The mixture of refrigerant vapor and non-condensable gases will circulate through the system as long as there are not any liquid traps therein, and in a system as shown in Fig. 2 where there are liquid traps, such as, for example, where a float valve 10 is used between the condenser and the evaporator, the non-condensable gases will collect in the high side of the system, and if the tank 25 is properly positioned as shown in Fig. 2, above the float chamber, the non-condensable gases will be collected in the tank. In the mixture of refrigerant and non-condensable gases which is pumped by the compressor 13 into the conduit 15, the refrigerant vapor is in a super-heated gaseous state. The mixture of superheated refrigerant gas and non-condensable gases fills the tank 25 passing through the conduit 26 into the tank. The tank 25 is exposed to the ambient air which is relatively cool and, since the tank obviously has considerable surface, the refrigerant gas loses its superheat and latent heat, is condensed, and returns by gravity to the conduit 15 in the form of liquid through the connecting tube 26. The air and other non-condensable gases, however, remain in the tank as there is nothing to force them out of the tank. As condensation of the refrigerant vapor occurs, the partial pressure of the refrigerant is reduced and the pressure in the tank 25 is reduced so that a flow of more superheated refrigerant gas and non-condensable gases occurs through the connecting tube 26 into the tank 25. There is, therefore, a counterflow of a mixture of refrigerant gas and non-condensable gases relative to condensed refrigerant liquid through the connecting tube 26. I have found that a tube of approximately 3/8 of an inch diameter or larger is suitable for the connecting tube 26. The compressor 13 is operated until all the air and non-condensable gases in the refrigerating system have been transferred to the tank 25, the tank preferably being sufficiently large to contain all of the air and non-condensable gases at the pressure at which they are present in the tank 25. When the compressor 13 has operated a sufficient length of time to transfer all the air and non-condensable gases to the container 25, the tube 26 is pinched off and soldered and the tank 25 is removed and re-used on another system. The only loss of refrigerant which occurs is the small amount of saturated gaseous refrigerant which is necessarily present in the tank with the non-condensable air and other gases when the tank is removed from the system.

It is obvious that the system shown in the drawing and described herein is diagrammatic and that suitable fittings may be utilized to connect the tank 25 to the system and furthermore that the invention is applicable to many other types of refrigerating systems. It will be apparent from the foregoing description that I have provided a means and method of removing air and non-condensable gases from a closed refrigerating system, including the refrigerant and lubricant therein, which requires very little apparatus and which may be readily used in the field. Furthermore, it is obvious that substantially all the air and non-condensable gases may be easily removed from the system merely by continuously operating the compressor for a period of time sufficient to collect the non-condensable gases. Such a system obviously makes it unnecessary to utilize expensive and cumbersome evacuating apparatus to remove the air and other non-condensable gases from the refrigerating system prior to charging and the great expense as well as the time of connecting the system up to the evacuating devices and the time of evacuation are therefore saved.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. The combined method of charging a refrigerating system and effecting the removal of the non-condensable gases initially contained therein, said system including a compressor, which method comprises charging the system with refrigerant while the system contains gases which are non-condensable at ordinary temperatures, connecting to the high pressure side of the system a container of a size sufficient to hold, at condenser pressure, the non-condensable gases contained in the system during said charging, and disposing said container above the point of its connection to the system, operating the compressor to effect flow of a mixture of non-condensable gases and refrigerant vapor at condenser pressure into said container, which said container is maintained at sufficiently low temperature to condense said refrigerant vapor at condenser pressure, for a period of time sufficient to collect the non-condensable gases in said container, the refrigerant condensed in said container being drained by gravity into the system, shutting off communication between the refrigerating system and said container, and disconnecting said container from the system while the non-condensable gases collected in the container are retained therein.

2. The combined method of charging a refrigerating system and effecting the removal of the non-condensable gases initially contained therein, said system including an evaporator, a compressor, a condenser, and an expansion device of a type which permits circulation of some gaseous fluid therethrough, which method comprises charging the system with refrigerant while the system contains gases which are non-condensable

at ordinary temperatures, connecting to the system between the compressor and the condenser a container of a size sufficient to hold, at condenser pressure, the non-condensable gases contained in the system during said charging and disposing said container above the point of its connection to the system, operating the compressor to effect circulation of gaseous fluid through the system and flow of a mixture of non-condensable gases and refrigerant vapor into said container at condenser pressure, while said container is maintained at sufficiently low temperature to condense said refrigerant vapor at condenser pressure, for a period of time sufficient to collect the non-condensable gases in said container, the refrigerant condensed in said container being drained by gravity into the system, shutting off communication between the refrigerating system and said container, and disconnecting said container from the system.

3. The combined method of charging a refrigerating system and effecting the removal of the non-condensable gases initially contained therein, said system having high and low pressure sides and including an evaporator, a compressor, a condenser, and an expansion device, which method comprises charging the system with refrigerant while the system contains gases which are non-condensable at ordinary temperatures, establishing communication between the high pressure side of the system and a container connected thereto and of sufficient size to hold, at condenser pressure, the non-condensable gases contained in the system during said charging, transferring said non-condensable gases from the system to the container by operating the compressor to effect flow of a mixture of non-condensable gases and refrigerant vapor at substantially condenser pressure into the container, condensing refrigerant vapor from the mixture in the container and returning the condensed refrigerant to the system, and disconnecting said container from the system while the non-condensable gases collected in the container are retained therein.

4. The combined method of charging a refrigerating system and effecting the removal of the non-condensable gases initially contained therein, said system having high and low pressure sides and including an evaporator, a compressor, a condenser, and an expansion device of a type which permits circulation of some gaseous fluid therethrough, which method comprises admitting a complete refrigerant charge to the system while the latter contains gases which are non-condensable at ordinary temperatures, connecting to the high pressure side of the system between the compressor and the condenser a container of a size sufficient to hold, at condenser pressure, the non-condensable gases contained in the system at the time of admitting said refrigerant charge thereto, transferring said non-condensable gases from the system to the container by operating the compressor to effect flow of a mixture of non-condensable gases and refrigerant vapor at substantially condenser pressure into the container, and condensing refrigerant vapor in the container and returning the condensed refrigerant to the system.

5. The combined method of charging a refrigerating system and effecting the removal from the system of the non-condensable gases initially contained therein, said system having high and low pressure sides and including an evaporator, a compressor, a condenser, and a constantly open flow-controlling device of fixed restriction for regulating the flow of refrigerant between the condenser and the evaporator, which method comprises admitting a refrigerant charge to the system, establishing communication between the system and a container connected thereto, transferring non-condensable gases from the system to the container by operating the compressor and effecting flow of a mixture of refrigerant vapor and non-condensable gases through the refrigerating system including the flow-controlling device and also effecting flow of a portion of said mixture into the container, and condensing refrigerant vapor from the mixture in the container and returning the condensed refrigerant to the system.

6. The method of removing non-condensable gases from a refrigerating system having high and low pressure sides and including an evaporator, a compressor, a condenser, and a constantly open flow-controlling device of fixed restriction for regulating the flow of refrigerant between the condenser and the evaporator, which method comprises establishing communication between the high pressure side of the system and a container connected to said high pressure side between the compressor and the condenser, transferring non-condensable gases from the system to the container by operating the compressor and effecting flow of a mixture of refrigerant vapor and non-condensable gases through the refrigerating system including the flow-controlling device and also effecting flow of a portion of said mixture into the container, and condensing refrigerant vapor from the mixture in the container and returning the condensed refrigerant to the system.

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