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REFRIGERATING APPARATUS

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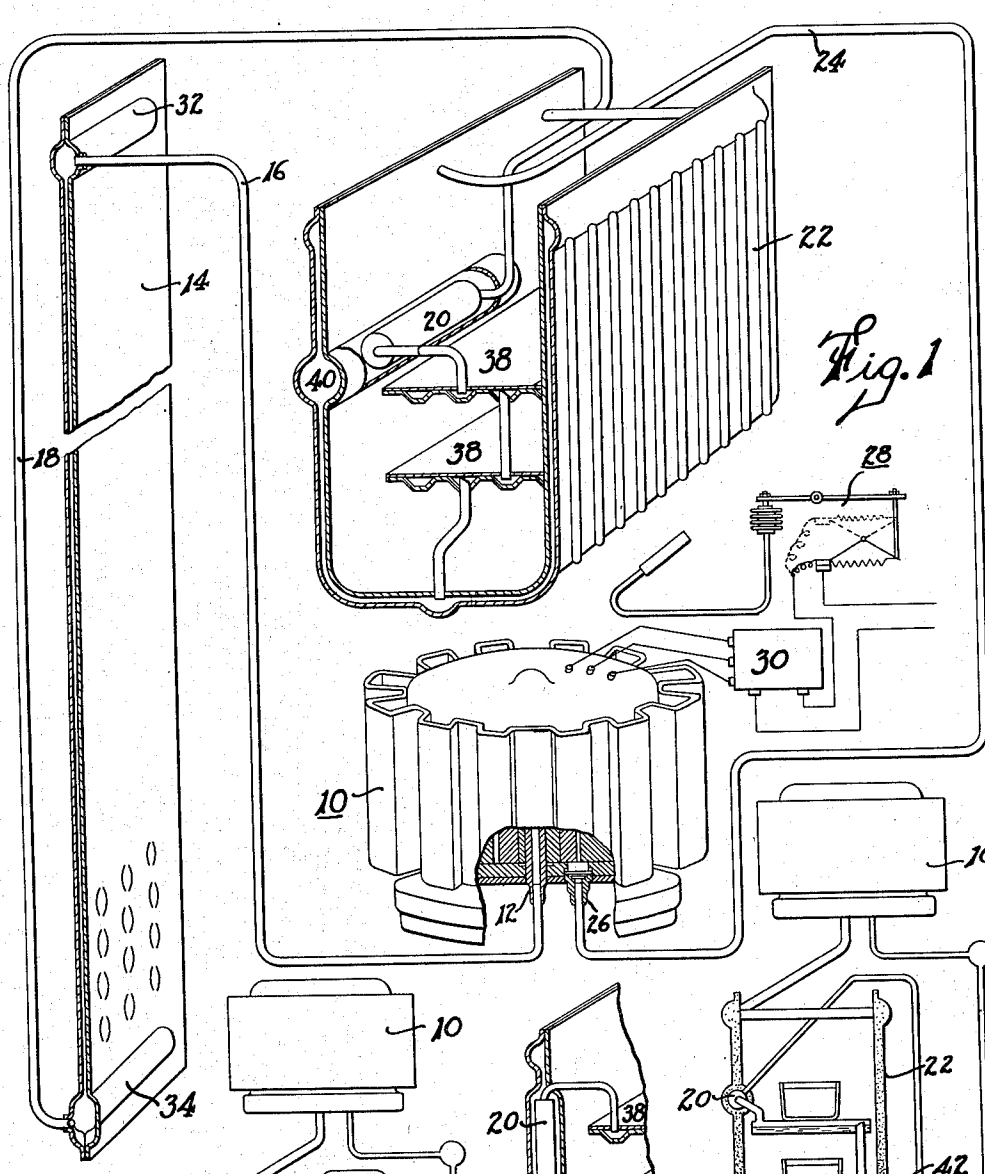


Fig. 1

Fig. 2

Fig. 4

Fig. 3

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REFRIGERATING APPARATUS

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10 Claims. (Cl. 62—3)

This invention relates to refrigerating apparatus and more particularly of the compressor-condenser-fixed restrictor-evaporator type.

In the copending application of Andrew A. Kucher, Serial No. 599,239, filed March 16, 1932, there is disclosed a refrigerating apparatus, the design of which is such that the apparatus may be operated continually throughout a given range of loads and the refrigeration output will be automatically adjusted to correspond to the load requirements for any given conditions. The present invention, although it is not limited to use with an apparatus of the design disclosed in that application, may be conveniently incorporated in such a system. In a refrigerating apparatus utilizing a fixed restrictor as the sole refrigerant expansion control, the rate of flow through the restrictor is ordinarily determined by the pressure difference across the restrictor. That is, in fixed restrictor systems heretofore designed, the only condition which effects the rate of flow through the restrictor and which varies under different conditions of operation is the pressure difference across the restrictor. While it is possible to produce a fixed restrictor refrigerating apparatus which is inherently self-controlling as explained in the aforementioned application throughout substantially the entire range of room temperatures normally encountered, the wide variation in both head pressures and back pressures existing in the system between the maximum and minimum load conditions results in operation of the system at rather low efficiencies under some conditions. Since for any given system, there is a certain optimum value of head pressure and back pressure at which the system will operate at maximum efficiency, any variations from this value results in less efficient operation. Naturally, the wider the variation in head or back pressure, the greater is the departure from maximum efficiency, and the lower is the average efficiency over a given period.

It is an object of the present invention, therefore, to provide a novel method and apparatus for controlling the rate of flow of refrigerant through a fixed restrictor and to thus provide smaller variations in the head and back pressures of the system for a given variation in output of the system.

It is a further object to provide a refrigerating apparatus which is self-controlling in its output throughout a substantial range of load requirement and in which the average efficiency of operation is materially increased.

Another object is to provide a novel evaporator construction for a refrigerating apparatus having a fixed restrictor associated therewith to have a variable rate of heat interchange between the restrictor and the refrigerant in the evaporator.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred form of the present invention is clearly shown.

In the drawing:

Fig. 1 is a diagrammatic view of a refrigerating apparatus embodying the present invention, portions of the apparatus being broken away to show its interior construction;

Fig. 2 is a diagrammatic view of the refrigerating apparatus illustrating the levels of liquid refrigerant therein under high load conditions;

Fig. 3 is a diagrammatic view of the refrigerating apparatus illustrating the levels of liquid refrigerant therein under low load conditions; and

Fig. 4 is a fragmentary view partly in cross section of a modified form of evaporator embodying the present invention.

Referring now to Fig. 1, there is shown a refrigerating apparatus comprising a motor-compressor unit 10 having an outlet 12 communicating with the condenser 14 by means of a conduit 16. The condenser 14 communicates at its bottom portion by means of a conduit 18 with a fixed restrictor 20, which, in turn, communicates with an evaporator 22. A conduit 24 connects the outlet of the evaporator with the inlet 26 of the compressor 10. In order to provide for intermittently operating the apparatus under certain conditions, a control switch 28 is provided for opening and closing the circuit to the motor-compressor unit 10 in response to cabinet temperatures, suitable motor starting control means 30 being provided intermediate the switch 28 and the motor-compressor unit 10.

The design of the various portions of the refrigerating apparatus is preferably that described in the copending application referred to previously, although it will be understood that the invention herein described may be utilized with varying degrees of advantage in other designs of apparatus. According to the embodiment illustrated, the condenser 14 and the evaporator 22 are both formed of metal sheets having corrugations or other deformations therein to provide, when the sheets have been suitably welded or otherwise secured together, refrigerant passages therebetween of suitable shape. The condenser 14 may include an upper header 32 for distributing compressed refrigerant across its full width and a

lower header 34 for collecting liquefied refrigerant. The evaporator 22 is formed into a general U shape to provide a sharp freezing zone for the freezing of water or other substances to be frozen and includes one or more horizontal shelves 38 which are formed with refrigerant passages therein to facilitate the rapid freezing of articles placed thereon. The outer vertical walls of the evaporator may be utilized for cooling the air or other circulating medium in a refrigerator cabinet to be cooled. One of the vertical walls of the evaporator 22 is formed with a bulged portion 40 within which the restrictor 20 is mounted. The vertical location of the bulged portion 40 is such that it lies intermediate the upper and lower limitations of travel of the liquid refrigerant level in the evaporator 22.

Assuming the apparatus illustrated has been designed in accordance with the copending application above referred to, it will be seen that the compressor 10 will run continuously under all loads above a certain low limit. The setting of the control switch is such that under load conditions below this limit, the apparatus will operate intermittently. When the compressor is running, refrigerant will be drawn from the evaporator through the conduit 24 and compressed by the compressor to be delivered through conduit 16 to the condenser 14. The liquid refrigerant condensed in the condenser 14 is delivered through the conduit 18 to the fixed restrictor 20 whence it is expanded into the evaporator 22 entering the shelves at the shelf 38. Under conditions of high load, such as for example, when the room temperature within which the refrigerating apparatus is operating is rather high, refrigerant will be delivered to the evaporator at a rather fast rate, due to the high head pressure existing in the condenser at high room temperatures. Consequently, liquid refrigerant will tend to accumulate in the evaporator 22 to some such level as that indicated at 42. Inasmuch as the level 42 is above the restrictor 20, the restrictor will be in direct contact with the liquid refrigerant in the evaporator 22. Since the liquid refrigerant entering the restrictor 20 is considerably warmer than the liquid refrigerant in the evaporator 22, heat will be transferred from the refrigerant in the restrictor to the refrigerant in the evaporator. Under high load conditions, with the refrigerator functioning as illustrated in Fig. 2, the heat exchange conditions between the restrictor and the liquid refrigerant in the evaporator are at their best, due to the surrounding of the restrictor with liquid refrigerant. Likewise, since the restrictor is surrounded with liquid refrigerant, the tendency of the refrigerant passing through the restrictor to gasify before leaving the restrictor is substantially eliminated, resulting in the delivery of practically pure liquid refrigerant from the restrictor 20.

Under conditions of low load, for example, on a cool day, the refrigerant is delivered to the evaporator at a lesser rate than on a warm day, resulting in the lowering of the level of liquid refrigerant in the evaporator to a point such as 44 shown in Fig. 3 which is below the restrictor 20. Under these conditions, the restrictor 20 is surrounded with gaseous refrigerant and not only is the heat exchange factor thereby reduced, but also since the restrictor is surrounded by gaseous refrigerant, there will be some tendency for the refrigerant passing through the restrictor to gasify before leaving the restrictor.

Comparing these two conditions of operation, it will be seen that under high load conditions, refrigerant leaves the restrictor in a liquid state, while under low load conditions, the refrigerant leaves the restrictor in a partly gasified condition. Inasmuch as any given fixed restrictor will pass many times the quantity by weight of refrigerant in the liquid phase than it will pass in the gaseous phase, it will be seen that the normal relation between the rate of flow through the restrictor and the pressure difference across the same is materially altered. Thus, for a given pressure difference across the restrictor, the rate of flow therethrough will be greater under high load conditions than it will be under low load conditions, due to the gasification of a part of the refrigerant passing through the restrictor under low load conditions. If this controlling effect on the rate of flow be now considered in relation to the variation of pressure differences across the restrictor under high and low load conditions, respectively, it will be seen that under high load conditions, the rate of flow through the restrictor is increased by the maintenance of the refrigerant in a liquid condition throughout the restrictor as well as by the high pressure difference across the restrictor, whereas under low load conditions, the refrigerant is held back by the gasification of some of the refrigerant in the restrictor, as well as by the lower pressure difference across the restrictor. It, therefore, follows that the pressure variations in the system do not need to be as great to accomplish a given amount of control over the rate of flow as are required without the use of the present invention.

In order to achieve a more gradual utilization of the controlling effect heretofore described, the evaporator may be constructed as shown in Fig. 4 in which the restrictor 20 is mounted in a vertical position rather than in a horizontal one and has its inlet at the bottom and its outlet at the top. By the use of this construction, the rising and falling of the liquid level within the evaporator produces a more gradual effect on the refrigerant in the restrictor than that produced by the construction of Fig. 1.

While the invention has been disclosed in connection with a refrigerating apparatus which is designed to operate continuously at varying outputs throughout a substantial range, it will be understood that many of its advantages may be derived from its incorporation in refrigerators of other design. While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a refrigerating apparatus, the combination of a compressor, a condenser, a restrictor and an evaporator connected to form a refrigerant circuit and proportioned to cause variations in the level of liquid refrigerant in the evaporator with variations in load conditions, the restrictor being in heat exchange relation with the refrigerant in the evaporator intermediate the upper and lower limits of travel of the liquid refrigerant level.

2. An evaporator for a refrigerating apparatus comprising means forming a vertically extending refrigerant chamber having a liquid refrigerant inlet and a gaseous refrigerant outlet, a restrictor comprising a passage of relatively great length and small cross section, and having a refrigerant inlet and a refrigerant outlet, said restrictor being mounted with at least a portion

in heat exchange relation to the refrigerant in said chamber intermediate the upper and lower limits of travel of the liquid refrigerant level therein and having its outlet in communication with the inlet to the evaporator.

3. An evaporator for a refrigerating apparatus comprising means forming a vertically extending refrigerant chamber having a liquid refrigerant inlet and a gaseous refrigerant outlet, a restrictor comprising a passage of relatively great length and small cross section, and having a refrigerant inlet and a refrigerant outlet, said restrictor being mounted with at least a portion inside said chamber and in heat exchange relation to the refrigerant in said chamber intermediate the upper and lower limits of travel of the liquid refrigerant level therein and having its outlet in communication with the inlet to the evaporator.

4. An evaporator for refrigerators comprising a plurality of sheet like portions secured together to form a vertically extending refrigerant chamber and a restrictor comprising a passage of relatively great length and small cross section in heat exchange relation with the refrigerant in said chamber positioned to exchange heat with said refrigerant at varying rates with variations in the liquid refrigerant level in said chamber.

5. An evaporator for refrigerating apparatus comprising means forming a vertically extending refrigerant chamber and a fixed restrictor in heat exchange relation with the refrigerant in said chamber positioned to exchange heat with said refrigerant at varying rates with variations in the liquid refrigerant level in said chamber.

6. An evaporator for refrigerators comprising a plurality of sheet like portions secured together to form a vertically extending refrigerant chamber and a fixed restrictor in heat exchange relation with the refrigerant in said chamber positioned to exchange heat with said refrigerant at varying rates with variations in the liquid refrigerant level in said chamber.

7. In a refrigerating apparatus, the combination of a compressor, a condenser, a restrictor and an evaporator connected to form a refrigerant circuit and proportioned to cause variations in the level of liquid refrigerant in the evaporator with variations in load conditions, the restrictor being within the evaporator in a position intermediate the maximum and minimum liquid refrigerant levels in said evaporator.

8. An evaporator for refrigerating apparatus comprising means forming a vertically extending refrigerant chamber having a liquid refrigerant inlet and a gaseous refrigerant outlet, a restrictor comprising a passage of relatively great length and small cross-section, and having a refrigerant inlet and a refrigerant outlet, said restrictor being mounted with at least a portion in heat exchange relation to the refrigerant in said chamber intermediate the upper and lower limits of travel of the liquid refrigerant level therein and having its outlet in communication with the inlet to the evaporator, said restrictor being vertically disposed whereby different portions of said restrictor are differentially cooled.

9. The method of controlling the circulation of refrigerant in a compressor-condenser-fixed restrictor-evaporator refrigerating system which comprises automatically controlling the amount of gasification of the refrigerant taking place in the fixed restrictor to increase the rate of flow therethrough by varying the heat transfer environment of said restrictor in accordance with changes in liquid level in the evaporator.

10. A refrigerating apparatus comprising a compressor, condenser, fixed restrictor and evaporator in a closed cycle refrigerant flow relationship, and means for automatically controlling the amount of gasification of refrigerant taking place in the fixed restrictor including means for varying the heat transfer environment of said restrictor.

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