

TITLE OF THE INVENTION
DIAPHRAGM VALVE AND METHOD OF ASSEMBLING THE SAME

Technical Field

5 **[0001]** The present invention relates to a diaphragm valve and a method of assembling the diaphragm valve.

Background Art

10 **[0002]** Diaphragm valves are conventionally known to be used in a process in the fields of biotechnology, semiconductors, and the like (Patent Literature 1). One example of such diaphragm valves is shown in Fig. 4.

15 **[0003]** This diaphragm valve 31 is provided with: a body 32 having a fluid inflow channel 32a and a fluid outflow channel 32b; a stem 33 vertically movable in relation to the body 32; a diaphragm 34 which opens and closes the fluid channels 32a and 32b of the body 32 associated with a vertical movement of the stem 33; a bonnet 35 which is provided above the body 32 and which guides the stem 33 so as to enable the stem to move vertically; 20 a diaphragm presser 36 which is attached at a lower end portion of the stem 33 and which presses the diaphragm 34 downward; and a handle 37 which is rotated to move the stem 33 vertically to an open position and a close position.

25 **[0004]** In Fig. 4, the stem 33 is located at a lower position and the diaphragm 34 is located between the fluid inflow channel 32a and the fluid outflow channel 32b whereby a closed state of the fluid channel is obtained.

Related Art Literature

Patent Literature

[0005] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2013-117241

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Summary of Invention

Technical Problem

[0006] In the closed state of the fluid channel of the diaphragm valve 31 shown in Fig. 4, the handle 37 may be further
10 rotated for tightening. But in this case, due to excessive tightening, excessive load may be applied to the diaphragm 34, which might cause a breakage of the diaphragm 34.

[0007] An object of the present invention is to provide a diaphragm valve that prevents application of excessive load to
15 the diaphragm due to excessive tightening, and a method of assembling such a diaphragm valve.

Solution to Problem

[0008] The diaphragm valve according to the present invention
20 is a diaphragm valve comprising: a body having a fluid channel; a stem vertically movable in relation to the body; a diaphragm which opens and closes the fluid channel of the body associated with a vertical movement of the stem; a bonnet which is provided above the body and which guides the stem so as to enable the stem
25 to move vertically; a diaphragm presser which is attached at a lower end portion of the stem and which presses the diaphragm downward; and a handle which is rotated to move the stem vertically to an open position and a close position; wherein a

female screw member is screwed to an upper end portion of a male screw portion provided on the stem, and when the stem reaches an appropriate close position, the female screw member comes into contact with an upper end of the bonnet thereby preventing the
5 stem from moving downward further.

[0009] The upper portion of the stem protrudes beyond the bonnet, and this protruding portion is screwed into the female screw member. The female screw member screwed to the upper end portion of the male screw portion provided on the stem moves
10 downward integrally with the stem when the stem moves downward. When the stem moves downward by a predetermined amount, the lower surface of the female screw member comes in contact with the upper surface of the bonnet. This contact position is made in agreement with a position in which the stem reaches the
15 appropriate close position, whereby downward movement of the stem beyond a designed position is prevented. Because of this configuration, no load more than designed is applied to the diaphragm, and excessive load applied to the diaphragm due to excessive tightening is therefore prevented, which in turn
20 greatly improves the durability of the diaphragm.

[0010] The diaphragm valve comprising: a body having a fluid channel; a stem vertically movable in relation to the body; a diaphragm which opens and closes the fluid channel of the body associated with a vertical movement of the stem; a bonnet which
25 is provided above the body and which guides the stem so as to enable the stem to move vertically; a diaphragm presser which is attached at a lower end portion of the stem and which presses the diaphragm downward; and a handle which is rotated to move

the stem vertically to an open position and a close position;
is known.

[0011] Compared with known diaphragm valves as a reference,
the diaphragm valve in accordance with the present invention has
5 a longer stem. With this elongation of the stem, the male screw
portion is also made longer, and the female screw member is
screwed to this elongated portion of the male screw portion.
That is, simply by newly adding the female screw member and
changing the stem, the conventional diaphragm valve having no
10 function of preventing excessive tightening may be changed to
a diaphragm valve having a function of preventing excessive
tightening.

[0012] The diaphragm is, for example, formed of: a diaphragm
which is made of fluororesin (for example, PTFE) and which is
15 square when viewed from the top; and a diaphragm which is made
of rubber (for example, butyl rubber), which is circular when
viewed from the top, and which is provided in close contact with
the upper surface of the fluororesin diaphragm, but is not
limited thereto.

20 [0013] The female screw member is, for example, a commercially
available nut, or two, but is not limited thereto.

[0014] At the position in which the stem reaches the
appropriate close position, the female screw member is screwed
to the male screw portion of the stem such that the lower surface
25 of the female screw member comes in contact with the upper surface
of the bonnet. Thereafter, the handle is fixed at an upper end
portion of the stem. In a state after the attachment of the
handle, the female screw member is covered with the handle so

that the position of the female screw member may not be changed due to the contact with a hand of the user, any object, or the like.

[0015] The female screw member preferably consists of: a first
5 nut which is fastened with a relatively low torque; and a second nut which is placed on the first nut and is fastened with a relatively high torque.

[0016] The lower nut is used to define the lower position of the stem, and the upper nut prevents the loosening of the lower
10 nut. Using two nuts as a female screw member securely performs locking of the female screw member.

[0017] In some cases, an overlapping surface of one of the nuts is provided with an annular protrusion having a tapered inner peripheral surface and having a diameter which becomes
15 greater toward an edge thereof, and an overlapping surface of the other nut is provided with an annular recess which is fitted to the protrusion.

[0018] Combination of using of the two nuts and the fitting of the nuts to each other at the protrusion and the recess enables
20 a more secured locking of the female screw member. As such a female screw member, a locking nut referred to as a Hardlock nut (registered trademark) may be used, for example. Using such a locking nut improves the locking performance.

[0019] The method of assembling the diaphragm valve in
25 accordance with the present invention is a method of assembling the above-mentioned diaphragm valve (in which two nuts are used as the female screw member) comprising: removing the handle from the stem in a state where the stem is positioned in a predetermined

position; loosening the first nut and the second nut; rotating the stem to move the stem to the close position; rotating the first nut to bring the first nut into contact with the bonnet; fastening the second nut; and attaching the handle to an upper
5 end portion of the stem.

[0020] With this method, the handle may be set to an intermediate degree of opening (any degree of opening), and furthermore a diaphragm valve which enables the prevention of the excessive fastening of the handle is obtained.

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Advantageous Effects of Invention

[0021] The diaphragm valve in accordance with the present invention prevents the stem to move downward beyond the designed position thereby preventing the application of the excessive
15 load on the diaphragm, which leads to a great improvement of the durability of the diaphragm.

Brief Description of Drawings

[0022] Fig. 1 is a vertical cross-sectional view of a diaphragm valve according to one embodiment of the present invention, which
20 shows a channel closed state.

Fig. 2 is a vertical cross-sectional view illustrating a channel open state of the diaphragm valve shown in Fig. 1.

Figs. 3A, 3B, and 3C each are an enlarged vertical
25 cross-sectional view of principle components which illustrates an in-progress assembled state of the diaphragm valve according to the present invention.

Fig. 4 is a vertical cross-sectional view of a conventional

diaphragm valve, which shows the channel closed state.

Reference Signs List

[0023] 1: diaphragm valve, 2: body, 3: stem, 4: diaphragm,
5 5: bonnet, 6: diaphragm presser, 7: handle, 11: male screw
portion, 18: female screw member, 19: first nut, 20: second nut,
21: protrusion, 21a: inner peripheral surface, 22: recess

Description of Embodiments

10 [0024] Embodiments of the present invention will be described
with reference to the drawings. In the following description,
the "upper", "lower", "right", and "left" sides in the drawings
will be referred to as "upper", "lower", "right", and "left",
respectively. However, these terms "upper", "lower", "right",
15 and "left" are used just for convenience of the description.
Therefore, in some cases, the diaphragm valve may be attached
with the "upper" and "lower" sides being directed oppositely to
each other or being directed laterally.

[0025] Figs. 1 and 2 show a diaphragm valve according to an
20 embodiment of the present invention. Fig. 1 shows a channel
closed state, and Fig. 2 shows a channel open state.

[0026] The diaphragm valve 1 includes a body 2 having a fluid
inflow channel 2a and a fluid outflow channel 2b, a stem 3
vertically movable in relation to the body 2, a diaphragm 4 which
25 opens and closes the space between the fluid inflow channel 2a
and the fluid outflow channel 2b at the boundary therebetween
associated with a vertical movement of the stem 3, a cylindrical
bonnet 5 which is provided above the body 2 and which guides the

stem 3 so as to enable the stem to move vertically, a diaphragm presser 6 which is attached at a lower end portion of the stem 3, and a handle 7 which is rotated to move the stem vertically to an open position and a close position.

5 **[0027]** The body 2 has the shape of a cylinder that extends in the right-and-left direction, and includes a circular through-hole 2c facing upward at a center portion of the body 2. The fluid inflow channel 2a into which fluid flows in from the left side and the fluid outflow channel 2b from which the
10 fluid flows out in the right side are both straight, and each of the channels 2a and 2b has an inner-side end portion which is open to the circular through-hole 2c.

[0028] The stem 3 has a male screw portion 11 and a stepped shaft portion 12 which is contiguous to an lower end of the male
15 screw portion 11. An attachment portion 13 which is fixed to the handle 7 is provided contiguously to the upper end of the male screw portion 11.

[0029] The diaphragm 4 is formed of: a diaphragm 14 which is made of PTFE and which is square when viewed from the top; and
20 a diaphragm 15 which is made of butyl rubber, which is circular when viewed from the top, and which is provided in close contact with the upper surface of the PTFE diaphragm 14. The diaphragm 4 is formed so as to protrude downward at a center portion thereof, and in the channel closed state shown in Fig. 1, the center portion
25 comes in contact with a bottom surface of the body 2, whereby a flow path from the fluid inflow channel 2a to fluid outflow channel 2b is closed. With such a configuration, the body 2 does not have any protrusion (weir portion) to receive the diaphragm

4 so that the flow path within the body 2 is straight.

[0030] The bonnet 5 includes, at an upper side thereof, a small-diameter cylindrical portion 16 and, at a lower side thereof, a large-diameter cylindrical portion 17 which is
5 integrally formed with the lower end of the small-diameter cylindrical portion 16 and which has inner and outer diameters both larger than those of the small-diameter cylindrical portion 16, respectively.

[0031] The large-diameter cylindrical portion 17 is provided
10 at a lower end portion thereof with a flange portion 17a. Between the flange portion 17a and an edge portion of the circular through-hole 2c of the body 2, the diaphragm 4 is sandwiched at a peripheral edge portion thereof. In this state, the flange portion 17a and the body 2 are connected by means of a male screw
15 member (not shown).

[0032] The small-diameter cylindrical portion 16 is provided on an inner peripheral portion thereof with a female screw portion 16a. Into this female screw portion 16a, the male screw portion 11 of the stem 3 is screwed. The male screw portion 11
20 of the stem 3 has a portion 11a which protrudes upward beyond an upper end of the bonnet 5. This upwardly-protruding portion 11a has an upper end portion. To the vicinity of this upper end portion, a female screw member 18 is screwed.

[0033] The female screw member 18 consists of at a lower side
25 thereof a first nut 19 and at an upper side thereof a second nut 20 which are overlapping with each other.

[0034] The second nut 20 is provided, on a lower surface (overlapping surface) thereof, with an annular protrusion 21

having a tapered inner peripheral surface 21a where the diameter becomes greater toward a lower side (an edge) thereof. An outer peripheral surface of the protrusion 21 has the same shape as an outer peripheral surface of the other portion of the second
5 nut 20. The protrusion 21 may be provided with one or more slits.

[0035] The first nut 19 is provided, on an upper surface (overlapping surface) thereof, with an annular recess 22 which has a tapered inner peripheral surface 22a where the diameter becomes smaller toward the upper side and which is fitted to the
10 annular protrusion 21 of the second nut 20.

[0036] The diaphragm presser 6 has the shape of a cylinder, and a female screw portion 6a is formed on an inner peripheral surface at an upper portion of the diaphragm presser 6. A large-diameter portion at the lower side of the stepped shaft
15 portion 12 of the stem 3 is fitted into a male screw 23 having the shape of a cylinder with a flange. The male screw 23 is screwed into the female screw portion 6a of the diaphragm presser 6. With this configuration, the diaphragm presser 6 is fixed to the stem 3 in a state where the center portion of the diaphragm
20 4 is pressed downward.

[0037] At a lower portion of the diaphragm presser 6, an upper portion of a hanging metal fitting 24 is supported. A lower end portion of the hanging metal fitting 24 is embedded in the center portion of the diaphragm 4. With this configuration, the center
25 portion of the diaphragm 4 moves vertically and integrally with the diaphragm presser 6 associated with the vertical movement of the diaphragm presser 6.

[0038] The diaphragm presser 6, in the channel closed state

shown in Fig. 1, has an outer peripheral edge portion 6b that presses an intermediate portion (a portion between the center portion and the outer peripheral edge portion) of the diaphragm 4. The outer peripheral edge portion 6b, in the channel open state shown in Fig. 2, moves upward and does not have a function to press the intermediate portion of the diaphragm 4 downward.

[0039] The handle 7 includes a cylindrical cover portion 7a that covers an upper portion of the bonnet 5. With this configuration, the upper portion of the bonnet 5, the male screw portion 11 of the stem 3, and the female screw member 18 are covered with the cover portion 7a of the handle 7, and are not exposed to the outside.

[0040] A cylindrical open/closed indication member 25 which allows visual confirmation for the open/closed state is provided to be positioned between the upper portion of the bonnet 5 and the cover portion 7a of the handle 7. In the channel closed state shown in Fig. 1, a lower end position of the open/closed indication member 25 and a lower end position of the cover portion 7a of the handle 7 are at the same level.

[0041] In the channel closed state shown in Fig. 1, the diaphragm presser 6 presses the diaphragm 4 downward, whereby the shape of the diaphragm 4 is defined in conformity with the shape of the lower surface of the diaphragm presser 6. The center portion of the diaphragm presser 6 is made integral with the diaphragm 4 via the hanging metal fitting 24, whereas the intermediate portion of the diaphragm 4 is made deformable when the diaphragm presser 6 moves upward.

[0042] Therefore, when the handle 7 is rotated to the open

direction from the state shown in Fig. 1, the stem 3 moves upward, and the diaphragm 4 that was in contact with the bottom surface of the body 2 also moves upward, which leads to the channel open state, as shown in Fig. 2. In this state, within the body 2,
5 a straight flow path from the fluid inflow channel 2a to the fluid outflow channel 2b, that is, a non-stagnant flow path, is formed, as shown in Fig. 2. In the channel open state, an upward movement of the diaphragm presser 6 causes the diaphragm 4 to deform due to its elastic deformation so as to restore its shape at the
10 intermediate portion thereof (i.e., an annular portion between: the outer peripheral edge portion sandwiched and held by the flange portion 17a of the bonnet 5 and the edge portion of the circular through-hole 2c of the body 2; and the center portion where the movement is inhibited by the hanging metal fitting 24)
15 of being a protrusion protruding upward, which is the shape when the diaphragm 4 is in a free state.

[0043] In the channel open state shown in Fig. 2, since the handle 7 moves upward, the open/closed indication member 25 is exposed from the lower end position of the cover portion 7a of
20 the handle 7, which enables confirmation of being in the open state.

[0044] When the above-mentioned diaphragm valve 1 is assembled, the stem 3 to which the diaphragm 4 and the diaphragm presser 6 are attached is screwed into the bonnet 5, and the bonnet
25 5 is connected to the body 2. Thereafter, before the attachment of the handle 7, the female screw member 18 is screwed to the portion 11a of the male screw portion 11 of the stem 3, which portions 11a protruding upward beyond the upper end of the bonnet

5. Then, the open/closed indication member 25 is fitted to the upper portion of the bonnet 5, and the handle 7 is fixed to the attachment portion 13 of the stem 3, whereby the assembling work is completed.

5 [0045] To position the female screw member 18 (the first nut 19 and the second nut 20) appropriately and to fix the handle 7 at an appropriate position, the diaphragm valve 1 may be assembled in the following order.

1. Rotate the handle 7 to position the stem 3 at a predetermined position so that an intermediate degree of opening (the state shown in Fig. 2) is obtained.

2. Remove the handle 7.

3. Loosen the first nut 19 and the second nut 20.

4. Rotate the stem 3 to move the stem to a close position. This state 3 is shown in Fig. 3A. To obtain this state, 4-1. the stem 3 may be fastened by rotating the attachment portion 13 of the stem using a torque wrench, or 4-2. the handle 7 may be attached to rotate the handle 7 so as to rotate the stem 3. In the latter case, after rotating the stem 3, the handle 7 is removed again.

5. Rotate the first nut 19 until the first nut 19 comes in contact with the bonnet 5. This state is shown in Fig. 3B. This rotation is performed by the hand (manual fastening).

6. Fasten the second nut 20. This state is shown in Fig. 3C. The fastening is performed using a torque wrench and is performed more intensely than in the case of the fastening of the first nut 19. That is to say, the first nut 19 is fastened with a relatively low torque whereas the second nut 20 is fastened with a relatively high torque. With this configuration, the relative

rotation between the first nut 19 and the second nut 20 is suppressed, and the first nut 19 and the second nut 20 being constantly integral with each other are moved vertically together with the stem 3.

5 7. Attach the handle 7.

[0046] By performing the above-mentioned procedure, assembling work is completed. Then, when the handle 7 is rotated, any operation may be performed. At this time, when the diaphragm valve 1 is closed as shown in Fig. 1, even if the handle
10 7 is fastened intensely, the female screw member 18 serves as a stopper, excessive fastening is prevented. By performing the above-mentioned setting (fastening of the first nut 19 and the second nut 20) at an intermediate degree of opening of the diaphragm valve 1, the handle 7 may be set to the intermediate
15 degree of opening (any degree of opening) and furthermore, the diaphragm valve 1 capable of preventing the handle 7 from being fastened excessively may be obtained.

[0047] As the above-mentioned female screw member 18, a locking nut referred to as a Hardlock nut (registered trademark)
20 may be used. Using such a locking nut serves a locking function due to the fitting of the tapered surfaces 21a and 22a to each other. Furthermore, the tapered surface 21a of the protrusion 21 is slightly eccentric to the screw hole of the nut 19 and the tapered surface 22a of the recess 22 is concentric with the screw
25 hole of the nut 20, whereby the locking function is further improved. It should be noted that the female screw member 18 is not limited to the Hardlock nut (registered trademark).

[0048] The structure for preventing excessive fastening using

the above-mentioned female screw member 18 may be applicable to various diaphragm valves. In such an application, the structures of the body, the stem, the diaphragm, the bonnet, the diaphragm presser, and the handle may be modified in various
5 manners.

Industrial Applicability

[0048] The present invention contributes to the improvement of the performance of the diaphragm valve since the durability
10 of the diaphragm of the diaphragm valve is greatly improved.

CLAIMS

1. A diaphragm valve comprising:
 - a body having a fluid channel;
 - 5 a stem vertically movable in relation to the body;
 - a diaphragm which opens and closes the fluid channel of the body associated with a vertical movement of the stem;
 - a bonnet which is provided above the body and which guides the stem so as to enable the stem to move vertically;
 - 10 a diaphragm presser which is attached at a lower end portion of the stem and which presses the diaphragm downward; and
 - a handle which is rotated to move the stem vertically to an open position and a close position;
 - wherein a female screw member is screwed to an upper end
 - 15 portion of a male screw portion provided on the stem, and when the stem reaches an appropriate close position, the female screw member comes into contact with an upper end of the bonnet thereby preventing the stem from moving downward further; and
 - wherein the female screw member consists of: a first nut
 - 20 which is fastened with a relatively low torque; and a second nut which is placed on the first nut and is fastened with a relatively high torque.
2. The diaphragm valve according to claim 1, wherein an
- 25 overlapping surface of one of the nuts is provided with an annular protrusion having a tapered inner peripheral surface where the diameter becomes greater toward an edge thereof, and an overlapping surface of the other nut is provided with an annular

recess which is fitted to the protrusion.

3. A method of assembling the diaphragm valve according to claim 1 or 2, comprising:

- 5 removing the handle from the stem in a state where the stem is positioned in a predetermined position;
 - loosening the first nut and the second nut;
 - rotating the stem to move the stem to the close position;
 - rotating the first nut to bring the first nut into contact
- 10 with the bonnet,
 - fastening the second nut; and
 - attaching the handle to an upper end portion of the stem.