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CONTROL BULB FOR THERMAL EXPANSION VALVES

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FIG. 1

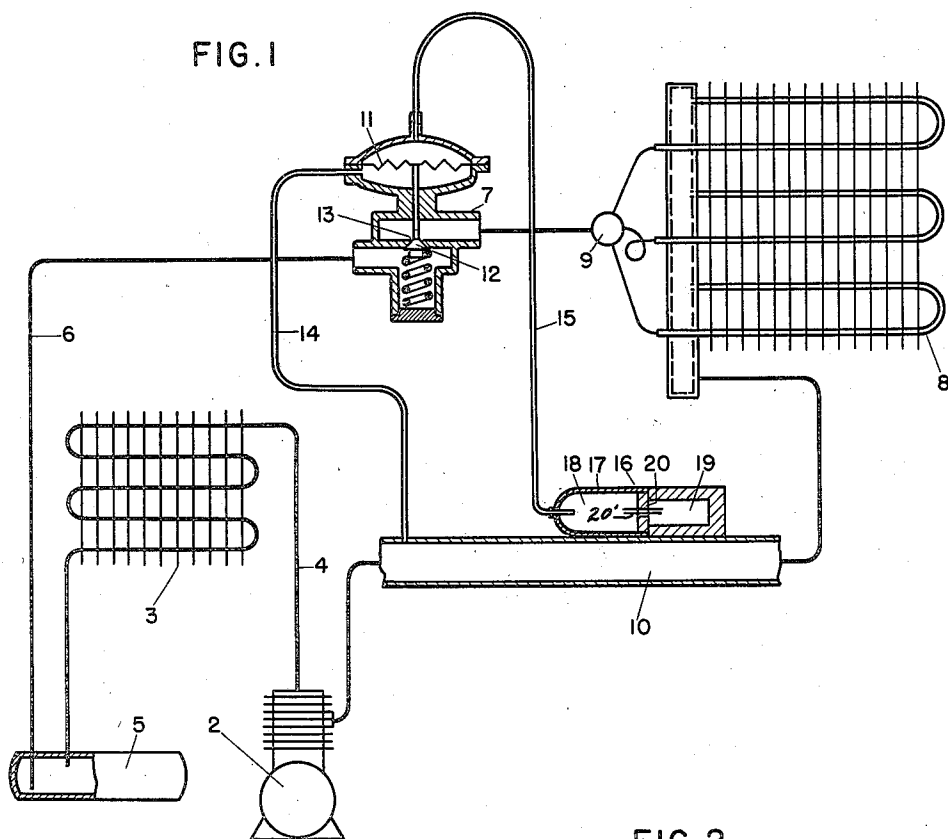
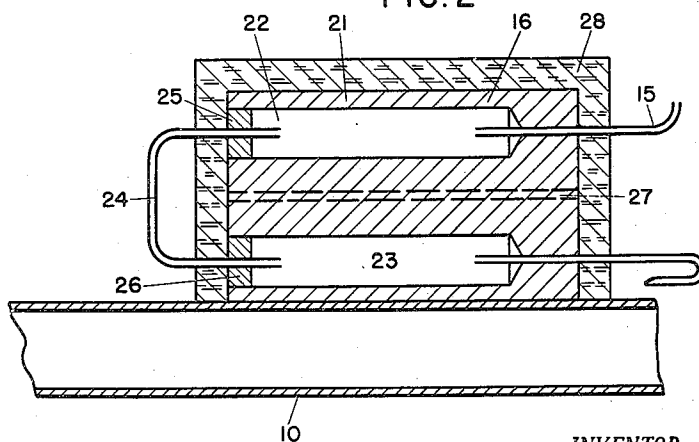


FIG. 2



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CONTROL BULB FOR THERMAL EXPANSION VALVES

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Application August 20, 1947, Serial No. 769,750

1 Claim. (Cl. 62—3)

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This application relates to a modification of the invention embodied in my co-pending application, Serial No. 730,605, filed February 24, 1947, which discloses a refrigeration system including a thermal expansion valve for regulating passage of refrigerant to the evaporator and equipped with suitable means to prevent "hunting" or cycling of the expansion valve when the system is in use.

"Hunting" or cycling of the expansion valve in a refrigeration system results from an unfavorable relationship between throttling range on the valve, valve size, valve throttling characteristic, length of circuit and hence time delay in the evaporator, and speed of response of the control bulb. This problem creates considerable difficulty resulting in unstable operation, unsatisfactory evaporator conditions, and may cause damage to the compressor because of repeated cut-in and cut-out from suction pressure. To eliminate the disadvantage, it has been proposed to provide the control bulb with considerable mass to render it impossible for the bulb to move the valve quickly, permitting the valve to be moved only at a relatively slow rate. Unfortunately, this proposal is not effective for if there is a sudden change in load imposed upon the evaporator the valve is incapable of moving sufficiently rapid to correct for the sudden change; as a result, liquid refrigerant is permitted to feed through the evaporator, carrying over to the compressor with resulting damage to the compressor.

The chief object of the present invention is to provide a regulating member for a thermal expansion valve which obviates "hunting" or cycling of the expansion valve when the system is in use.

An object of the invention is to provide a regulating member for a thermal expansion valve which permits prompt response of the valve to a decrease in temperature in the suction line of a refrigeration system while retarding response of the valve to an increase in temperature in the suction line. Other objects of my invention will be readily perceived from the following description.

This invention relates to a regulating member for a thermal expansion valve which comprises a first element adapted to respond rapidly to a change in temperature, a second element adapted to respond less rapidly to a change in temperature, the member being filled in such manner as to contain a minor quantity of liquid at its coldest point during operation at normal temperature ranges, said elements being so disposed with respect to each other that upon a decrease in temperature in the first element the valve responds promptly to such decrease while upon an increase in temperature in such element action of the valve is retarded.

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This invention further relates to a refrigeration system of the compressor-condenser-expander type including, in combination, an expansion valve for regulating flow of refrigerant to the evaporator, and a thermal responsive system responsive to change of temperature in the suction line for actuating the expansion valve to move toward open or closed positions, said system including a first element adapted to respond rapidly to a change in temperature in the suction line, a second element adapted to respond less rapidly to a change in temperature, the system being filled in such manner as to contain a minor quantity of liquid at its coldest point during operation at normal temperature ranges, said elements being so disposed with relation to one another that upon a decrease in temperature in the suction line condensation of the fill occurs at the first element permitting the valve to respond promptly to such decrease while upon an increase in temperature in the suction line condensation of the fill occurs at the second element retarding response of the valve to such increase in temperature.

The attached drawing illustrates a preferred embodiment of the invention, in which

Figure 1 is a diagrammatic view of a refrigeration system including the control means of the present invention in exaggerated scale; and

Figure 2 is a sectional view illustrating a modification of the control.

Referring to the drawing, in Figure 1 there is shown a refrigeration system of the compressor-condenser-expander type including the regulating means of the present invention. The system comprises a compressor 2, a condenser 3 connected to the compressor by discharge line 4, and a receiver 5 adapted to receive condensed liquid refrigerant, the condensed liquid refrigerant passing through liquid line 6 to a thermal expansion valve 7 which regulates the passage of refrigerant to evaporator 8 through a distributor 9 which supplies the refrigerant to the various coils of evaporator 8. Refrigerant is evaporated in evaporator 8, the gaseous refrigerant returning through suction line 10 to compressor 2.

Expansion valve 7 includes a diaphragm 11 adapted to move a valve member 12 toward and from a port 13 to regulate passage of refrigerant through the valve. Pressure is imposed against one side of diaphragm 11 by means of equalizer line 14 connected to suction line 10. Pressure is imposed against the opposite side of diaphragm 11 through a capillary tube 15 connected to a thermal responsive member 16 disposed adjacent the suction line 10. The chamber in valve 7 above diaphragm 11, capillary tube 15 and member 16 are gas charged; that is, they are filled with saturated gas at a temperature representing the normal upper limit of suction line tem-

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perature. During operation at normal temperature ranges, a minor quantity of liquid is present and such liquid will locate at the coldest point of member 16.

Thermal responsive member 16 may consist of a shell 17 enclosing elements 18 and 19, capillary tube 15 being connected to one of the elements, as shown element 18, and element 19 being connected or open to element 18. Preferably, the wall of element 19 is thicker than the wall of element 18; thus, the "fill" in element 18 responds more rapidly to a change in temperature (superheat) in suction line 10 than the "fill" in element 19 since the wall of element 19 having a heavier mass will not warm or cool as quickly as the wall of element 18 which possesses less mass. In effect, each element forms a chamber enclosed by a wall which differs in thickness from the wall enclosing the other chamber, such chambers being open to each other to permit "fill" to condense in either depending upon the temperature therein.

For ease of assembly, elements 18 and 19 may be formed separately; for example, element 19, as shown in Figure 1, may be provided with a plug-like portion 20 adapted to fit within element 18, the joint between elements 18 and 19 being sealed in any suitable manner.

If desired, the wall of element 19 may be made of a material of low thermal conductivity such as stainless steel while the wall of element 18 may be made of a material having a relatively high thermal conductivity such as copper. Under such circumstances, the walls of the respective elements may be made more nearly the same thickness. A reentrant tube 20', if desired, may be disposed in the opening connecting the chambers.

In either case, it will be appreciated flow of condensed refrigerant from one element to the other should be prevented so that the only movement of "fill" between the elements is in the form of gas.

In operation, assume the thermal system is controlling the expansion valve at a stable point and that a change in temperature (an increase in superheat) occurs in the suction line due to a change in load. Suction line 10 warms and the wall of element 18, having relatively small mass, warms quickly; element 19, having a relatively greater mass, warms more slowly. Since, under the circumstances, element 19 is colder than element 18, liquid adjacent the wall of element 18 evaporates and condenses at element 19. Pressure imposed upon the diaphragm 11 of expansion valve 7, therefore, corresponds to the temperature at element 19. Instead of the valve opening quickly, its action is retarded and occurs only at the rate of speed with which element 19 changes in temperature. Thus, on a rise in temperature the opening of valve 7 is retarded.

Assume, however, that the change in temperature is a decrease in superheat such as might occur if air flow over the evaporator were discontinued suddenly. The temperature of the suction line reduces; the wall of element 18 having less mass than the wall of element 19 permits a rapid response. Element 18 is then colder than element 19; liquid in element 19 evaporates and condenses at element 18. The pressure imposed against diaphragm 11 of valve 7 corresponds to the temperature of element 18. Valve 7 thus responds quickly. Cycling which occurs when an expansion valve responds quickly in both opening and closing directions is greatly retarded or substantially eliminated.

In Figure 2, a modification of the present inven-

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tion is illustrated. In this case, member 16 consists of a metal block 21 provided with openings 22 and 23 connected to one another by capillary tube 24 and closed by plugs 25 and 26. Opening 23 may be considered as adjacent the suction line when the member is in use while opening 24 is more remote from the suction line and hence "fill" therein responds less rapidly to a change in temperature in the suction line. Member 16 is filled as described above. Operation of the member is the same as described in connection with Figure 1. If desired, a plurality of small openings 27 may be provided in block 21 between openings 22 and 23 thus further retarding the response of "fill" in opening 22 to a change in temperature in the suction line 10.

Members 16 shown in Figures 1 and 2 may be shielded from ambient atmosphere by means of any suitable insulating material 28.

The present control system eliminates for all practical purposes "hunting" or cycling of a thermal expansion valve employed in a refrigeration system. The control member is inexpensive and simple to install. By its use, materially improved performance of refrigeration systems of the compressor-condenser-expander type may be achieved.

While I have described a preferred embodiment of my invention it will be understood my invention is not limited thereto since it may be otherwise embodied within the scope of the following claim.

I claim:

A regulating member for a thermal expansion valve which comprises a thermal responsive element responsive to the temperature of refrigerant in the suction line of a refrigeration system, said element having an opening therein at a predetermined distance from the suction line, said element having a second opening therein at a greater distance from the suction line, said openings being connected and being charged with a fill comprising saturated gas at a temperature representing the normal upper limit of suction line temperature whereby during operation at normal temperature ranges a minor quantity of liquid is present at the coldest point of the openings, said element having a plurality of minor openings formed in said element between the first opening and the second opening to retard response of the fill in the second opening to a change in temperature in the suction line, the first and second openings being so disposed with respect to each other that, upon a decrease in temperature in the suction line during operation of the refrigeration system, the liquid is present in the first opening so that the valve responds promptly to such decrease while, upon an increase in temperature in the suction line during operation of the refrigeration system, the liquid in the first opening evaporates and condenses in the second opening thereby retarding action of the valve by condensation of fill at the coldest point of the opening to obviate "hunting" when the valve is in use.

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