

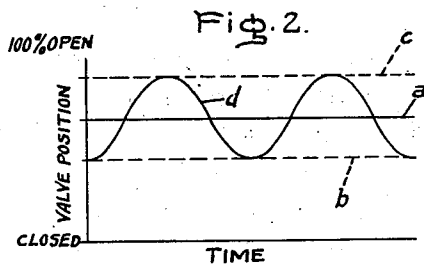
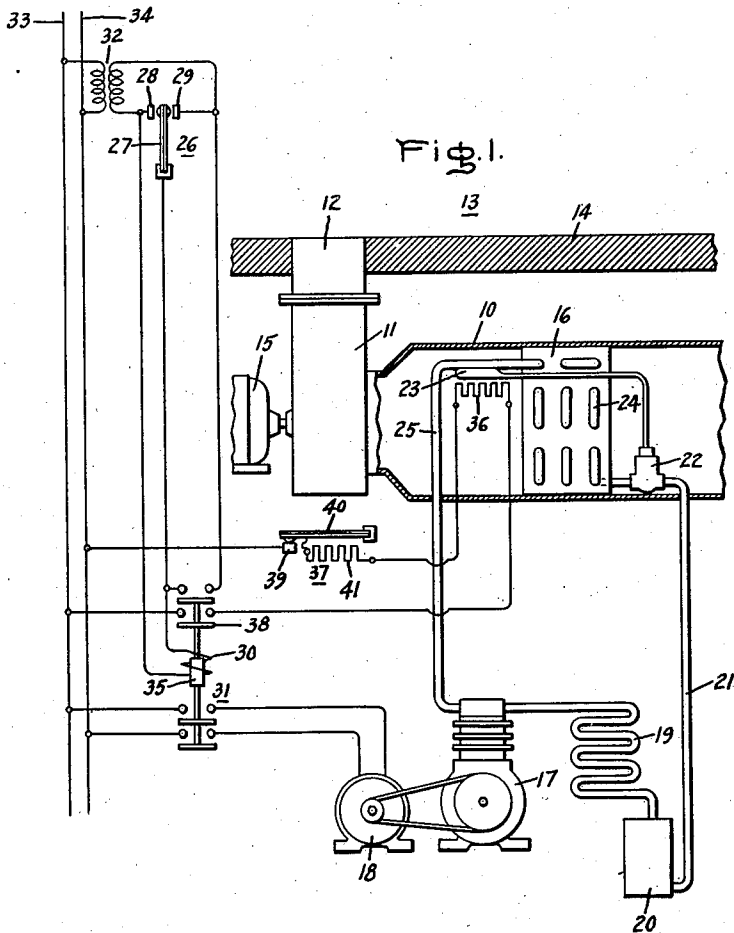
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W. O. LUM

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REFRIGERATING SYSTEM

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2,319,005

REFRIGERATING SYSTEM

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5 Claims. (Cl. 62—8)

My invention relates to refrigerating systems and particularly to devices for controlling the admission of refrigerant to the evaporators of refrigerating systems.

Expansion valves for controlling the admission of refrigerant to evaporators of refrigerating machines and particularly to evaporators of the non-flooded type are commonly controlled in accordance with the temperature and pressure conditions in the evaporator. One form of valve in common use is the thermostatic expansion valve which is provided with an element responsive to the pressure in the evaporator which tends to close the valve on an increase in pressure and an element responsive to the temperature of the refrigerant withdrawn from the evaporator which tends to open the valve on a rise in temperature. The operation of the thermostatic expansion valve is such that it tends to maintain substantially constant the amount of superheat in the vaporized refrigerant withdrawn from the evaporator. In some evaporators, for example those arranged directly in the air stream of an air conditioning system, in which there may be sudden changes in temperature, it becomes difficult to provide a temperature controlled expansion valve which will not "hunt" or, in other words, which will not overcorrect the flow of refrigerant in the direction of a momentary demand. For example, on a momentary demand for an increased flow of refrigerant, the valve may open wide and then upon a sudden change in demand, the valve will remain open and admit more refrigerant than desired and as a result it becomes necessary for the control to be corrected in the opposite direction. The momentary unstable period may therefore cause a hunting back and forth to overcorrection in each direction for a substantial period of time. This may result in an objectionable loss of efficiency in the operation of the evaporator.

It is an object of my invention to provide a refrigerating system including an improved arrangement for controlling the admission of refrigerant to the evaporator of the system.

Another object of my invention is to provide a refrigerating system including an evaporator and a thermostatically controlled expansion valve for regulating the flow of refrigerant to the evaporator and an improved arrangement for minimizing "hunting."

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 in which Fig. 1 is a diagrammatic view of an air conditioning system including a refrigerating machine embodying my invention and Fig. 2 is a curve illustrating the characteristics of operation of the control shown in Fig. 1.

Briefly, the air conditioning system shown in the drawing comprises an air circulating duct within which is arranged an evaporator of a compression type refrigerating machine. The supply of liquid refrigerant from the liquid receiver of the refrigerating machine to the evaporator is controlled by an expansion valve of the thermostatic type. In order to prevent hunting of the valve in its control of the admission of refrigerant to the evaporator, a timing device is arranged to modify the operation of the valve periodically so that it admits amounts of refrigerant alternately greater and less than the amount required by the evaporator for its operation under the prevailing conditions. In the illustrated embodiment of the invention the timing mechanism comprises a thermal timer which alternately energizes and deenergizes the circuit of a small electric heater placed adjacent the thermal element of the expansion valve. The valve is so adjusted that when the heater is off it will supply less refrigerant than required and when the heater is on it will supply more refrigerant than required.

Referring now to the drawing, in Fig. 1, I have illustrated an air conditioning system including a duct 10 arranged to receive air to be conditioned and to deliver the air through a fan 11 and a discharge duct 12 to a room 13 having a wall 14. The fan 11 is driven by a suitable electric motor 15. In order to cool the air passing through the duct 10, I provide a direct expansion evaporator 16 which may be of the finned tube type commonly employed for such installations. The evaporator 16 is connected in the refrigerant circuit of a refrigerating machine including a compressor 17 driven by an electric motor 18, a condenser 19 and a liquid receiver 20. During the operation of the compressor hot compressed refrigerant is delivered by the compressor to the condenser 19 where it is cooled and liquefied and flows to the liquid receiver 20. From the liquid receiver the refrigerant flows to the evaporator through a liquid line 21 under control of a thermostatic expansion valve 22 having a thermal element or bulb 23 secured in heat exchange rela-

tion with the evaporator adjacent its outlet. The expansion valve 22 may be of the thermostatic type commonly employed to control the superheat of the vaporized refrigerant withdrawn from the evaporator, such valves being provided with a temperature responsive element which tends to open the valve on a rise in temperature and a pressure responsive element which tends to close the valve on a rise in pressure. The evaporator comprises a continuous coil 24 extending back and forth across the duct 10. The refrigerant vaporized within the evaporator by the absorption of heat from air flowing from the duct 10 is withdrawn from the evaporator through a suction line 25 and returned to the compressor.

The operation of the refrigerating machine is controlled by a thermostat 26 including a bimetallic element 27 and stationary contacts 28 and 29. The thermostat 27 is arranged within the room 13, and upon a rise in temperature in the room, the bimetallic element 27 moves to the right and engages the contact 29. This connects a coil 30 of a switch 31 in the secondary circuit of a transformer 32, the primary of which is connected across alternating current supply lines 33 and 34. The energization of the coil 30 raises an armature 35 of the switch and moves the switch to its upper position. The top arm of the switch closes a holding circuit of the coil 30 and the two bottom arms of the switch connect the motor 18 to the supply lines 33 and 34, thereby starting the compressor 17.

The evaporator 16 has a relatively low mass and is of the type normally constructed of copper or other material having high heat conductivity. The transfer of heat from the air flowing over the evaporator to the refrigerant within the coil 24 is therefore rapid and changes in the temperature of the air are quickly reflected in the conditions of the refrigerant within the evaporator. A sudden change may cause the expansion valve 22 to open or close too far in an effort to correct the change, and if the changed condition is not sustained, the valve will attempt to correct in an opposite direction. This causes a swinging back and forth from open to closed position which constitutes hunting. Hunting is objectionable as it represents a loss in efficiency of operation of the evaporator. I have found that hunting may be minimized by providing an arrangement for periodically causing the valve to supply amounts of refrigerant alternately greater and less than the amount required for the desired condition of the evaporator. In the illustrated embodiment of my invention I have provided an electric heater 36 adjacent the thermal bulb 23 and have connected the heater in the circuit of a thermal timer 37 which circuit is energized upon operation of the switch 31, an arm 38 of which closes the circuit. The timer 37 comprises an electric switch having a stationary contact 39 and a movable contact mounted on a bimetallic element 40 which is connected in the circuit. An electric heater 41 is arranged in the circuit adjacent the bimetallic element 40. Whenever the heater 41 attains a predetermined temperature, the element 40 opens the switch and deenergizes the heater 36 and also the heater 41. The element 40 then cools and reestablishes the circuit. This operation obviously will continue at predetermined spaced intervals as long as the switch 33 is closed. The thermostatic valve 22 is so adjusted that when the heater 36 is deenergized, the valve will supply less refrigerant than

is required by the evaporator 16. It is therefore obvious that when the timer 37 opens and closes the circuit of the heater 36 it changes the control of the valve 22 alternately from supplying too much refrigerant to supplying too little refrigerant.

The manner in which the valve operates is readily apparent from a curve shown in Fig. 2 in which the degree of opening of the valve is plotted against time. The full line *a* represents the desired valve position for the particular condition under which the evaporator is operating. The dotted line *b* represents the degree of opening of the valve when the heater 36 is deenergized and the dotted line *c* represents the degree of opening of the valve when the heater is energized. The curve *d* is the operating curve of the valve when the heater 36 is being energized and deenergized alternately by operation of the timer 37. The resultant of the alternating operation as shown in curve *d* is to supply an amount of refrigerant corresponding to operation on the curve *a*, in other words, the alternate large and small amounts of refrigerant are chosen so that their average provides the desired amount to be admitted over any predetermined period. However, any hunting action due to momentary changes in the conditions of operation is minimized because of the alternating readjustment of the valve.

Another advantage of the quick alternating changes in the setting of the valve is that the effects of friction in the moving parts of the valve are minimized.

During the operation of the air conditioning system described above, whenever the temperature of the air in the room 13 rises above a predetermined value, the thermostat 26 operates to close the switch 31 and start the compressor and also starts the operation of the timer 37 to alternately energize and deenergize the heater 36. The thermostatic expansion valve 22 then supplies refrigerant to the evaporator 16 in amounts alternately greater and less than the amount actually required at any particular moment so that a waving characteristic curve such as shown in Fig. 2 is followed and hunting of the valve is minimized. Whenever the temperature of the air in the room 13 falls below a predetermined value the bimetallic element 27 moves to the left and engages the contact 28 and short-circuits the coil 30, thereby causing the switch 31 to drop out and disconnect the refrigerating system from the supply lines 33 and 34.

The above described arrangement for modifying the operation of a thermostatic expansion valve is particularly desirable for refrigerating systems in which it is necessary to operate the evaporator so that the superheat temperature of the refrigerant withdrawn from the evaporator is only slightly above the temperature of saturation. In installations of this type the effects of friction in the mechanism and hunting due to sudden changes in temperature or pressure within the evaporator are particularly noticeable and a control embodying my invention offsets these effects to a very considerable degree.

From the foregoing it is readily apparent that I have provided a simple and effective arrangement for preventing hunting during the operation of a refrigerating system employing a temperature responsive valve and furthermore that I have provided an arrangement for minimizing

the effects of friction in the moving parts of the valve.

While I have illustrated my invention in connection with an air conditioning system employing a finned tube evaporator, 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 construction described and 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 an evaporator, an expansion valve for controlling the admission of refrigerant to said evaporator, means including a temperature responsive element secured in heat exchange relation with said evaporator for actuating said valve normally to admit less than the amount of refrigerant required by said evaporator, and means for applying heat periodically to said element to cause said valve to admit to said evaporator an amount of refrigerant greater than required by said evaporator whereby said valve admits to said evaporator amounts of refrigerant alternately greater than and less than the amount required by said evaporator, the degrees of opening of said valve when admitting said greater and lesser amounts of refrigerant, respectively, being selected so that the average amount of refrigerant admitted is the amount required by said evaporator.

2. A refrigerating system including an evaporator, a thermostatic expansion valve for controlling the admission of refrigerant to said evaporator and for normally admitting less refrigerant than required by said evaporator, said valve including a thermal element responsive to the temperature of refrigerant withdrawn from said evaporator, a heating element adjacent said thermal element, and a timing means for energizing said heating element periodically during the operation of said system to cause said valve to admit to said evaporator an amount of refrigerant greater than required by said evaporator whereby said valve during operation of said system admits to said evaporator amounts of refrigerant alternately greater than and less than the amount required by said evaporator, the degrees of opening of said valve when admitting said greater and lesser amounts of refrigerant, respectively, being selected so that the average amount of refrigerant admitted is the amount required by said evaporator.

3. A refrigerating system including an evaporator, an expansion valve for controlling the admission of refrigerant to said evaporator, means including a temperature responsive element secured in heat exchange relation with said evaporator for actuating said valve normally to admit less refrigerant than the amount required by said evaporator, means including an electric heating element and a circuit for energizing the same for applying heat to said temperature responsive element whereby said valve will admit

more than the required amount of refrigerant to said evaporator, and means including a switch in said circuit and a timing mechanism for energizing said circuit periodically during the operation of said system whereby said valve is actuated to admit to said evaporator amounts of refrigerant alternately greater than and less than the amount required by said evaporator, the degrees of opening of said valve when admitting said greater and lesser amounts of refrigerant, respectively, being selected so that the average amount of refrigerant admitted is the amount required by said evaporator.

4. A refrigerating system including an evaporator, a thermostatic expansion valve for controlling the admission of refrigerant to said evaporator, said valve including a thermal element responsive to the temperature of refrigerant withdrawn from said evaporator for actuating said valve normally to admit to said evaporator an amount of refrigerant less than required thereby, an electric heating element adjacent said thermal element for modifying the operation of said valve to admit to said evaporator more than the required amount of refrigerant, a circuit for said heating element, means for energizing said circuit simultaneously with the starting of said refrigerating system, and means including a timing mechanism for periodically interrupting the circuit of said electric heating element during the operation of said system to cause said valve to admit to said evaporator amounts of refrigerant alternately greater than and less than the amount required by said evaporator.

5. A refrigerating system including an evaporator and a condensing unit for supplying liquid refrigerant to said evaporator, means for circulating a medium to be cooled over said evaporator, a thermostatic expansion valve for controlling the admission of liquid refrigerant to said evaporator, said valve including a thermal element responsive to the temperature of vaporized refrigerant withdrawn from said evaporator for actuating said valve normally to admit to said evaporator an amount of refrigerant less than the amount required thereby, an electric heating element adjacent said thermal element for modifying the operation of said valve to admit to said evaporator more than the required amount of liquid refrigerant, an electric circuit for said heating element, means responsive to the temperature of the medium to be cooled by said evaporator for controlling the operation of said refrigerating system, means for energizing said electric circuit simultaneously with the starting of said refrigerating system and for deenergizing said circuit when said system is stopped, and means including a timing mechanism for periodically interrupting said electric circuit during the operation of said system to cause said valve to admit to said evaporator amounts of refrigerant alternately greater than and less than the amount required by said evaporator.

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