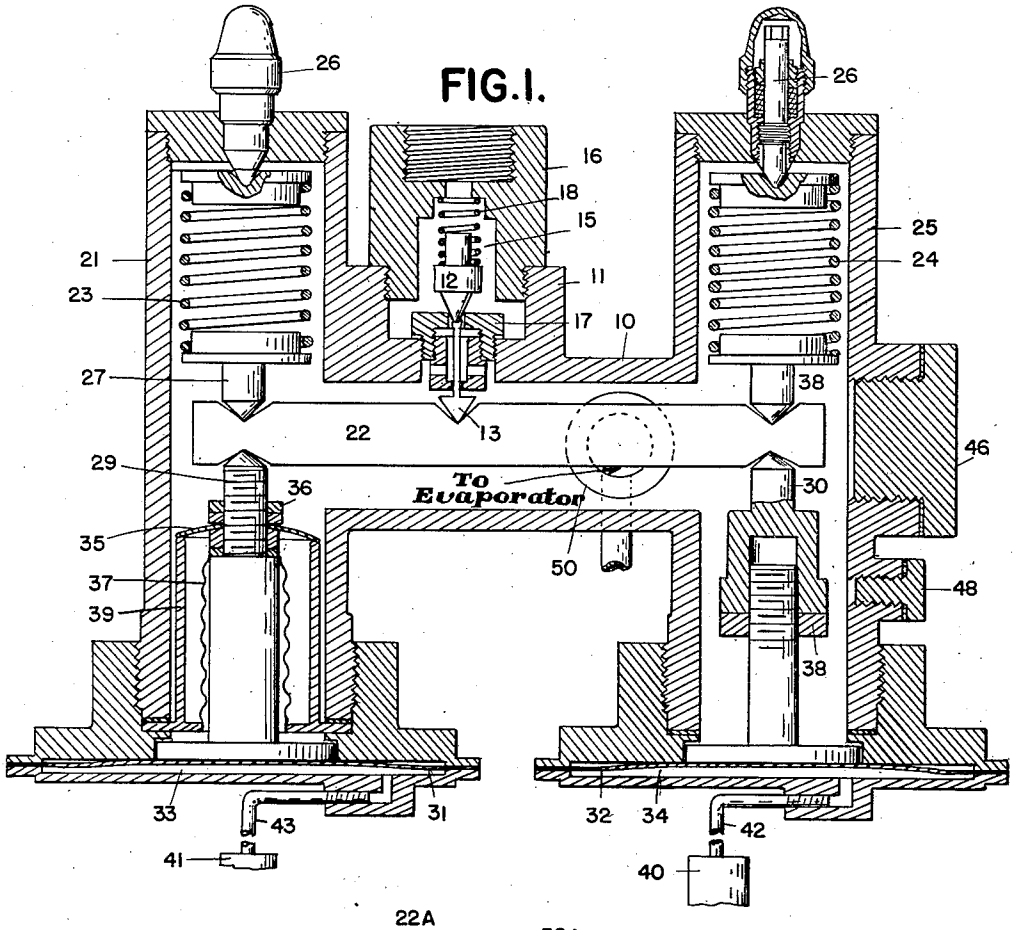
Jan. 28, 1941. W. C. HILL 2,230,056

AUTOMATIC EXPANSION VALVE

Filed April 21, 1937 2 Sheets-Sheet 1

FIG.1.



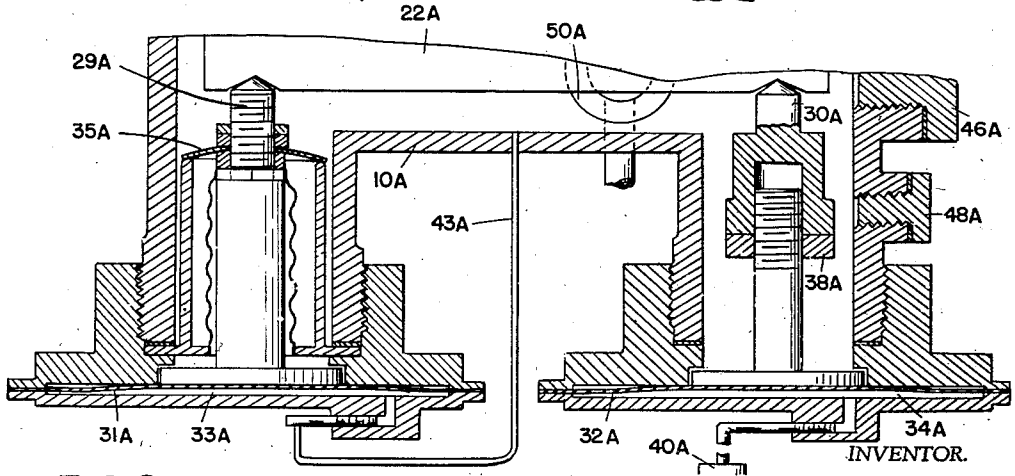


FIG.2.

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AUTOMATIC EXPANSION VALVE

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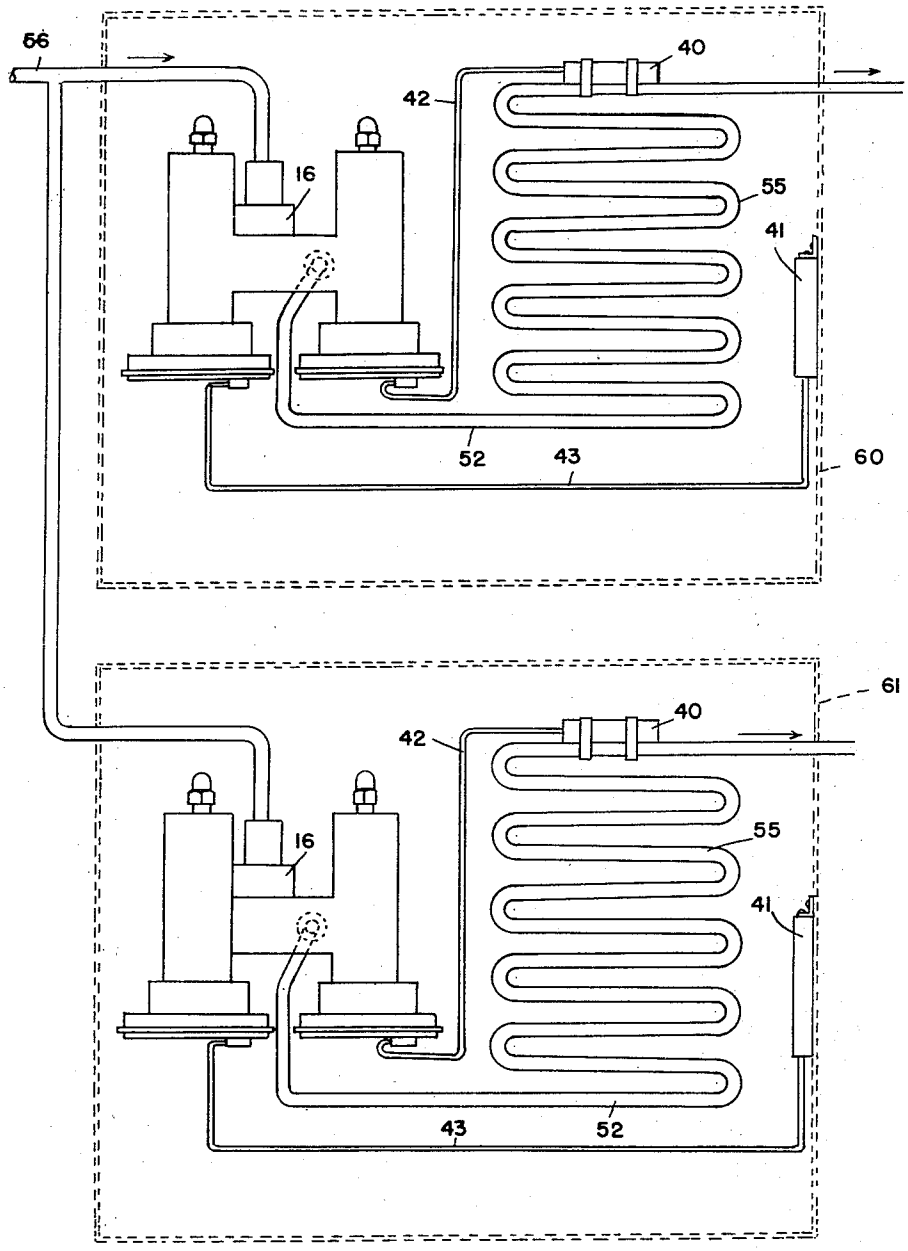


FIG.3.

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UNITED STATES PATENT OFFICE

2,230,056

AUTOMATIC EXPANSION VALVE

William C. Hill, Detroit, Mich.

Application April 21, 1937, Serial No. 138,118

9 Claims. (Cl. 62—2)

This invention relates to refrigerating apparatus, and particularly to the provision of an improved expansion valve, so constructed and governed in its operation as to control in a novel and more efficient manner the flow of refrigerant to an evaporator or cooling coil to which the valve is appurtenant, resulting in more perfect control of the evaporator in accordance with desired conditions in the refrigerated zone or material, and whereby the operation of the evaporator, while it may be affected by the "low side" pressure, is independent thereof to such extent that in multiple evaporator installations, wherein a plurality of evaporators, each equipped with one of my improved valves, are connected to the same refrigerating system, the operation of one evaporator cannot be so influenced by the operation of the others as to be inconsonant with conditions in its served zone.

The invention also finds important application in installations in which it is advantageous to shut off the evaporator before it can accumulate frost to an undesirable extent, as well as in installations wherein extremely accurate control of evaporator operation is required, in response either to served zone temperatures, or any other desired controlling factor, and it is accordingly an object of the invention to provide such a valve capable of automatic regulation in response to a plurality of governing factors, and wherein the forces required to operate the valve are relatively slight. A further object is to provide such a valve with additional means for either causing the partial closure of the valve or for positively maintaining the valve in closed position at desired times, thereby preventing, at least temporarily, normal variation of valve positioning under the influence of the resultant of the aforementioned plurality of governing factors.

In the drawings:

Figure 1 is a sectional elevational view taken longitudinally and substantially centrally through a valve incorporating the principles of this invention, and

Figure 2 is a similar view of the lower portion only of a somewhat modified valve arrangement.

Figure 3 is a schematic diagram showing a typical installation of my improved valve, in conjunction with refrigerating apparatus.

Referring now to the drawings, reference character **10** designates the casing for the control mechanism which governs the operation of the valve **12**, the valve being carried in a supplementary housing **15** formed by an inlet nipple **16** threaded into a suitably tapped boss **11** provided upon the casing. The casing will be seen to be generally in the form of an H, in my preferred embodiment, the valve housing and inlet nipple being mounted upon the cross leg and nearer one side than the other. The vertical legs of the H-shaped casing are designated **21—25**, each such section containing a controlling mechanism for the valve, the effects of the two controlling mechanisms being conveyed to the valve through a beam **22** which, as shown, extends through the cross bar section of the casing, in which it is freely vertically movable. The movement of the beam is transmitted to the valve through a thrust bar **13** which is provided with a suitable pointed or knife edge bearing resting in a cup or groove formed in the top of the beam, the thrust member extending upwardly through the valve seat assembly **17**. A spring **18** tends to close the valve, and springs **23—24**, one mounted in the upper end of each vertical section of the casing, also tend to depress the beam, and thereby to allow the valve to close. The initial effort of each such spring **23—24** is regulable by means of an adjusting screw assembly projecting through the top of each vertical leg of the casing and generally designated **26**.

Pointed thrust bearing members **27—29** transmit the downward force of the springs to the ends of the beam **22**, and it will be seen that an upward force, in opposition to that of the springs **23—24**, is adapted to be imposed upon the bottom of the beam at each end, as through pointed thrust bearing members **29—30**. Each of the thrust members **29—30** is actuable by means of a diaphragm, as **31—32**, under whatever pressure may be applied to the diaphragm chambers **33—34**.

A spring **35** of short stroke tends to raise the left end of the beam, as viewed in Figure 1, such spring taking the form of a cupped washer, biased to reassume the position in which it is shown in full lines in Figure 1, which position it maintains with considerable force, although less than that exerted by the spring **23**. The resistance of the cupped spring **35** also decreases greatly when it is driven downward so that all or a part of it is thrown through its central plane. A corrugated bellows as **37** attached to the stem near its top is sealed at its lower end to the substantially cylindrical cage **39** which serves as a bearing for the cupped spring washer **35**. Spring washer **35** is held upon the stem between adjustable jam nuts **36**, by which its initial positioning, and that of the plunger **29**, may be varied.

A thermostat bulb **41** is connected to the diaphragm chamber **33**, as by means of tube **43**, and it will be seen that the bulb may be subjected to the temperature in the served zone, or otherwise controlled by the temperature conditions prevailing in any desired supervising agency. The effort exerted upon thrust member **30** by diaphragm **32** is similarly under the influence of a thermostat consisting of a bulb **40** connected to a diaphragm chamber **34** by means of a tube **42**, and it will

be seen that bulb 40 is likewise subjectable to any desired temperature controlling influence.

In the preferred hook-up shown in Figure 3, each of the valves is arranged to control the individual evaporator to which it is connected. Each of thermostat bulbs 41 is mounted directly in the box, while bulb 40 is in each case attached to the evaporator near the outlet end.

Plunger 30 is formed in two threaded sections, normally locked by a jam nut 36. Loosening the latter allows adjustment of the setting by changing the length of the thrust member, which is also provided with a head against which the diaphragm 32 bears. To permit such adjustment, openings provided with plugs as 46—46 are formed in the end of the casing. The outlet 50 is formed directly in the body of the casing.

As previously stated, the resistance of the cupped washer spring 35 to the closing effort of spring 23 is decreased materially as it is driven downward, so that if, due to the influence of a lowered temperature upon thermostat 41, valve 12 is closed, it tends to remain closed during a lag period, until the temperature which controls the operation of the bulb 41 has re-risen to a predetermined extent. Full depression of either end of the beam is sufficient to close valve 12. A normal method of hooking up the device is to subject bulb 40 directly to the temperature of the evaporator itself. Bulb 41 may be exposed to the temperature of the air in the served zone, or of the work or material being cooled. It will be recognized that were the assembly minus the left-hand control assembly contained in casing section 21, its functioning would be that of present-known types of automatic expansion valves of the so-called thermostatic constant superheat type. Therefore, except in multi-evaporator installations in which its equalizing action is desirable, the bulb assembly 42—40, which constitutes nothing more than a thermostatic spring, could be eliminated and a mechanical or other conventional spring employed. It will be seen that the evaporator pressure exerts a modifying influence upon the action of the diaphragms, which modifying influence is of greater effect, however, on diaphragm 32, its action being in opposition to, and in the usual way balanced against, that of such diaphragm, as the evaporator pressure and temperature vary substantially simultaneously. The presence of bellows 37 reduces the effect of evaporator pressure upon the left-hand control assembly to an unimportant factor.

If the evaporator is one provided with an extended surface, and which is not intended to accumulate frost, the indicated set-up promotes and virtually insures the desired re-evaporation of moisture from the surface of the evaporator during the periods in which valve 12 is closed, by positively maintaining the valve closed for a substantial period whenever the served zone temperature tends to fall too low, and until such temperature has again risen to a point materially higher than the temperature at which the valve was closed under the influence of spring 23. When not subjected to such overcontrol due to decreased temperature in the served zone, however, the admission of refrigerant is controlled in accurate response to the evaporator temperature and pressure, these factors being modified by the effect of served zone temperature, the normal valve action being then the resultant of three governing factors, comprising evaporator temperature, served zone temperature, and "low side" pressure.

The forces act cooperatively, and their resultant is that which governs the actuation of the valve, only so long as neither end of the beam is depressed sufficiently to actually close the valve. It the latter event the cooperative or resultant action is destroyed until the depressed end again rises sufficiently to allow the valve to open. Because of the above described snap action of the spring washer 35, the left end of the beam moves quickly and sharply to its open and closed positions, imposing the aforementioned lag before reopening, during which closed period the resultant action of the forces on the valve does not obtain. This effect also prevents "hunting" of the valve under the influence of the left-hand control assembly, but where the hunting action is desirable, it is only necessary to remove the spring washer 35, or move it up to a position clear of the cage 39.

Spring washer 35, in combination with diaphragm and thermostat assembly 31—41, and in fact, the entire left-hand governing assembly constitutes temperature-responsive means for holding the valve in closed position, which holding means might of course operate electrically rather than mechanically, or in other desired fashion.

In the modified construction shown in Figure 2, parts analogous to those described in connection with the disclosure of the first embodiment are designated by like reference characters, with the addition of the letter "A" to each. In this construction the left hand diaphragm 31A is directly subjected to the influence of the "low side" pressure, as by means of a tube 43A, which connects the diaphragm chamber 33A to the casing 10A, out of which the outlet 50A to the evaporator opens, as in the previous embodiment. Obviously the tube 43A might connect to any other convenient point on the low side of the system. The thermostat bulb 40A may be responsive to the served zone temperature and control the actuation of the diaphragm 32A. The other parts, being equivalent to those described in connection with the first embodiment, need no detailed redescription.

It will be observed that in this embodiment the snap action of the left hand control assembly, due to the presence of the cupped spring washer 35A (when in operative position) does not impose its delay in valve re-opening in response to depression of served zone temperature, to insure the defrosting action previously described, for which reason the embodiment of Fig. 2 is more particularly applicable where the expansion coil is submerged, or where for other reason frosting difficulties are not present. It will be seen that although unduly low evaporator pressure can cause positive closure of the valve and a lag before re-opening, the ordinary operation of the valve is one in which the influence of this factor is modified by the additional controlling factor introduced in the imposition of the effects of variation of served zone temperature upon diaphragm 32A.

Outlet 50 is of course usually directly connected to an evaporator, as 55 (Fig. 3), the connecting tube being designated 52, while the inlet nipple 16 is connected to the liquid refrigerant supply line 56. In Fig. 3 two refrigerated receptacles are diagrammatically represented at 60 and 61, each receptacle having its evaporator controlled by one of my improved valves in the above described manner, the thermostat bulb 40 of each assembly being clamped to the evaporator in the usual

way, and bulb 41 subjected to the temperature within the receptacle. It will be apparent that additional units, controlled similarly or otherwise, might also be connected to the same return line 56.

What I claim is:

1. In an automatic expansion valve construction, in combination with a casing having inlet and outlet connecting portions, and a valve member movable to control communication between such portions, a beam in said casing bodily movable transversely of its length to control the movement of said valve, the valve being connected to the beam between the ends thereof, and means for independently moving the opposite ends of the beam.

2. An expansion valve construction as set forth in claim 1 in which said means for moving the opposite ends of the beam comprises a pair of pressure-operable means, one acting upon each end of the beam, and thermostatic means for controlling said pressure operable means.

3. Means as set forth in claim 1 in which said last named means comprises two pressure operable means, one acting upon each end of the beam, and delay-imposing restraining means acting upon at least one end of the beam to prevent instantaneous response thereof to said means for moving the same.

4. An automatic expansion valve construction adapted to control a circulatory refrigerating system, of the variety which includes a medium to be refrigerated and an evaporator therein, comprising a casing having inlet and outlet connection portions and a valve member movable to control communication between said portions, a plurality of governing agencies for said valve member including a member responsive to the temperature within said evaporator substantially at the outlet thereof, and acting upon said valve to automatically regulate the same, means for modifying the effect of said member comprising another member responsive to the temperature of said medium and acting both to modify and to render inoperative said first mentioned member.

5. An automatic expansion valve construction adapted to control a circulatory refrigerating system, of the variety which includes a medium to be refrigerated and an evaporator therein, comprising a casing having inlet and outlet connecting portions and a valve member movable to control communication between said portions, a plurality of governing agencies for said valve member including at least one affected by temperature and pressure conditions substantially at the outlet of said evaporator, another affected by temperature of the refrigerated medium, and a force proportionating device providing connection between both of said agencies and the valve member.

6. An automatic expansion valve construction adapted to control a circulatory refrigerating system, of the variety which includes a medium to be refrigerated and an evaporator therein, comprising a casing having inlet and outlet connecting portions and a valve member movable to control communication between said portions, a plurality of governing agencies for said valve member including at least one element affected by variations of pressure within and substantially at the outlet of said evaporator, another element affected by temperature of the refrigerated medium, means yieldably tending to close the valve in opposition to the efforts of both of said agencies, and means proportionating the relative effects of said two agencies upon the valve member and providing connection between said agencies and said valve member.

7. An automatic expansion valve construction adapted to control a circulatory refrigerating system, of the variety which includes a medium to be refrigerated and an evaporator therein, comprising a casing having inlet and outlet connecting portions and a valve member movable to control communication between said portions, a plurality of governing agencies for said valve member including means tending to close the valve in response to a fall of pressure within and substantially at the outlet of said evaporator, means tending to open the valve in response to a rise of the temperature of said medium, separate spring means tending to close the valve in opposition to the efforts of said means responsive to said pressure and temperature, said entire governing agency being rendered ineffective when said valve member is closed under the influence of either of said spring means.

8. An automatic expansion valve construction adapted to control a circulatory refrigerating system, of the variety which includes a medium to be refrigerated and an evaporator therein, comprising a casing having inlet and outlet connection portions and a valve member movable to control communication therebetween, a plurality of separate governing means, one tending to close the valve member in response to a fall of pressure within and substantially at the outlet of said evaporator, and another tending to open the valve member in response to a rise of the temperature of said medium, separate spring means opposing each of said separate means, each of said spring means tending to close the valve member and to prevent reopening of the same by the other governing means, and delaying means preventing immediate reopening of the valve member under the influence of at least one of said governing means.

9. An automatic expansion valve construction adapted to control a circulatory refrigerating system, of the variety which includes a medium to be refrigerated and an evaporator therein, comprising a casing having inlet and outlet connecting portions and a valve member movable to control communication between said portions, a plurality of governing agencies for said valve member including one having a motor responsive to temperature within and substantially at the outlet of the evaporator, another having a motor responsive to the temperature of the medium to be refrigerated, said first mentioned motor also being affected by the pressure substantially at the inlet of said evaporator, each of said motors being capable of inducing closure of the valve, and of maintaining it closed regardless of the action of the other, and a force proportionating device providing connection between both of said motors and the valve member, whereby both agencies act cooperatively to influence the valve when open.

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