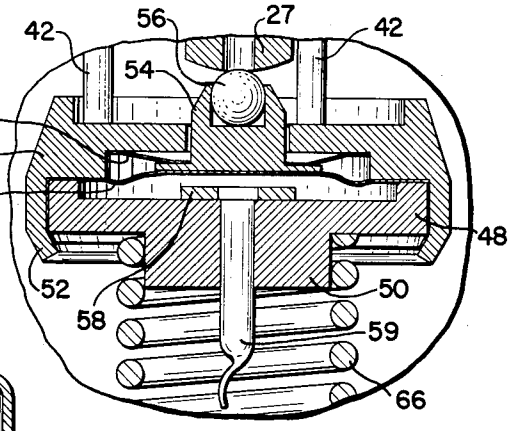
July 17, 1956 C. B. BOLES 2,755,025

REFRIGERATION EXPANSION VALVE APPARATUS

Filed April 18, 1952

Fig. 2



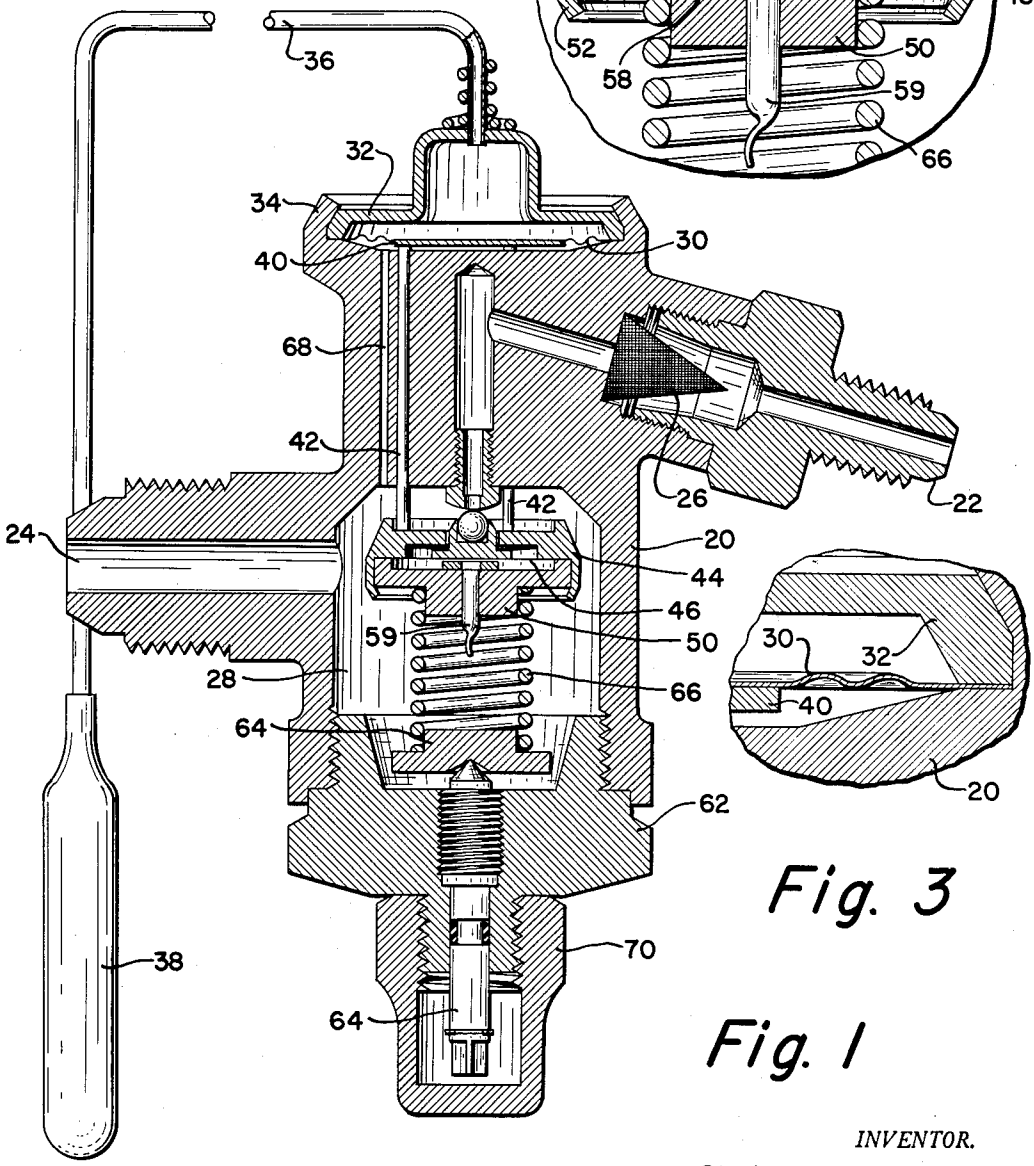


Fig. 3

Fig. 1

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REFRIGERATION EXPANSION VALVE APPARATUS

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8 Claims. (Cl. 236—92)

This invention relates to refrigerating apparatus and more particularly to expansion valves with a limiting device for preventing excessive loads.

Recently there has been introduced on the market thermostatic expansion valves with pressure limiting devices which collapse to assist the closing of the valve when a predetermined pressure is attained in the valve outlet.

It is an object of my invention to provide a thermostatic expansion valve with a limiting device which expands instead of collapses to directly close the valve.

It is another object of my invention to provide a thermostatic expansion valve with a small unitary readily replaceable limiting device located in a chamber of the valve which is readily opened.

These objects are attained by providing a thermostatic expansion valve in which the valve element is carried directly by a sealed capsule located in the valve outlet chamber. During normal operation of the valve the valve element is carried in retracted position and the capsule is bodily moved by the usual combined temperature and pressure responsive element of the valve as if no limiting device were included. This results in a normal refrigerant flow from the condenser to the evaporator. When the temperature and pressure is reached in the valve outlet chamber at which it is desired to limit the flow through the valve, the sealed capsule expands to move the valve element into or towards engagement with its seat to close or limit the flow through the valve.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Figure 1 is a vertical sectional view through an expansion valve embodying one form of my invention;

Figure 2 is an enlarged sectional view of the pressure limiting capsule and fragments of adjacent parts; and

Figure 3 is a fragmentary enlarged section of the thermostatic chamber and diaphragm.

Referring now to the drawings and more particularly to Figure 1 there is shown a valve body **20** having an inlet **22** provided with a flare connection for connection with a refrigerant condenser. The valve body **20** is also provided with an outlet **24** provided with a flare connection for connection with a refrigerant evaporator. The inlet **22** connects with an inlet passage provided with a conical straining screen **26** which leads to a vertical passage provided along the axis of the valve body **20**. This vertical passage connects directly with a valve seat insert **27** which is threaded into the lower end of the vertical passage and is provided with a valve seat at the outlet of the passage. The passage discharges directly into a valve chamber **28** within the valve body **20**. This valve chamber **28** has a side outlet connecting with the flare connection **24** which in turn connects to the refrigerant evaporator.

At the top of the valve body **20** there is provided a diaphragm **30**. The outer rim of the diaphragm **30** is held in place by the downwardly turned flange of a cap member **32** secured in place by a bent over upwardly facing flange **34** provided at the top of the valve body **20**. The top of this cap member **32** is connected by a capillary tube **36** with a thermostat bulb **38**. The cap **32**, the capillary tube **36** and the bulb **38** may be charged with a thermostatic liquid or a volatile liquid or vapor, but preferably the bulb **38** is provided with a charge of activated charcoal and it together with the capillary tube **36** and the cap member **32** are provided with a charge of a permanent gas such as carbon dioxide which is adsorbed and evolved from the activated charcoal in the bulb **38** according to the temperature of the bulb **38**. According to present refrigeration practices it is customary to clamp the bulb **38** in thermal exchange relationship with the outlet portion or suction conduit of the refrigerant evaporator. When the evaporator outlet temperature is high as prevails when the system is shutdown for a considerable length of time the diaphragm **30** will be depressed by the pressure of the gas or vapor in the cap **32**. This would cause an ordinary expansion valve to be held wide open to provide an abnormally high pressure in the evaporator to impose an abnormally heavy load upon the compressor.

Beneath the diaphragm **30**, there is a metal diaphragm pad **40** which rests upon three pins each designated by the reference character **42**. These pins **42** extend into the chamber **28** and their lower ends engage the upwardly facing recessed surface of a valve supporting means **44** located within the chamber **28**. The valve supporting means **44** is provided with a flexible diaphragm **46**. The outer portion of this diaphragm **46** is held by an upwardly facing flange **48** of an insert **50** provided in the bottom of the valve supporting member **44**. The flange **48** holds the outer portion of the diaphragm **46** in contact with a shoulder in a diaphragm chamber within the central portion of the valve supporting means **44**. The diaphragm **46** and the member **50** are sealed to the valve supporting means **44** by a downwardly extending rim **52** upon the valve supporting means **44** which is rolled inwardly to accomplish the sealing. This sealing may be made doubly sure by the use of solder.

Mounted upon the upper face of the diaphragm **46** is a flanged valve element **54** which protrudes through a centrally located aperture in the top of the diaphragm chamber in the valve supporting means **44**. The uppermost portion of the valve element **54** is provided with a ball **56** which engages the valve seat insert **27** to close the inlet passage in the valve body **20**. Under normal conditions, the valve element **54** and the ball **56** will be held in retracted position within the valve supporting means **44** with the central portion of the diaphragm **46** resting upon a centrally located stop pad **58** upon the bottom of the diaphragm chamber. According to my invention the chamber formed beneath the diaphragm **46** is sealed. It is subject to the pressure of the refrigerant in the valve chamber **28** which has access to the upper surface of the diaphragm **46** through the opening in the top of the valve supporting means through which projects the top of the valve element **54**. This pressure tends to keep the valve element retracted within the valve supporting means **44** with the diaphragm **46** in engagement with the stop pad **58**.

To provide my valve with a pressure limiting feature, the chamber beneath the diaphragm **46** is charged with a temperature responsive expansible medium having a steeper pressure-temperature curve than the refrigerant controlled by the valve. Preferably this chamber is charged with the vapor of a volatile liquid having a

steeper pressure-temperature curve than the refrigerant being used. This chamber is charged through a charging tube **59** and is then sealed when the proper amount of charge is applied. If desired the chamber beneath the diaphragm **46** can be charged with an absorbent such as activated charcoal and a permanent gas such as carbon dioxide. If the pressure of the selected volatile liquid placed in the chamber beneath the diaphragm **46** is appreciably higher than the pressure of the refrigerant which passes through the chamber **28** at which it is desired to limit the flow through the valve, there is provided a spring **60** having its upper outer portion bearing against the valve supporting means and having its lower inner portion bearing against the top of the flange on the valve element **54**. This spring **60** may be of any suitable shape but preferably is in the form of a dished ring which may have inwardly extending fingers resting upon the top of the flange of the valve element **54**. With such an arrangement, when the pressure and temperature is reached in the outlet chamber **28** at which the limiting action is desired, the pressure beneath the diaphragm will be great enough to move the valve member toward or into engagement with the valve seat insert **27**.

As specific examples of the invention, it will be assumed that in two different applications it is desired to reduce the flow through the valve to a minimum when the refrigerant within the chamber **28** rises to temperatures of 10° F. and 38° F. These limiting temperatures would be suitable for frozen food systems and beverage cooling systems respectively. Difluorodichloromethane (F–12) and methyl chloride (CH_3Cl) have been selected as examples of refrigerants which are suitable for use in the refrigerating system. The following refrigerants are selected as examples of the vapors which may be used in the diaphragm chamber of the valve supporting means **44** since in the range of useful operating temperatures in which the valve operates they have steeper pressure-temperature curves than F–12 and methyl chloride:

Monochlorodifluoromethane (F–22), ammonia, perfluoropropane (C_3F_8) (F–218) and pentafluoromonochloroethane (C_2ClF_5) (F–115).

The following table indicates the pressures of these refrigerants and vapors at 10° F. and 38° F. as well as the differences in the pressures between each of these vapors and each of the refrigerants:

Table of refrigerant pressures and differences

	F12	F22	Diff.	NH_3	Diff.	F218	Diff.	F115	Diff.
10° F.	14.7	33.0	18.3	23.8	9.1	26.5	12.2	27.5	12.8
38° F.	35.2	66.1	30.9	55.7	20.5	55.5	20.3	57.1	21.9
	CH_3Cl								
10° F.	8.9	33.0	24.1	23.8	14.9	26.5	17.6	27.5	18.6
38° F.	26.9	66.1	39.2	55.7	28.7	55.5	28.5	57.1	30.1

In each case the pressure is higher than the pressures of the F–12 and methyl chloride. This difference in pressures must be counteracted and substantially exactly equaled by the spring force of the diaphragm **46** and the spring **60**. For a frozen food installation requiring a valve with a limiting action effective at about 10° F., with F–12 as the refrigerant if the effective area of the diaphragm **46** is about .11 sq. in. then a spring force of about 2 pounds would be required with F–22, while spring forces of one pound would be required for ammonia; 1.35 pounds would be required for F–218 and 1.4 pounds would be required for F–115. This spring force would be the force of the spring **60** and the diaphragm **46** in a position near the uppermost position.

With any of these examples, as long as the temperature within the valve chamber is an adequate amount below 10° F., there will be no limiting action because below about 10° F. the pressure of the refrigerant upon the diaphragm **46** plus the spring force of the spring **60** and the diaphragm **46** is always greater than the pressure of the vapor within the diaphragm chamber in the valve supporting means **44** so that the diaphragm **46** will be pushed down against the pad **58**. This must be true since if the balanced condition is about 10° F. and the vapor has a steeper pressure-temperature curve than the refrigerant, the refrigerant and allied spring forces will be greater than the force of the vapor below 10° F. and less than the force of the vapor above 10° F. It follows from this that above 10° F., the vapor pressure within the diaphragm chamber in the valve supporting means **44** always will be greater than the opposing refrigerant pressure and the allied spring forces so that the diaphragm **46** will be forced upwardly to move the ball **56** toward or into engagement with the valve seat in the insert **27**.

As another example, assume for a beverage cooler installation it is desired to set the valve so that its maximum limiting action would be reached at 38° F. The pressures of these different vapors at 38° F. are indicated in the table as well as the difference in pressure between these particular vapors and F–12 at 38° F. Again we assume that the diaphragm **46** has an effective area of .11 sq. in. A downward spring force of the diaphragm **46** and the spring **60** would be required. For F–22 this force would be 3.4 pounds, for ammonia 2.3 pounds, for F–218 2.25 pounds and F–115 2.4 pounds. It appears that for these latter three one particular spring arrangement would be satisfactory and this could be set at about 2.3 pounds.

Instead of F–12 as the refrigerant in the system, methyl chloride could be used as shown in the table. Methyl chloride at 10° F. would have a pressure of 8.9 pounds and at 38° F. it would have a pressure of about 27 pounds. The difference in pressure between any one of the refrigerants in the capsule would be greater as illustrated by the differenec in pressure noted in the table. The spring force required at 10° F. would be 2.66 pounds for F–22, 1.65 pounds for ammonia, 1.94 pounds for F–218 and 2.06 pounds for F–115. With methyl chloride at 38° F., a spring force of 4.33 pounds would be required for F–22, 3.17 pounds with ammonia, 3.18 pounds with F–218 and 3.35 pounds with F–115.

For other selected limiting temperatures different spring forces could be provided. These spring support assemblies could be made in sets for different refrigerants and different limiting temperatures and pressures. They would be interchangeable in the chamber **28**. They could be readily removed and inserted from the chamber **28** by removing the threaded cap member **62** which is threaded into the open end portion of the chamber **28**. This cap member **62** has a threaded adjusting screw **64** therein which engages a spring retainer **64** provided at the lower end of the valve closing spring **66**. The upper end of this valve closing spring **66** rests against the bottom of the member **50** and holds the spring support assembly **44** in engagement with the three pins **42**.

The chamber **28** may be connected by a passage **68** with the chamber beneath the diaphragm **30** which contains the pad **40**. Otherwise the passages through which the pins **42** extend may be relied upon for this purpose. The chamber beneath the diaphragm **30** may also be connected to the outlet of the evaporator if desired. The screw **64** may be turned to adjust the tension of the spring **66** so as to adjust the pressure and temperature at which the valve normally opens. The lower end of the screw **64** is enclosed by a cap nut **70** to complete the sealing of the chamber **28**.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. An expansion valve for controlling the flow of a refrigerant including a valve body having an inlet and an outlet, a valve means for controlling the flow of refrigerant

from said inlet to said outlet, a flexible diaphragm means associated with said valve body and having operative connecting means for moving said valve means to open position, means for deflecting said diaphragm means to operate said valve means, said valve means including a second bodily movable sealed diaphragm means and a valve member carried by and operated by said sealed diaphragm means, said sealed diaphragm means and said valve member constituting principal parts of and being bodily movable with the valve means and said flexible diaphragm means, adjusting means associated with said valve body, spring means extending between said adjusting means and said valve means, and a temperature responsive expansible medium within said sealed diaphragm means having a greater rise in pressure for a corresponding rise in temperature than the refrigerant controlled by the valve, said valve member having a connection to said diaphragm means for movement toward valve closing position upon expansion of the second diaphragm means within the same range of operating temperatures.

2. An expansion valve for controlling the flow of a refrigerant including a valve body having an inlet and an outlet, a valve means for controlling the flow of refrigerant from said inlet to said outlet, a flexible diaphragm means associated with said valve body and having operative connecting means for moving said valve means to open position, means for deflecting said diaphragm means to operate said valve means, said valve means including a second bodily movable sealed diaphragm means and a valve member carried by and operated by said sealed diaphragm means, said sealed diaphragm means and said valve member constituting principal parts of and being bodily movable with the valve means and said flexible diaphragm means, adjusting means associated with said valve body, spring means extending between said adjusting means and said valve means, and a temperature responsive expansible medium within said sealed diaphragm means having a greater rise in pressure for a corresponding rise in temperature than the refrigerant controlled by the valve within the same range of operating temperatures, said valve means also including spring means for biasing said second diaphragm means, said valve member having a connection to said diaphragm means for movement toward valve closing position upon expansion of the second diaphragm means.

3. An expansion valve for controlling the flow of a refrigerant including a valve body having an inlet and an outlet, a valve means for controlling the flow of refrigerant from said inlet to said outlet, a flexible diaphragm means associated with said valve body and having operative connecting means for moving said valve means to open position, means for deflecting said diaphragm means to operate said valve means, said valve means including a second bodily movable sealed diaphragm means and a valve member carried by and operated by said sealed diaphragm means, said sealed diaphragm means and said valve member constituting principal parts of and being bodily movable with the valve means and said flexible diaphragm means, adjusting means associated with said valve body, spring means extending between said adjusting means and said valve means, and a temperature responsive expansible medium within said sealed diaphragm means having a greater rise in pressure for a corresponding rise in temperature than the refrigerant controlled by the valve within the same range of operating temperatures, said valve means also including a stop arrangement for limiting the movement of the valve member, said valve member having a connection to said diaphragm means for movement toward valve closing position upon expansion of the second diaphragm means.

4. A thermostatic expansion valve for controlling the flow of a refrigerant including a valve body having an inlet and an outlet and a chamber connected to the outlet, said body having a valve seat located between said chamber and said inlet, a thermostatic operating means located on one side of said valve seat, a valve supporting means located in said chamber on the opposite side of the valve seat from said thermostatic operating means, a sealed diaphragm means located upon said supporting means, a valve member positively mounted on the face of said sealed diaphragm means nearest said valve seat for movement toward the valve seat upon expansion of the sealed diaphragm means, a movement transmitting means extending from said thermostatic means to said valve supporting means, said sealed diaphragm means being charged with a volatile liquid having a greater rise in pressure for a corresponding rise in temperature than the refrigerant within the same range of operating temperatures, said valve member having a connection to said diaphragm means for movement toward valve closing position upon expansion of the second diaphragm means for expanding said diaphragm means above a predetermined refrigerant temperature to reduce the amount of valve opening.

5. A thermostatic expansion valve for controlling the flow of a refrigerant including a valve body having an inlet and an outlet and a chamber connected to the outlet, said body having a valve seat located between said chamber and said inlet, a thermostatic operating means located on one side of said valve seat, a valve supporting means located in said chamber on the opposite side of the valve seat from said thermostatic operating means, a sealed diaphragm means located upon said supporting means, a valve member positively mounted on the face of said sealed diaphragm means nearest said valve seat for movement toward the valve seat upon expansion of the sealed diaphragm means, a movement transmitting means extending from said thermostatic means to said valve supporting means, said sealed diaphragm means being charged with a volatile liquid having a greater rise in pressure for a corresponding rise in temperature than the refrigerant within the same range of operating temperatures for expanding said diaphragm means above a predetermined refrigerant temperature to reduce the amount of valve opening, and adjustable spring means bearing upon said supporting means for opposing said thermostatic operating means.

6. A thermostatic expansion valve for controlling the flow of a refrigerant including a valve body having an inlet and an outlet and a chamber connected to the outlet, said body having a valve seat located between said chamber and said inlet, a valve supporting means located in said chamber adjacent said valve seat, a diaphragm located upon the side of the valve seat opposite said valve supporting means, said valve body having a shallow chamber adjacent said diaphragm, a cap member enclosing said diaphragm, said cap member and said diaphragm being sealed to said valve body around said shallow chamber, a thermostat bulb connected to said cap member, push pins extending from said shallow chamber through the valve body to said valve supporting means for moving the valve supporting means in accordance with the movement of the diaphragm, said valve supporting means being provided with a shallow chamber facing said valve seat, a second diaphragm covering said shallow chamber and having its edge portions sealed to said supporting means, a valve member positively supported upon the face of said second diaphragm nearest the valve seat for engagement with said valve seat, said shallow chamber in said supporting means being charged with a volatile liquid having a greater rise in pressure for a corresponding rise in temperature than the refrigerant within the same range of operating temperatures for expanding said second diaphragm toward said valve seat above a predetermined refrigerant temperature to reduce the opening of the valve.

7. A thermostatic expansion valve for controlling the flow of a refrigerant including a valve body having an inlet and an outlet and a chamber connected to the outlet, said body having a valve seat located between said chamber and said inlet, a valve supporting means located in said chamber adjacent said valve seat, a diaphragm

located upon the side of the valve seat opposite said valve supporting means, said valve body having a shallow chamber adjacent said diaphragm, a cap member enclosing said diaphragm, said cap member and said diaphragm being sealed to said valve body around said shallow chamber, a thermostat bulb connected to said cap member, push pins extending from said shallow chamber through the valve body to said valve supporting means for moving the valve supporting means in accordance with the movement of the diaphragm, said valve supporting means being provided with a shallow chamber facing said valve seat, a second diaphragm covering said shallow chamber and having its edge portions sealed to said supporting means, a valve member positively supported upon the face of said second diaphragm nearest the valve seat for engagement with said valve seat, said shallow chamber in said supporting means being charged with a volatile liquid having a greater rise in pressure for a corresponding rise in temperature than the refrigerant within the same range of operating temperatures for expanding said second diaphragm toward said valve seat above a predetermined refrigerant temperature to reduce the opening of the valve, said supporting means being provided with a stop arrangement cooperating with said valve member to limit the movement of said valve member.

8. A thermostatic expansion valve for controlling the flow of a refrigerant including a valve body having an inlet and an outlet and a chamber connected to the outlet, said body having a valve seat located between said chamber and said inlet, a valve supporting means located in said chamber adjacent said valve seat, a diaphragm located upon the side of the valve seat opposite said valve supporting means, said valve body having a shallow chamber adjacent said diaphragm, a cap member enclosing said diaphragm, said cap member and said diaphragm being sealed to said valve body around said shallow chamber, a thermostat bulb connected to said cap member, push pins extending from said shallow chamber through the valve body to said valve supporting means for moving the valve supporting means in accordance with the movement of the diaphragm, said valve supporting means being provided with a shallow chamber facing said valve seat, a second diaphragm covering said shallow chamber and having its edge portions sealed to said supporting means, a valve member positively supported upon the face of said second diaphragm nearest the valve seat for engagement with said valve seat, said shallow chamber in said supporting means being charged with a volatile liquid having a greater rise in pressure for a corresponding rise in temperature than the refrigerant within the same range of operating temperatures, said valve member having a connection to said diaphragm means for movement toward valve closing position upon expansion of second diaphragm means for expanding said second diaphragm toward said valve seat above a predetermined refrigerant temperature to reduce the opening of the valve, said supporting means being provided with spring means for biasing said second diaphragm.

References Cited in the file of this patent

UNITED STATES PATENTS

2,505,933	Aughey et al.	May 2, 1950
2,506,413	Dube	May 2, 1950
2,511,565	Carter	June 13, 1950