

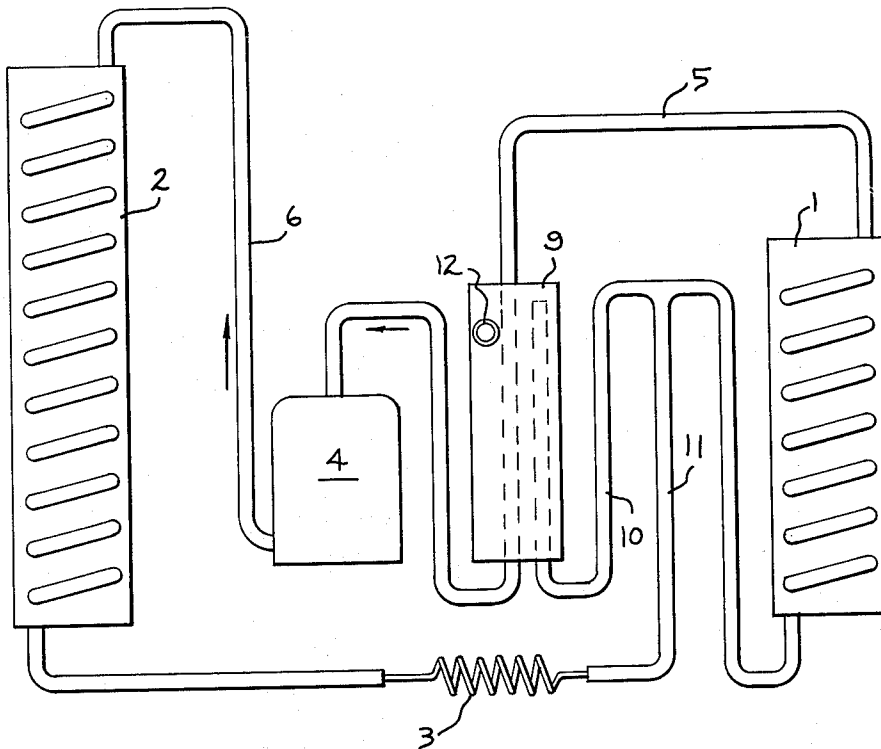
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REFRIGERATION SYSTEM INCLUDING CHARGE CHECKING MEANS

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3,191,397 REFRIGERATION SYSTEM INCLUDING CHARGE CHECKING MEANS

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1 Claim. (Cl. 62—125)

The present invention relates to refrigeration systems of the type employed for conditioning the air within an enclosure and is particularly concerned with a system comprising fixed flow control means for controlling the flow of refrigerant through the system, charge modulating means for regulating the effective circulating charge of the refrigerant under various operating conditions and charge checking means for quickly determining whether or not the system contains the proper charge of refrigerant.

A refrigeration system of the type used for cooling the air within an enclosure comprises a refrigerant circuit including, in closed series connection, a condenser, flow restricting means, an evaporator and a compressor. The compressor withdraws low pressure refrigerant vapor from the evaporator and discharges high pressure refrigerant to the condenser. A tubular flow restrictor, generally known as a capillary tube, provides a simple and low cost means for controlling or restricting the refrigerant flow so as to maintain a pressure difference between the condenser and evaporator. However, since a capillary tube provides a substantially fixed flow restriction, it has only one ideal operating condition. In other words a simple refrigerant circuit including a capillary tube flow restrictor will operate with maximum efficiency within a relatively narrow range of temperatures and pressures determined by the system design and refrigerant charge. In order to provide a more efficient operation of a refrigeration system under a range of operating conditions, it is desirable to provide means for modifying or changing the circulating refrigerant charge depending upon the operating conditions. One means for accomplishing this objective comprises a dead-end storage receptacle which is heat exchanged with a portion of the refrigerant circuit between the evaporator and the compressor and which is connected by a two-way flow connection to a portion of the refrigerant circuit which operates at substantially the same pressure as the evaporator. Refrigerant is withdrawn from or added to the circuit by the modulating means in accordance with changes in system pressure and temperature conditions of the portions of the system with which the receptacle is associated.

The present invention is concerned with a modulated system of this type and has as its principal object the provision of means for accurately checking the charge in such a system and for indicating when the proper charge is present in the system.

Further objects and advantages of the present invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with a preferred embodiment of the present invention, there is provided a refrigeration system comprising a condenser, a fixed flow restrictor, an evaporator, a suction line, and a compressor series-connected in a closed refrigerant circuit. Charge modulating means comprising a dead-end storage receptacle is connected by a two-way flow connection to a low pressure portion of the system between the restricting means and the evaporator and this receptacle is also heat exchanged with the suction line. The receptacle includes a liquid-gas interface indicating means, such as a sight glass or bleed cock, positioned in an aperture at a predetermined height or

level in the receptacle wall such that when the system is operating under predetermined conditions, preferably under no load conditions on the evaporator and maximum head or condenser pressure, a liquid-vapor interface will be observed at the indicating means.

For a better understanding of the invention reference may be had to the accompanying drawing in which the single figure is a diagrammatic illustration of a simple refrigeration system embodying the present invention.

While the invention will be specifically described with reference to a simple air conditioning system for cooling an enclosure, it will be obvious that it is also applicable to a reversible system in which the flow of refrigerant through the circuit may be reversed for the purpose of heating an enclosure.

With reference now to the drawing, the illustrated embodiment of the invention comprises an evaporator 1, a condenser 2 and fixed flow restricting means in the form of a capillary tube 3 connecting these two heat exchangers. A compressor 4 withdraws low pressure or vaporized refrigerant from the evaporator 1 through a suction line 5 and discharges hot compressed or high pressure refrigerant to the condenser 2 through the discharge line 6. Thus the compressor 4, condenser 2, capillary tube 3, evaporator 1 and the suction line 5 are connected to form a closed refrigerant circuit in which the capillary tube 3 provides fixed means for controlling the flow of refrigerant from the condenser 2 to the evaporator 1 to provide the desired pressure differential between these two heat exchangers. It will be understood that in the usual air conditioning application of such a refrigerating system, fan means (not shown) are provided for respectively circulating air from an enclosure over the evaporator 1 and outdoor air over the condenser 2.

As has been previously indicated, in any refrigerant circuit including a fixed or capillary tube flow restricting means, there is an optimum circulating charge for most efficient operation of the system under any particular set of operating conditions. For the purpose of modifying or changing the circulating refrigerant charge in order to provide the most efficient operation of the refrigeration system under a range of operating conditions, the system also includes charge modulating means in the form of a dead-end storage receptacle 9 which, as illustrated, is in heat exchange relationship with a portion of the suction line 5. The receptacle is directly connected by a two-way flow connection or conduit 10 to a portion of the low pressure side of the circuit, preferably the conduit 11 connecting the capillary tube 3 with the evaporator 1.

When the compressor 4 is operating, the temperature of the receptacle 9 follows the temperature of the low pressure refrigerant returning to the compressor through the suction line 5 so that refrigerant is withdrawn from or returned to the system through the connection 10 depending upon the temperature of the refrigerant flowing through the line 5. This withdrawal from or addition to the circuit of refrigerant is also influenced by the particular system pressure and temperature conditions in the low pressure portion of the system, such as the conduit 11, to which the two-way flow connection 10 is directly connected. In other words, the receptacle 9 holds a constant super-heat which in the illustrated embodiment of the invention is equal to the pressure drop through the evaporator 1. It maintains this constant superheat either by adding or removing charge from the main refrigerant circuit depending, as previously stated, on the system conditions including the temperature of the refrigerant flowing through the suction line 5 and the pressure conditions in that portion of the system represented by the conduit 11.

For any set of operating conditions, the liquid level of refrigerant in the receptacle 9 is unique. In other words,

for a system of any given design the liquid level of refrigerant in the receptacle will always be the same for a given set of operating conditions and a given charge. The addition of refrigerant to the system or the removal of refrigerant from the system within the modulating capacity of the receptacle will not change the operating pressures or temperatures but will only change the level of the liquid in the receptacle 9. In accordance with the present invention, advantage is taken of this fact to provide a simple means for determining when the system contains the optimum or proper refrigerant charge.

To this end the receptacle 9 is provided with at least one liquid-gas interface or liquid level indicating means 12 which in the illustrated embodiment of the invention is shown as a sight glass although it will be understood that a bleed cock can also be used. The indicating means 12 is provided at a predetermined height or level in the wall of the receptacle 9 such that the presence of a liquid-gas interface at the indicator 12 under predetermined operating conditions indicates that the system is properly charged.

If desired a plurality of level indicating means 12 may be provided at various heights or levels in the receptacle 9. By means of suitable chart setting forth the proper liquid levels corresponding to the correct system charge under different operating conditions, a serviceman can then determine whether or not the liquid level is proper for any of a plurality of operating conditions.

However, in accordance with the preferred embodiment of the present invention no charts or similar operating data are required and only a single indicating means 12 is required. More specifically, the indicating means 12 is so positioned that it will indicate a liquid-gas interface under a set of conditions which are independent of ambient temperatures. More specifically, the indicating means 12 is arranged at the gas-liquid interface level which is proper for the system when it is operated under modified conditions in which the air flow or heat exchange of both the evaporator 1 and the condenser 2 is at a minimum. When the heat exchangers 1 and 2 are contained in the usual housings, this may be done merely by stopping the fans which are employed for circulating air streams through the two heat exchangers. Otherwise, blocks of insulating material or the like may be applied to one or both sides of the heat exchangers for decreasing their heat transfer rates to a minimum. Under such conditions, the evaporator 1 will operate at a minimum pressure while the condenser 2 will operate at a maximum pressure which is above normal operating pressures. These conditions are independent of ambient temperature conditions so that regardless of how or when the

system is being tested, the amount and level of the liquid refrigerant contained in the receptacle 9 will be the same. Accordingly, the liquid level indicating means 12 is positioned in a wall of the receptacle 9 to show a gas-liquid interface when the system is operated under these test conditions. In the event a gas-liquid interface is not observed, the serviceman has only to add or withdraw refrigerant from the system through suitable charging or bleed-off valve means until the liquid-gas interface is at the same level as the indicating means.

While the invention is described with reference to a particular system employed for cooling an enclosure, it will be obvious that it is not limited thereto. For example, it may also be applied to reversible systems including one or more charge modulating means by operating the system in such a manner that the charge modulating means associated with the heat exchanger acting as the evaporator is equipped with the level indicating means and is performing a charge modulating function during the test cycle. Therefore, it is intended by the appended claim to cover all modifications within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

A refrigeration system comprising a condenser, fixed flow restricting means, an evaporator, a suction line and a compressor in series connected to form a closed refrigerant circuit, charge modulating means comprising a dead-end liquid storage receptacle in heat exchange relation with said suction line and connected by a two-way flow connection to the low pressure side of said system between said restricting means and said evaporator, said receptacle having a wall with an aperture formed there-through and a sight glass means disposed in said aperture, said aperture disposed at a level so that a liquid-gas interface shows at said sight glass means only when said system is properly charged and said system is operated under modified conditions in which heat exchange at both said evaporator and said condenser is at a minimum.

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