

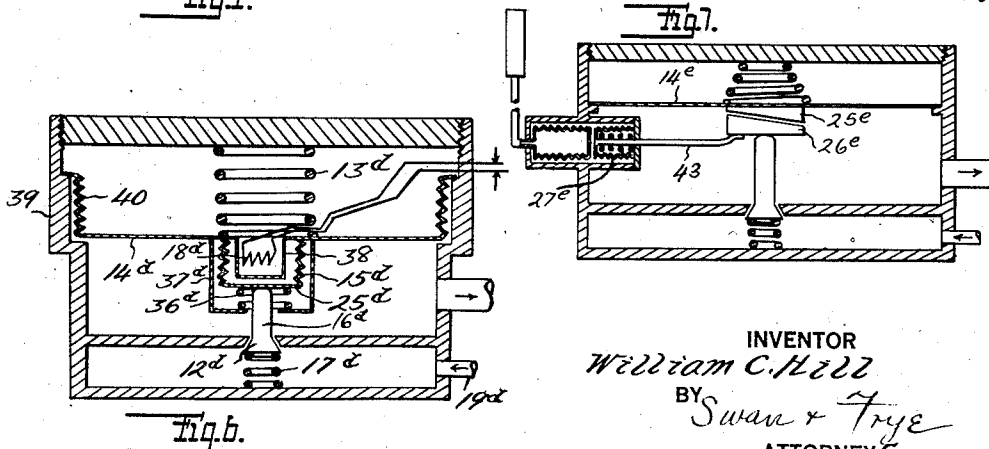
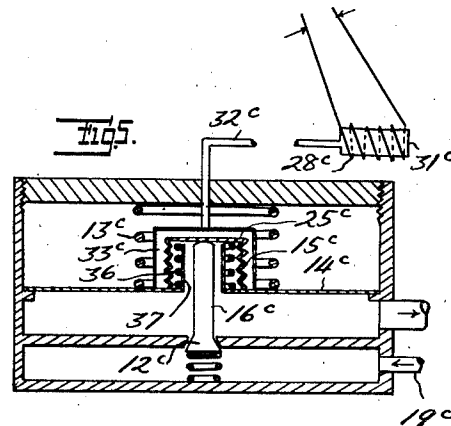
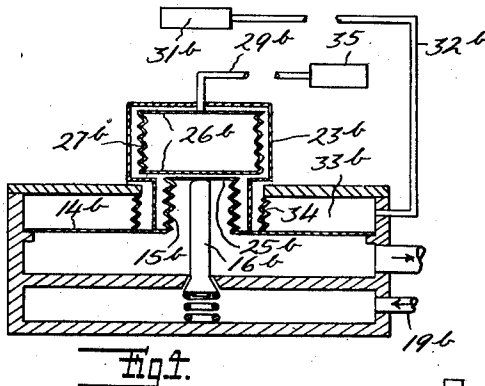
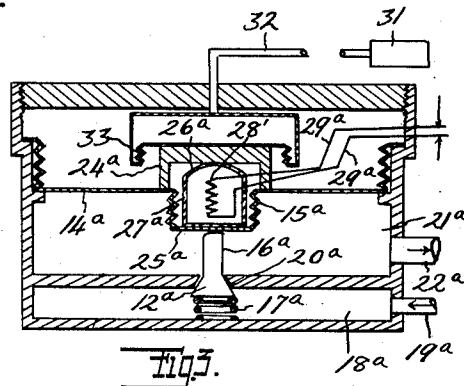
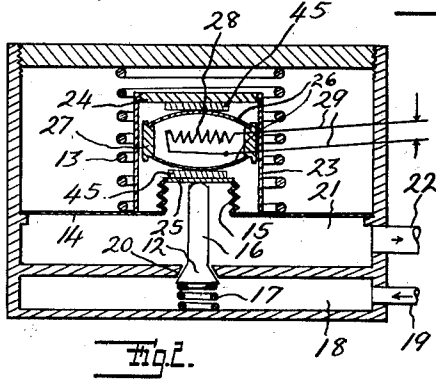
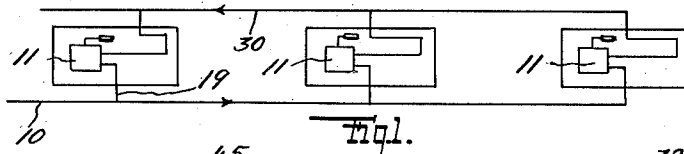
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EXPANSION VALVE REGULATING MECHANISM FOR REFRIGERATING SYSTEMS

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EXPANSION VALVE REGULATING MECHANISM FOR REFRIGERATING SYSTEMS

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14 Claims. (Cl. 62-8)

This invention relates to expansion valves of the type commonly used in mechanical refrigeration systems, and has for one of its objects provision of a greatly improved expansion valve having especial utility when arranged to independently control the supply of refrigerant to one of a plurality of evaporators all of which are incorporated in the same refrigerating circuit, that is, supplied by the same compressor with refrigerant which returns thereto.

Another object of this invention is the provision of such an expansion valve as will maintain one of a plurality of so arranged cooling units at any desired temperature, independently of the temperature of the other units, and semi-independently of the back-pressure in the evaporator. As is well known, most of such expansion valves, when incorporated in a mechanical refrigerating circuit of the usual type comprising a compressor, condenser, expansion valve and evaporator, rely for their operation upon the rise and fall of back-pressure generated in the evaporator or expansion tank, by the presence therein or absence thereof of sufficient gaseous refrigerant at sufficiently high pressure to permit closure or opening of the valve under the influence of one of a pair of opposed springs or the like. When a number of evaporators, each having its own expansion valve, are supplied from a single compressor and condenser, however, it becomes a practical impossibility to maintain such evaporators at variant temperatures (which is frequently a desideratum) as the back pressure in such units tends to equalize, due to their connection to a common return line.

It is an object of this invention to so control the operation of each expansion valve, independently of the back pressure in its evaporator, that such units may be maintained at any desired variant temperature.

It is also an object of this invention to provide improved electrical controlling means for the operation of an expansion valve.

A still further object of this invention lies in the provision of means for preventing undesired opening of the expansion valve of a refrigerating system when the pressure on its "low side" falls below the reduced point at which the valve normally opens.

Other objects and advantages will be apparent from the following description, wherein reference is made to the accompanying drawing illustrating preferred embodiments of my invention, and wherein similar reference numerals

designate similar parts throughout the several views.

In the drawing:

Figure 1 is a fragmentary schematic diagram of a refrigerating system, showing a plurality of cooling units connected to refrigerant supply and return lines.

Figure 2 is a sectional and partly diagrammatic view of an expansion valve incorporating one form of my invention.

Figures 3, 4, 5, 6, and 7 are views similar to Figure 2 of expansion valves incorporating somewhat modified forms of my invention.

Referring now to the drawing, reference character 10 represents a refrigerant supply pipe, on the "high side" of a circulatory refrigerating system, and 11 a plurality of expansion valves and their appurtenant pipes located in suitable and desired positions therealong, for controlling the supply of refrigerant to separate evaporators. Since this invention concerns itself entirely with expansion valve constructions, no attempt is made to illustrate or describe in detail the other portions of a refrigerating system, further than is necessary to render clear the present disclosure. It is to be understood moreover that such refrigerating apparatus may be of any desired form and construction, and that my improved expansion valve might also be adapted to numerous other uses.

In the construction shown in Figure 2, the valve 12 is normally maintained in opened position by the compression spring 13, which urges downwardly the diaphragm 14, the central offset syphon portion 15 of which is engaged by the stem 16 of the valve 12. The valve is urged toward closed position by the spring 17, which is of course weaker than the spring 13. Refrigerant enters the chamber 18 through the supply tube 19, which is connected to the main supply line 10, and passes through the valve orifice 20 to the chamber 21 immediately beneath the diaphragm 14, whence it is conducted to the evaporator by the tube 22. It will be obvious that when the pressure rises sufficiently in the chamber 21, due to the boiling of the refrigerant in the evaporator, the tendency of the thus generated back pressure is to lift the diaphragm 14 against the force of the spring 13, which, in an ordinary expansion valve construction would permit the spring 17 to close the valve and halt the flow of refrigerant. Thus far my improved expansion valve functions in the normal manner.

In a system incorporating an expansion valve of the ordinary type, as above remarked, as soon

as the pressure in the chamber 21 falls sufficiently, the valve reopens, as the spring 13 then overcomes the opposing force of the spring 17. This is frequently undesirable, as it may be desired to maintain the evaporator controlled by this particular expansion valve at a higher temperature than the possible minimum. To prevent reopening of the valve, despite the decreasing back-pressure, until a desired temperature has been attained, I provide the diaphragm 14 with the above mentioned offset flexible bellows or syphon portion 15, against which the valve stem engages. A sleeve 23 surrounds such syphon portion, and its bottom is secured to the diaphragm. The sleeve is provided with an end cap 24 at its upper extremity, which may be screw-threaded therein to permit adjustment, as shown in Figure 2. The upper end of the flexible bellows portion 15 of the diaphragm 14 is closed by a relatively stiff buffer plate 25, which receives the thrust of the valve stem 16. It will be apparent that, due to the flexibility of the bellows 15, in order to open the valve, or to maintain the same in opened position, the downward movement of the spring 13 must be transmitted through the buffer plate 25, as the downward force exerted by spring 13 on the main diaphragm 14 is rendered relatively ineffective by the interposition of the bellows 15 between the diaphragm and valve stem.

Between the end cap 24 and the buffer plate 25 is positioned a thrust-transmitting element, which may be rendered operable or ineffective by suitable outside controlling means. The thrust-transmitting member is shown in Figure 2 as comprising a pair of relatively flexible and outwardly convexed metallic plates 26, secured to a cylindrical retainer 27 which is slidable within the sleeve 23. The normal tendency of the plates 26 is to collapse sufficiently to prevent transmission of enough of the thrust of the spring 13 to the valve stem to effect the opening of the valve. An electrical heating element 28 incorporated in the thrust-transmitting member is adapted when heated to swell the plates 26 sufficiently to establish contact between plates 24 and 25, thereby rendering the spring 13 operative to open the expansion valve, provided the pressure in the chamber 21 is sufficiently reduced. The flexible conductors 29 may connect the heating element with a thermostat (not shown) in the refrigerated zone, or other suitable outside controlling means, automatic or otherwise. If desired pads or spacers 45 formed of material of poor thermal conductivity may be used to separate and insulate the buffer plate 25 and the adjacent one of the plates 26 on the one hand and the end cap 24 and another one of the plates 26 on the other side.

It will be apparent that as long as the heating element 28 is energized and the plates 26 distended, the valve will function in the normal manner, but that when the plates of the thrust-transmitting member are allowed to collapse, due to the de-energization of the heating element, the valve will remain closed, since the thrust of the spring 13 is then ineffective to open it. In this manner a thermostat may be arranged to so control the functioning of the expansion valve that the valve may be allowed to remain closed, independently of falling pressure on the low side, until the temperature in the refrigerated zone reaches any desired point at which the thermostat may be set; and this though the evaporator may be one of several

connected to a common return line, as 30, Figure 1.

In Figures 3, 4, 5, 6 and 7 are illustrated somewhat modified forms of my invention, all of which are productive of similar results. In Figure 3 is shown an expansion valve normally controlled in the conventional manner by a thermostat comprising the bulb 31, connected tube 32 and bellows 33, in which may be trapped a suitable volatile fluid in the well known manner. The thrust of the bellows 33 is transmitted to the thrust plate 14^a through the crown cap 24^a. The thrust plate 14^a will be seen to be centrally provided with an offset flexible syphon portion 15^a, similar to the portion 15 previously described, but extending in the opposite direction. A relatively stiff buffer plate 25^a similarly closes the end of the syphon portion and bears against the stem 16^a. A thrust-transmitting member may be provided partially housed within the syphon portion 15^a, and comprising a substantially cylindrical cupped portion 27^a closed at its upper end by a distortable outwardly convexed metallic cap 26^a. A heating element 28' is similarly provided within the thrust-transmitting member, which, when heated, is adapted to expand the air or other fluid contents of the thrust-transmitting member, to upwardly distend the cap 26^a. It will be seen that the pressure exerted by the bellows 33 can only be made effective to open or maintain in open position the valve 12^a when the heating element 28^a is energized and the thrust-transmitting member expanded to operatively connect the buffer plate 25^a and cap 24^a, upon which the thrust of the bellows is directly imposed. The flexible leads 29^a may connect the electrical heating element with any suitable outside controlling means, in the manner set forth in connection with the first described embodiment, and it will be seen that when the heating element is energized the operation of this form of my invention is also similar to that of an ordinary expansion valve; and accordingly need not again be described. The parts of such conventional portions of the device are numbered similarly to those of the first described embodiment, with the addition of "a" exponents to the reference characters. The construction shown in Figure 4 differs from that of Figure 3 principally in that the combined chamber 33^b and diaphragm 14^b serve the function performed, as to the construction shown in Figure 3 by the thrust plate 14^a and the bellows 33.

Figure 4 shows another somewhat modified form of my invention in which a conventional type of thermostatic control may be provided, governed by the bulb 31^b, tube 32^b and chamber 33^b, which is closed by the diaphragm 14^b to which the chamber is sealed by the flexible bellows 34. Such thermostatic controlling means may be rendered normally ineffective to open the expansion valve in a similar fashion, as by centrally providing the diaphragm 14^b with an offset flexible portion 15^b closed by a buffer cap 25^b, against which the valve stem 16^b engages. Secured to and movable with the diaphragm 14^b surrounding the syphon 15^b is a light but rigid housing 23^b, which is provided with an enlarged cylindrical upper extremity serving as a casing for the bellows 27^b, which constitutes an auxiliary thermostatic element and is connected by means of the tube 29^b to the bulb 35. The bellows 27^b will be seen in this embodiment to

constitute the thrust-transmitting element, and its operation will be seen to be controlled thermostatically rather than electrically, although this is of course optional. Only when the bellows 27^b is expanded sufficiently to permit sufficient transmission of the downward pressure upon the diaphragm, exerted within the thermostatic chamber 33^b by engagement of the end caps 26^b of the bellows with the buffer plate 25^b and the upper end of the housing 23^b, is the expansion valve operable in the normal manner, that is, under the control of the thermostatic bulb 31^b as to the opening of the valve.

As shown in Figure 5, the expansion valve may be controlled by a thermostatic bulb 31^c, which is in turn controlled by an electrical heating element 28^c. The thrust of the spring 13^c is in this embodiment imposed directly upon the diaphragm 14^c, but is rendered ineffective to open the valve under normal conditions by the offset syphon portion 15^c, against the buffer plate 25^c of which the valve stem 16^c engages. The thermostatic chamber 33^c may be closed by the same syphon, 15^c, as there shown, and is connected to the bulb 31^c by the tube 32^c. The end or buffer plate 25^c of the syphon is normally urged upwardly and away from the end of the valve stem by the coil spring 36. This spring may be positioned by an upwardly projecting boss or sleeve portion 37 carried by the diaphragm 14^c. The fluid within the connected bulb 31^c, tube 32^c and chamber 33^c is of such quantity and volatility that it cannot expand sufficiently under normal operating conditions to move the plate 25^c downwardly into engagement with the valve stem, to permit opening of the valve 12^c, except when the heating element 28^c is energized to sufficiently expand the contents of the thermostatic system. It will of course be obvious that the energization or otherwise of the bulb 31^c may be regulated in the same manner as that provided as to the bulb 35 in the construction shown in Figure 4.

The modified form shown in Figure 6 is also electrically controlled, and the heating element 18^d may be housed in a cupped central portion 38 formed in the thrust plate 14^d. The thrust plate is connected to the housing 39 of the valve by a flexible bellows 40, and the downward force of the spring 13^d, tending to open the valve 12^d against the tension of the spring 17^d, must be exerted through the syphon 15^d and its buffer cap 25^d. The flexibility of the syphon is such, however, that sufficient pressure cannot be transmitted to accomplish opening or maintenance of the valve in open position unless the air or other fluid trapped between the syphon 15^d and cupped portion 38 of the diaphragm is expanded, as by energization of the heating element 18^d. The plate 25^d is normally urged away from the end of the valve stem by the spring 36^d, which is supported by a spider or cupped support 37^d secured to the thrust plate 14^d. Actual separation of the plate 25^d and the valve stem 16^d may occur, dependent upon the degree of energization of the heating element 18^d. The operation of the remainder of this embodiment of my invention will be seen to be analogous to the operation of the embodiments previously described.

As shown in Figure 7, a member in the nature of a wedge, as 26^e may be interposed between the end of the valve stem and the pressure-responsive diaphragm 14^e, which may be moved to the left, as viewed in that Figure, to so sepa-

rate the complementarily wedge-shaped buffer 25^e carried by the diaphragm 14^e from the valve stem as to render the latter non-actuatable by the former. The wedge member 26^e may be operable in any suitable manner, analogous to one of those previously described, as by the bellows 27^e connected thereto by the link 43, and the like functioning of the device to those previously described will be apparent.

As to each of the suggested modified forms shown in Figures 3 to 7 inclusive, pads of insulating or semi-insulating material similar to the pads 45 described as to the construction shown in Figure 2 may, if desired, be used to adequately separate the heat-energized parts from the adjacent cap and buffer plates.

It will be apparent that by employing one or more of my improved expansion valves provided with auxiliary controlling means in the manner herein described, in conjunction with such an arrangement of independent cooling units as is diagrammed in Figure 1, it is possible to govern with complete independence the temperature at which each unit will be maintained by its valve. It will also be seen that many other modifications of the principles herein disclosed might be made, by changes of construction and arrangement which would nevertheless fall within the spirit of this invention, and which I contemplate as being within the scope thereof.

What I claim is:

1. In an expansion valve, a valve member, a valve seat, actuating means for moving the valve relatively to the seat, means connecting the valve member and actuating means, and temperature-responsive means for rendering such connecting means ineffective.

2. In an expansion valve, a valve seat, a valve member movable relatively to the seat, actuating means including a movable pressure-responsive member for governing movement of the valve member, means forming a plurality of parts connecting the valve member and actuating means to enable controlling the former by the latter, and temperature controllable means for preventing movement of one part of said connecting means by another to render said connecting means ineffective at desired times.

3. In combination with a circulatory refrigerating system including a plurality of evaporators, an expansion valve for independently controlling the flow of refrigerant through each evaporator, each valve including a valve seat, a valve member movable relatively to the seat, a movable diaphragm member for governing the actuating of the valve member, means connecting the valve and diaphragm members to enable controlling the motivation of the former by the latter, and means subject to outside control for preventing operation of said connecting means.

4. In a circulatory refrigerating system including a plurality of evaporators, an expansion valve for controlling the admission of refrigerant to each evaporator, each valve including a valve member, a valve seat, a pressure-responsive member for moving the valve relatively to its seat, means connecting the valve and valve actuating members, and means for rendering said connecting means ineffective in response to temperature conditions temporarily prevailing in the area refrigerated by the evaporator controlled thereby, comprising a member forming part of said connecting means, and movable to break the continuity thereof, and means re-

sponsive to temperature changes in said area for moving said member.

5. In a refrigerating system including an evaporator, an expansion valve controlling the admission of refrigerant to the evaporator, means normally responsive to pressure variances in the evaporator for actuating the valve toward opened or closed position, means mechanically connecting the valve and its actuating means, and a member forming part of the connecting means and controllable in response to varying temperature conditions in the refrigerated area for breaking such mechanical connection to render the pressure-responsive actuating means inoperative to move the valve.

6. In an expansion valve, a valve member, means for actuating said valve, means connecting the valve and the actuating member, and temperature-responsive means for selectively breaking the connecting means to render the actuating means ineffective.

7. In combination with a refrigerating system having a cooled zone and an evaporator incorporated therein, an expansion valve member controlling the admittance of refrigerant to the evaporator, means normally responsive to the pressure on one side of the valve for actuating the same toward open or closed position, means connecting the valve member and actuating means, and means responsive to temperature in the cooled zone, for rendering the connecting means ineffective under desired temperature conditions therein.

8. In an expansion valve incorporating a valve member, a valve seat, means adapted to control the opening and closing of the valve, actuating means for the valve, and temperature-responsive means for automatically connecting and disconnecting the valve and its actuating means at desired times.

9. In an expansion valve, a valve member, a valve seat, a pressure-responsive member for moving the valve toward and from its seat, means operatively connecting the valve and valve-actuating members, and means for rendering said connecting means ineffective, comprising a member forming part of the connecting means movable to change the effective length of said connecting means, and temperature-responsive means for so moving said movable member.

10. An automatic pressure-regulating expansion valve for a refrigeration system including an evaporator and suitable connections between the valve and the evaporator, and comprising in combination with a valve member and a seat therefor, means responsive to pressure variations in the system whereby the normal opening and closure of said valve are regulated, and means operable independently of such pressure variations and responsive to predetermined temperature changes within the refrigerated space

served by said evaporator for positively closing the valve and preventing operation thereof by said pressure-responsive means.

11. In combination with a circulatory refrigerating system including a plurality of evaporators, a valve appurtenant each evaporator and including a valve member, a seat therefor, means for effecting the opening and closing movement of said valve conformably to variations in relative pressures within said refrigeration system and means appurtenant each valve and controllable independently of such relative pressures for preventing one of such pressures from influencing operation of the valve, to thereby enable its positive maintenance in one position independently of such pressures.

12. In combination with a circulatory refrigerating system including a plurality of evaporators, an expansion valve appurtenant each evaporator and including a valve member and a port relatively to which the valve is movable, means subject to the influence of pressure variances acting upon said valve for controllably so moving the valve member, and means controllable in response to temperature conditions in a zone served by the appurtenant evaporator for positively preventing the operation of the valve by such pressure variations and whereby the valve may be maintained in one position independently thereof.

13. The combination, with a plurality of spaces to be refrigerated, an evaporator in each space and a common circulatory refrigerant system connected to all of such evaporators, a pressure-regulated expansion valve controlling the flow of refrigerant fluid through each evaporator, means associated with each of said valves for regulating the opening and closure thereof responsively to pressure variations in the system, and independent means responsive to thermal conditions within the space served by the appurtenant evaporator for rendering said pressure-responsive means inoperative to control movement of the valve.

14. In combination with a common refrigerant supply line and with a plurality of pressure-activated expansion valves connected thereto, an expansion system connected to each valve, and a zone cooled by each expansion system, pressure-responsive means appurtenant each of said expansion valves for governing the opening and closing thereof responsively to pressure conditions within the system, including a spring urging the valve toward one position, and means responsive to thermal conditions prevailing within the appurtenant served zone for rendering said pressures ineffective to move the valve, whereby it may be held in one position by said spring.

WILLIAM C. HILL.