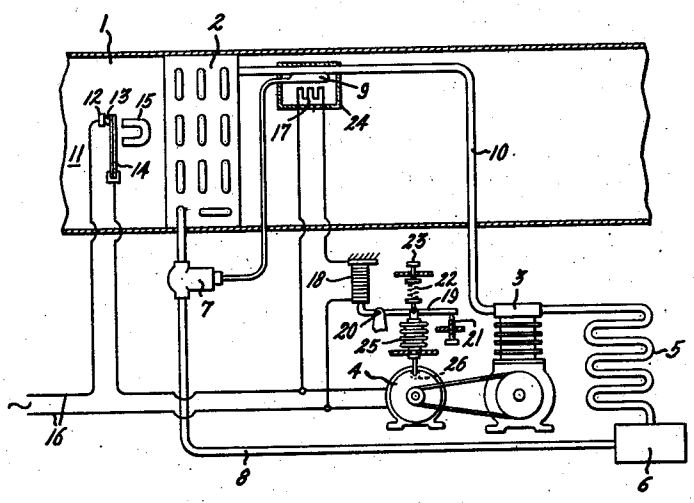
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REFRIGERATING SYSTEM

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Inventor:
Robert U. Berry,
by Harry E. Dunham
His Attorney.

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REFRIGERATING SYSTEM

Robert U. Berry, Glen Ridge, N. J., assignor to General Electric Company, a corporation of New York

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5 Claims. (Cl. 62—4)

My invention relates to refrigerating systems having refrigerant compressors driven by prime movers such as electric motors and particularly to arrangements for controlling such systems under abnormal operating conditions to avoid danger of overheating the prime mover.

My invention is an improvement on an invention of Wayne E. Dodson described and claimed in a copending application, Serial No. 542,782, filed concurrently herewith and assigned to the same assignee as the present invention, the present invention being disclosed but not claimed in the said Dodson application.

Refrigerating machines, particularly those required for supplying refrigeration in air conditioning systems, frequently encounter excessive loads particularly during summer weather or during the initial starting of the system after a long period of idleness. Various safety devices have been provided for preventing operation of the prime mover at excessive temperatures; however, such devices result in short cycling and in long periods when no refrigeration is supplied because of the time required for the prime mover to cool down sufficiently to permit restarting. In accordance with the aforesaid Dodson application, a control is provided which is responsive to the abnormal condition, such as a predetermined limiting temperature of the prime mover, and reduces the mass flow of refrigerant through the system thereby reducing the load on the prime mover and preventing excessive heating thereof; the system then continues to operate and provides an appreciable amount of cooling, although less than the full cooling capacity.

It is an object of my invention to provide a simple and effective control arrangement for minimizing overloading of the prime mover of a refrigerating system and which may be applied to an existing refrigerating system without alteration of the refrigerant circuit or reconstruction of the elements thereof.

It is a further object of my invention to provide a simple and effective arrangement for modifying the operation of the thermostatic expansion valve in a refrigerating system in response to changes in prime mover temperature to permit continued operation of the prime mover without excessive temperature rise.

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

For a better understanding of my invention reference may be had to the accompanying drawing the single figure of which represents diagrammatically an air conditioner provided with a refrigerating machine embodying my invention.

Referring now to the drawing, the air conditioner includes a duct 1 through which air is circulated by operation of a suitable blower (not shown) and in which is arranged an evaporator or cooling element 2 for reducing the temperature of the air as it passes through the duct. The evaporator 2 is connected in the closed refrigerant circuit of a refrigerating machine including a compressor 3 driven by an electric motor or prime mover 4 to supply hot compressed refrigerant to a condenser 5 which liquefies the refrigerant, the liquid refrigerant collecting in a liquid receiver 6. The flow of refrigerant to the evaporator 2 is controlled by a thermostatic expansion valve 7 arranged in a liquid line 8 connecting the receiver 6 and the evaporator 2. The valve 7 is provided with a temperature responsive feeler bulb 9 secured adjacent the outlet of the evaporator on a suction line 10 connecting the outlet of the evaporator and the intake of the compressor 3. The thermostatic expansion valve 7 is of the conventional type which operates to maintain a predetermined amount of superheat in the vaporized refrigerant withdrawn from the evaporator. In order to effect this control this type of valve includes a control element responsive to the pressure of the refrigerant in the evaporator and a second control element responsive to the temperature of the vaporized refrigerant withdrawn from the evaporator. These two elements act in opposition, the temperature responsive element tending to open and admit more liquid refrigerant to the evaporator upon a rise in temperature of the vaporized refrigerant and the pressure element tending to close the valve upon a rise in evaporator pressure.

The refrigerating machine illustrated is operated in accordance with the temperature of the air to be cooled as determined by a thermostat 11 located in the duct 1 ahead of the evaporator 2. The thermostat includes a stationary contact 12 and a movable contact 13 mounted on a bimetallic strip 14. The bimetallic strip 14 includes a magnetic portion, and a permanent magnet 15 is located adjacent the movable end of the strip to impart a snap acting characteristic to the thermostat in a manner known to the art. When the contacts 12 and 13 are closed on a demand for cooling, the thermostat connects the motor 4 across power supply lines 16. Operation of the

motor 4 continues as long as there is a demand for cooling as determined by the thermostat 11, and when the air in the duct reaches a predetermined low temperature the operation of the refrigerating machine is terminated. It will be understood that the control thermostat may be placed in any suitable location where it is responsive to the temperature of the air in the room to be cooled, it being assumed in the present instance that room air is returned to the duct 11 for cooling.

During the operation of the refrigerating machine illustrated, it may happen that the temperature of the cooling medium circulated over the condenser 5 rises to an abnormal value or that some other abnormal condition prevails such that an excessive load is placed upon the system and the temperature of the motor tends to become too great. Such excessive loading may be prevented in accordance with the invention of the aforesaid Dodson application by reducing the mass flow of refrigerant through the evaporator whenever the temperature of the motor tends to exceed a predetermined value. This permits continued operation of the motor with the system operating at reduced capacity and avoids the necessity of stopping the operation of the system completely after the motor has exceeded a temperature determined by the conventional high temperature safety control. In order to provide an effective arrangement for reducing the mass flow of refrigerant in the system which employs conventional circuit elements, I provide an electric heater 17 mounted adjacent the temperature feeler bulb 9. The heater 17 is connected across the motor terminals through a suitable variable impedance such as a carbon pile resistor 18. The pressure on the carbon pile 18 is arranged to be adjusted by a lever 19 pivoted at 20 and under normal operating conditions the amount of current supplied to the heater 17 is adjusted to a predetermined value by manually setting a stop 21 so that a spring 22 adjusted by a knob 23 presses the lever 19 against the stop which determines the maximum pressure on the carbon pile and the maximum current in the heater circuit. The heat supplied to the bulb 9 by the heater 17 produces a false ambient temperature about the bulb and the bulb and heater preferably are enclosed in an insulated casing 24 so that the temperature is not influenced by changes in the true ambient air temperature.

Should the temperature of the motor 4 rise due to abnormal operating conditions, a bellows 25 will be expanded by pressure produced by heat supplied to a thermal bulb 26 arranged in the motor, the bulb 26 being partially filled with a vaporizable liquid so that the pressure in the bellows 25 depends upon the temperature at the bulb 26. When the pressure in the bellows 25 exceeds a predetermined value selected by the setting of the spring 22, the bellows rotates the lever 19 in a counterclockwise direction to reduce the pressure on the carbon pile 18 and thereby decrease the flow of current through the heater 17. The resulting reduction of heat supplied to the bulb 9 reduces the opening of the expansion valve 7 for a given temperature and pressure of the vaporized refrigerant withdrawn from the evaporator. Consequently, the mass flow of refrigerant for a given operating condition is reduced and the motor 4 is maintained in operation to drive the compressor 3 and supply a substantial amount of refrigerant regardless of the abnormal condition and without danger of overheating the motor windings. Whenever the abnormal condition disappears the motor temperature falls and the control is restored to normal operation.

The arrangement of the heater 17 controlled in accordance with an abnormal condition, such as excessive temperature of the motor 4, provides a very simple and effective arrangement for modulating the operation of the expansion valve 7 so that the mass flow of refrigerant will be no greater than that which will permit the electric motor to operate without exceeding a predetermined desired temperature. It will readily be apparent that a control responsive to other conditions than the motor temperature, for example, a control responsive to motor current as disclosed in the aforesaid Dodson application may be employed to vary the energization of the heater 17.

While I have described a single embodiment of my invention in connection with an air conditioning system, having a compressor driven by an electric motor, other applications will readily be apparent to those skilled in the art. I do not, therefore, desire my invention to be limited to the particular arrangement illustrated and I intend in the appended claims to cover all modifications within the spirit and scope of my invention.

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

1. A refrigerating system including a compressor and a condenser and an evaporator, a prime mover for driving said compressor, an expansion valve having a control element arranged to be responsive to the temperature of the vaporized refrigerant withdrawn from said evaporator for controlling the flow of refrigerant from said condenser to said evaporator, a heater for supplying normally a predetermined amount of heat to said control element, and means dependent upon a predetermined abnormal operating condition of said prime mover for decreasing the amount of heat supplied by said heater to said element to decrease the flow of refrigerant to said evaporator without interrupting the operation of said prime mover.

2. A refrigerating system including a compressor, a condenser and an evaporator, a prime mover for driving said compressor, a thermostatic expansion valve having a control element arranged to be responsive to the temperature of the vaporized refrigerant withdrawn from said evaporator for controlling the flow of refrigerant to said evaporator to maintain a predetermined normal amount of superheat in the vaporized refrigerant, an electric heater for supplying a predetermined normal amount of heat to said control element, and means responsive to a predetermined abnormal operating temperature of said prime mover for decreasing the amount of heat supplied by said heater to said element to decrease the flow of refrigerant to said evaporator without interrupting the operation of said prime mover.

3. A refrigerating system including a compressor and a condenser and an evaporator, a prime mover for driving said compressor, an expansion valve having a control element arranged to be responsive to the temperature of the vaporized refrigerant withdrawn from said evaporator for controlling the flow of refrigerant from said condenser to said evaporator, means including an electric heater and a circuit therefor for supplying normally a predetermined amount of heat to said control element, means in said circuit for

varying the current supplied to said heater, and means dependent upon a predetermined abnormal operating condition of said prime mover for actuating said current varying means to decrease the current supplied to said heater whereby the flow of refrigerant to said evaporator is decreased without interrupting the operation of said prime mover.

4. A refrigerating system including a compressor, a condenser and an evaporator, an electric motor for driving said compressor, a thermostatic expansion valve having a control element arranged to be responsive to the temperature of the vaporized refrigerant withdrawn from said evaporator for controlling the flow to said evaporator to maintain a predetermined normal amount of superheat in the vaporized refrigerant, an electric heater and a circuit therefor for supplying a predetermined normal amount of heat to said control element, a variable impedance in said circuit, and means responsive to a predetermined abnormal operating temperature of said motor for adjusting said impedance to decrease the current supplied to said heater whereby the flow of refrigerant to said evaporator is decreased without interrupting the operation of said motor.

5. A refrigerating system including a compressor and a condenser and an evaporator, a prime mover for driving said compressor, an expansion valve having a control element arranged to be responsive to the temperature of the vaporized refrigerant withdrawn from said evaporator for controlling the flow of refrigerant from said condenser to said evaporator, a heater for supplying normally a predetermined amount of heat to said control element, and means dependent upon a predetermined abnormal operating condition of said system for decreasing the amount of heat supplied by said heater to said element to decrease the flow of refrigerant to said evaporator without interrupting the operation of said prime mover.

ROBERT U. BERRY.