Jan. 23, 1951 F. Y. CARTER 2,538,861

REFRIGERATION EXPANSION VALVE

Filed Oct. 1, 1947 3 Sheets-Sheet 1

FIG. 1

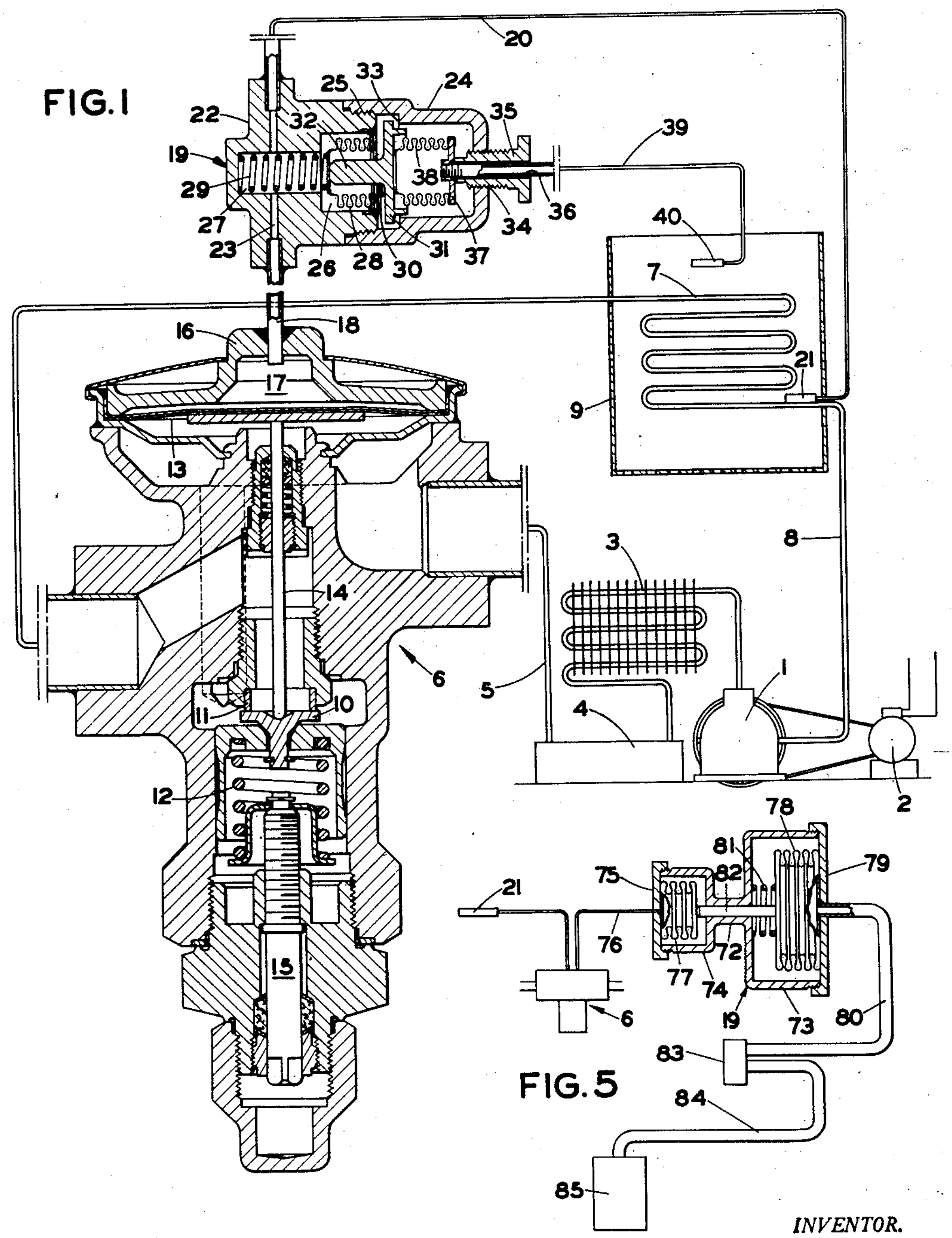


FIG. 5

INVENTOR.
Franklyn Y. Carter
BY
Andrew K. Foulds
his ATTORNEY

Jan. 23, 1951 F. Y. CARTER 2,538,861

REFRIGERATION EXPANSION VALVE

Filed Oct. 1, 1947 3 Sheets-Sheet 2

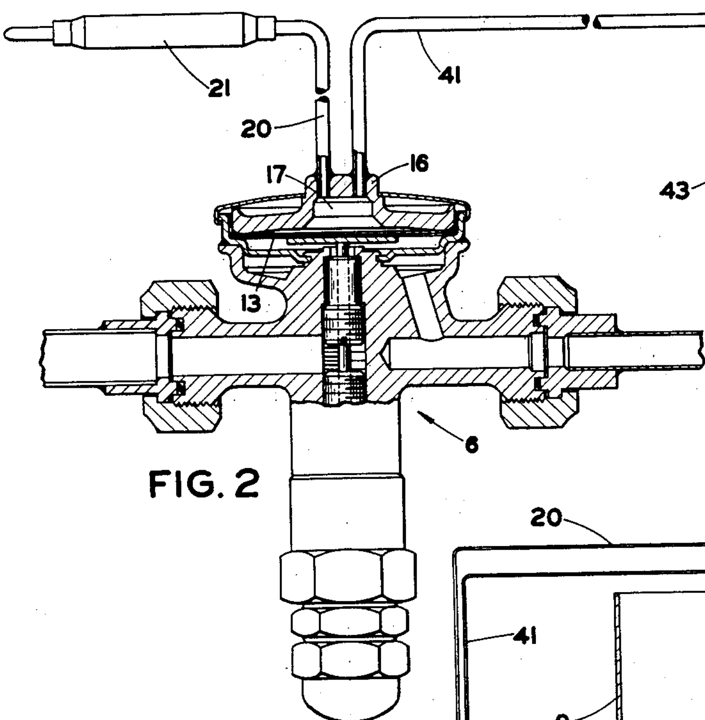
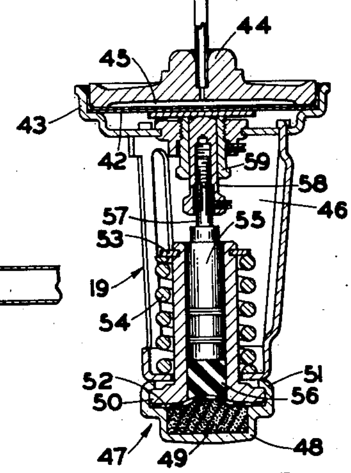


FIG. 2



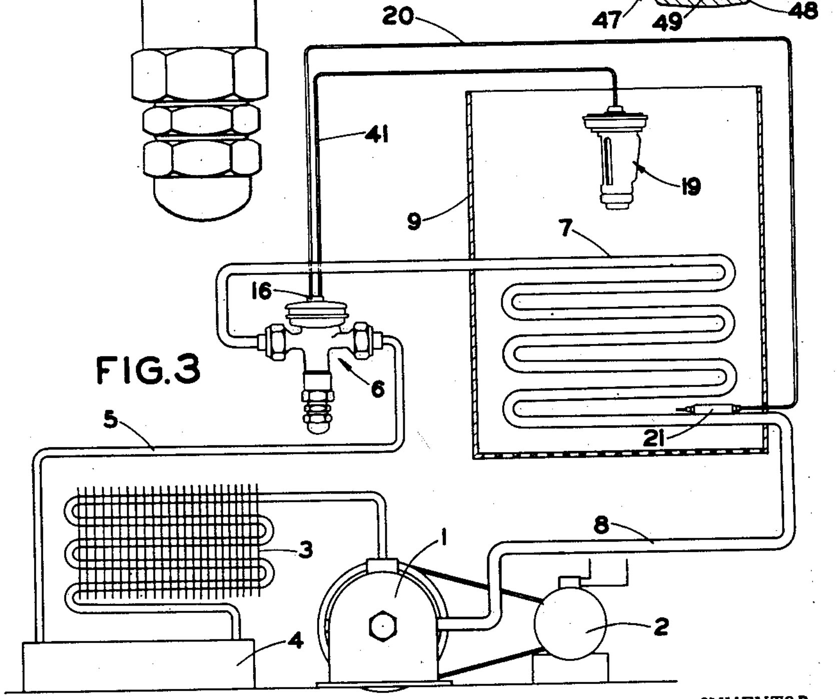


FIG. 3

INVENTOR.

Franklyn Y. Carter

BY

Andrew K. Foulds

his ATTORNEY

Jan. 23, 1951 F. Y. CARTER 2,538,861

REFRIGERATION EXPANSION VALVE

Filed Oct. 1, 1947 3 Sheets-Sheet 3

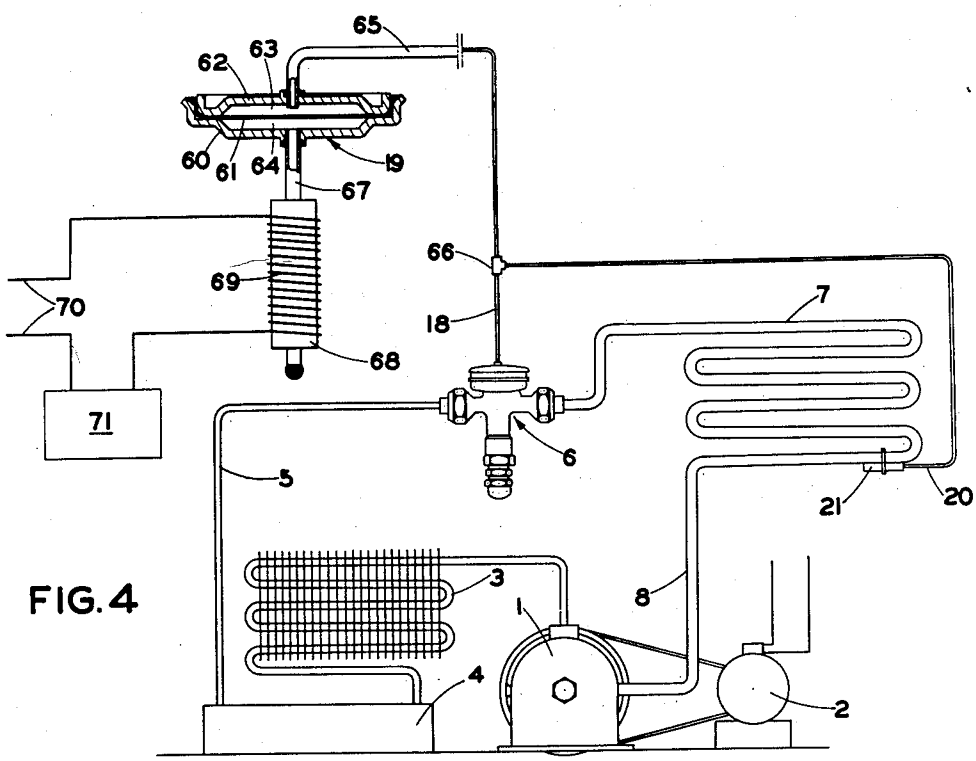


FIG. 4

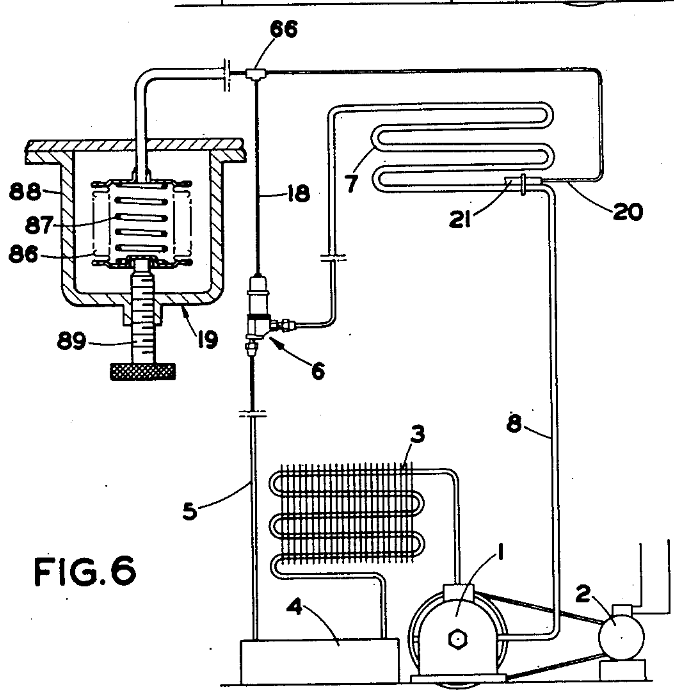


FIG. 6

INVENTOR.
Franklyn Y. Carter
BY
Andrew K. Foulds
his ATTORNEY

Patented Jan. 23, 1951 **2,538,861**

UNITED STATES PATENT OFFICE

2,538,861

REFRIGERATION EXPANSION VALVE

Franklyn Y. Carter, Dearborn, Mich., assignor to Detroit Lubricator Company, Detroit, Mich., a corporation of Michigan

Application October 1, 1947, Serial No. 777,198

8 Claims. (Cl. 62—127)

1

This invention relates to new and useful improvements in refrigeration expansion valves.

One of the objects of this invention is to provide a refrigeration expansion valve having new and improved control means therefor.

Another object is to provide a "gas charged" expansion valve having means to vary the maximum operating pressure thereof.

Another object is to provide an air conditioning system utilizing an expansion valve having a variable maximum operating pressure to control dehumidification of the air.

Other objects will become apparent from time to time throughout the specification and claims as hereinafter related.

In the accompanying drawings, to be taken as a part of this specification, there are clearly and fully illustrated several preferred embodiments of this invention, in which drawings:

Figure 1 is a diagrammatic view of a refrigerating system having an expansion valve with an expansible chamber for controlling maximum operating pressure of the valve and a thermostatic bulb element for controlling said expansible chamber, the expansion valve and expansible chamber being shown in vertical cross-section,

Fig. 2 is a view in elevation of an expansion valve similar to that shown in Fig. 1 with the upper portion of the valve shown in broken section and having an expansible chamber for controlling the maximum operating pressure of the valve, the expansible chamber being controlled by a thermal expansive element,

Fig. 3 is a diagrammatic view of a refrigerating system utilizing the valve and expansible chamber shown in Fig. 2,

Fig. 4 is a diagrammatic view of a refrigerating system including an expansion valve and expansible chamber similar to that shown in Fig. 2 but having an electrically operated heat motor for controlling the expansible chamber, the expansible chamber being shown enlarged and in partial section,

Fig. 5 is a diagrammatic view of an expansion valve having an expansible chamber shown in section, the expansible chamber being pneumatically controlled, and

Fig. 6 is a diagrammatic view of a refrigerating system having an expansible chamber shown in section, the expansible chamber being controlled by a manual adjustment screw.

Referring to the drawings by characters of reference in Fig. 1 there is an air conditioning system comprising a refrigerant compressor **1** driven by a motor **2** supplying compressed refrigerant to a condenser **3** which is in turn connected to a

2

liquid refrigerant receiver **4**. A conduit **5** runs from the receiver **4** to an expansion valve **6** which controls flow of refrigerant to an evaporator **7**, the evaporator **7** being connected by a conduit **8** to the suction side of the compressor **1**. The refrigerant evaporator **7** is positioned within an enclosure **9** and is operable to cool air circulating therewithin. The refrigeration expansion valve **6** is a conventional gas-charged thermostatic expansion valve comprising a movable valve member **10** which is urged towards a valve seat **11** by a spring **12**. The expansion valve **6** has a pressure responsive diaphragm **13** which is operable through a thrust rod **14** to vary the opening of the valve member **10**. There is an adjustment screw member **15** which is operable to vary the compression of the spring **12** thereby to determine the superheat setting for the valve. A cover member **16** encloses a space **17** over the pressure responsive diaphragm **13** and is operable to receive gaseous pressure for the operation of the diaphragm **13**. From the cover member **16** a conduit **18** runs to a maximum operating pressure control member **19** which is in turn connected by a conduit **20** to a thermostatic bulb element **21** positioned at the outlet end of the evaporator **7**. The thermostatic bulb element **21** contains a volatile liquid for transmitting gaseous pressure to the space **17** enclosed above the diaphragm **13** of the expansion valve **6**. The amount of volatile liquid contained in the bulb element **21**, the conduits **18** and **20**, and the space **17** is such that all of the same may be contained within the space **17**. The control member **19** comprises a body member **22** having a transverse passageway **23** therethrough and a cap or cover member **24** screw-threadedly carried thereby as at **25**. The body member **22** has a cylindrical cavity or chamber **26** therein communicating with a cylindrical cavity **27** of smaller diameter into which opens the passageway **23**. Positioned in and sealing the opening from the chamber **26** is a flexible hollow bellows **28** having a spring **29** positioned against the end thereof and urging the same towards a compressed position. There is a thrust member **30** positioned at the open end of the bellows **28** and having an annular flange portion **31** and a cylindrical projecting portion or tongue **32** bearing against the inner face of the end wall of the bellows **28** in opposition to the spring **29**. The cap member **24** has an annular shoulder portion **33** cooperable with the annular flange portion **31** of the thrust member **30** and operable to limit movement thereof in the direction of thrust of the spring **29**. The cap member **24** has an aperture **34** centrally positioned

in the end wall thereof and a cylindrical plug member 35 screw-threadedly positioned therein. The plug member 35 has a longitudinal cylindrical aperture 36 extending therethrough. The plug member 35 terminates inside the cap member 24 in an annular disc portion 37 which has a flexible hollow bellows 38 secured thereto having a closed end wall bearing against the thrust member 30. The aperture 36 in the plug member 35 opens into the hollow interior of the bellows 38 and is operable to receive a conduit 39 leading to a thermostatic bulb element 40.

In operation this expansion valve and system functions as follows:

During normal cooling operation air is circulated within the enclosure 9 and heat removed therefrom by the refrigerant evaporator 7 which is controlled by the expansion valve 6 functioning as a conventional gas type thermostatic expansion valve. The maximum operating pressure control member 19 is shown in an intermediate position of operation, its normal position being with the thrust member 30 moved into engagement with the face of the body member 22 and the bellows 28 fully expanded. When the bellows 28 are fully expanded the volume of the space enclosed within the member 19, i. e. the space 26 and 27 and passageway 23, is at a minimum value. The bulb element 40 is positioned in the path of circulating air within the enclosure 9 and contains a volatile liquid which is responsive to the temperature of such circulating air and is operable to transmit pressure through the conduit 39 to the bellows 38. As the temperature of the air circulating over the bulb element 40 to the evaporator 7 decreases the pressure in the bellows 38 will decrease permitting the spring 29 to force the bellows 28 towards a collapsed position. As the bellows 28 is forced towards collapsed position the volume of space enclosing the volatile liquid and its vapors from the bulb element 21 is gradually increased thereby permitting the volatile liquid in the bulb element 21 to enter the gas phase in greater quantity until all of said volatile liquid will be in the gas phase when the bellows 28 has been compressed to a position limited by engagement of the annular flange 31 of the thrust member 30 with the annular shoulder 33 of the cap member 24. It is then seen that as the temperature of air circulating over the bulb element 40 is decreased the bellows 28 is compressed thus increasing the volume of the space enclosing the volatile liquid from the bulb element 21 and eventually permitting all of the same to enter the gas phase. The expansion of the space enclosing the volatile liquid from the bulb element 21 will cause a decrease in the pressure at which all of said volatile liquid may enter the gas phase thereby decreasing the maximum operating pressure of the valve 6 and causing the valve member 10 to close thereby decreasing flow of refrigerant to the evaporator 7. The aforementioned decrease of flow of refrigerant to the evaporator 7 will cause the evaporator to be starved, that is, the amount of refrigerant supplied thereto will be sufficient to keep only a portion of the evaporator refrigerated although that portion which is refrigerated will be at a lower temperature due to increased throttling through the expansion valve. The starving of the evaporator 7 and lowered temperature of the portion thereof is operable to cause greater amounts of moisture to be condensed thereon thereby increasing the rate of dehumidification of the air circulating within the enclosure 9. It is seen then that this system provides a novel means for controlling the dehumidification of air within an air conditioning system. In normal operation the air passing over the evaporator 7 is cooled and continuously circulated within the enclosure 9, the cooling being principally the removal of sensible heat. When the temperature of the air circulating within the enclosure 9 drops to a predetermined value the bellows 28 in the control member 19 has been compressed a predetermined amount sufficient to increase the volume of the space enclosing the volatile liquid controlling the diaphragm 13 of the expansion valve 6 thereby decreasing the pressure of the same causing increased throttling of refrigerant passing to the evaporator 7 thereby to starve the evaporator 7 and increase the rate of dehumidification as heretofore described.

In Fig. 3 there is a diagrammatic view of an air conditioning or refrigerating system similar to that shown in Fig. 1 comprising a compressor 1 driven by a motor 2 supplying refrigerant to a condenser 3 which is in turn connected to a receiver 4. The receiver 4 is connected by a conduit 5 to an expansion valve 6 which is in turn connected to a refrigerant evaporator 7 from which a conduit 8 leads to the suction side of the compressor 1. There is a thermostatic bulb element 21 connected by a conduit 20 to a cover member 16 in the expansion valve 6. In this form of the invention, however, the maximum pressure control member 19 is connected in parallel with the bulb element 21 rather than in series, it being connected by a conduit 41 to the cover member 16 of the expansion valve 6. In Fig. 2 the expansion valve 6 shown in the system of Fig. 3 is enlarged, partially broken away and the control member 19 is shown in vertical section. In this form of the invention all parts or portions of parts which are common or essentially common to those in Fig. 1 will be given the same reference numbers and duplication of terminology given will thereby be avoided.

The expansion valve 6 in Fig. 2 is shown only in sufficient detail to show the connection to the control member 19 inasmuch as the detail construction of the valve is immaterial, it being merely a conventional gas charged thermostatic expansion valve. The control member 19 in Fig. 2 is similar to that shown in Fig. 1 with a slight change in that the bellows 28 of Fig. 1 has been replaced with a flexible diaphragm 42. In the control member 19 of Fig. 2 there is an annular dish-shaped member 43 having a flexible diaphragm 42 thereacross which is held in position and sealed thereto by a cover member 44. The cover member 44 and diaphragm 42 enclose an expansible and contractable chamber 45 which is communicable with the space 17 above the flexible diaphragm 13 of the expansion valve 6 through the conduit 41. There is a body member 46 carried by the annular dish-shaped member 43 which carries a thermostatic control member 47. The thermostatic member 47 comprises an annular hat-shaped member 48 and encloses a thermostatically expandible material 49 having a high rate of expansion in passing from the solid to liquid states. There is an annular sleeve member 50 to which the hat-shaped member 48 is secured by an annular flange portion 51, the sleeve member 50 extending into the hollow interior of the body member 46. There is a flexible diaphragm 52 sealed and secured by the sleeve member 50 and the hat-shaped member

48 for transmitting the expansive force of the expansive material 49. The sleeve member 50 has an annular disc member 53 at its upper end which has a spring 54 bearing thereagainst at one end and against the end wall of the body member 46 at the other end for holding the thermostatic member 47 yieldably secured thereto. The sleeve member 50 is hollow and has a longitudinally movable piston member 55 positioned therein. A cylindrical plug member 56 is positioned between the flexible diaphragm 52 and the piston member 55 and is operable to transmit thrust therebetween. The piston member 55 has a projecting portion 57 secured to a second piston member 58 which is longitudinally movable in a sleeve member 59 which is carried by the wall of the dish-shaped member 43. The pistons 55 and 58 transmit thrust from the thermal expansive member 47 to the flexible diaphragm 42.

In operation this form of the invention functions almost identically with the form shown and described in Fig. 1. The thermal expansive material 49 contained in the thermal expansive element 47 is positioned in the path of circulating air and is operable to respond to the temperature thereof. At higher temperatures the expansive material 49 is expanded and the pistons 55 and 58 move to an extreme upward position compressing the diaphragm 42 against the inner face of the cover member 44 thereby decreasing the volume of the expandible chamber 45 to a minimum value. As the temperature of air circulating within the enclosure 9 decreases the temperature of the thermal expansive material 49 likewise decreases causing the same to contract permitting the pistons 55 and 58 to move downward and the diaphragm 42 to move away from the inner face of the cover member 44 thereby increasing the volume of the chamber 45 and providing the heretofore described adjustment of maximum operating pressure of the expansion valve 6.

In the form of the invention shown in Fig. 4 there is a refrigerating system very similar to that shown in Fig. 3, the essential difference being in the means for adjusting the volume of the maximum operating pressure control member 19. The member 19 comprises an annular dish-shaped member 60 having a flexible diaphragm 61 positioned thereacross and sealed thereto by a dish-shaped cover member 62. The diaphragm 61 divides the space between the cover member 62 and the dish-member 60 into two chambers 63 and 64. There is a conduit 65 leading from the cover member 62 and chamber 63 to a T connection 66 joining the conduit 20 from the bulb element 21 and the conduit 18 leading to the expansion valve 6. There is a conduit 67 leading from the annular dish-shaped member 60 and chamber 64 to a closed cylindrical container 68 which contains a volatile liquid and is operable as a heat motor. There is an electric heating coil 69 positioned around the container 68 which is supplied with current from a power source 70 and controlled by a thermostat 71 (shown diagrammatically).

In this form of the invention the operation is very similar to those heretofore described:

The electric heating coil 69 is normally energized and heat supplied to the container 68 to cause the volatile liquid therewithin to vaporize and supply pressure to the chamber 64. The expansion of the chamber 64 by the pressure of vapor therein will cause the diaphragm 61 to be compressed against the inner face of the cover member 62 thus causing a minimum volume for the chamber 63. The thermostat 71 is positioned in the path of air circulating over the evaporator 7 and is operable upon decrease of temperature of said circulating air to a predetermined value to de-energize the electric heating coil 69 thus permitting the volatile liquid in the container 68 to cool and condense thereby decreasing the pressure in the chamber 64 permitting the diaphragm 61 to move to a position against the inner face of the annular dish-shaped member 60. This operation of the member 19 as described performs the same function as the members 19 in the other forms of the invention heretofore described in that a predetermined increase in volume of the expansible chamber 63 will cause a predetermined decrease in the maximum operating pressure of the expansion valve 6 causing the same to throttle flow of refrigerant to the evaporator 7 and thus increase the rate of dehumidification of the air circulating thereover.

In the form of the invention shown in Fig. 5 the expansion valve 6 is shown diagrammatically and the control member 19 is shown in sectional view to illustrate the operation thereof. The control member 19 comprises a body member 72 having an enlarged cylindrical end portion 73 and a smaller cylindrical portion 74. The smaller cylindrical end portion 74 has an end wall member 75 which is connected by a conduit 76 to the expansion valve 6 operable to control the effective volume containing the thermostatic liquid from the thermostatic bulb 21. There is a flexible hollow bellows 77 sealed to the end wall 75 of the member 19 and operable to form an expansive and contractible chamber for controlling the maximum operating pressure of the expansion valve 6. In the large cylindrical portion 73 there is larger bellows 78 which is sealed to the end wall member 79 which has a conduit 80 opening thereinto. The bellows 78 is urged toward a compressed position by a spring 81 and has a thrust rod 82 operatively interconnecting the bellows 78 and 77. The conduit 80 is connected to a thermostat 83 (shown diagrammatically) which is in turn connected by a conduit 84 to a source of pneumatic pressure 85. This form of the invention operates almost identically with that shown in Fig. 1, the only difference being that the pressure of the bellows 78 is supplied from a pneumatic pressure source 85 and controlled by a pneumatic thermostat 83 instead of a bulb element 40 as shown in Fig. 1.

As in the other forms of the invention the thermostat 83 is operable upon the temperature of circulating air being cooled to a predetermined value to permit pressure within the bellows 78 to exhaust and the spring 81 to push the same toward collapsed position thereby expanding the bellows 77 and permitting the volatile liquid in the expansion bulb 21 to enter the gas phase thereby to decrease the maximum operating pressure of the expansion valve 6.

In the form of the invention shown in Fig. 6 the control member 19 has been altered as to make it manually adjustable. In this form of the invention as that shown in Fig. 4 there is a T connection 66 joining the conduit 20 from the thermostatic bulb element 21, the conduit 18 leading to the expansion valve 6 and the conduit 65 leading from the control member 19. The conduit 65 leads to a sealed flexible bellows 86 which is closed at both ends and is operable to vary the volume enclosing the thermostatic liquid from the bulb element 21. The bellows 86 has a spring 87 therein which adjusts the same towards normal expanded position. The control member 19 has a main body member or casing 88 which encloses the bellows 86 and which has an adjustment screw 89 extending thereinto. The adjustment screw 89 is operable upon movement to expand or contract the bellows 86 thereby to perform the desired adjustment of maximum operating pressure which was accomplished in the other forms of the invention by automatic means.

It should be noted that the maximum operating pressure referred to throughout the specification is well known to the art being the maximum suction pressure of the evaporator 7 at which the valve 6 will open. This maximum operating pressure can also be expressed as the pressure within the bulb element 21 when the volatile liquid therewithin has entirely entered the gas phase less the pressure equivalent of the superheat setting of the valve. It should be further noted that although some forms of this invention are shown to use flexible bellows and others to use flexible diaphragms any suitable pressure responsive member or equivalent thereof could be substituted to perform the same function herein. It should also be noted that when the aforementioned maximum operating pressure is decreased by a predetermined amount so that all of the liquid in the bulb or power element enters the gas phase the valve will at that point have changed from a thermostatic action to an "automatic" or pressure responsive action since the bulb or power element can no longer respond to the evaporator temperature.

What is claimed and is desired to be secured by Letters Patent of the United States is:

1. A "gas charged" refrigeration expansion valve comprising a valve member, a movable member responsive to a differential of pressure and operatively connected to said valve member for moving the same, means enclosing a pressure system and including a wall member enclosing a space over said pressure responsive member, a volatile thermostatic liquid in said pressure system operable to supply gaseous pressure for moving said pressure responsive member; said thermostatic liquid being of a predetermined quantity such that the same may be completely vaporized within the range of normal operating temperatures of said valve, the pressure and temperature at which said thermostatic liquid is completely vaporized being determined by the amount of liquid present and the volume of said pressure system; a movable wall member in said pressure system for varying the volume thereof, and means to move said movable wall member to vary the volume of said pressure system thereby to vary the temperature and pressure at which said thermostatic liquid will be completely vaporized.

2. A refrigeration expansion valve comprising a movable valve member, a pressure responsive member operatively connected to said valve member and operable to move the same, a wall member enclosing a space above said pressure responsive member, a bulb element operable to contain a thermostatic liquid for supplying gaseous pressure to said pressure responsive member, a conduit interconnecting said bulb element and said enclosed space; said enclosed space, said conduit, and said bulb element forming an enclosed pressure system operable to control said pressure responsive member, said thermostatic liquid being of a predetermined quantity such that the same may be completely vaporized within the range of normal operating temperatures of said valve, the pressure and temperature at which said thermostatic liquid is completely vaporized being determined by the amount of liquid present and the volume of said pressure system, means forming an expansible and contractable chamber communicable with said enclosed pressure system, means operable to expand and contract said chamber to vary the volume of said pressure system, and said last named variations in pressure system volume being operable to vary the temperature and pressure at which said thermostatic liquid will be completely vaporized.

3. A refrigeration expansion valve comprising a movable valve member, a pressure responsive member operatively connected to said valve member and operable to move the same, a wall member enclosing a space above said pressure responsive member, a bulb element operable to contain a thermostatic liquid for supplying gaseous pressure to said pressure responsive member, a conduit interconnecting said bulb element and said enclosed space; said enclosed space, said conduit, and said bulb element forming an enclosed pressure system operable to control said pressure responsive member, said thermostatic liquid being of a predetermined quantity such that the same may be completely vaporized within the range of normal operating temperatures of said valve, the pressure and temperature at which said thermostatic liquid is completely vaporized being determined by the amount of liquid present and the volume of said pressure system, means forming an expansible and contractable chamber communicable with said enclosed pressure system, thermostatic means operable to expand and contract said chamber to vary the volume of said pressure system, and said last named variations in pressure system volume being operable to vary the temperature and pressure at which said thermostatic liquid will be completely vaporized.

4. A refrigeration expansion valve comprising a movable valve member, a pressure responsive member operatively connected to said valve member and operable to move the same, a wall member enclosing a space above said pressure responsive member, a bulb element operable to contain a thermostatic liquid for supplying gaseous pressure to said pressure responsive member, a conduit interconnecting said bulb element and said enclosed space; said enclosed space, said conduit, and said bulb element forming an enclosed pressure system operable to control said pressure responsive member, said thermostatic liquid being of a predetermined quantity such that the same may be completely vaporized within the range of normal operating temperatures of said valve, the pressure and temperature at which said thermostatic liquid is completely vaporized being determined by the amount of liquid present and the volume of said pressure system, means forming an expansible and contractable chamber communicable with said enclosed pressure system, a heat motor operable to expand said chamber thereby to provide a predetermined increase in volume of said enclosed pressure system, an electric heating coil for said heat motor, a thermostat for controlling energization of said heating coil, and said predetermined increase in volume being operable to reduce by a predetermined amount the temperature and pressure at which said thermostatic liquid will be completely vaporized.

5. An air conditioning system comprising a re-

frigerant evaporator for removing heat from air circulating within an enclosure; an expansion valve for controlling flow of refrigerant to said evaporator, said expansion valve comprising a valve member, a pressure responsive member operatively connected to said valve member and operable to move the same, a cover member forming with said pressure responsive member an enclosed space, a bulb element communicable with said enclosed space and operable to contain a thermostatic liquid for supplying gaseous pressure thereto, said thermostatic liquid being of a quantity capable of being contained entirely within said enclosed space, means forming an expansible and contractable chamber communicable with said enclosed space and operable upon a predetermined expansion to provide a predetermined increase in the effective volume of said enclosed space thereby to decrease by a predetermined amount the maximum operating pressure of said valve, means cooperable with and operable to expand said chamber, and said predetermined decrease in maximum operating pressure being operable to cause said valve member to throttle flow of refrigerant to said evaporator thereby decreasing the temperature of a portion of said evaporator to a point below the dew point of water vapor in said circulating air for more efficient dehumidification.

6. An air conditioning system comprising a refrigerant evaporator for removing heat from air circulating within an enclosure; an expansion valve for controlling flow of refrigerant to said evaporator, said expansion valve comprising a valve member, a pressure responsive member operatively connected to said valve member and operable to move the same, a cover member forming with said pressure responsive member an enclosed space, a bulb element communicable with said enclosed space and operable to contain a thermostatic liquid for supplying gaseous pressure thereto, said thermostatic liquid being of a quantity capable of being contained entirely within said enclosed space, means forming an expansible and contractable chamber communicable with said enclosed space and operable upon a predetermined expansion to provide a predetermined increase in the effective volume of said enclosed space thereby to decrease by a predetermined amount the maximum operating pressure of said valve, thermostatic means positioned in the path of said circulating air and responsive to the temperature thereof, said thermostatic means being cooperable with said chamber and operable upon cooling of said circulating air to a predetermined temperature to cause said predetermined expansion of said chamber, and said predetermined decrease in maximum operating pressure being operable to cause said valve member to throttle flow of refrigerant to said evaporator thereby decreasing the temperature of a portion of said evaporator to a point below the dew point of water vapor in said circulating air for more efficient dehumidification.

7. A refrigeration expansion valve comprising a movable valve member, a pressure responsive member operatively connected to said valve member and operable to move the same, a wall member cooperable with said pressure responsive member to form an enclosed space, a bulb element operable to contain a thermostatic liquid for supplying gaseous pressure to said pressure responsive member, a casing member having a passageway therethrough and an aperture communicable with said passageway, a conduit interconnecting said bulb element and one end of said passageway, a second conduit interconnecting the other end of said passageway and said enclosed space, a movable wall member closing said casing aperture and forming an expansible and contractable chamber communicable with said passageway, and means cooperable with said movable wall member to expand and to contract said chamber.

8. A refrigeration expansion valve comprising a movable valve member, a pressure responsive member operatively connected to said valve member and operable to move the same, a wall member cooperable with said pressure responsive member to form an enclosed space, a bulb element operable to contain a thermostatic liquid for supplying gaseous pressure to said pressure responsive member, a conduit interconnecting said bulb element and said enclosed space, a casing member having an aperture thereinto, a movable wall member cooperable with and closing said aperture and operable to enclose an expansible and contractable chamber, means interconnecting said chamber and said enclosed space, and means cooperable with said movable wall member operable to expand and to contract said chamber.

FRANKLYN Y. CARTER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,199,498	Kaufman	May 7, 1940
2,227,760	Newcum	Jan. 7, 1941
2,242,334	Wile	May 20, 1941
2,297,872	Carter	Oct. 6, 1942
2,319,993	Kaufman	May 25, 1943
2,475,556	Seligman	July 5, 1949