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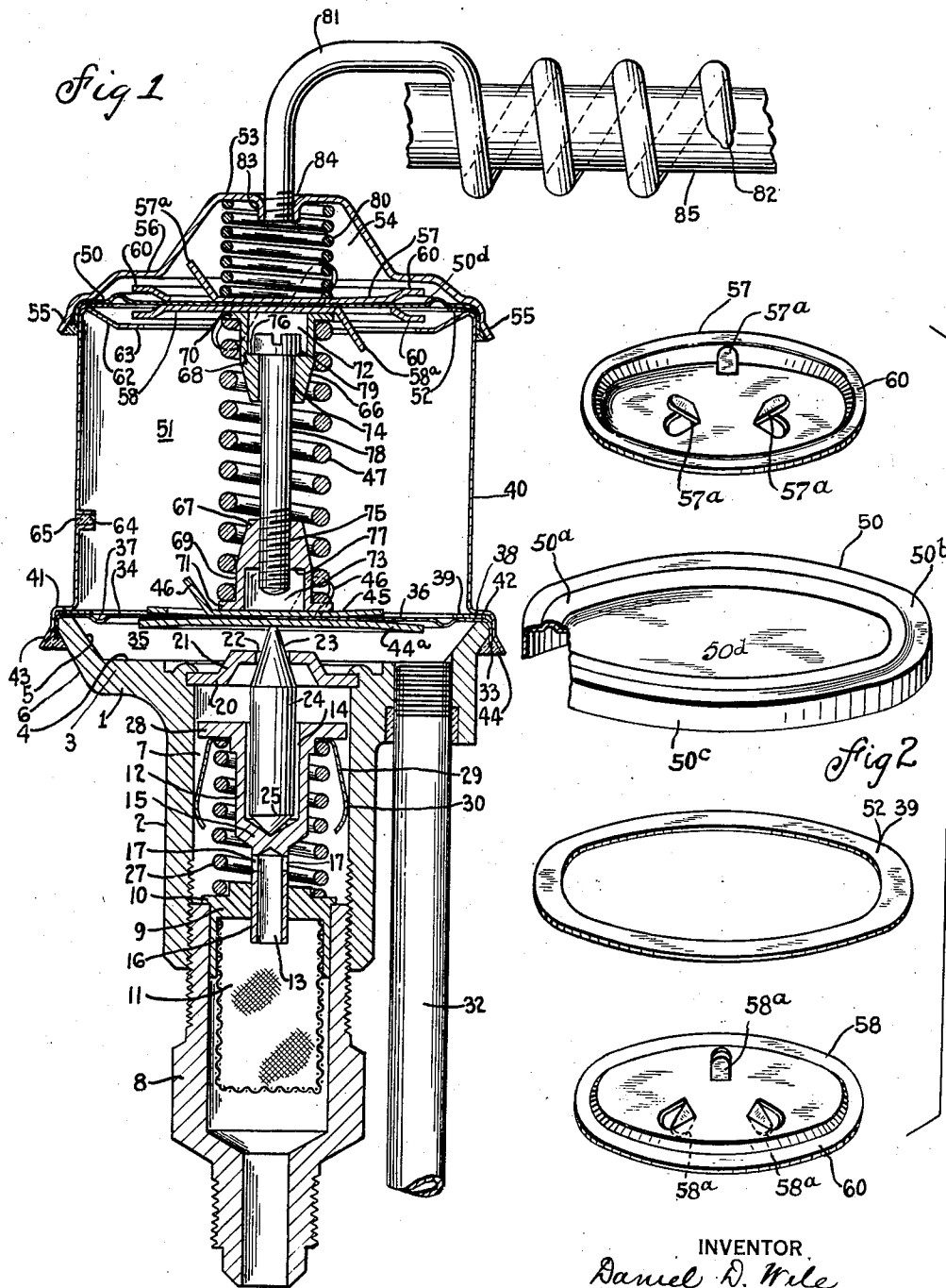
D. D. WILE

2,192,117

CONTROL DEVICE

Filed May 22, 1935

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

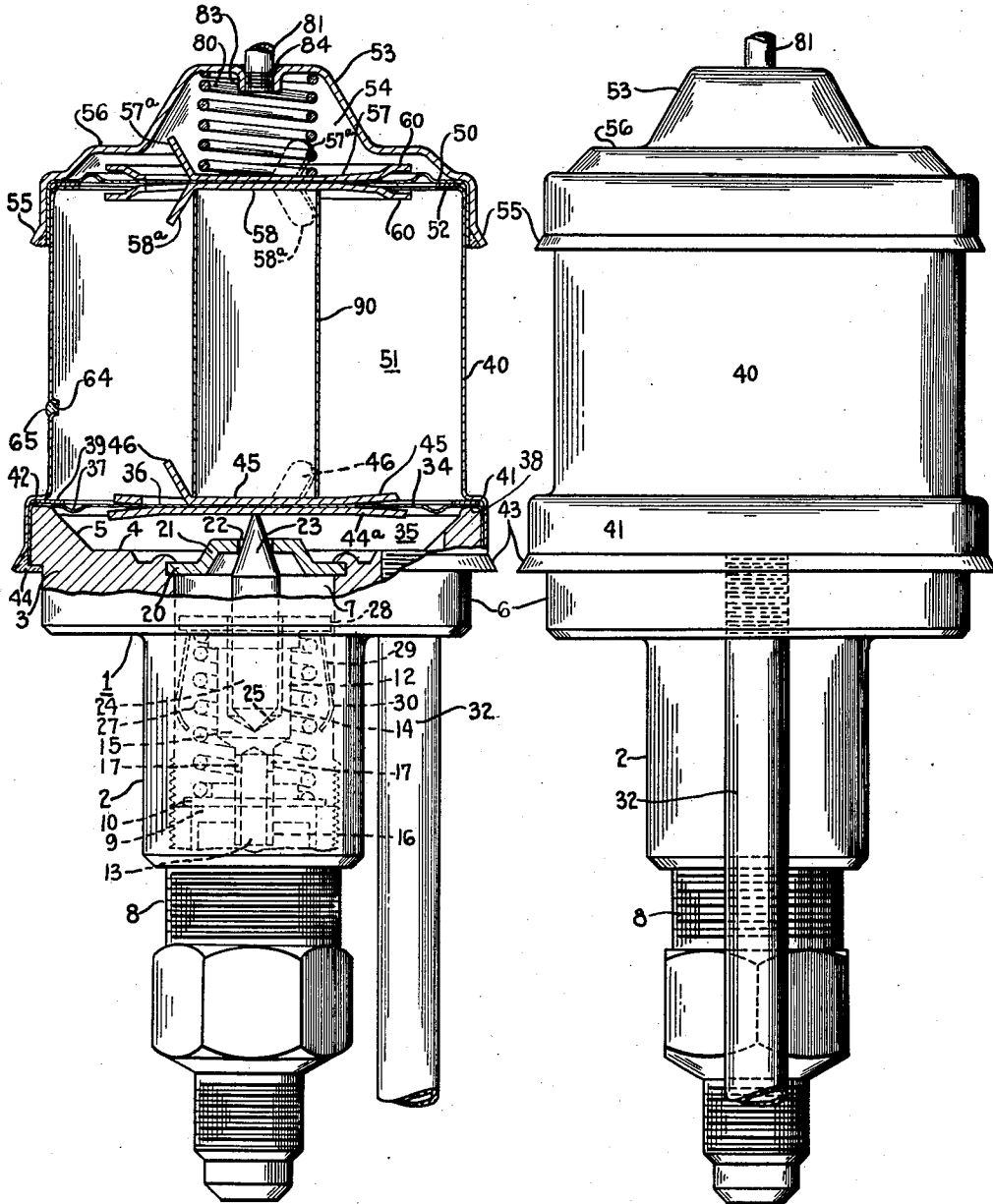


Fig 1

Fig 3

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2,192,117

CONTROL DEVICE

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Application May 22, 1935, Serial No. 22,769

18 Claims. (Cl. 236—92)

My invention relates generally to valves and more particularly to valves of the thermostatic expansion type.

One of the objects of my invention is to provide a new and improved expansion valve control device for refrigerating apparatus and of a character such that the refrigerant compressor will not be overloaded during pull-down period.

Another object of my invention is to provide a thermostatic expansion valve having a new and novel connecting member between the thermostatic power element and the valve.

Another object of my invention is to provide a thermostatic expansion valve having a lost motion connecting member between the thermostatic element and the valve to prevent the opening of the valve until the pressure of the refrigerant in the evaporator has been lowered to a predetermined pressure.

Another object of my invention is to provide an expansion valve having a new and improved arrangement of the operating parts thereof.

Another object of my invention is to provide a control device having a new and improved arrangement of the valve and cooperating valve carrying structure to insure proper seating of the valve.

The invention consists in the improved construction and combination of parts to be more fully described hereinafter and the novelty of which will be particularly pointed out and distinctly claimed.

In the accompanying drawings, to be taken as a part of this specification, I have fully and clearly illustrated my invention, in which drawings—

Fig. 1 is a view shown in longitudinal cross-section of my improved thermostatic expansion valve;

Fig. 2 is a schematic view in perspective of the parts of a diaphragm structure employed in the expansion valve and embodying features of my invention;

Fig. 3 is a view shown in side elevation of a modified form of the device of Fig. 1, and

Fig. 4 is a view looking from the left to right of Fig. 3 and partly broken away and in section.

Referring to the drawings by characters of reference, the numeral 1 designates, in general, a casing or body portion of my expansion valve and which is formed, in this instance, having a tubular portion 2, one end or upper end, as seen on the drawings, having an enlarged portion in the form of an annular flange 3. The end wall of the enlarged portion 3 is recessed, as at 4, the inner side wall

5 defining the recess preferably being circular in contour and tapered or flared outwardly from wall 4 and preferably around the entire periphery of the enlarged portion 3. The outer wall surface 6 of the tapered wall portion preferably extends in the same general direction, or substantially parallel with the inner wall 5, as shown. The tubular portion 2 of the body 1 extends centrally from wall 4 and its bore 7, which constitutes the valve chamber, runs out of the recessed wall 4, preferably centrally thereof and runs out of the opposite end of the tubular portion, at which end it is internally threaded for receiving an externally threaded tubular fitting 8. The other end of the fitting 8 is externally threaded for connection with a refrigerant supply conduit leading from a refrigerant compressor (not shown) and the supply conduit may be connected to the expansion valve such as by a nipple or nut (not shown) or by any other suitable attaching means. The inner end of the fitting 8, within the bore or valve chamber 7, is closed by a tubular closure member 9 sleeve fitted into the inner end of the tubular fitting 8 and which has an annular flange 10 for bearing against the end of the tubular fitting 8. A strainer member 11 is telescoped within the tubular closure member 9 and is supported thereby within the tubular fitting 8.

Disposed within the bore 7 of the body portion 2 there is a reciprocal valve supporting or carrying member 12 which has two aligned bores 13 and 14 coaxial with bore 7 and which are separated by a substantial transverse wall portion 15 integral with member 12 and intermediate its ends. In the present instance, the end portion of the supporting member 12, adjacent the closure member 9, is of relative reduced diameter, as at 16, and extends through an aperture centrally disposed in the closure member 9 and is slidably engageable with the closure member for guiding the reciprocal valve carrying member 12. In the side wall of the reduced tubular portion 16, and within the chamber 7, are provided apertures 17 providing communication between the valve chamber 7 and the interior of fitting 8 through bore 13 of the reduced portion 16.

In the valve chamber 7, adjacent the recessed wall 4, there is a valve seat member 20 which, in the present instance, is in the form of a plate disposed transversely across the chamber 7 closing the same. The valve seat member 20 may be a separate part, as shown, or it may be an integrally formed part of the body 1, if desired. The seat member 20, in the present construction, is secured in an annular groove formed in the wall

of chamber 7 adjacent the wall 4. In the present instance, the valve seat member 20 is formed having a cup-shaped portion 21 which portion extends out of chamber 7 slightly beyond the recessed wall 4. An aperture 22 is provided in the transverse end wall of the cup-shaped portion 21 providing a valve port and seat for cooperating with the conical face 23 of a needle valve 24 to control flow of refrigerant through the device to an evaporator.

The needle valve 24 is carried by the reciprocal supporting member 12 within bore 14 thereof, which bore runs out of the end of member 12 that is disposed toward the valve seat member 20. The valve 24 is preferably not fixedly connected to the supporting member 12 but rather is loosely supported in bore 14, the diameter of bore 14 preferably being relatively larger than the diameter of the valve 24 so that the valve can tilt or cant slightly if it should have a tendency to do so and, by so doing, adjust itself to seat properly and eliminate side strain. The wall or partition 15, one face of which forms the inner end wall of bore 14, has a conical recess 25 which tapers to an apex and in which the substantially pointed end of the valve extends and engages in the apex of the recess. The valve 24 thus has a single point bearing or pivot point in the conical recess which retains the pointed end of the valve to prevent side movement of the pointed end, and around which point the valve 24 may pivot or cant in order to properly seat. The other end of the valve 24 extends beyond the end wall of the supporting member 12 toward the valve seat member 20 and preferably the conical portion 23 of the valve and its valve seat 22 are so designed that a portion of the end of the conical valve projects through the valve port and extends beyond the recessed wall 4, as shown.

A coil spring 27 surrounds the valve supporting member 12 and is under compression tending to move the valve 24 toward closed position or against its seat. One end of the coil spring 27 bears against an annular flange 28, formed on the member 12, while the other end of the spring bears against the closure member 9. The closure member 9 and the member 12 are provided with projecting portions to receive the adjacent ends of the spring to retain the same in proper position. By rotating the fitting 8, it will be seen that the spring 27 may be placed under greater or less compression force, so that the force tending to close the valve may be varied.

Between the flange 28 and the adjacent coil of the spring 27, is held a pair of oppositely disposed spring bearing members or fingers 29 having convex-shaped bearing portions engaging the wall of bore 7, as at 30. The spring fingers 29, engaging the wall of bore 7, provide sufficient friction to dampen vibratory action of spring 27 so that the valve and its supporting member have a more controlled reciprocating action. By dampening vibrations of the spring 27, over-travel of the valve is prevented when the valve is throttled and resultant noise, due to engagement of the valve with its seat, is eliminated.

Mounted on the circular rim or edge of the recessed end of the body 1 is a movable wall means or diaphragm 34, one side of which cooperates with the recessed wall 4 and the adjacent circular side wall 3 providing a chamber 35 through which refrigerant passes from the inlet side to the outlet side of the device, controlled by the valve 24. Through the annular flange 3 and leading out from chamber 35 there

is a threaded aperture for receiving an externally threaded end portion of a refrigerant evaporator coil 32. The diaphragm 34 is preferably a pan-shaped structure having a circumferential reinforcing flange 33, the diaphragm preferably telescoping snugly over the recessed end of the body 1. The diaphragm 34 is preferably of the snap-acting type in which only a circular central portion 36 of the diaphragm is movable when sufficient pressure is brought to bear thereagainst to move the same over central. The central movable portion 36 is defined by and capable of snap-action movement by reason of a bent and rib-shaped portion 37 which circumscribes or defines the movable portion and is spaced from the peripheral edge of the diaphragm to provide a marginal portion 38 for seating against the end of the body 1. As is well known in diaphragms of this type, the flexing movement takes place through the bending of the circular bent portion 37 to permit flexing movement of the central portion 36 without such movement being transferred to the annular seating portion 38.

Mounted on the body 1 there is an extension or spacer member 40 in the form of a tubular housing or sleeve member. The housing member 40 is preferably cylindrical in form and, at one end, has a portion 41 of enlarged diameter which telescopes snugly over the enlarged end 3 of the casing 1 and provides an annular shoulder or seating surface 42 for seating on the body. An edge portion of the portion of enlarged diameter is preferably flared outwardly therefrom around its entire periphery, as at 43. Between the seating shoulder 42 of the housing 40, and the diaphragm 34 there is preferably provided a flat reinforcing ring or washer 39. In the spaced between the outer tapered wall 6 of the body 1 and the inner wall of the diaphragm flange 36, and between the outer wall of the flange 36 and the inner flared wall of the encircling housing 40 there is preferably provided a sealing material such as solder, indicated at 44, for securing the diaphragm 34, ring 39 and housing 40 together and to the body 1, and for sealing the chamber 35 against leakage of fluid.

Carried by the diaphragm 34 and within the chamber 35 is a reinforcing member in the form of a plate 44^a which is secured to the central movable portion 36 of the diaphragm, there preferably being a marginal space between the peripheral edge of the reinforcing member and the circular bent portion of the diaphragm. The reinforcing plate 44^a may be welded or otherwise suitably secured to the flexible portion 36 of the diaphragm. The reinforcing plate 44^a besides serving to reinforce the diaphragm also serves, in the present instance, as a bearing surface for the end portion of the conical face 23 of the valve 24. When the diaphragm is flexed toward the recessed wall 4, the valve is moved away from its seat and refrigerant flows from chamber 7 through chamber 35 into the inlet end of the evaporator coil 32. Carried by the movable wall portion 36 of the diaphragm 34 and within the housing 40, there is a second reinforcing plate 45 which may be secured thereto, such as by welding. The plate 45 has provision, in the form of extended portions or tabs 46, for retaining the adjacent end of the spring 27 in proper position, substantially central of the diaphragm 34. The tabs 46, of which there are three in the present instance, are preferably equally spaced from each other and from the center of the plate 45. Preferably the tabs 46 are formed out of the plate 75

45 and are bent out of the plane thereof so that they extend in an upward and outward direction.

Mounted on the other end or top of the housing member 40 there is a thermostatic power element which includes a pan-shaped diaphragm 50 of similar shape and construction as the previously described diaphragm 34, with a rib-shaped portion 50^a, a marginal portion 50^b, a reinforcing flange 50^c, and a circular portion 50^d. The diaphragm 50 telescopes snugly over the upper end portion of the housing member 40. One side of the diaphragm 50 cooperates with the diaphragm 34 and the inner wall of the sleeve or housing 40 to provide a closed chamber 51. Between the diaphragm 50 and the end of the housing, there is provided a flat circular reinforcing ring 52 like the ring 39 previously described. Mounted on the diaphragm 50 and telescoped thereover is a cap or casing 53, the inner wall of which cooperates with the adjacent side of the diaphragm 50 providing a closed chamber 54. A marginal edge portion of the cap 53, at its open side, is preferably flared outwardly, as at 55, along the entire periphery thereof. Between the outer wall of the diaphragm reinforcing flange and the inner flared edge portion of the cap 53 there is provided a sealing material such as solder, which is disposed therein so as to secure the cap 53, ring 52 and diaphragm 50 together and to the housing 40, and to seal the chamber 54 against leakage of fluid therefrom.

The cap 53 is in the form of a truncated cone and has, in the present instance, a stepped wall portion in its side wall, as at 56, which preferably extends around the entire periphery thereof, the inner wall of the stepped portion being disposed over and adjacent the diaphragm 50. Carried by the diaphragm 50 and on opposite sides thereof, are similar reinforcing plates 57 and 58, plate 57 being shown in Fig. 2. Each of the plates 57 and 58 is preferably formed having a marginal edge portion disposed in a plane offset from the plate proper, as at 60, and preferably around its entire periphery. The plates 57 and 58 are assembled to the diaphragm 50 with their marginal offset portions extending away from the diaphragm in opposite directions, the plates being welded or otherwise suitably secured to the flexible portion of the snap-acting diaphragm 50. The plates 57 and 58, like those carried by the diaphragm 34, are centrally disposed relative to the diaphragm and to each other and within the confines of the circularly extending bent portion 37. The upper end of the housing 40 is formed with an inwardly extending flange 62 which may extend entirely around the housing and which, in the present instance, extends downwardly and then substantially horizontally, providing an inner marginal edge portion 63 adjacent the underside of the offset marginal portion 60 of plate 58. The inwardly extending flange portion 62 serves as a stop for the diaphragm to prevent rupture of the same and is engaged by the offset portion 60 of the adjacent plate 58, while the stepped portion of the cap 53 serves as a stop against which the offset portion 60 of plate 57 engages and thus limits movement of the diaphragm in its direction.

The chamber 51 is charged with a gas under pressure, preferably air, for exerting a substantially constant pressure against the diaphragms 34 and 50. In the side wall of the sleeve housing 40 there is provided an aperture 64 through which air may pass into chamber 51, and which

aperture may be sealed such as by means of solder, indicated at 65. The gas in chamber 51 will exert a pressure on the diaphragms 34 and 50 equal to atmospheric pressure, but the force exerted by the air will not be the same on both diaphragms since diaphragm 50 is preferably relatively smaller in area than diaphragm 34, in the present instance.

In order to provide a thermostatic expansion valve of a character such that the refrigerant compressor will not be overloaded during pull-down periods, I provide a lost motion connecting means for connecting the thermostatic power element or diaphragm 50 and the pressure actuated diaphragm 34, which connecting member prevents opening of the valve 24 until the pressure of the refrigerant in chamber 35 has been reduced by the compressor to a predetermined pressure. The lost motion connecting means is disposed in chamber 51 and includes the heretofore mentioned coil spring 47, which is under compression therein with its opposite ends adjacent the diaphragms 34 and 50. The ends of the spring 47 surround bearing members 66 and 67, which are similar in shape having tubular portions 68 and 69 respectively which extend part-way into the spring coaxially therewith. The bearing members 66 and 67 are formed with annular flanges 70 and 71 respectively providing bearing surfaces for engaging the adjacent sides of the plates 45 and 58. The reinforcing plates 58 and 57, like the plate 45, have tabs 58^a and 57^a respectively, which are formed and bent out of the plane of the plates. The tabs 58^a, of which there are three in the present instance, are preferably equally spaced relative to each other and from the center of plate 58, the center of plate 58 preferably being in alignment with the center of diaphragm 50. The bearing member 66 is disposed centrally of the plate 58, and therefore of diaphragm 50, with the tabs 58^a extending downwardly and outwardly at points around the periphery of the annular flange 70 of member 66. Preferably, there is a small clearance between the tabs 58^a and the periphery of flange 70 to permit slight side movement of member 66 if it should have a tendency to do so, the purpose of which is hereafter described. The ends of the spring 47 are preferably spring fitted over their respective bearing members 66 and 67 and bear against the annular flanges 70 and 71 thereof respectively. The members 66 and 67 are provided with relatively large bores 72 and 73 respectively, which extend longitudinally and centrally thereof coaxial with the spring 47 and which run out of the ends thereof which bear against the plates 45 and 58. The bores 72 and 73 extend to a point intermediate the ends of the portions 68 and 69, where reduced bores 74 and 75 run out of the inwardly extending ends of the portions 68 and 69 thus providing outward facing internal annular shoulders 76 and 77 respectively. The reduced bore 75 of the bearing member 67 is preferably internally threaded to receive a threaded end portion of a bolt or pin 78, the other end of the bolt extending through the reduced bore of member 66 and having a head 79 bearing against the annular shoulder 76 thereof. The diameter of the reduced bore 74 is preferably made sufficiently larger than the diameter of the bolt 78 so that there will not be any frictional engagement between the parts and so that relative movement between the diaphragm and bolt will be permitted. The spring 47 is preferably only under sufficient compression to maintain the bearing

members 66 and 67 in engagement with their respective diaphragms 34 and 50. By this arrangement, the bearing members 66 and 67 are slidably movable sideways, restricted in such movement by the tabs of the plates 45 and 58. By providing a loosely disposed connecting member between diaphragms 34 and 50, it will be seen that the connecting member will be self-centering and that the force transmitted by the diaphragms 10 to the spring 47 will always be in a direction coaxial of the spring. Or in other words, the loosely arranged connecting member will not cant.

Within the chamber 54 there is a coil spring 80 under compression with one end bearing against the inner end wall of the cap 53 and the other bearing against the plate 57 tending to flex the diaphragm 50 inwardly. The spring 80 is preferably substantially in coaxial alignment with spring 47 and the end bearing against the plate 57 is restricted in side movement by the tabs 57^a thereof. The thermostatic power element includes a temperature responsive element 81 which, in the present instance, is in the form of a tube or conduit having one end closed, as at 82, with the other end in open communication with the chamber 54. The cap 53 is formed on its end wall with an inwardly extending tubular portion 83, internally threaded for receiving a threaded end portion of the tube 81. Preferably, solder or other suitable sealing material is provided around the tube between the tube and the outer wall of the cap, as at 84, to insure against leakage of fluid. The tube 21 may be charged with a suitable expansible-contractible fluid such as methyl chloride, and preferably the tube is wound around the evaporator coil adjacent the outlet end 85 and in good heat transfer relation therewith. Preferably, the expansible-contractible fluid is placed in the thermostatic element under a pressure such that within the range of operating temperature of the evaporator, some of the fluid remains in its liquid state.

The operation of my expansion valve in connection with a refrigerating system is as follows: When the refrigerant evaporator is relatively warm such as, for example, after the defrosting period, the fluid in the tube 81, and consequently in chamber 54, will have expanded and will exert a force against diaphragm 50 corresponding to the temperature of the evaporator coil at the point of location of tube 81. Also, in chamber 35, the expanded refrigerant in the evaporator will exert a force against diaphragm 34 in accordance with the pressure of the refrigerant in the evaporator. The pressure of the expansible-contractible fluid in chamber 54 tends to flex diaphragm 50 in a valve opening direction while the pressure of the refrigerant in chamber 35 tends to flex diaphragm 34 in a direction which will permit spring 27 to seat the valve. During the shut-down period, the pressure exerted by the refrigerant in chamber 35, and the pressure exerted by the expansible-contractible fluid in chamber 54, because of its liquid charge, will be substantially equal, but the cooperating forces, namely the springs acting on the diaphragms and the difference in areas of the diaphragms, will be such as to permit the valve 24 to be seated during the shut-down period. When the force exerted by the expansible-contractible fluid in chamber 54, plus the force of the spring 80 therein, exceeds the force of the spring 47 exerted in holding the abutment member 76 against

the head 79 of pin 78, the diaphragm 50 will be flexed inwardly, or in a valve opening direction. Instead of such movement being transmitted to diaphragm 34, and therefore unseating valve 24, the lost motion connecting means or spring 47 allows the diaphragm 50 to flex inwardly into the chamber 51, and the force necessary for the flexing of the diaphragm counteracts the increased force exerted on the diaphragm by the increased pressure in the chamber 54. The spring 47 thereby prevents the motion of diaphragm 50 from being transferred to the diaphragm 34 and prevents unseating of valve 24. However, when the pressure in chamber 35 has been reduced by the compressor to a predetermined pressure, the valve 24 will unseat to allow flow of refrigerant. Accordingly, the compressor is not overloaded in that when it is first started it will not have to overcome a relatively high back pressure exerted by expanding gas in chamber 35 due to the feeding of liquid refrigerant by the valve 24. When the pressure in chamber 35 has been decreased by the compressor to a predetermined pressure, then the potential force stored in spring 47, tending to engage head 79 with member 76 will exceed the combined forces of spring 27 and the fluid pressure acting through the diaphragm 34 so that the diaphragm 34 will be flexed by any movement in a valve opening direction of the diaphragm 50, and unseat valve 24. For example, if the refrigerant pressure desired to be maintained in the evaporator is say 60 lbs. pressure, and the pressure thereof is 80 lbs. when the compressor is started, then the valve 24 will not be opened until the pressure in chamber 35 has been decreased below the predetermined pressure of 60 lbs., or the pressure which acts on the diaphragm 34 in conjunction with spring 27, equals the pressure exerted by the spring 47 in holding the bolt 78 in engagement with member 76.

When the valve 24 is opened due to a reduction in pressure below the predetermined pressure, refrigerant flows through port 22 into chamber 35 and from chamber 35 into the inlet end of the evaporator coil 32. The coil 32 is first refrigerated at its inlet end and gradually throughout its length, as though an ordinary spring actuated, automatic expansion valve were being used. When the coil has been refrigerated at the point of location of tube 81, then the pressure in chamber 54 decreases. When the pressure in chamber 54 has been decreased such that the force exerted thereby against the diaphragm 50 is less than the opposing force of spring 47, then the diaphragm 50 will be returned to its normal operating position. If the pressure in chamber 54 has been reduced to the predetermined pressure, then my thermostatic expansion valve operates in the same manner as the well known thermostatic expansion valve. When the evaporator coil is completely refrigerated to the point of location of the tube 81, in heat transfer relation therewith, the reduction of temperature of tube 81 causes a reduction in pressure in chamber 54 and the valve 24 tends to throttle so as to prevent an excessive amount of refrigerant from being admitted to the evaporator. A pressurestat or other suitable means (not shown) may be employed to cut-in and cut-out the refrigerant compressor between pressure or temperature limits.

Referring now to Figs. 3 and 4 in which a modified form of my thermostatic expansion valve is shown, this expansion valve, like that previously described, prevents overloading of the

refrigerant compressor during pull-down periods. It will be understood at this point, that the thermostatic element of the expansion valve of Fig. 1 is charged with a so-called liquid charge and

that opening of valve 24 is delayed by reason of the lost motion connecting means, to prevent overloading the compressor during pull-down periods. The thermostatic expansion valve of Figs. 3 and 4 is in general structure substantially the same as that of Fig. 1 except that a rigid motion transmitting means rather than a lost motion connecting means is employed and the thermostatic element, namely the chamber 54 and tube 81, is charged with a so-called gas charge. The motion transmitting means is disposed in the chamber 51 for transmitting flexing movement of one diaphragm to the other. The motion transmitting means may be of any suitable form and, as in the present instance, may consist of a tubular member 90 arranged with its opposite ends bearing against the plates 45 and 58 carried by the diaphragms 34 and 50 respectively. Preferably the member 90 is not fixed to either of the diaphragm structures, nor otherwise fixed, but rather is loosely disposed therebetween so as to be self-centering. As in the previously described expansion valve, the tabs 46 and 58^a prevent undue side movement of the member 90 and maintain it substantially in central alignment with the diaphragm.

In the operation of the thermostatic expansion valve of Figs. 3 and 4, the spring 27 tending to seat valve 24 preferably exerts a greater force than spring 80 tending to unseat valve 24. The force exerted by spring 27 may be varied by rotating fitting 8, and the spring may be placed under a greater or less compression force as desired. The expansible-contractible fluid in the thermostatic element, that is, in chamber 54 and tube 81, is placed therein under a predetermined pressure which is governed by the desired pressure at which the valve will open, or say a valve opening pressure of 60 lbs. When the refrigerant evaporator temperature increases, such as during the defrosting period, the pressure of the expansible-contractible fluid in the thermostatic element increases correspondingly until it has reached the pressure at which it was placed therein, after which the entire body of the expansible-contractible fluid is in a gaseous state. After the entire body of fluid in the thermostatic element is in its gaseous state, then further increase in the temperature of the evaporator will only cause a slight accompanying increase in the pressure of the gas which will then be superheated. However, the pressure of the refrigerant in chamber 35 increases in accordance with the increase in evaporator temperature, providing liquid refrigerant is present therein, and as a result, it will exert a greater force against diaphragm 34 than the superheated gas will exert against diaphragm 50. Also, because of the difference in areas of the diaphragms, there will be a greater force exerted against diaphragm 34 than against diaphragm 50. Therefore, during the shut down period the force exerted by the expanded refrigerant in chamber 35, plus the force of spring 27, will exceed the force exerted by the gas in chamber 34, plus the force of spring 80, and as a result the valve 24 will be held in closed position or seated. If it is desired to maintain the refrigerant in the evaporator at a pressure of 60 lbs. and the pressure therein is 80 lbs. when the compressor is started, it will be seen that the force exerted by the expanded fluid in cham-

ber 54, plus the force of spring 80, will be insufficient to unseat the valve against the force of spring 27, plus the force exerted by the expanded refrigerant in chamber 35, until the evaporator pressure has been decreased below 60 lbs. pressure. When the pressure in chamber 35 has been decreased below 60 lbs. pressure by the compressor, then the diaphragm 50 will be flexed inwardly or in a valve opening direction, and move the motion transmitting means 90 which will flex diaphragm 34 and unseat valve 24. Refrigerant is then admitted to the evaporator coil 32 to maintain the predetermined maximum pressure in the coil and chamber 35 until such time as the coil is completely refrigerated to the point of location of tube 81, after which the valve 24 is throttled by reason of the reduction in pressure in chamber 54 and temperature of tube 82. As the temperature of tube 81 decreases below the temperature corresponding to the desired 60 lbs. pressure, the gas therein condenses and the change from the gaseous to the liquid state corresponds to the decrease in evaporator temperature. The thermostatic expansion valve now operates in the well known manner to admit just enough refrigerant to maintain the evaporator coil completely refrigerated. It will be understood that a pressurestat or similar control device (not shown) may be employed to cut-in and cut-out the refrigerant compressor between pressure limits.

From the foregoing description it will now be appreciated that I have provided a new and improved thermostatic expansion valve for a refrigerating system, and of a character such that overloading of the compressor during pull-down periods is prevented. By reason of the lost motion connecting means, in the device of Fig. 1, the opening of the valve is delayed until the compressor has had time to withdraw expanded refrigerant from the evaporator which would otherwise oppose the delivery of refrigerant to the compressor and thus overload the same. It will also be seen that I have provided a new and improved thermostatic expansion valve of the gas charged type. In addition, I have provided a thermostatic expansion valve which will prevent the compressor from being overloaded and one which has a new and improved motion transmitting means connecting the thermostatic element and the valve. Furthermore, I have provided a new and improved arrangement of a valve, valve carrier and associated parts to insure proper seating of the valve.

What I claim and desire to secure by Letters Patent of the United States is:

1. In an expansion valve for controlling the admittance of a refrigerant medium to a refrigerant evaporator, a casing having an inlet and an outlet port and having a tubular-shaped extension, said extension being formed at its open end with a reentry flange portion having a portion extending substantially transverse to the longitudinal axis of said tubular extension, a valve for controlling flow through said casing, means for actuating said valve including a diaphragm, said diaphragm having an outer border portion seated on and closing the open end of said extension, means for securing said diaphragm to said extension, means operatively connecting said diaphragm and said valve, and a reinforcing plate member for said diaphragm to prevent rupture of the same, said reinforcing plate member being carried by said diaphragm and within said extension, said reinforcing plate

member having an offset portion positioned for engagement with said transverse portion of said extension for limiting flexing movement of said diaphragm.

2. In an expansion valve for controlling the admittance of a refrigerant medium to a refrigerant evaporator, a casing having an inlet and an outlet port and having a tubular-shaped extension having an open end, a reciprocal valve for controlling flow through said casing, means for actuating said valve including a diaphragm seated on and closing the open end of said extension, a truncated cap member having an end wall and seating on an outer border portion of said diaphragm, said cap member and said diaphragm cooperating to provide an expansible chamber for containing a fluid responsive to evaporator temperature, said cap member having an offset wall portion extending substantially parallel to said diaphragm and overlying the same in spaced relation thereto, means for securing said cap member, diaphragm and extension together and for hermetically sealing said expansible chamber, a reenforcing plate member secured to said diaphragm to prevent rupture of the same, said plate member being disposed in said chamber and formed having an offset portion positioned to engage with said offset wall portion of said cap member to limit flexing movement of said diaphragm, and a loosely disposed coil spring in said chamber having one end abutting said end wall of said cap member and the other end abutting said reenforcing plate member for urging said diaphragm in one direction, the side wall of said truncated cap member at said end wall limiting lateral movement of said one end of said spring, said plate member being formed having tabs extending into said chamber around the other end of said spring and defining a space for limited lateral movement of the other end of said spring.

3. In an expansion valve for controlling the admittance of a refrigerant medium to a refrigerant evaporator, a casing through which refrigerant flows enroute to the evaporator and having a tubular-shaped extension, said extension having an open end formed with an annular reentry portion having an annular flange portion extending substantially transverse to the longitudinal axis of said tubular extension, a cap member mounted on the open end of said extension and having an annular offset wall portion overlying and extending substantially parallel to said first-named annular flange portion in spaced relation thereto, a reciprocal valve for controlling flow through said casing, means for actuating said valve including a diaphragm disposed between said annular flange portions and clamped at its outer periphery between the end wall of said extension and said cap member, means for sealing and securing said cap member, diaphragm and casing together, said diaphragm and cap member cooperating to provide an expansible chamber containing a fluid responsive to evaporator temperature, and a reenforcing plate member fixed to each side of said diaphragm to prevent rupture of the same, said reenforcing plate members having oppositely disposed offset portions engageable with said first-named and said second-named flange portions to limit flexing movements of said diaphragm in opposite directions.

4. In an expansion valve for controlling the admittance of a refrigerant medium to a refrigerant evaporator, a valve body having an inlet

and an outlet for refrigerant, a diaphragm mounted on said body and cooperating with a wall thereof to provide an expansible chamber communicating with said inlet, said diaphragm being acted on by refrigerant pressure in said chamber, a valve in said body for controlling flow through said inlet, said valve having operative connection with said diaphragm, a tubular open ended extension member having one end seated on and closed by said diaphragm, means for securing said diaphragm, tubular member and body together and hermetically sealing said chamber, a second diaphragm, said second-named diaphragm seating on and closing the other end of said extension member, a cap member seating on said second-named diaphragm and cooperating therewith to provide a second expansible chamber containing an expansible-contractible fluid responsive to evaporator temperature and acting on said second-named diaphragm for flexing the same, means for securing said second-named diaphragm, cap member and extension member together and for sealing said second-named chamber, reenforcing plate members carried on opposed sides of said diaphragms, a connecting member in said extension member and having its opposite ends abutting said reenforcing plates, said reenforcing plates having tabs formed out of the plates and extending around the ends of said connecting member, said tabs defining a space for limited lateral movement of the ends of said connecting member, a reenforcing plate carried by said second-named diaphragm and within said second-named chamber, and a coil spring in said second-named chamber and having one end in abutment with a wall of said cap member and the other end in abutment with said last-named reenforcing plate, said last-named reenforcing plate having tabs formed out of the plate and positioned around the adjacent end of said spring to limit lateral movement of said spring.

5. In an expansion valve for controlling the admittance of a refrigerant medium to a refrigerant evaporator, a casing having an expansible chamber, a valve in said casing controlling flow therethrough, a pair of spaced and movable wall means in said casing, one of said wall means forming a wall of said expansible chamber and acted on by evaporator pressure and the other of said wall means forming a wall of a second expansible chamber containing an expansible-contractible fluid responsive to evaporator temperature, said valve being in operative engagement with one of said wall means, a rigid tubular-shaped connecting member loosely disposed and extending between said wall means with its opposite ends in operative engagement with opposed faces of said wall means to transmit movement of one of said wall means to the other, means carried by said wall means and positioned around opposite ends of said connecting member to permit slight lateral movement thereof and limiting such movement to prevent displacement of said connecting member, and opposed yieldable means maintaining said valve, connecting member and wall means in operative engagement and acting to operate said valve in opposite directions.

6. In an expansion valve for controlling the admittance of a refrigerant medium to a refrigerant evaporator, a casing having an expansible chamber, a valve in said casing controlling flow therethrough, a pair of spaced movable dia-

phragms in said casing, one of said diaphragms forming a wall of said expansible chamber and acted on by evaporator pressure and the other of said diaphragms forming a wall of a second expansible chamber containing an expansible-contractible fluid responsive to evaporator temperature, said valve having operative connection with one of said diaphragms, reenforcing plates carried by said diaphragms on opposed faces thereof for preventing rupture of said diaphragms, an open ended tubular sheet metal connecting member loosely positioned between said diaphragms with its opposite ends in engagement with said reenforcing plates for transmitting movement of one of said diaphragms to the other, and opposed yieldable means maintaining said valve, connecting member and diaphragms in operative engagement and acting to operate said valve in opposite directions, said reenforcing plates having tabs formed out of the plates and positioned around the ends of said connecting member to limit lateral movement thereof, said connecting member having slight lateral movement so that it will be self-centering to prevent undue strain on said diaphragms.

7. In an expansion valve for controlling the admittance of a refrigerant medium to a refrigerant evaporator, a casing having an expansible chamber in communication with the refrigerant enroute to the evaporator, a reciprocal valve in said casing controlling flow therethrough, a pair of spaced diaphragms in said casing, one of said diaphragms forming a wall of said expansible chamber and the other of said diaphragms forming a wall of a second expansible chamber containing an expansible-contractible fluid responsive to evaporator temperature, spring means operable to maintain engagement between one of said diaphragms and said valve and operable to move said valve in one direction, a coil spring disposed between said diaphragms for transmitting movement from one of said diaphragms to the other to move said valve in an opposite direction, loosely disposed bearing members for opposite ends of said coil spring and abutting the opposed faces of said diaphragms, said coil spring maintaining said bearing members in engagement with said diaphragms, and reenforcing members for said diaphragms and secured to the opposed faces thereof for abutment with said loosely disposed bearing members, said reenforcing members having tabs positioned around said bearing members to limit lateral movement thereof.

8. In an expansion valve for controlling the admittance of a refrigerant medium to a refrigerant evaporator, a casing having an expansible chamber in the refrigerant enroute to the evaporator, a reciprocal valve in said casing controlling flow therethrough, a pair of spaced diaphragms in said casing, one of said diaphragms forming a wall of said expansible chamber and the other of said diaphragms forming a wall of a second expansible chamber containing an expansible-contractible fluid responsive to evaporator temperature, spring means operable to maintain engagement between one of said diaphragms and said valve and operable to move said valve in one direction, a coil spring disposed between said diaphragms for transmitting movement from one of said diaphragms to the other to move said valve in an opposite direction, loosely disposed bearing members for opposite ends of said coil spring and abutting the opposed faces of said diaphragms, said coil spring maintaining said bearing members in engagement

with said diaphragms, reenforcing members for said diaphragms and secured to the opposed faces thereof for abutment with said loosely disposed bearing members, said reenforcing members having tabs positioned around said bearing members to limit lateral movement thereof, one of said bearing members being hollow and having an internal end wall, and a rigid connecting member for said bearing members, said connecting member having an annular flange portion loosely disposed in said hollow bearing member, said flange portion being engageable with said end wall to transmit movement in one direction of one of said diaphragms to the other of said diaphragms and providing a lost motion connection between said diaphragms upon movement of said one diaphragm in the opposite direction.

9. In a control device, a valve casing having a port and a valve chamber in communication therewith and having an opening in a wall of said chamber, a detachable tubular open ended fitting having one end projecting into said chamber and closing said opening, a tubular-shaped closure member fitting into and closing the inner end of said fitting, said closure member having an end wall having an aperture therethrough, a tubular-shaped strainer member fitting into and supported by said tubular closure member, said strainer member extending from said closure member and being positioned within said fitting, a valve member in said chamber for controlling said port, a reciprocal supporting member in said chamber for supporting said valve member and having an end portion slidably guided in the aperture in said closure member, means operable to move said valve supporting member in one direction, said supporting member having a passage through said end portion providing communication between the interior of said tubular strainer member and said valve chamber, and a coil spring in said valve chamber having one end in abutment with said closure member and the other end in abutment with said supporting member for moving said valve member in the opposite direction.

10. In a control device, a casing having a valve chamber and a valve port in communication therewith, said valve port having a valve seat, a reciprocal valve supporting member in said chamber, a valve carried by said supporting member and controlling flow through said port, means operable to move said supporting member in one direction, guide means for said supporting member, a coil spring surrounding said supporting member and operable to move the same in the opposite direction, and spring fingers carried by said supporting member and frictionally engaging the inner wall of said valve chamber, said spring fingers acting to dampen vibratory action of said spring to obtain a smooth reciprocal valve action.

11. In a control device, a casing having a valve port and having a valve chamber, a valve member in said valve chamber and operable for controlling the port, a rigid reciprocal supporting member in said casing and carrying said valve member, guide means for said supporting member, means including a coil spring in said casing operable to actuate said supporting member and said valve member, said coil spring surrounding and having one end abutting said supporting member and having its other end abutting said guide means, and spring fingers having a portion thereof interposed between said one end and said supporting member and movable with said

supporting member, said fingers having frictional engagement with an interior wall face of said valve chamber to dampen vibratory action of said actuating means to obtain a smooth reciprocal valve action.

- 5 12. In a thermostatic expansion valve, a valve body, a valve member controlling flow through said body, an open ended metallic tubular spacer member carried by said body, means for actuating said valve member including a movable wall means interposed between one end of said spacer member and a wall of said body, said movable wall means cooperating with said body to provide an expansible chamber for a refrigerant
- 10 medium, means for securing said wall means, spacer member and body together and hermetically sealing the expansible chamber, a cap fitted over the other end of said spacer member, a movable wall means interposed between the other
- 15 end of said spacer member and said cap, said second-named wall means cooperating with said cap to provide an expansion chamber for a thermostatic fluid, said cap having an annular flange overlapping an end portion of said spacer member and being spaced from the outer wall surface
- 20 thereof to provide an annular space, sealing means disposed in the annular space for securing said spacer member, cap and said second-named wall means together and for hermetically sealing
- 25 said second-named expansion chamber, and means operatively connecting said first-named wall means and said second-named wall means.

13. In a thermostatic expansion valve, a valve body having a wall provided with a recessed portion, a valve member in said body controlling flow therethrough, an open ended tubular spacer member having one end disposed toward said recessed wall, said wall and said spacer member having overlapping spaced portions providing an
- 35 annular space, means for actuating said valve member including a movable wall interposed between said spacer member and said recessed wall and operatively connected to said valve member, said movable wall and said recessed wall cooperating
- 40 to provide an expansible chamber for a refrigerant medium, a cap member mounted on the other end of said spacer member, a movable wall interposed between said cap member and said spacer member, means operatively connecting
- 45 said movable walls, said cap member and said second-named movable wall cooperating to provide an expansible chamber, said cap member and said spacer member having overlapping spaced portions providing an annular space therebetween, means in said first-named space securing
- 50 said first-named movable wall, body and spacer member together and hermetically sealing said first-named expansible chamber, and means in said second-named space securing said spacer member, cap member and said second-named
- 55 movable wall together and hermetically sealing said second-named expansible chamber.

14. In an expansion valve for controlling admittance of a refrigerant medium to a refrigerant evaporator, means having a passage therethrough including a port for refrigerant, a valve member to control said port, a movable wall cooperating with said means to provide an expansion chamber communicative with said passage and operatively connected to said valve member, means
- 60 urging said valve member in one direction, a thermostatic power element including a movable wall spaced from said first-named movable wall, a pair of abutment members between said spaced walls, one of said abutment members abutting one

of said walls and the other of said abutment members abutting the other of said walls, said abutment members being arranged to have limited movement lateral to the direction of movement of said movable walls, a helical coil spring acting to hold said abutment members in abutting relation with the movable walls and yieldably opposing inward movement of said walls by said urging means and said power element, and lost motion connecting means operatively connecting said abutment members so that upon a predetermined maximum thrust said connecting means will collapse to allow relative movement between said walls.

15. In a control device, a valve casing, a pair of spaced wall members dividing said casing into an intermediate chamber and a pair of spaced end chambers, said wall members each having an aperture therethrough, a reciprocal valve member in said intermediate chamber and cooperable with one of said wall member apertures to control flow therethrough, a reciprocal supporting member in said intermediate chamber and carrying said valve member, said supporting member having a portion thereof slidably received and guided in the other of said wall member apertures, said supporting member having a shoulder portion facing one of said wall members, spring means interposed between the said one wall member and said shoulder portion, a spring finger having one end thereof held between said shoulder portion and said spring means and having a portion engaging a side wall of said intermediate chamber to dampen vibration of said supporting member, means for fluid flow from one of said end chambers to said intermediate chamber, and means in the other of said end chambers for actuating said valve member.

16. In an expansion valve for controlling admittance of a refrigerant medium to a refrigerant evaporator, means having a passage therethrough including a port for refrigerant, a valve member to control said port, a movable wall cooperating with said means to provide an expansion chamber communicative with said passage and operatively connected to said valve member, means urging said valve member in one direction, a thermostatic power element including a movable wall spaced from said first-named movable wall, a pair of abutment members between said spaced walls, one of said abutment members abutting one of said walls and the other of said abutment members abutting the other of said walls, said abutment members being arranged to have limited movement lateral to the direction of movement of said movable walls, means secured to one of said abutment members and operable to engage the other of said abutment members to limit separating movement of said members, and a helical coil spring acting to hold said abutment members to the limit of their separating relation and in engagement with the movable wall, said coil spring upon predetermined maximum thrust acting to yieldably oppose inward movement of said walls by said urging means and said power element.

17. In an apparatus of the character described, a metallic body member having a passageway therethrough, a metal cap member, a thin walled tubular metallic spacer positioned between and joining together said members, one end portion of said spacer having lapping relation with said body member to provide a continuous channel surrounding said spacer end portion, the other

end portion of said spacer having lapping relation with said cap member to provide a continuous channel surrounding said other spacer end portion, a pair of spaced diaphragms, one of said
 5 diaphragms extending across said one spacer end portion and having a marginal portion seating against said body member and extending into said first-named channel, the other of said diaphragms extending across said other spacer end
 10 portion and having a marginal portion seating against said cap member and extending into said second-named channel, means in said first-named channel hermetically sealing said spacer and said one diaphragm marginal portion to said
 15 body member, means in said second-named channel hermetically sealing said spacer and said other diaphragm marginal portion to said cap member, valve means controlling flow through said passageway and controlled by said one dia-
 20 phragm, and means interposed between said diaphragms whereby said other diaphragm is operable to control said valve means.

18. In an expansion valve for controlling the admittance of a refrigerant medium to a refrigerant evaporator, a casing through which re-
 25 frigerant flows enroute to the evaporator and

having a tubular-shaped extension, said extension having an open end having an annular flange portion extending substantially transverse to the longitudinal axis of said tubular extension, a cap member mounted on the open end of said
 5 extension and having a peripheral portion spaced from said extension to provide a channel, said cap member having an annular offset wall portion extending substantially parallel to said annular
 10 flange portion and inward of said peripheral portion, a reciprocal valve for controlling flow through said casing, means for actuating said valve including a diaphragm disposed between
 15 said cap member and said flange portion, sealing material in said channel and securing said cap member, diaphragm and casing together, said diaphragm and cap member cooperating to provide an expansible chamber for containing a fluid
 20 responsive to evaporator temperature, and a reinforcing plate member fixed to said diaphragm to prevent rupture of the same, said plate member having a portion engageable with said wall
 portion to limit flexing movement of said diaphragm in one direction.

DANIEL D. WILE. 25

CERTIFICATE OF CORRECTION.

Patent No. 2,192,117.

February 27, 1940.

DANIEL D. WILE.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, line 8, for the word "period" read periods; page 2, second column, line 11, for "central" read center; page 4, first column, line 34, for "tube 21" read tube 81; page 5, first column, line 30, for "diaphragm" read diaphragms; page 6, second column, line 4, claim 4, for "inlet" read outlet; page 7, first column, line 57, claim 8, after "in" insert communication with; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 2nd day of April, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.