

[TITLE OF DOCUMENT] Description

[TITLE OF THE INVENTION] Pressure Reducing Valve and Upper-Layer Diaphragm Addition Unit to Be Used for the Pressure Reducing Valve

[Technical Field]

[0001] The present invention relates to a pressure reducing valve and an upper-layer diaphragm addition unit to be used for the pressure reducing valve.

[Background Art]

[0002] Patent Document 1 discloses a pressure reducing valve including a valve body including a valve element that is provided so that a primary-side flow channel and a secondary-side flow channel communicate with each other through a valve opening, and that is attachable to and detachable from a valve seat provided on a secondary-side opening end face of the valve opening, and a diaphragm that is joined to the valve element via a valve stem and is displaced by a pressure change of the secondary-side flow channel, and a spring cover including a cover flange provided so as to be capable of press-contacting the peripheral edge of the diaphragm, an adjusting spring incorporated so as to bias the diaphragm in a valve opening direction of the valve element, and an adjusting screw screwed-in movably up and down so as to press the adjusting spring in the

valve opening direction.

[0003] This pressure reducing valve is configured so that a biasing force of the adjusting spring is adjusted to a valve closing force of the valve element corresponding to a product of a pressure receiving area of the diaphragm and a secondary-side pressure by a vertical position of the adjusting screw by screwing the adjusting screw into the spring cover, the diaphragm makes the valve element open by moving in response to a pressure decrease on the secondary side caused by use of tap water, and high-pressure tap water supplied from the primary side is reduced in pressure to a desired set pressure and flowed into the secondary side through the valve opening.

[Prior Art Document]

[Patent Document]

[0004]

[Patent Document 1] Japanese Unexamined Patent Application Publication No. 2013-127803

[Summary of the Invention]

[Problem to be Solved by the Invention]

[0005] In the pressure reducing valve configured as described above, when the valve opening diameter is increased to increase the flow rate, the pressure receiving area of the valve element inevitably expands, and the valve opening force

to be applied to the valve element is increased, and accordingly, the diaphragm must also be increased in diameter to respond to this valve opening force, so that the pressure reducing valve is formed to be increased in diameter in a centrifugal direction of the diaphragm.

[0006] In this case, the pressure reducing valve interferes with separate piping and other devices adjacent to piping in which the pressure reducing valve is installed, and this causes problems such as it makes it difficult to secure an installation space for the pressure reducing valve with the increased diameter, requires troublesome operations including changing the installation position and posture of the pressure reducing valve with respect to the piping.

[0007] Therefore, an object of the present invention is to provide a pressure reducing valve configured to avoid an increase in size in a diaphragm centrifugal direction by acquiring a valve closing force with respect to a valve opening force of the valve element corresponding to a product of a pressure receiving area of the valve element that is increased by an increase in valve opening diameter and a primary-side pressure by a product of a total area of diaphragms by multi-staging existing diaphragms without increasing the diaphragm diameter and a secondary-side pressure, and an

upper-layer diaphragm addition unit to be used for the pressure reducing valve.

[Means for Solving the Problem]

[0008] In view of the above-described problems, a pressure reducing valve according to the present invention includes a valve body including a valve element that is provided so that a primary-side flow channel and a secondary-side flow channel communicate with each other through a valve opening, and that is attachable to and detachable from a valve seat provided on a secondary-side opening end face of the valve opening, and a lowermost-layer diaphragm that is joined to the valve element via a valve stem and is displaced by a pressure change of the secondary-side flow channel, a spring cover including a cover flange provided so as to be capable of press-contacting the peripheral edge of an upper-layer diaphragm having the same shape as the lowermost-layer diaphragm, an adjusting spring incorporated so as to bias the upper-layer diaphragm in a valve opening direction of the valve element, and an adjusting screw screwed-in movably up and down so as to press the adjusting spring in the valve opening direction, and at least one or more upper-layer diaphragm addition units interposed and joined between the spring cover and the valve body, and the upper-layer diaphragm addition unit is provided with a recessed pressure

chamber an upper opening of which is closed by an upper-layer diaphragm and which is connectable to the secondary-side flow channel, and a diaphragm chamber which is partitioned by a bottom plate of the recessed pressure chamber and covers the lowermost-layer diaphragm or another upper-layer diaphragm, and in which a valve spring to bias the lowermost-layer diaphragm or another upper-layer diaphragm in the valve opening direction of the valve element as necessary is incorporated, a connection valve stem is provided to penetrate through and project upward and downward from an upper-layer diaphragm, and a lower end of the connection valve stem is inserted slidably in a watertight manner through the center of the bottom plate so as to be joined to an upper end of the valve stem penetrating through and projecting from the lowermost-layer diaphragm or an upper end of a connection valve stem penetrating through and projecting from another upper-layer diaphragm.

An upper-layer diaphragm addition unit to be used for the pressure reducing valve according to the present invention is configured so that a pressure reducing valve is configured by interposing and joining at least one or more upper-layer diaphragm addition units between the valve body and the spring cover, and is provided with a recessed pressure chamber an upper opening of which is closed by an upper-layer diaphragm and which

is connectable to the secondary-side flow channel, and a diaphragm chamber which is partitioned by a bottom plate of the recessed pressure chamber and covers a lowermost-layer diaphragm or another upper-layer diaphragm, and in which a valve spring to bias the lowermost-layer diaphragm or another upper-layer diaphragm in the valve opening direction of the valve element as necessary is incorporated, and a connection valve stem is provided to penetrate through and project upward and downward from an upper-layer diaphragm, and a lower end of the connection valve stem is inserted slidably in a watertight manner through the center of the bottom plate so as to be joined to an upper end of the valve stem penetrating through and projecting from the lowermost-layer diaphragm or an upper end of a connection valve stem penetrating through and projecting from another upper-layer diaphragm.

[Effects of the Invention]

[0009] In short, according to the present invention, as described above, one or more upper-layer diaphragm addition units are interposed and joined between a spring cover and a valve body in the pressure reducing valve, the upper-layer diaphragm addition unit is provided with a recessed pressure chamber an upper opening of which is closed by an upper-layer diaphragm and which is connectable to a secondary-side flow

channel, and a diaphragm chamber which is partitioned by a bottom plate of the recessed pressure chamber and covers a lowermost-layer diaphragm or another upper-layer diaphragm, and in which a valve spring to bias the lowermost-layer diaphragm or another upper-layer diaphragm in the valve opening direction of the valve element as necessary is incorporated, a connection valve stem is provided to penetrate through and project upward and downward from an upper-layer diaphragm, and a lower end of the connection valve stem is inserted slidably in a watertight manner through the center of the bottom plate so as to be joined to an upper end of a valve stem penetrating through and projecting from the lowermost-layer diaphragm or an upper end of a connection valve stem penetrating through and projecting from another upper-layer diaphragm. Accordingly, in comparison with a conventional pressure reducing valve that certainly needs to be increased in size because, when the valve opening diameter is increased to increase the flow rate, the pressure receiving area of the valve element inevitably expands and a valve opening force to be applied to the valve element is increased, and therefore the diaphragm needs to be increased in diameter to respond to this valve opening force, without the increase in diameter of the diaphragm as in the conventional case, by multi-staging of ready-made (lowermost-layer and upper-layer)

diaphragms having the same shape, a valve closing force with respect to a valve opening force of the valve element corresponding to a product of the pressure receiving area of the valve element that is increased by an increase in diameter of the valve opening and a primary-side pressure is acquired by a product of a total area of the lowermost-layer diaphragm and the upper-layer diaphragms and the secondary-side pressure, so that an increase in size of the pressure reducing valve in a centrifugal direction of the diaphragm is avoided.

Therefore, the present invention solves such conventional problems that, in a conventional pressure reducing valve formed to have an increased diameter in a centrifugal direction of the diaphragm, the increased-diameter portion interferes with separate piping and other devices adjacent to piping to which the pressure reducing valve is attached, which makes it difficult to secure an installation space for the pressure reducing valve with the increased diameter and requires troublesome operations including changing the installation position and posture of the pressure reducing valve with respect to the piping.

In addition, when using multi-layered diaphragms, use of the same upper-layer diaphragm addition units makes assembly of the units comparatively easy and reduces the number of components to be newly developed, which brings about significant

practical effects such that costs can be reduced correspondingly.

[Brief Description of the Drawings]

[0010]

Fig. 1 is a longitudinal sectional view of a valve closed state of a pressure reducing valve according to the present invention.

Fig. 2 is a longitudinal sectional view of a valve opened state of the same as above.

Fig. 3 is an exploded sectional view of the same as above.

Fig. 4 is a longitudinal sectional view of a valve closed state showing another example.

Fig. 5 is a longitudinal sectional view of a valve opened state of the same as above.

Fig. 6 is an exploded sectional view of the same as above.

Fig. 7 is a sectional view of a conventional pressure reducing valve.

[Modes for Carrying Out the Invention]

[0011] Hereinafter, an embodiment of the present invention is described based on the drawings.

A pressure reducing valve according to the present invention shown in Figs. 1 to 6 includes a valve body 8 including a valve element 5 which is provided so that a primary-side flow

channel 1 and a secondary-side flow channel 2 present on the same straight line communicate with each other through a valve opening 3 and is attachable to and detachable from a valve seat 4 provided on a secondary-side opening end face 3a of the valve opening 3, and a lowermost-layer diaphragm 7 which is joined to the valve element 5 via a valve stem 6 and is displaced by a pressure change of the secondary-side flow channel 2, a spring cover 10 including a cover flange 10a provided so as to be capable of press-contacting the peripheral edge of an upper-layer diaphragm 9 having the same shape as the lowermost-layer diaphragm 7, an adjusting spring 11 incorporated so as to bias the upper-layer diaphragm 9 in the valve opening direction of the valve element 5, and an adjusting screw 12 screwed-in movably up and down so as to press the adjusting spring 11 in the valve opening direction, and at least one or more upper-layer diaphragm addition units 13 interposed and joined between the spring cover 10 and the valve body 8.

[0012] The pressure reducing valve according to the present invention is configured by installing one or more upper-layer diaphragm addition units 13 in a conventional pressure reducing valve including the valve body 8 and the spring cover 10 as shown in Fig. 7.

[0013] The valve body 8 has an inlet 14 and an outlet 15

respectively opened at the left side and the right side of the valve body, and the primary-side flow channel 1 and the secondary-side flow channel 2 provided inside the valve body respectively communicate with the inlet 14 and the outlet 15.

[0014] At the center inside the valve body 8, a partition wall 16 vertically partitioning the primary-side flow channel 1 and the secondary-side flow channel 2 is provided, the valve opening 3 is opened at a horizontal portion of the partition wall 16 so that the flow channels 1 and 2 communicate with each other, and the flow channels 1 and 2 of the inlet 14 and the outlet 15 are formed into Z shapes in the example shown in the drawings.

[0015] In an upper portion of the valve body 8, a circular dish-shaped recessed pressure chamber (hereinafter, referred to as a pressure detection chamber) 17 provided with a flange 17a circumferentially and having an upper opening closed by the lowermost-layer diaphragm 7 is provided.

[0016] The pressure detection chamber 17 communicates with the primary-side flow channel 1 through a circular opening provided at the center of a lower portion (which is a portion of the upper portion of the valve body 8 corresponding to the valve opening 3), and a cylindrical portion 18 with a predetermined length is provided to continue downward from the

opening.

[0017] A lower circumferential wall of the cylindrical portion 18 hangs downward so as to continue to the partition wall 16 between the primary-side flow channel 1 and the secondary-side flow channel 2, and a portion of the lower circumferential wall facing the primary-side flow channel 1 is opened so as to communicate with the primary-side flow channel 1, and a portion where a lower portion of the pressure detection chamber 17 is adjacent to the cylindrical portion 18 corresponding to the secondary-side flow channel 2 in the partition wall 16 is opened so that the secondary-side flow channel 2 and the pressure detection chamber 17 communicate with each other.

[0018] At the center of the lowermost-layer diaphragm 7, the valve stem 6 inserted through the cylindrical portion 18 and the valve opening 3 is formed so as to hang downward, and at a lower end of the valve stem 6, the disc-shaped valve element 5 that opens and closes the valve opening 3 is provided.

[0019] The valve element 5 is formed so that it is attachable to and detachable from the valve seat 4 projecting in a toric shape from the secondary-side opening end face 3a of the valve opening 3 so as to receive the primary-side pressure in the valve opening direction, and so that an opening degree is

controlled by displacement of the lowermost-layer diaphragm 7.

[0020] The valve element 5 is formed by fitting a synthetic-rubber-made valve part 5a formed into a disc shape into a circular dish-shaped valve element cover 5b only an upper side of which is opened while only a surface (upper surface in the drawing) facing the valve seat 4 is left, and accordingly, the shape of the valve part 5a is retained.

[0021] At an upper portion of the valve stem 6, a piston 19 that slides on the inner wall of the cylindrical portion 18 is provided to project outward and an O-ring 20 is fitted in a recessed groove provided circumferentially on the piston 19 so that the primary-side flow channel 1 and the pressure detection chamber 17 are partitioned in a watertight manner.

[0022] An effective pressure receiving area of the piston 19 is set to be slightly larger than an effective pressure receiving area of the primary side of the valve element 5.

[0023] The lowermost-layer diaphragm 7 directly above the piston 19 is respectively sandwiched at the respective upper and lower surfaces by a disc-shaped diaphragm presser 21 and a diaphragm receiver 22.

[0024] An upper end 6a of the valve stem 6, which penetrates through and projects from the lowermost-layer diaphragm 7 and

on which a male screw is threaded, penetrates through the diaphragm presser 21 coupled to the upper surface of the lowermost-layer diaphragm 7, and the valve stem upper end 6a is formed so that it is inserted through a washer 23 and a collar 24 with a predetermined height and the valve stem upper end 6a projects by a predetermined length from the collar 24 (refer to Figs. 3 and 6).

[0025] The diaphragm receiver 22 coupled to a lower surface of the lowermost-layer diaphragm 7 is formed integrally with the valve stem 6 and formed to have a larger diameter than the cylindrical portion 18, and in a state where the lowermost-layer diaphragm 7 is displaced to a lower limit, this diaphragm receiver 22 is seated on the upper opening end face of the cylindrical portion 18, and in this state, restricts the valve element 5 from being lifted.

[0026] At the center of a lower portion of the valve element 5, a guide rod 25 is provided vertically, and slidably inserted and fitted in a cylindrical recessed portion 26 recessed in a bottom portion of the valve body 8.

[0027] The spring cover 10 is formed into a hat shape circumferentially provided with a cover flange 10a at a lower portion opening end, and a projection portion 10b on which a female screw is threaded is provided to project at the center

of the upper end of the spring cover, and an adjusting screw 12 consisting of a bolt inserted through a seal washer 27 on the projection portion 10b and screwed and inserted through a lock nut 28 is screwed into and penetrates inside the spring cover 10 from above the projection portion 10b.

[0028] An upper-layer diaphragm addition unit 13 (hereinafter simply referred to as a unit 13) is provided with a dish-shaped recessed pressure chamber 29 with an upper opening 29a closed by the upper-layer diaphragm 9 and connectable to the secondary-side flow channel 2, and a hat-shaped diaphragm chamber 31 which is partitioned by a bottom plate 29b of the recessed pressure chamber 29 and covers the lowermost-layer diaphragm 7 or another upper-layer diaphragm 9 in a watertight manner, and in which a valve spring 30 to bias the lowermost-layer diaphragm 7 or another upper-layer diaphragm 9 in the valve opening direction of the valve element 5 as necessary is incorporated, a connection valve stem 32 is provided to penetrate through and project upward and downward from the upper-layer diaphragm 9, and a lower end 32b of the connection valve stem 32 is inserted slidably in a watertight manner through the center of the bottom plate 29b so as to be joined to an upper end 6a of the valve stem penetrating through and projecting from the lowermost-layer diaphragm 7 or an upper end 32a of the connection

valve stem 32 penetrating through and projecting from another upper-layer diaphragm 9.

[0029] The unit 13 is configured so that an upper flange 13a and a lower flange 13b are provided to respectively project from an upper opening peripheral edge of the recessed pressure chamber 29 and a lower opening of the diaphragm chamber 31, and to the upper flange 13a, the cover flange 10a of the spring cover 10 or a lower flange 13b of another unit 13 is coupled, and to the lower flange 13b, the flange 17a of the valve body 8 or an upper flange 13a of another unit 13 is coupled, and coupling of the flanges 13a, 13b, 10a, and 17a coupled in this manner is fixed by using fastening members (not shown) such as bolts and nuts.

[0030] Inside the unit 13, an insertion opening 33 for the connection valve stem 32 provided in the bottom plate 29b is formed to be smaller in diameter than the valve opening 3, a cylindrical portion 33a with a predetermined length is provided to continue downward from the insertion opening 33, a piston 34 that slides on an inner wall of the cylindrical portion 33a is provided by expanding the diameter of the lower end 32b of the connection valve stem 32, an O-ring 35 is fitted in a recessed groove circumferentially provided on the piston 34, and accordingly, the recessed pressure chamber 29 and the diaphragm

chamber 31 are partitioned in a watertight manner.

[0031] The upper-layer diaphragm 9 directly above the piston 34 is sandwiched at the respective upper and lower surfaces by a diaphragm presser 36 and a diaphragm receiver 37.

[0032] The diaphragm presser 36 coupled to the upper surface of the upper-layer diaphragm 9 is configured so that the connection valve stem upper end 32a on which a male screw is threaded penetrates through the diaphragm presser, the connection valve stem upper end 32a is inserted through a washer 38 and a collar 39 with a predetermined height, and the connection valve stem upper end 32a projects by a predetermined length from the collar 39 (refer to Figs. 4 to 6).

[0033] The diaphragm receiver 37 coupled to the lower surface of the upper-layer diaphragm 9 is formed integrally with the connection valve stem 32 and formed to be larger in diameter than the cylindrical portion 33a, and the diaphragm receiver 37 is set so as to be seated on the upper end face of the insertion opening 33 in a state where the upper-layer diaphragm 9 is displaced to a lower limit.

[0034] Only in the unit 13 to be joined to the spring cover 10, a nut 40 is screwed and fitted to the connection valve stem upper end 32a without inserting the washer 38 and the collar

39 to the connection valve stem upper end 32a (refer to Figs. 3 and 6).

[0035] Then, the flange 17a of the valve body 8 and the lower flange 13b of the unit 13 are coupled via the lowermost-layer diaphragm 7 and fastened by a fastening member, and the valve stem upper end 6a projecting upward from the lowermost-layer diaphragm 7 is screwed and inserted to a female screw threaded on the bottom surface of the connection valve stem lower end 32b (piston 34), and accordingly, the valve stem 6 and the connection valve stem 32 are joined integrally on the same vertical axis.

[0036] At this time, in a case where the valve spring 30 is incorporated inside the diaphragm chamber 31 (refer to Figs. 4 to 6), the valve stem upper end 6a is loosely inserted in the valve spring 30, and the valve spring 30 is compressively interposed between the top plate (bottom plate) 29b of the diaphragm chamber 31 of the unit 13 and the diaphragm presser 21 provided on the upper surface of the lowermost-layer diaphragm 7 to apply an elastic force of the valve spring 30 to the upper surface of the lowermost-layer diaphragm 7.

[0037] The valve spring 30 does not need to be installed inside the diaphragm chamber 31 as shown in Figs. 1 to 3 if the biasing force of the adjusting spring 11 can be adjusted

so as to correspond to a valve closing force of the valve element corresponding to a product of a total pressure receiving area obtained by summing a total of pressure receiving areas of upper-layer diaphragms 9 according to the number of units 13 installed in the pressure reducing valve and a pressure receiving area of the lowermost-layer diaphragm 7 and a secondary-side pressure, however, the number of upper-layer diaphragms 9 increases according to the number of units 13 used in the pressure reducing valve, and therefore, in the case where the biasing force of the adjusting spring 11 cannot correspond alone to the valve closing force described above, as shown in Figs. 4 to 6, the valve springs 30 are stored and installed inside the diaphragm chambers 31 of the units 13 as necessary.

[0038] In a case where one unit 13 is interposed and joined between the spring cover 10 and the valve body 8, in a state where the unit 13 is placed on and joined to the valve body 8 as described above, the adjusting spring 11 is compressively interposed between a spring bearing 41 attached to a lower end of the adjusting screw 12 and the diaphragm presser 36 provided on an upper surface of the upper-layer diaphragm 9 of the unit 13 to apply an elastic force of the adjusting spring 11 to the upper surface of the upper-layer diaphragm 9 (refer to Figs. 1 to 3).

[0039] The spring bearing 41 is provided with a recessed portion 41a that receives a tip end of the adjusting screw 12 at an upper surface center of a circular substrate with a predetermined diameter and a flat columnar bulge portion 41b at a lower surface center of the same, and the bulge portion 41b is fitted onto an upper end of the adjusting spring 11 that biases the valve element 5 in a valve closing direction.

[0040] In a case where two or more units 13 are interposed and joined between the spring cover 10 and the valve body 8, in the same manner as described in Paragraph No. [0035], in a state where a unit 13 is placed and joined onto the valve body 8, on this unit 13, the other one or more units 13 are stacked.

[0041] In other words, an upper flange 13a of the lower unit 13 above the valve body 8 and a lower flange 13b of the upper unit 13 stacked on the lower unit are coupled via the upper-layer diaphragm 9 of the lower unit and fastened by a fastening member, and a connection valve stem upper end 32a projecting upward from the upper-layer diaphragm 9 of the lower unit is screwed and inserted to the female screw of the connection valve stem lower end 32b (piston 34) of the upper-layer diaphragm 9 of the upper unit, one or more units 13 are stacked in multi-stages on the valve body 8, the valve stem 6 and the

connection valve stems 32 of the respective units 13 are joined integrally on the same vertical axis, and the spring cover 10 is placed so as to cover the unit 13 of the uppermost stage in a manner such that an adjusting spring 11 is compressively interposed between the diaphragm presser 36 on the upper surface of the upper-layer diaphragm 9 of the unit 13 and the spring bearing 41 of the spring cover 10 so that an elastic force of the adjusting spring 11 is applied to the upper surface of the upper-layer diaphragm 9.

[0042] By moving the adjusting screw 12 vertically, elastic forces of the adjusting spring 11 and the valve springs 30 used in the valve are adjusted, and accordingly, displacements of the lowermost-layer diaphragm 7 and the upper-layer diaphragms 9 are adjusted.

[0043] In the recessed pressure chamber 29 of each unit 13, a secondary-side communication channel 42 is connected between the recessed pressure chamber and the secondary-side flow channel 2 so that a secondary-side pressure is applied to the lower surface of the upper-layer diaphragm 9, and in the case where a plurality of units 13 are installed in the pressure reducing valve, the secondary-side communication channels 42 connected to the respective recessed pressure chambers 29 may be respectively connected to the secondary-side

flow channel 2, or as shown in Figs. 4 to 6, the secondary-side communication channel 42 connected to the secondary-side flow channel 2 may be branched and connected to the respective recessed pressure chambers 29.

[0044] In the pressure reducing valve configured as described above, a secondary-side pressure is held at a constant pressure lower than a primary-side pressure as the opening degree of the valve element 5 is controlled by balancing a force to be applied upward (valve closing direction) to the lowermost-layer diaphragm 7 and the upper-layer diaphragms 9 by the secondary-side pressure of the pressure detection chamber 17 communicating with the secondary-side flow channel 2 inside the valve body 8 and the recessed pressure chamber 29 communicating with the secondary-side flow channel 2 through the secondary-side communication channel 42 with a force to be applied downward (valve opening direction) only by the adjusting spring 11 in the pressure reducing valve shown in Figs. 1 to 3 or by the adjusting spring 11 and the valve springs 30 in the pressure reducing valve shown in Figs. 4 to 6.

[0045] In comparison with a conventional pressure reducing valve that must be increased in size because, when the valve opening diameter is increased to increase the flow rate, the pressure receiving area of the valve element inevitably expands

and a valve opening force to be applied to the valve element is increased, and therefore the diaphragm needs to be increased in diameter to respond to this valve opening force, in the pressure reducing valve according to the present invention, without the increase in diameter of the diaphragm as in the conventional case, by multi-staging ready-made (lowermost-layer and upper-layer) diaphragms 7 and 9 having the same shape, a valve closing force with respect to a valve opening force of the valve element 5 corresponding to a product of the pressure receiving area of the valve element 5 that is increased by an increase in diameter of the valve opening 3 and a primary-side pressure is acquired by a product of a total area of the lowermost-layer diaphragm 7 and the upper-layer diaphragms 9 and the secondary-side pressure, so that an increase in size of the pressure reducing valve in a centrifugal direction of the diaphragm is avoided.

[0046] Accordingly, such conventional problems can be solved that, in a conventional pressure reducing valve expanded in size in a centrifugal direction of the diaphragm, this increased-diameter portion interferes with separate piping and other devices adjacent to piping to which the pressure reducing valve is attached, which makes it difficult to secure an installation space for the pressure reducing valve with the

increased diameter and requires troublesome operations including changing the installation position and posture of the pressure reducing valve with respect to the piping.

[0047] In addition, when using multi-layered diaphragms, use of the same units 13 makes assembly of the units comparatively easy and reduces the number of components to be newly developed, and accordingly, costs can be reduced correspondingly.

[Description of Symbols]

[0048]

- 1 Primary-side flow channel
- 2 Secondary-side flow channel
- 3 Valve opening
- 3a Secondary-side opening end face
- 4 Valve seat
- 5 Valve element
- 6 Valve stem
- 6a Upper end
- 7 Lowermost-layer diaphragm
- 8 Valve body
- 9 Upper-layer diaphragm
- 10 Spring cover
- 10a Cover flange
- 11 Adjusting spring

- 12     Adjusting screw
- 13     Upper-layer diaphragm addition unit
- 29     Recessed pressure chamber
- 29b    Bottom plate
- 30     Valve spring
- 31     Diaphragm chamber
- 32     Connection valve stem
- 32a    Upper end
- 32b    Lower end

[TITLE OF DOCUMENT]      WHAT IS CLAIMED IS:

[Claim 1]    A pressure reducing valve comprising: a valve body including a valve element that is provided so that a primary-side flow channel and a secondary-side flow channel communicate with each other through a valve opening and is attachable to and detachable from a valve seat provided on a secondary-side opening end face of the valve opening, and a lowermost-layer diaphragm that is joined to the valve element via a valve stem and is displaced by a pressure change of the secondary-side flow channel; a spring cover including a cover flange provided so as to be capable of press-contacting the peripheral edge of an upper-layer diaphragm having the same shape as the lowermost-layer diaphragm, an adjusting spring incorporated so as to bias the upper-layer diaphragm in a valve opening direction of the valve element, and an adjusting screw screwed-in movably up and down so as to press the adjusting spring in the valve opening direction; and at least one or more upper-layer diaphragm addition units interposed and joined between the spring cover and the valve body, wherein the upper-layer diaphragm addition unit is provided with a recessed pressure chamber an upper opening of which is closed by an upper-layer diaphragm and which is connectable to the secondary-side flow channel, and a diaphragm chamber which is partitioned by a bottom

plate of the recessed pressure chamber and covers the lowermost-layer diaphragm or another upper-layer diaphragm, and in which a valve spring to bias the lowermost-layer diaphragm or another upper-layer diaphragm in the valve opening direction of the valve element as necessary is incorporated, a connection valve stem is provided to penetrate through and project upward and downward from an upper-layer diaphragm, and a lower end of the connection valve stem is inserted slidably in a watertight manner through the center of the bottom plate so as to be joined to an upper end of the valve stem penetrating through and projecting from the lowermost-layer diaphragm or an upper end of a connection valve stem penetrating through and projecting from another upper-layer diaphragm.

[Claim 2] An upper-layer diaphragm addition unit configured so that a pressure reducing valve is configured by interposing and joining at least one or more upper-layer diaphragm addition units between a valve body including a valve element that is provided so that a primary-side flow channel and a secondary-side flow channel communicate with each other through a valve opening and is attachable to and detachable from a valve seat provided on a secondary-side opening end face of the valve opening, and a lowermost-layer diaphragm that is joined to the valve element via a valve stem and is displaced by a pressure change of the

secondary-side flow channel, and a spring cover including a cover flange provided so as to be capable of press-contacting the peripheral edge of an upper-layer diaphragm having the same shape as the lowermost-layer diaphragm, an adjusting spring incorporated so as to bias the upper-layer diaphragm in a valve opening direction of the valve element, and an adjusting screw screwed-in movably up and down so as to press the adjusting spring in the valve opening direction, wherein the upper-layer diaphragm addition unit is provided with a recessed pressure chamber an upper opening of which is closed by an upper-layer diaphragm and which is connectable to the secondary-side flow channel, and a diaphragm chamber which is partitioned by a bottom plate of the recessed pressure chamber and covers a lowermost-layer diaphragm or another upper-layer diaphragm, and in which a valve spring to bias the lowermost-layer diaphragm or another upper-layer diaphragm in the valve opening direction of the valve element as necessary is incorporated, a connection valve stem is provided to penetrate through and project upward and downward from an upper-layer diaphragm, and a lower end of the connection valve stem is inserted slidably in a watertight manner through the center of the bottom plate so as to be joined to an upper end of the valve stem penetrating through and projecting from the lowermost-layer diaphragm or an upper end

of a connection valve stem penetrating through and projecting from another upper-layer diaphragm.