

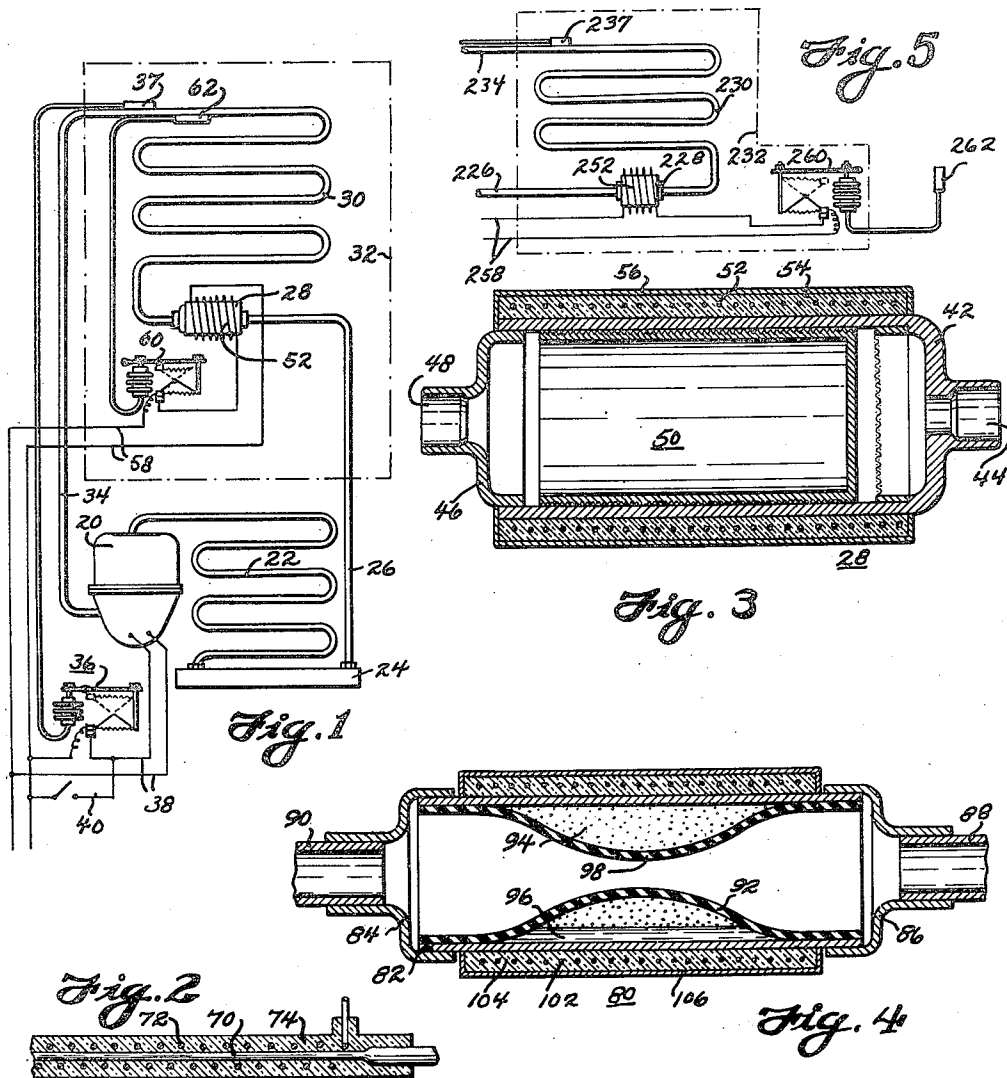
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REFRIGERATING APPARATUS

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REFRIGERATING APPARATUS

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12 Claims. (Cl. 62—8)

This invention relates to refrigerating apparatus and more particularly to means for controlling the liquid flow from the condenser to the evaporator.

In many refrigeration applications restrictors have replaced valves for controlling the flow of liquid from the condenser to the evaporator. The chief reason for this is because of the extreme simplicity and the lack of moving parts of the restrictor, which renders the restrictor substantially foolproof, and this reduces service troubles. Restrictors, however, do not accommodate varying refrigeration loads as well as desired. In the ordinary refrigerating system the liquid flow should be great during heavy loads and small during light loads. In restrictor type systems use is made of the varying condensing pressure and the cycling of the system to secure some variation of the liquid flow in accordance with the varying loads. However, it has been found that in ordinary systems there is still not sufficient throttling of the liquid refrigerant during light loads and as a result the evaporating means becomes too full of liquid refrigerant and the suction line becomes frosted, thus rendering the operation of the system under such conditions rather inefficient.

It is an object of my invention to provide a means for reducing the flow of liquid refrigerant through the restrictor when desired and particularly to prevent a collection of an excessive amount of liquid refrigerant in the evaporating means under light load conditions.

It is another object of my invention to reduce the flow of liquid refrigerant through the restrictor when an excessive amount of liquid refrigerant collects within the evaporating means.

It is still another object of my invention to heat the restrictor when an excessive amount of liquid refrigerant collects in the evaporator.

It is another object of my invention to provide a means for electrically heating the restrictor in order to gasify a portion of the liquid refrigerant for reducing the flow of liquid refrigerant through the restrictor.

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 view of a refrigerating system partly diagrammatic embodying one form of my invention;

Fig. 2 is a view of a tube type restrictor provided with an electric heating element;

Fig. 3 is a sectional view of a threaded type restrictor such as is shown in Fig. 1, provided with an electrical heating element;

Fig. 4 is a modified form of restrictor in which the amount of restriction may be changed by the heat generated in the electrical heating element; and

Fig. 5 is a view of a modified arrangement.

Briefly, I have shown a refrigerating system of the compression type provided with a restrictor surrounded by an electric heating element which is energized when liquid refrigerant reaches a thermostat provided upon the suction line adjacent the outlet of the evaporating means, and which is deenergized when the amount of liquid refrigerant within the evaporating means is reduced. Two forms of such an electrically heated restrictor are shown while in another form shown a restrictor changes its restriction according to the application of heat thereto. In the last form, the electrical heating element heats a bi-metal element which operates a valve for controlling the flow of liquid refrigerant in the refrigerating system.

Referring now to the drawing and more particularly to Fig. 1 there is shown a sealed motor-compressor unit 20 for compressing refrigerant and for forwarding compressed refrigerant to a condenser 22 where the compressed refrigerant is liquefied and collected in the receiver 24. From the receiver 24 the liquid refrigerant is forwarded through a supply conduit 26 to a restrictor 28 which controls the flow of liquid refrigerant into the evaporating means 30. This evaporating means is located within the compartment 32 which is to be kept cool. The liquid refrigerant evaporates within the evaporating means 30 under reduced pressure and the evaporated refrigerant is returned to the compressor through the suction conduit 34.

The refrigerating system may be operated either continuously or intermittently. In order to provide for the intermittent operation a thermostatic switch 36 is connected into the electric motor circuit 38 of the motor-compressor unit 20 and is operated in accordance with the temperature conditions of a thermostat bulb 37 which is mounted upon the outlet of the evaporating means 30 within the compartment 32. A shunt 40 is provided around the thermostat switch 36 and is provided with a switch which when closed will provide for continuous operation of the refrigerating system.

The restrictor 28 is better shown in Fig. 3 and includes a thimble member 42 containing an inlet 44 and closed at its opposite end by a cap member 46 provided with an outlet 48. Within the thimble member 42 is a cup member 50 having its outer surface provided with an ordinary helical single thread which fits tightly within the thimble member 42 so that any refrigerant passing from the inlet 44 to the outlet 48 must traverse the entire length of the groove between the convolutions of the thread. This provides a long capillary passage of very small cross-section which throttles the refrigerant sufficiently to maintain the proper pressure conditions between the condenser and the evaporator under full load conditions.

It has been found that under light load conditions and some other unusual conditions, such as when the condenser pressure is unusually high, together with a fairly light load, that too much liquid refrigerant passes into the evaporating means so that some is drawn into the suction line causing frosting of the suction line and inefficient operation of the system, and also creates the possibility of damaging the compressor because of liquid being drawn into the compressor. These conditions cause inefficient operation of the refrigerating system. Although the condenser pressure is reduced under light load conditions, this reduction pressure is not sufficient to reduce the amount of liquid flow to the evaporating means sufficiently to prevent the supply of too much liquid.

In order to avoid this difficulty I have provided an electric heating element 52 which is embedded in electrical insulating material 54 having a relatively high heat conductivity. The heating element 52 and its insulation 54 surround and are molded upon the thimble 42 so as to provide excellent heat conductivity between the heating element 52 and the refrigerant which flows through the grooves of the threaded outer surface of the member 50. The electric heating element 52 and its insulating material 54 are enclosed within a metal jacket 56. The electric heating element 52 is connected by an electric circuit 58 to the same source of power which is used for the motor-compressor unit 20. This electrical circuit 58 is provided with a thermostatic switch 60 which is operated in accordance with temperature conditions of the thermostat bulb 62 which is clamped to the outlet of the evaporating means 30.

By this arrangement when the refrigerating system operates under light loads and too much liquid refrigerant flows into the evaporating means 30, this liquid refrigerant will reach the portion of the refrigerant circuit at which the bulb 62 is located, thereby cooling the bulb 62 and causing the closing of the thermostat 60. This will cause electric current to flow through the heating element 52 thereby heating the restrictor 28 and the refrigerant passing through the restrictor 28 so that a small portion of the liquid refrigerant will be evaporated. The increased volume of the gas as compared to liquid volume causes increased velocity through the restrictor and therefore a greater amount of frictional resistance. This will reduce the total amount of liquid which flows through the restrictor into the evaporating means. When the amount of evaporated refrigerant is reduced the thermostatic bulb 62 will be warmed thereby causing switch 60 to be opened to deenergize the heating element and allow the normal flow of

liquid refrigerant through the restrictor. In this way the undesired condition of too much liquid refrigerant within the evaporating means is overcome.

In Fig. 2 is shown a capillary tube type restrictor provided with a heating element to be used in a refrigerating system like the restrictor shown in Figs. 1 and 3. When this form of restrictor is employed it ordinarily extends substantially between the entire distance of the condenser and the evaporator both as a liquid and as a restrictor. Thus this tube type restrictor replaces the supply conduit 26 and the restrictor 28 which is shown in Fig. 1. The restrictor shown in Fig. 2 comprises a capillary tube 70 having a sufficiently small bore and being sufficiently long to provide restriction of the flow of liquid refrigerant under full load conditions. This capillary tube 70 is surrounded by a spiral electrical heating element 72 which is embedded within the electrical insulating material 74 which is molded onto the tube in order to insulate the heating element 72. The heating element 72 is connected to the circuit 58 and provided with a thermostat switch like switch 60 in Fig. 1.

In Fig. 4 another form of restrictor or capillary tube is provided which is designated by the reference character 80. In this form of restrictor, a metal sleeve 82 is provided with metal cap members 83 and 86 at its ends, one of which connects to the liquid supply conduit 26 at the one end of the restrictor and to the conduit 90 at the other end connecting to the evaporating means, such as the evaporating means 36. Within the sleeve 82 is provided a sleeve 92 of a rubber-like material, such as a compound which includes a polymer of chloroprene or neoprene, such as those sold under the trade name of "Duprene." This sleeve 92 of the rubber-like material is bonded at its ends to the ends of the metal members 82 by vulcanization or some form of clamping means.

In the space between the middle portions of the two sleeves 82 and 92 there is provided a space 94 which is partially filled with a volatile liquid 96 and the remainder is filled with the vapor of the volatile liquid 96. The midportion of the sleeve 92 is necked in order to provide a restricted passage within the sleeve from one end to the other. In this necked portion 98 the liquid refrigerant is throttled in its flow from the condenser to the evaporator. The size of this necked portion 98 is controlled by the pressure of the volatile liquid and its vapor within the space 94. When this pressure is great the size of the neck is reduced to provide a greater restriction to the flow of refrigerant through the neck while when the pressure is low within the space 94 the neck 98 may be larger in size to provide a lesser amount of restriction.

In order to control the pressure within the space 94 an electric heating element 102 is provided which is embedded within an electrical insulating material of relatively high heat conductivity which is molded onto the outside of the sleeve 82. This insulating material is provided with a metal case 106. This electrical heating element 102 may be connected into the electrical circuit 58 as is the heating element 52 or it may be energized in another manner such as under the control of a variable resistance. By controlling the current flowing through the heating element 102 the heating of the volatile liquid is controlled so as to control the pressure within

the space 94 and thereby to control the size of the restriction provided by the necked portion 98. This restrictor may be either used alone or in series with another restrictor of any type such as a threaded or a tube type restrictor. If desired, the space 94 may be connected directly to the condenser in order to apply condenser pressure to it for controlling the restriction of the restrictor.

Thus by any one of the forms of control described the flow of liquid may be reduced whenever liquid conditions within the evaporating means make it necessary or desirable.

In Fig. 5 there is shown a modified form of the invention in which the heating of the restrictor is controlled by the temperature outside of the compartment which, of course, is the main controlling factor in the variation in heat leaking into the compartment 32. In reality the temperature of the evaporating means is proportional to the temperature of the air outside the compartment.

In Fig. 5 there is provided a compartment 232 to be kept cool which contains a refrigerant evaporating means 230 supplied with liquid refrigerant through the liquid supply conduit 226 from a compressor and condenser unit, not shown. A restrictor or capillary tube 228 controls the supply of liquid refrigerant into the evaporating means 230 and this liquid refrigerant evaporates under reduced pressure and is returned to the compressor through the return conduit 234. The operation of the compressor is controlled by the thermostat bulb 237 located within the compartment 232 upon the outlet of the evaporating means 230.

It has been found under light load conditions, such as occur when the air outside the compartment 232 is comparatively cold, that too much liquid refrigerant flows into the evaporating means 230. In order to reduce this supply of liquid I heat the restrictor 228 under such conditions that a small portion of the liquid refrigerant will be evaporated in the restrictor. The increased volume of gas in the restrictor as compared with the liquid volume causes increased velocity through the restrictor and therefore a greater amount of frictional resistance therein. This will reduce the total amount of liquid which flows into the evaporating means.

Instead of controlling this heating directly by evaporator temperature and indirectly according to temperature conditions inside and outside the compartment to be cooled, as in Fig. 1, I control the heating of the restrictor by the temperature outside the compartment 232 to be cooled. In order to do this I provide an electric heating means 252 for the restrictor 228 and connect this electric heating means to an electrical supply circuit 258 which is provided with a thermostatic switch means 260 in series with the heater 252. This thermostatic switch means 260 is provided with a thermostat bulb 262 outside the compartment 232 to be cooled. With this arrangement, under cold room conditions the thermostat bulb 262 will be cooled to cause the switch 260 to be closed in order to energize the heater 252 for heating the restrictor 228 to reduce the liquid flow to the evaporating means 260. Under warm room conditions the thermostat 262 will open the switch 260 to prevent the heating of the restrictor 228. Thus by this system under warm room conditions an ample flow of refrigerant to the evaporating means is provided and yet by heating the restrictor under cold room

conditions the amount of liquid flow is reduced as is desired.

While the form of embodiment of the 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. Refrigerating apparatus including a compartment to be cooled; a closed refrigerant circuit including an evaporating means in heat exchange relation with said compartment, a compressing means, a condensing means, and a restrictor means for controlling the flow of refrigerant from the condensing means to the evaporating means; and means responsive to temperature conditions outside of said compartment for heating the restrictor means for changing the amount of flow of refrigerant.

2. Refrigerating apparatus including a closed circuit containing compressing, condensing and evaporating means and also restrictor means providing a continuously and uniformly open capillary passage of great length in proportion to its cross section for controlling the flow of liquid from the condensing means to the evaporating means, means operating upon the restrictor means for changing the frictional resistance of flow of refrigerant through the restrictor means, and snap acting means for controlling said means operating upon the restrictor means.

3. Refrigerating apparatus including a closed circuit containing compressing, condensing and evaporating means, and also restrictor means providing a continuously and uniformly open capillary passage of great length in proportion to its cross section for controlling the flow of liquid from the condensing means to the evaporating means, and means independent of said closed circuit for changing the temperature of said restrictor means for changing the frictional resistance of the flow of refrigerant through the restrictor means.

4. Refrigerating apparatus including a closed circuit containing compressing, condensing, and evaporating means, and also restrictor means providing a continuously and uniformly open capillary passage of great length in proportion to its cross section for controlling the flow of liquid from the condensing means to the evaporating means, and means for applying heat from a source outside the closed circuit to the restrictor means to change the frictional resistance of flow of refrigerant through the restrictor means.

5. Refrigerating apparatus including a closed circuit containing compressing, condensing, and evaporating means, and also restrictor means providing a continuously and uniformly open capillary passage of great length in proportion to its cross section for controlling the flow of liquid from the condensing means to the evaporating means, and means responsive to a surplus of liquid in the evaporating means for changing the temperature of the restrictor means for changing the frictional resistance of flow of refrigerant through the restrictor means.

6. Refrigerating apparatus including a closed circuit containing compressing, condensing, and evaporating means, and also restrictor means providing a continuously and uniformly open capillary passage of great length in proportion to its cross section for controlling the flow of liquid from the condensing means to the evaporating means, and electrical means for changing the

frictional resistance of flow of refrigerant through the restrictor means.

7. Refrigerating apparatus including a closed circuit containing compressing, condensing, and evaporating means, and also restrictor means providing a continuously and uniformly open capillary passage of great length in proportion to its cross section for controlling the flow of liquid from the condensing means to the evaporating means, and electrical heating means for changing the frictional resistance of flow of refrigerant through the restrictor means.

8. Refrigerating apparatus including a closed circuit containing compressing, condensing, and evaporating means, and also restrictor means providing a continuously and uniformly open capillary passage of great length in proportion to its cross section for controlling the flow of liquid from the condensing means to the evaporating means, and electrical means for heating the restrictor means.

9. Refrigerating apparatus including a compartment to be cooled; a closed refrigerant circuit including an evaporating means in heat exchange relation with said compartment, a compressing means, a condensing means, and a restrictor means providing a continuously and uniformly open capillary passage of great length in proportion to its cross section for controlling the flow of refrigerant from the condensing means to the evaporating means; and means rendered effective upon predetermined low temperature conditions within said compartment and operating upon said restrictor means for changing the frictional resistance of flow of refrigerant through the restrictor means.

10. Refrigerating apparatus including a compartment to be cooled; a closed refrigerant circuit including an evaporating means in heat exchange relation with said compartment, a com-

pressing means, a condensing means, and a restrictor means providing a continuously and uniformly open capillary passage of great length in proportion to its cross section for controlling the flow of refrigerant from the condensing means to the evaporating means; and means rendered effective upon predetermined low temperature conditions and ineffective upon predetermined high temperature conditions within said compartment for operating upon the restrictor means for changing the frictional resistance of flow of refrigerant.

11. Refrigerating apparatus including a compartment to be cooled; a closed refrigerant circuit including an evaporating means in heat exchange relation with said compartment, a compressing means, a condensing means, and a restrictor means providing a continuously and uniformly open capillary passage of great length in proportion to its cross section for controlling the flow of refrigerant from the condensing means to the evaporating means; and means responsive to temperature conditions outside of said compartment and operating upon said restrictor means for changing the amount of flow of refrigerant through the restrictor means.

12. Refrigerating apparatus including a closed circuit containing compressing, condensing and evaporating means, and also restrictor means providing a continuously and uniformly open capillary passage of great length in proportion to its cross section for controlling the flow of liquid from the condensing means to the evaporating means, and means responsive to a surplus of liquid in a portion of the closed circuit for changing the temperature of the restrictor means for changing the frictional resistance to the flow of refrigerant through the restrictor means.

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CERTIFICATE OF CORRECTION.

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It is hereby certified that error appears in the above numbered patent requiring correction as follows: In the drawing, strike out entire Figure 5 appearing at bottom of sheet; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 24th day of June, A. D. 1941.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.