March 5, 1940. R. E. TOBEY 2,192,851

REFRIGERATING APPARATUS

Filed June 4, 1938

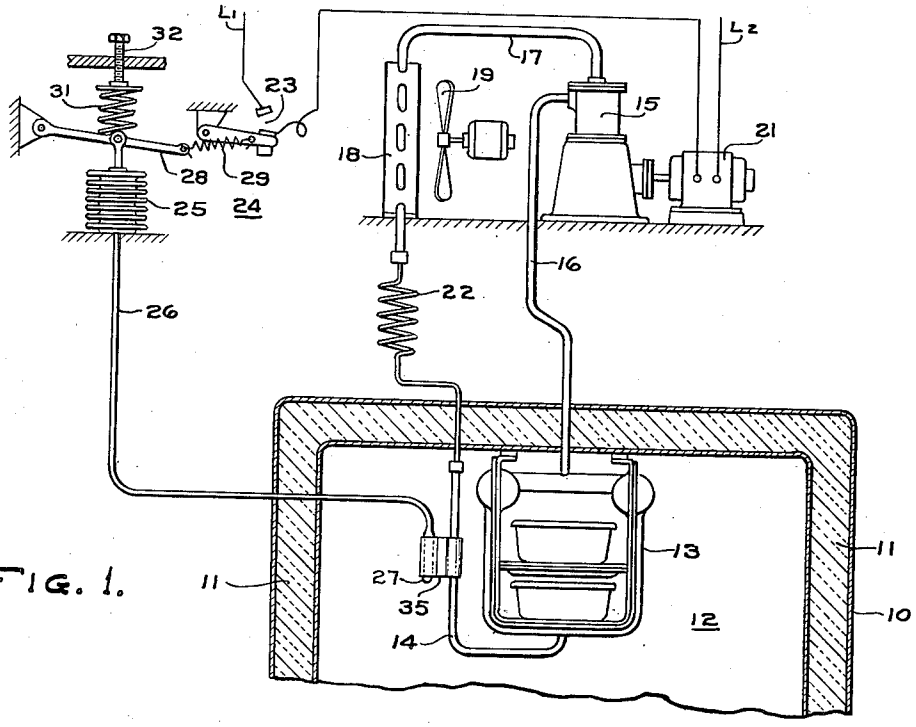


FIG. 1.

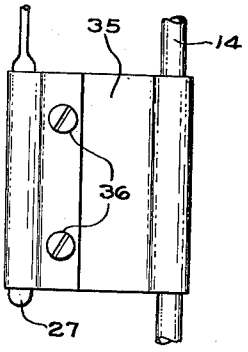


FIG. 2.

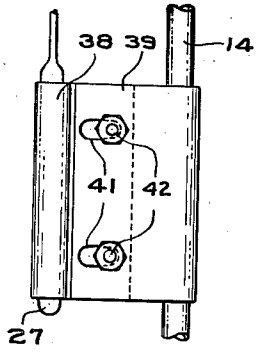


FIG. 3.

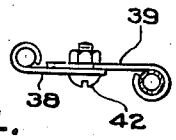


FIG. 4.

WITNESSES:

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REFRIGERATING APPARATUS

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8 Claims. (Cl. 62—4)

My invention relates to refrigerating apparatus and has for an object to provide improved apparatus of this character.

A further object of the invention is to maintain the temperature of the air in a refrigerated zone within close limits irrespective of changes in temperature of the ambient atmosphere exteriorly of said zone.

A further object of the invention is to vary the means temperature of the cooling element of a refrigerating machine inversely with changes in the temperature of the atmosphere exteriorly of the zone refrigerated by the element.

A further object of the invention is to initiate operation of a refrigerating machine in response, primarily, to the temperature of the medium cooled thereby and to terminate operation of the same conjointly in response to the temperature of the cooling element of the machine, and the temperature of the medium cooled thereby.

It is still a further object of the invention to provide improved control means for a refrigerating machine that is affected by variations in the temperature of the atmosphere exteriorly of the refrigerated zone and by the heat load in the zone.

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 which:

Fig. 1 is a diagrammatic view of a refrigerating machine controlled in accordance with my invention;

Fig. 2 is a view of a detail employed in Fig. 1;

Figs. 3 and 4 are side and plan views of a second embodiment of the detail shown in Fig. 2.

Reference will now be had to Figs. 1 and 2 of the drawing wherein I have shown my invention applied to a refrigerating machine of the domestic type and including a cabinet structure 10 having insulated walls 11 for defining the chamber 12 to be refrigerated. Heat is abstracted from the air in the chamber 12 by an evaporator 13 of conventional construction which includes an inlet conduit 14 for condensed refrigerant. Refrigerant vaporized in the evaporator 13 is withdrawn therefrom by a compressor 15 through a suction conduit 16. The refrigerant withdrawn from the evaporator is compressed in the compressor 15 and delivered through a conduit 17 to a suitable condenser 18. Cooling of the condenser 18 is effected by a fan 19. An electric motor 21 is employed for driving the compressor 15 and is energized from a suitable source of power indicated by the line conductors L_1 and L_2.

Refrigerant liquefied in the condenser 18 is conveyed to the conduit 14 through a suitable expansion device shown by way of example as a capillary tube 22. It will be apparent from the foregoing description that the apparatus operates on the well-known compressor-condenser-expander cycle, so that further description of its construction and operation is deemed unnecessary.

Operation of the motor 21 and the compressor 15 is controlled by a switch 23 forming a part of a conventional gas-type thermostat, generally indicated at 24. The thermostat 24 includes a bellows 25 connected by means of a tube 26 to a bulb or reservoir 27. The bellows 25, tube 26, and bulb 27 define a closed chamber for an expansible and preferably volatile fluid. As is well understood, the pressure within the bellows 25 is a function of the temperature of the bulb 27 so that expansion and contraction of the bellows 25 is in response to increases and decreases in temperature of the fluid in the bulb 27. Movement of the bellows 25 is imparted to a pivoted lever 28 that is connected through a suitable over-center, snap-acting mechanism 29 to the switch 23. The pressures within the bellows and, therefore, the temperatures of the bulb 27 at which the switch 23 are opened and closed are determined by the bias of a spring 31 which opposes movement of the bellows 25. A suitable adjusting mechanism 32 is provided for varying the bias of the spring and the temperatures at which the switch 23 is operated.

In accordance with my invention, the operation of the compressor 15 is initiated in response, primarily, to the temperature of the air in the chamber 12 and is terminated conjointly in response to the temperatures of the evaporator 13 and the air cooled thereby. In practicing the invention, a heat conducting member or fin 35 is employed for supporting the bulb 27 of the thermostat 24 in the air within the chamber 12, which fin 35 is carried by a portion of the evaporator of low heat storage capacity such as, the evaporator inlet conduit 14. The bulb 27 may be clamped within a turned-over portion of the fin 35 by screws 36 and the fin 35 may be soldered or otherwise suitably secured to the conduit 14 as shown best in Fig. 2.

The inlet conduit 14 defines a portion of the low side of the system that includes the evaporator 13, and, during operation of the compressor 15, the temperature of the conduit 14 is depressed

to substantially the same value as the evaporator 13, or in some instances to a value below the average evaporator temperature depending upon the size and heat abstracting capacity of the evaporator. During the inactive periods of the compressor 15, the temperature of the conduit 14 increases faster than the temperature of the evaporator 13 due to its relatively small mass and because it is subjected only to the relatively high temperature air in the chamber.

The fin 35 spaces the thermostat bulb 27 and the evaporator conduit 14 so that the heat exchange therebetween is through the fin 35. The mass of the fin 35 is relatively small so that its temperature is readily affected by the temperatures of the cooled air and the inlet conduit 14.

In the copending application of Leslie B. M. Buchanan, Serial No. 243,279, filed November 30, 1938, which is a division of application Serial No. 157,101, filed August 3, 1937, both of which applications are assigned to the assignee of the present application, a system of the character set forth heretofore is disclosed wherein the control bulb of the thermostat is directly connected to the inlet conduit of the evaporator for controlling the operation of the refrigerating system. The present application relates to an improvement of the system shown in the copending application in that the thermal responsive element is rendered more responsive to the air temperature by the provision of the fin 35 between the inlet conduit of the evaporator and the thermal responsive element. While the inlet conduit of the evaporator is of relatively low mass, some cooling of the thermal responsive bulb is effected thereby after the compressor is stopped. As the conduit is connected to the evaporator which defines a relatively large cold body, its temperature rise is retarded thereby during the inactive periods of the compressor. By disposing the thermal element in spaced relation with the evaporator inlet conduit, I have found that the temperature of the thermal responsive element more closely follows air temperature during inactive periods of the compressor. The fin counteracts the cooling effect of the inlet conduit at this time and facilitates the flow of heat from the air to the thermal responsive element. As the fin has high heat conducting properties, the temperature of the thermal responsive element is readily reduced by the inlet conduit during operating periods of the compressor. At this time, the thermostat responds primarily to the temperature of the inlet conduit compensated, of course, by cabinet air temperature. I have found that the temperature of the air in the refrigerated zone may be maintained within closer limits when controlled in the manner disclosed in the present application.

Operation

As shown in the drawing, the thermostatic switch 23 is closed so that the motor 21 is energized and the compressor 15 is active for the circulation of refrigerant. During operating periods of the compressor, the temperatures of the thermostat bulb 27 and the fin 35 are depressed by the flow of heat therefrom to the cold inlet conduit 14. The temperature of the bulb 27 at this time is determined by both the temperature of the conduit 14 and the temperature of the cooled air. If the temperature of the air is high due to a high temperature of the air exteriorly of the chamber 12 or to some other reason such as, for example, the insertion of warm products in the chamber 12, the flow of heat to the fin 35 and bulb 27 is relatively high so that the compressor is operated for a relatively long period of time in order to cool the fin and bulb 27 to the value at which operation of the compressor 15 is terminated.

Accordingly, heat is abstracted from the air at a high rate in order to compensate for the high rate of heat leakage into the chamber 12. The increase in temperature of the cooled air above the desired value due to the high heat load at this time is, therefore, relatively low. When the temperature of the bulb 27 is depressed to a predetermined value, the thermostat 24 operates to terminate operation of the compresor.

When the temperature of the air exteriorly of the chamber 12 is low, the heat leakage into the chamber 12 is correspondingly low. Accordingly, the flow of heat to the fin 35 and bulb 27 is relatively low and the temperature of the bulb 27 is reduced to the value at which it terminates operation of the compressor after a relatively short period of operation of the same.

Starting of the compressor is effected primarily in response to the temperature of the air in the chamber 12. During periods of high heat load, the temperatures of the inlet conduit 14, the fin 35 and thermal responsive bulb 27 increases at a high rate compared with the main body of the evaporator 13. Therefore, operation of the compressor is initiated when the temperature of the evaporator 13 is relatively low. Accordingly, when the heat load is high, the evaporator is maintained between temperatures that define a narrow range or differential so that the mean temperature of the evaporator 13 is low at this time.

When the heat load is low, the increase in temperature of the thermal responsive element 27 relative to the temperature increase of the evaporator 13 is correspondingly low so that the temperature of the evaporator 13 is relatively high when the compressor is started. Accordingly, the evaporator 13 is maintained between temperatures that define a wide range or differential so that the mean temperature of the evaporator 13 is high at this time. It will be apparent from the foregoing description that, during periods of high heat load, the compresor is operated more frequently and for longer periods than during periods when the heat load is low. Furthermore, the mean temperature of the evaporator is high when the heat load is low and, conversely, the mean evaporator temperature is low when the heat load is high.

From the foregoing description, it will be apparent that some variation in temperature of the air within the chamber 12 due to a varying heat load, is necessary in order to effect the compensation described. However, the variation is maintained at a low value because of the compensation effected by my novel arrangement of the thermal responsive bulb 27, fin 35 and conduit portion 14 of the evaporator 13, which compensation provides for different mean evaporator temperatures. The description of the operation of the system set forth heretofore is, of course, for a given position of the adjustment 32. A lower or higher mean temperature of the air in the chamber 12 may be effected by moving the adjustment 32 to a position corresponding to the desired temperature.

I have shown in Figs. 3 and 4 a second embodiment of the invention. In this embodiment, I employ a fin structure that is adjustable for vary-

ing the rate of heat transfer between the conduit 14 and the bulb 27. The fin structure includes first and second fin portions 38 and 39, secured, respectively, the bulb 27 and conduit 14. The portion 39 is provided with slots 41 and the portions 38 and 39 are clamped together by screws 42 which extend through the slots 41. Accordingly, the fin portions 38 and 39 may be adjusted relative each other whereby the length of the fin structure and the spacing of the bulb 27 and conduit 41 are variable. In accordance with this embodiment, the compensation effected by varying cabinet air temperatures is adjustable. By moving the bulb 27 nearer to the conduit 14, the compensation is reduced. If the control is under-compensating, the bulb 27 is spaced farther from the conduit 14.

From the foregoing description, it will be apparent that I have provided improved refrigerating apparatus so controlled that the temperature of the air in the refrigerated zone is maintained within close limits irrespective of variations in the amount of heat leakage into the zone caused by variations in the temperature of the air exterior of the zone.

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. In refrigerating apparatus, the combination of means defining a zone to be refrigerated, an evaporator for abstracting heat from the air in said zone, means for circulating refrigerant through the evaporator and including a conduit for conveying the refrigerant to the evaporator, said conduit having a portion thereof spaced from the evaporator, a heat conducting member secured to said conduit portion and disposed in heat transfer relation with the air in the zone, and thermostatic means for controlling operation of the circulating means and having a thermal responsive element secured to a portion of the heat conducting member, the disposition of said heat conducting member being such that its temperature is directly affected solely by the temperatures of said conduit portion and of the air in said zone.

2. In refrigerating apparatus, the combination of means defining a zone to be refrigerated, an evaporator for abstracting heat from the air in said zone, means for circulating refrigerant through the evaporator and including a conduit for conveying the refrigerant to the evaporator, said conduit having a portion thereof spaced from the evaporator, a fin secured to said conduit portion and extending into the air in the zone, the disposition of the fin being such that its temperature is affected solely by the temperatures of said conduit and of the air in said zone, and thermostatic means for controlling operation of the circulating means and including a thermal responsive element secured to a portion of said fin remote from said conduit portion.

3. The combination as claimed in claim 2 including means for adjusting said thermal responsive element relative to said conduit whereby the rate of heat transfer therebetween is varied.

4. In refrigerating apparatus, the combination of means defining a zone to be cooled, an evaporator for abstracting heat from the air in said zone, means for condensing at relatively high pressure refrigerant vaporized in the evaporator at relatively low pressure, an expansion device for conveying the high pressure condensed refrigerant from the condenser and for reducing the pressure thereof to the pressure of vaporization maintained in the evaporator, an inlet conduit for conveying the low pressure condensed refrigerant from said expansion device to the evaporator, said conduit having a portion thereof spaced from the evaporator, a heat conducting member secured to said conduit portion and extending into the air in said zone, said heat-conducting member being so disposed that its temperature is affected solely by the temperature of said spaced portion of said conduit and the temperature of the air in said zone, and thermostatic means for controlling the operation of the condensing means and having a thermal responsive element disposed in heat transfer relation with the portion of said heat conducting member which is disposed in the air in said zone.

5. In refrigerating apparatus, the combination of means defining a zone to be refrigerated, an evaporator for abstracting heat from the air in said zone, means for condensing at relatively high pressure refrigerant vaporized in the evaporator at relatively low pressure, means for conveying condensed refrigerant from the condenser to the evaporator and for reducing the pressure thereof to the pressure maintained in the evaporator, said evaporator having a portion of relatively low heat storage capacity for receiving the low pressure condensed refrigerant from the conveying means, a thermostatic device for controlling the operation of the condensing means and including a thermal responsive element disposed in heat transfer relation with the air in said zone, and a member of low heat storage capacity for conducting heat from the thermal responsive element to said portion of the evaporator of relatively low heat storage capacity, the arrangement being such that the temperature of said thermal responsive element is affected solely by the temperature of the air in said zone and the temperature of said portion of the evaporator of relatively low heat storage capacity.

6. In refrigerating apparatus, the combination of a cabinet structure embodying a chamber to be refrigerated, an evaporator for refrigerating the air in said chamber and including a portion of relatively small mass compared to the main body of the evaporator, an expansion device for conveying condensed refrigerant from the condensing means to the portion of the evaporator of small mass, thermostatic means for controlling the operation of the condensing means and including a thermal responsive element disposed in heat transfer relation with the air in said chamber, and a member of relatively low heat storage capacity connected to the portion of the evaporator of relatively small mass and defining a support for the thermal responsive element, the arrangement being such that the temperature of the thermal responsive element is affected solely by the temperature of the air in said chamber and the temperature of the portion of the evaporator of relatively small mass.

7. In refrigerating apparatus the combination of a cabinet structure embodying a chamber to be refrigerated, an evaporator for abstracting heat from said chamber and including an inlet conduit for condensed refrigerant, a compressor for withdrawing vaporous refrigerant from the evaporator, a condenser for liquefying the with-

drawn refrigerant, an expansion device having a relatively long passage of fixed flow area for conveying condensed refrigerant from the condenser to said inlet conduit, thermostatic means for controlling the operation of said compressor and including a thermal responsive element disposed in the air within said chamber and a heat conducting fin of relatively low heat storage capacity connecting said thermal responsive element and the inlet conduit of the evaporator for effecting transfer of heat therebetween, the arrangement of said inlet conduit, said thermal responsive element and the fin being such that the temperature of the thermal responsive element is affected solely by the temperature of the inlet conduit and the temperature of the air within said chamber.

8. In refrigerating apparatus, the combination of means for defining a zone to be refrigerated, an evaporator for abstracting heat from the air in said zone and including a portion of relatively small mass, means for circulating refrigerant through the evaporator, a thermostatic device for controlling the operation of the circulating means and including a thermal responsive element disposed in heat transfer relation with the air in said zone, and a member of low heat storage capacity connecting said thermal responsive element and the portion of the evaporator of relatively small mass for conducting heat therebetween, the arrangement of the evaporator portion of relatively small mass, said thermal responsive element and the member of low heat storage capacity being such that the temperature of the thermal responsive element is affected solely by the temperature of the air in said zone and the temperature of the portion of the evaporator of relatively small mass.

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