United States Patent

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[33] **Germany**
[31] **P 16 75 504.7**

[54] **EXPANSION VALVE**
18 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **137/614.21,** 137/613
[51] **Int. Cl.** **G05d 16/06**
[50] **Field of Search** 137/614.21, 614.19, 613

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ABSTRACT: An expansion valve has a main valve nozzle cooperating with a main valve body and an auxiliary valve nozzle cooperating with an auxiliary valve body; the opening of the auxiliary valve nozzle is controlled by control means on the outside of the valve moving the auxiliary valve body between its closed and its open positions; a pair of membrane chambers are separated by a membrane operating the main valve body, one of the membrane chambers may be selectively connected with either an inlet of the valve or the outlet thereof.

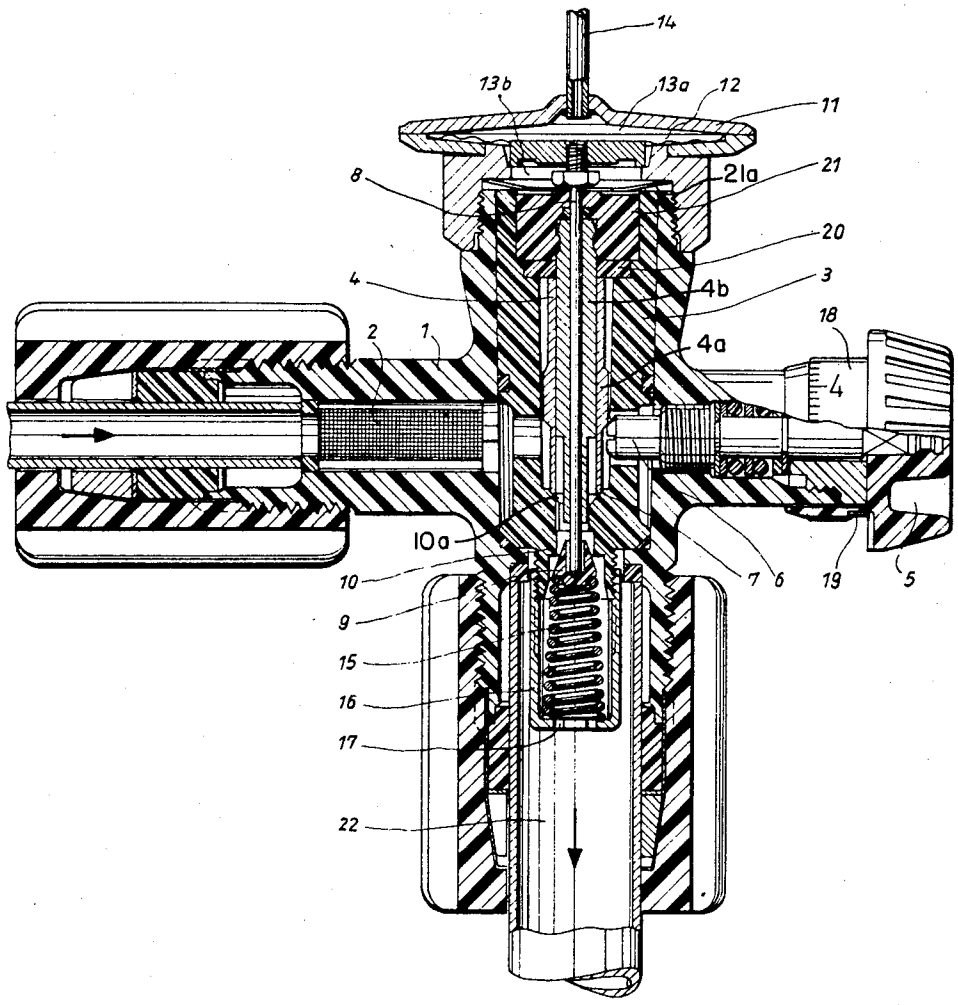

Fig. 1

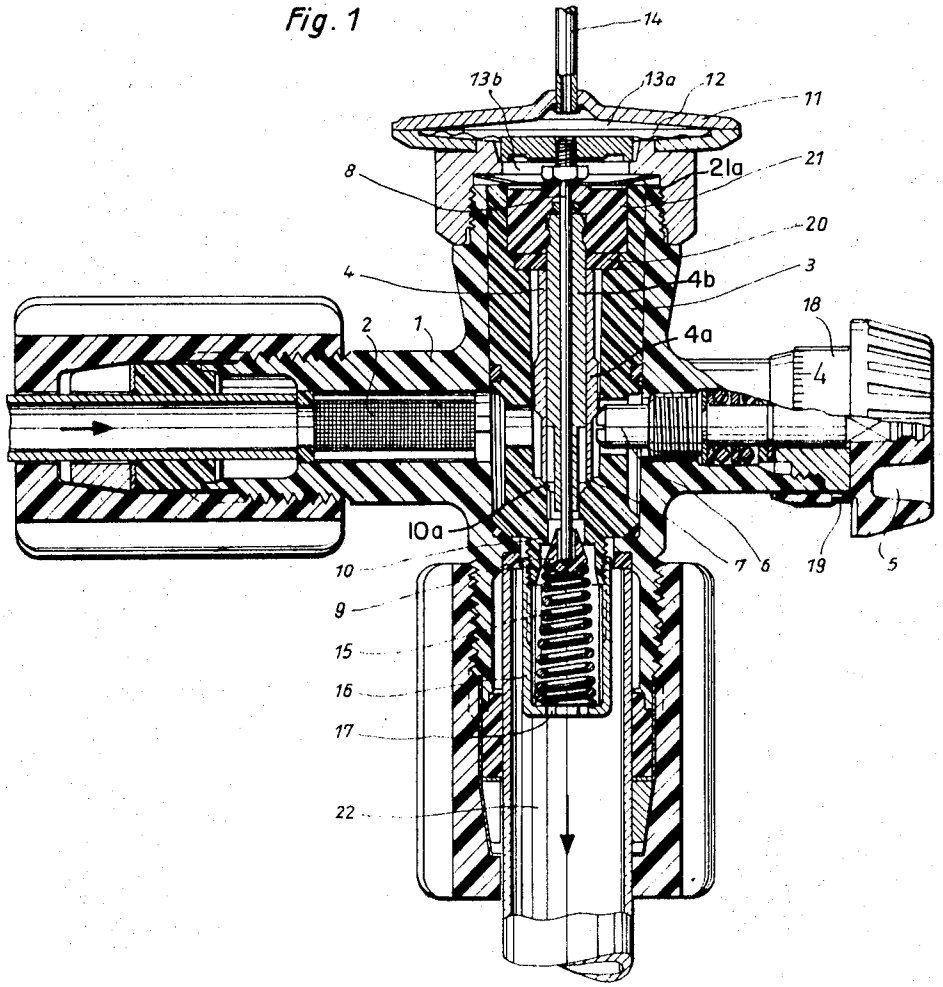

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Fig. 2

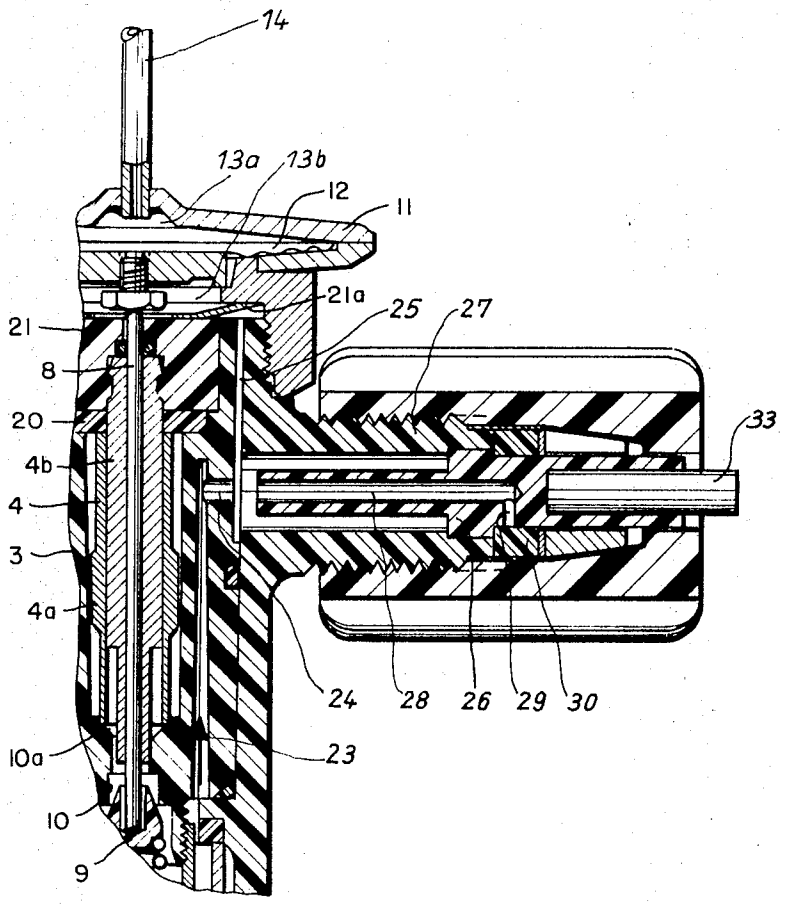

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Fig. 3

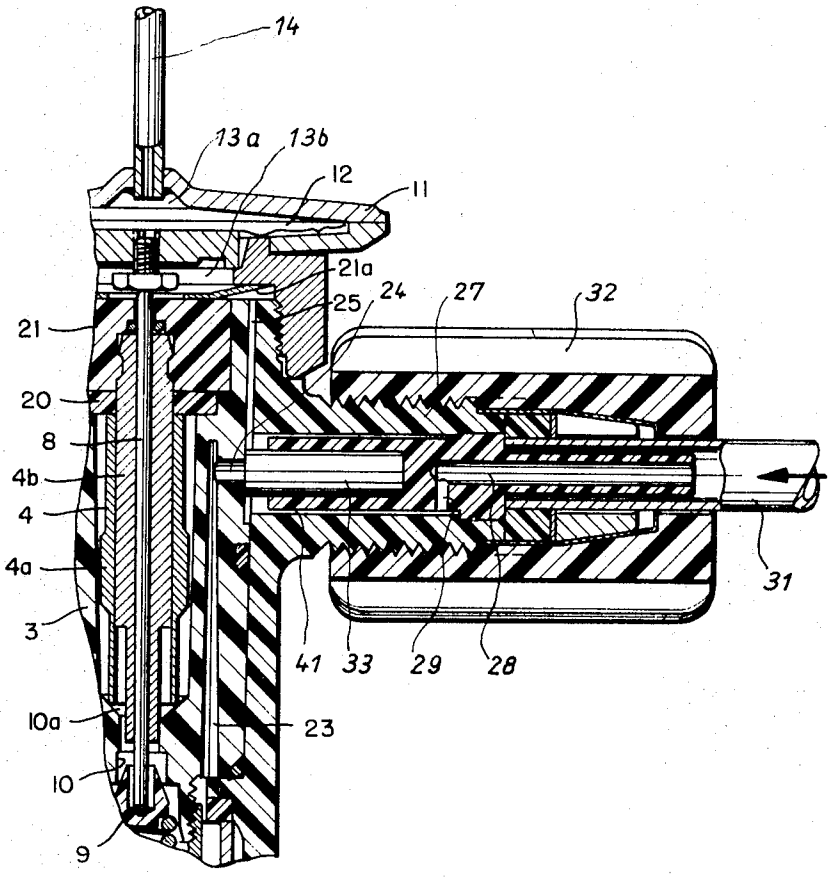

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Fig. 4

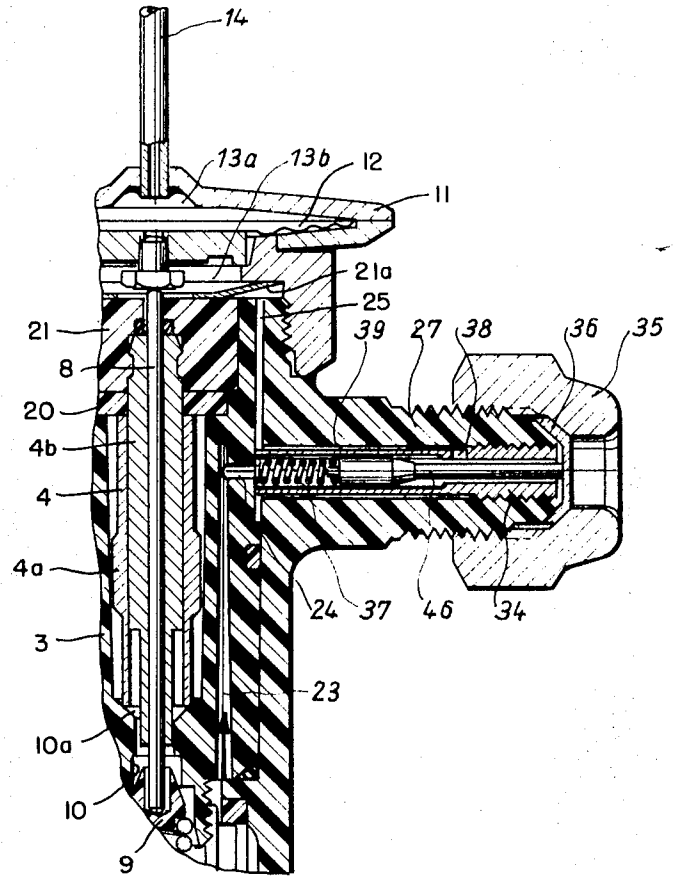

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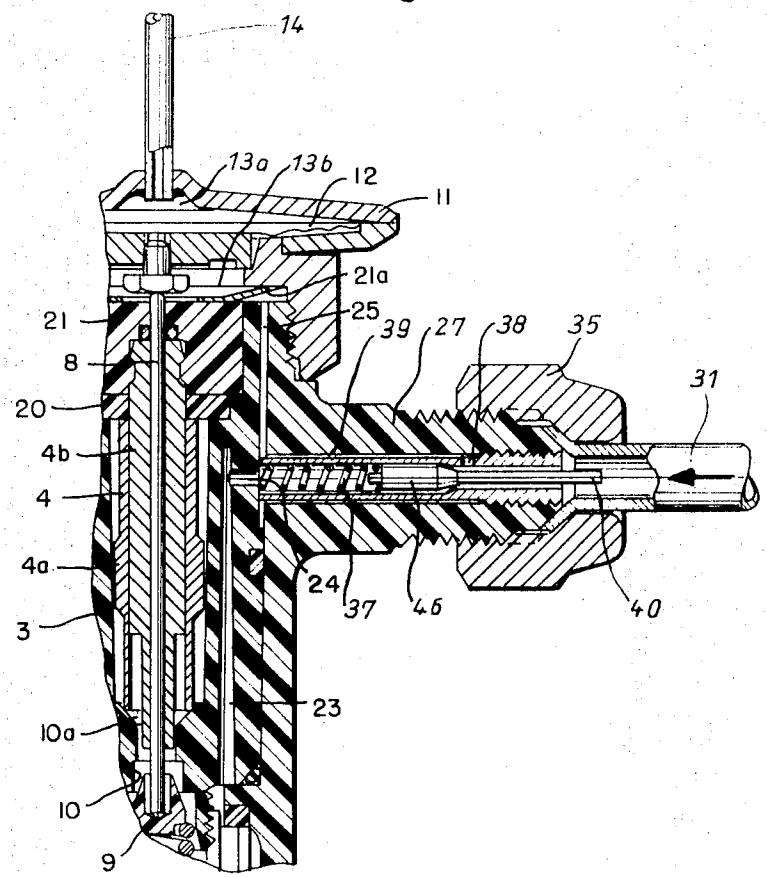
Fig. 5



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EXPANSION VALVE

FIELD OF THE INVENTION

This invention relates to an expansion valve or cutoff valve, the valve body of which is operable by a pressure pin which in turn is operated by a membrane which also serves to divide a space in said valve into two pressure tight compartments. One of these compartments, i.e., the outer compartment in the valve is connected with a pressure generating sensor, whereas the other, i.e., inner compartment is connected with the medium flowing through the valve.

DESCRIPTION OF THE PRIOR ART

Thermostatic expansion or cutoff valves, known in the art, have the disadvantage that their operational range can be changed only with great difficulties if it can be changed at all. Consequently a valve whose dimensions or capacity do not correspond to the requirements of the installation in which it has been incorporated can be adjusted only with great difficulties to give proper service.

Such an adjustment of the valve could be done by changing the optimal setting of the progress of superheating of the valve as it was originally provided in the manufacturing plant. This however, influences unfavorably the economy of the installation. Also the possibilities for an adjustment are very limited. The difficulties which have been thus encountered have resulted in the production of a great number of various types of expansion valves with a variety of openings.

SUMMARY OF THE INVENTION

The principal object of the invention is to provide a new expansion valve which can be changed with respect to the output even after the valve has been mounted in an installation.

It is a further object of the invention to provide an expansion valve which is adaptable to various control requirements of cooling plants.

It is still another object of the invention to provide an expansion valve in which the switch over from external pressure equalization to internal pressure equalization and vice versa can easily be made by a simply manual operation even in a valve which is mounted in a plant. In this respect it should be understood that in the case of an internal pressure equalization the inner membrane chamber or compartment, is connected with an inlet of the respective vaporizer, whereas in the case of an external pressure equalization the same membrane chamber is connected via an additional conduit with the outlet of the vaporizer.

In this way the inner membrane compartment can be selectively connected either to the higher inlet pressure of the vaporizer or to the reduced internal pressure of the outlet of the vaporizer. In the later case the influence of the flow-through-resistance of the evaporator on the controls and thus on the operation of the valve is eliminated.

A change in the time constant of valves of known construction could be achieved by changing the material used as a filler in the temperature sensor, which of course could not be done without removal of the complete valve.

Another way to change the time constant is to change properties of the spring which transmits the closing force of the valve. This procedure has only a limited application and has furthermore the disadvantage that as a consequence of the change in the degrees of overheating of the machine the limits of utilization of the evaporator are also changed.

An expansion valve according to the invention is arranged in such a way that the medium, before it reaches the main valve body and the main valve opening or nozzle, moves or flows through an auxiliary valve the stroke of which being continually adjustable from the outside of the expansion valve. Thereby it is possible to change the flow characteristic of the valve openings without making changes in the adjustment of the overheating system.

In an expansion valve according to the invention, the auxiliary valve comprises a tubular valve body extending into a

longitudinal tube with a bore therethrough to receive a movable pressure pin of the main valve. A slanting shoulder is disposed on the outer wall of said tube cooperating with a conical end of a drive arranged to move the tube in the direction if its axis.

For controlling or adjusting of a small output the valve body of the auxiliary valve is not tight with the respective valve seat thus permitting a certain leakage therethrough. This can also be achieved by having the valve body arranged with a small bore or another opening.

A separate tube may be inserted into the bore of the longitudinal tube whenever it is desirable to prevent a direct contact between the longitudinal tube and the pressure pin.

An annular packing of a resilient material, disposed near the membrane compartment, may be arranged to press against the longitudinal tube to counteract the pressure of the conical drive against the shoulder.

The main valve body is urged against its seat by a spring the pressure of which may be adjusted by turning a threaded cup receiving said spring. The cup may have an opening in its bottom to permit the flow of the cooling medium therethrough.

The drive for the axial movement of the longitudinal tube and of the valve body of the auxiliary valve may be provided with a hand wheel or a suitable knob for easier operation and may be equipped with a scale for easier readjustment.

A special insert which is usable in two different positions is provided to permit equalization of the internal or the external pressure. For this purpose the lower portion of the membrane chamber may be selectively connected either with the outlet of the expansion valve or with the inlet branch of the expansion valve. For this purpose, the expansion valve is provided with a tubular valve nozzle carrier which receives for slidable movement the longitudinal tube of the auxiliary valve. The tubular valve nozzle carrier is provided on its end near the valve outlet with a bore connecting with the valve outlet on one of its ends and with a lateral bore leading to the periphery of the tubular valve nozzle carrier on its other end. A portion of the tubular valve nozzle carrier extending from the membrane chamber to at least the lateral bore has a smaller diameter than the remaining portion thereof.

Two embodiments of the insert have been found to be specifically advantageous. One is an axially symmetrical longitudinal body having on one of its ends a packing coaxially located therewith and on he other end a centrally located bore connected with a lateral bore leading to the outer wall of the insert.

Another embodiment provides for an insert, mounted in an inlet pipe, and having an axially located valve stem which is urged by a spring against its seat thereby interrupting the connection between the inner membrane chamber and the inlet pipe. The valve stem is provided with an axially located pin which extends beyond the inlet branch of the extension valve when the valve stem abuts its seal. The opening of the inlet branch may be closed by a separate cover plate held in place by a suitably-shaped nut. The inlet branch is connected to a inlet pipe preferably by a suitable flange.

In both embodiments of the inserts the location of the inlet branch is coaxial with or located close to the lateral bore in the tubular valve nozzle carrier.

BRIEF DESCRIPTION OF THE DRAWING

In order that the present invention may be readily carried into effect, it will now be described with reference to the accompanying drawings wherein:

FIG. 1 is a partially cross-sectional view a preferred form of an expansion valve according to the invention;

FIG. 2 is a cross-sectional view of a modification of a portion of the expansion valve of FIG. 1 taken in a plane extending through the vertical axis of the valve of FIG. 1 and normal to the plane of FIG. 1, and showing an insert position of internal pressure equalization;

FIG. 3 is a cross-sectional view of the structure as shown in FIG. 2 in which the insert is positioned for external pressure equalization;

FIG. 4 is a cross-sectional view of a modification of the arrangement of FIG. 2 with an insert positioned for internal pressure equalization; and

FIG. 5 is a cross-sectional view of the structure as shown in FIG. 4 with the insert positioned for external pressure equalization.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to FIG. 1 it will be seen that an expansion valve according to the invention has a valve housing with an inlet branch 1 through which a medium, e.g., a cooling medium may enter the valve. A filter 2 is located in the bore of the inlet branch. The inlet branch connects to the tubular valve nozzle carrier 3. Thus a cooling medium entering through the inlet branch 1 flows through the filter into the bore of the valve nozzle carrier 3. The tubular extension of the valve body 4 of an auxiliary valve is located in the bore of the valve nozzle carrier and coaxial therewith. The valve body 4 is axially displaceable with relation to the tubular valve nozzle carrier 3. This displacement is controlled by control knob 5 which rotates a spindle 6 having a conical end portion. The spindle 6 has a threaded portion so that its rotation effects the axial movement of the conical end portion against a bevelled shoulder 4*a* on the tubular extension of the valve body 4, thereby controlling the distance between an auxiliary valve nozzle 7, formed by the valve nozzle carrier 3, and the auxiliary valve body 4. A sleeve 4*b* disposed inside of the tubular extension 4 and coaxial therewith receives a pressure pin 8. On one end of pressure pin 8 is mounted the valve body 9 of the main valve cooperating with the main valve nozzle 10. The other end of pressure pin 8 extends into the control head 11. A membrane 12 disposed inside the control head 11 divides a chamber therein into an outer chamber 13*a* and an inner chamber 13*b*. A conduit 14 connected to the upper chamber 13*a* transmits the pressure of a temperature sensor, (not shown in the drawing), into the upper chamber 13*a*.

Pressure exerted in the control head against pressure pin 8 acts to move the pressure pin in a direction away from the pressure head and thus operates the main valve body 9 to open the main valve nozzle 10.

A spring 15, disposed at the outlet end of the main valve and held in position by a cup 16, adjustably mounted on the nozzle carrier, acts on the main valve body in a direction opposite to that of the pressure pin 8 and urges the main valve body 9 in a direction to close the main valve nozzle 10.

The bottom of cup 16 is provided with an opening or bore 17 to facilitate the flow of a cooling medium therethrough.

Control knob 5 cooperates with an annular seal 18 which after the initial adjustment is held in position by suitable retaining means such as bead 19.

An annular packing 20 disposed on the outside of sleeve 4*b* and coaxial therewith serves as a seal both for the tubular extension of the auxiliary valve body 4 as well as for the cylinder 21. At the same time the packing urges the tubular extension 4 in a direction opposite to the direction of the force exerted thereon by the conical end portion of the spindle 6. The cylinder 21 is held against a shoulder in an enlarged bore portion of nozzle carrier 3 by means of a spring 21*a* extending between the cylinder 21 and head 11. This also serves to hold the nozzle carrier in a fixed position against a shoulder in the housing. The upper end of sleeve 4*b* is rigidly held in cylinder 21.

Thus, according to the invention, an auxiliary valve (valve body 4 and valve nozzle 7) is connected in series with the main valve (valve body 9 and valve nozzle 10). The stroke of the auxiliary valve is continuously adjustable by means of control knob 5 and scale 18. An output setting of an unusually wide range can thus be provided by adjusting the stroke of the auxiliary valve which can be done from outside without interference with the operation of the plant in which the valve is used. Also the expansion valve can be adjusted to the time constant of the plant by adjusting the through flow characteristic of the valve.

Furthermore, the setting for any pressure limitation can be achieved with a degree of accuracy which previously could be attained only by the use of special valves.

To calibrate the scale ring 18 the ring is attached loosely. After the valve body of the auxiliary valve 4 has been put in its closed position, the scale ring 18 is set for zero and then fixed in this position.

The dimensions of the conical end portion of spindle 6 are selected so as to move the valve body of the auxiliary valve between its two extreme position with one full turn of the spindle.

A bypass in form of a fine bore 10*a* or the like is provided in the auxiliary valve permitting a small quantity of medium to flow through the auxiliary valve even if the same is in a completely closed position. The dimension of the bypass is such that the through flow is less than the minimum capacity for which the expansion valve is calculated. This arrangement makes it possible to control with accuracy a through flow of very small volume in spite of the comparatively large main valve nozzle opening.

The arrangement of at least two valve nozzles in series makes it possible to utilize for the purpose of control the flow of cooling fluids having two stages. For this purpose the setting for the auxiliary nozzle is selected in such a way that if the through flow exceeds a certain nominal capacity in the auxiliary nozzle the fluid will have already two state characteristics (gaseous liquid). It thus will be necessary to provide a main valve nozzle of large cross section.

This use of two state of aggregation of the fluid before it enters the nozzle of the main valve results in substantially equal control of the through flow; no overreacting of the control for large quantities or underreacting for small quantities will occur.

Referring now to FIG. 2, in order to provide internal equalization of the pressure, the inner membrane chamber 13*b* is connected with outlet 22. For this purpose a longitudinal bore 23 is provided in the valve nozzle carrier 3. The bore 23, which runs substantially parallel to the axis of the valve nozzle carrier connects on one of its ends with the outlet of the expansion valve and on the other end with a lateral bore 24 leading to the outer wall of the valve nozzle carrier 3. The diameter of the valve nozzle carrier 3 between the opening in its wall created by the lateral bore 24 and the inner membrane chamber 13*b* is slightly reduced so that an annular space 25 is formed connecting the opening of the lateral bore 24 with the inner membrane chamber 13*b*. Thus the pressure in the inner membrane chamber is the same as pressure in the outlet 22 which serves to control the main valve. The spring 21*a* does not seal the chamber 13*b* from the space 25. For inducing internal equalization of the pressure, an insert 26 is provided in control knob 5 of the manual control unit, as shown, instead of the spindle shown in FIG. 1. This insert is reversably positioned in an auxiliary, external inlet branch 27, as shown in FIGS. 2 and 3.

In the position of FIG. 2 the inlet branch 27 is completely closed since the bores 28 and 29 are closed by packing ring 30. In this position of the insert it is, however, impossible to insert a connecting pipe.

If, however, insert 26 is reversed, external equalization of pressure can be effected, so that the inner membrane chamber 13*b* is under the same pressure as exist in the connecting pipe 31, which pipe can now be attached with the aid of nut 32 (as shown in FIG. 3). This could not be done in the position as shown in FIG. 2. Lateral bore 24 is closed by packing 33 and consequently the internal pressure equalization cannot take place. At the same time, the inner membrane space 13*b* is now connected with the connecting pipe 31 via bores 28 and 29 and the annular space 41. This is best seen in FIG. 3.

Various means may be used for attaching a connecting pipe to the inlet branch, e.g., a threaded flange as shown in FIGS. 4 and 5.

In FIGS. 4 and 5 an embodiment is shown in which a valve body 46 having a valve stem 40 is movably disposed in the insert 34 which is mounted in the bore of the inlet branch 27.

If internal equalization of the pressure is required a cover plate 36 is inserted to cover the opening of the inlet branch. The cover plate 36 is held in position by a threaded flange 35 (FIG. 4). In this position the cover plate 36 will move the valve stem 46 against pressure of spring 37 and thus lift the valve body 46 from its seat thereby connecting the lateral bore 24 with the inner chamber 13*b* via bore 38 and with an annular space 39 which is formed between the inner wall of the inlet branch and the outer wall of the insert.

For external equalization of the pressure, the cover plate 36 is removed and the connecting pipe 31 is connected to the inlet branch 27 with the help of flange 35.

The valve body 46 and its valve stem is urged by spring 37 against its seat thereby interrupting the connection for the internal pressure equalization with the bore 38. The connecting pipe 31 is now connected with the inner chamber 13*b* via the annular space, formed by the valve stem 40 and the inner wall of the insert 34, the bore 38 and annular space 39.

As best can be seen in FIG. 5, connecting pipe 31 can be attached with the help of flange 35 only if the cover plate 36 (FIG. 4) is removed thereby allowing valve 46 to return into its closed position and thereby to close the connection for the internal pressure equalization and to open the connection for the external equalization of pressure.

It has been found that an expansion valve constructed according to the invention can be used in a number of different applications for which it ordinarily would be necessary to use about 30 different types of valves of a construction known so far in the art. This means of course a great saving and increased economy in the construction of plants and installations using this type of valves.

I claim:

1. In an expansion valve for regulating the flow of refrigerant fluid having a valve housing with an inlet and an outlet the arrangement comprising a first valve means disposed in the path of said fluid flowing from the inlet to the outlet; second valve means disposed in the path of said fluid flowing from the first valve means to said outlet; means for varying the degree of opening of said first valve means; a pressure responsive control means for controlling said second valve means; a pressure source for normally supplying control pressure to said pressure responsive control means; connecting means for normally connecting said outlet with said pressure responsive control means for supplying fluid from said outlet to said pressure responsive control means to act thereon in a direction opposite to that of the pressure supplied by said pressure source; and manually operable means located on the outside of said housing for controlling the means for varying the degree of opening of the first valve means, to adjust the response of the expansion valve to said control pressure.

2. In an expansion valve for regulating the flow of fluids having a valve housing with an inlet and an outlet the arrangement comprising a tubular valve nozzle carrier defining a main valve nozzle near one of its ends and an auxiliary valve nozzle spaced from the main valve nozzle; an auxiliary tubular valve body disposed inside the tubular nozzle carrier and movable between a closed and an open position, said auxiliary valve body cooperating with said auxiliary valve nozzle for closing and opening thereof; a main valve body cooperating with said main valve nozzle for opening and closing thereof; a pressure pin disposed in the auxiliary valve body slidable movement therein, one end of said pressure pin being attached to said main valve body for joint movement therewith; a valve head having inner walls defining a space; a membrane disposed inside said space and dividing said space into an inner and an outer chamber, said chambers being pressuretight in relation to each other, the other end of said pressure pin being connected to said membrane for joint movement therewith; a pressure inlet for supplying control pressure into said outer chamber to induce movement of said membrane and said pressure rod in the direction of said valve nozzles, thereby releasing said main valve body from the opening of the main valve nozzle; a spring means urging said main valve body against said main valve nozzle in opposition of said movement of said pressure rod; and control means located on one side of said expansion valve for influencing the movement of said auxiliary valve body in relation to said auxiliary valve nozzle and thereby determining the through flow capacity of said auxiliary valve nozzle.

3. An expansion valve as set forth in claim 2, also comprising connecting means for connecting said inner chamber with a fluid flowing between the inlet and the outlet of the expansion valve.

4. An expansion valve as set forth in claim 2, also comprising a shoulder disposed on the outer wall of said auxiliary tubular valve body and wherein said control means comprises a spindle having a conical end portion on one end thereof and a control knob attached to the other end thereof, said conical end portion cooperating with said shoulder for moving said auxiliary valve body when said spindle is rotated by turning of said control knob.

5. An expansion valve as set forth in claim 4, wherein said control means also comprises a graduated scale for indication of the position of the control knob.

6. An expansion valve as set forth in claim 2, also comprising stop means preventing said auxiliary tubular valve body to completely close said auxiliary valve nozzle even if the valve body is in its closed position.

7. An expansion valve as set forth in claim 2, wherein an additional opening is provided in the tubular valve nozzle carrier to permit passage of fluid even if said auxiliary tubular valve body is in its closed position.

8. An expansion valve as set forth in claim 2, also comprising an annular packing disposed in said tubular valve nozzle carrier for supporting said auxiliary tubular valve body.

9. An expansion valve as set forth in claim 2, wherein said spring means comprise a helical spring and a cup receiving said spring said cup being adjustably mounted on said tubular valve nozzle carrier for increasing and decreasing the tension of said spring.

10. An expansion valve as set forth in claim 9, wherein said cup has an opening in the bottom thereof to permit fluid to flow in the direction of the outlet.

11. An expansion valve as set forth in claim 2, also comprising an additional inlet branch with an additional inlet, an insert disposed in said inlet selectively in a first position and a second position, first connecting means connecting said inner chamber with the outlet of the expansion valve when said insert is in its first position and second connecting means connecting said inner chamber with the additional inlet when said insert is in its second position.

An expansion valve as set forth in claim 11, wherein said tubular valve nozzle carrier has an axial bore and a lateral bore said bores connecting with each other one end of said axial bore also connecting with the outlet of the expansion valve and one end of said lateral bore also connecting with an opening in the surface of said carrier, and wherein the diameter of said tubular valve nozzle carrier in the region between said opening in its surface and the end thereof near said inner chamber is smaller than the diameter of the remaining portion of said carrier.

13. An expansion valve as set forth in claim 12, wherein said additional inlet branch is located substantially close to the location of said opening in the surface of said valve nozzle carrier.

14. An expansion valve as set forth in claim 13, wherein said insert is an axially symmetrical body having on one end a first axial bore and having also a radial bore the latter located substantially in the middle of the axial length of said insert and connecting with one end to said axial bore and with the other

end to the surface of said insert forming an opening therein, said insert having also a second axial bore at its end opposite to the end housing the first axial bore and separated therefrom, and also comprising a packing partially disposed in said second axial bore and protruding therefrom.

15. An expansion valve as set forth in claim **14**, wherein said insert has a reduced diameter along a portion of the first axial bore.

16. An expansion valve as set forth in claim **14**, wherein said insert has a reduced diameter along the axial length of said second bore and up to the opening formed in the surface of said insert by said radial bore.

17. An expansion valve as set forth in claim **2**, also comprising an additional inlet branch with an additional inlet, an insert disposed in said additional inlet said insert having a bore forming a valve seat having an opening, a valve body disposed inside said insert and cooperating with said valve seat for closing and releasing said opening, spring means disposed in said insert urging said valve body against said valve seat thereby closing said opening and connecting means connecting said additional inlet to said inner chamber when said valve body closes said opening.

18. An expansion valve as set forth in claim **2**, also comprising an additional inlet branch with an additional inlet, an insert disposed in said additional inlet, said insert having a bore forming a valve seat with an opening, a valve body disposed inside said insert and cooperating with said valve seat for closing and releasing said opening, spring means disposed in said insert urging said valve body against said valve seat thereby closing said opening, a valve pin attached to said valve body in said insert and protruding out of said insert, a cover plate covering said additional inlet thereby displacing said pin in a direction opposite to the direction of the pressure exerted by said spring means in said insert and connecting means connecting said inner chamber with said outlet when said additional inlet is covered by said plate and said valve body in said insert is removed from said valve seat through the displacement of said valve pin by said cover plate.