SPECIFICATION

TITLE OF INVENTION: CHECK VALVE

TECHNICAL FIELD

[0001] The present invention relates to a check valve.

BACKGROUND ART

[0002] There are known check valves for allowing fluid in a pipe to pass in one direction.

In relation to this type of technology, Patent Document 1 listed below discloses a check valve of a straight pipe joint type in which a primary flow path (inflow path) on an upstream side and a secondary flow path (outflow path) on a downstream side are coaxially disposed. This check valve is of a so-called oblique lift type in which a valve body moves obliquely with respect to a main axis direction of the primary flow path and the secondary flow path. More specifically, the check valve of Patent Document 1 includes a valve casing (12) having a valve seat (15), a housing (23) capable of seating on the valve seat (15), and a coil spring (18) having a biasing force in a direction to push a valve body (16) down.

A fluid pushes up the valve body (16) and flows from the primary flow path to the secondary flow path. While the fluid is flowing from the primary flow path to the

secondary flow path, the valve body is maintained in a state of being pushed upward by the flow of the fluid.

CITATION LIST

PATENT DOCUMENT

[0003] Patent Document 1: U. S. Patent No. 1703248

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] However, while the valve body remains pushed upward, because the primary flow path and the secondary flow path are in communication, the fluid has a tendency of moving from the primary flow path toward the secondary flow path along the main axis direction. Accordingly, because the valve body pushed upward is placed in a position apart from the flow path through which the fluid moves, the valve body does not easily receive the fluid pressure of the fluid. As a result, after the valve body has been pushed upward, it may be difficult in some situations to maintain the state in which the valve body is pushed upward.

[0005] In view of the problem described above, the present invention provides a check valve in which it is possible to easily maintain the state in which the valve body is pushed upward.

MEANS FOR SOLVING THE PROBLEM

[0006] A check valve of the present invention is a check valve of a straight pipe joint type and of an oblique lift type in which a fluid flows from an upstream side to a downstream side. The check valve includes: a valve seat; a moving body capable of linearly reciprocating between a closed state of being in close contact with the valve seat and an open state of being separated from the valve seat; a valve casing to which the valve seat is fixed, the valve casing including a valve cylinder extending in a moving direction of the moving body, in which the moving body moves; a primary flow path positioned on the upstream side relative to the valve cylinder and using a main axis direction being a straight line as an axis; and a secondary flow path positioned on the downstream side relative to the valve cylinder and using the main axis direction as an axis. A flowing direction of a first main flow of the fluid passing through the inside of the valve cylinder from the upstream side toward the downstream side has a larger component in the moving direction of the moving body than a component in the main axis direction.

[0007] Because the flowing direction of the first main flow being a main flow of the fluid passing through the inside of the valve cylinder has the larger component in the moving direction of the moving body than the component in the main axis direction, the first main flow principally flows in a direction of pushing up the valve

body in the moving direction (in particular, toward a ceiling side in the moving direction).

EFFECT OF THE INVENTION

[0008] In the check valve of the present invention, because the first main flow principally flows in the direction of pushing up the valve body in the moving direction, the fluid keeps colliding with the valve body in the direction of pushing up the valve body.

Consequently, it is possible to easily maintain the state in which the valve body is pushed upward.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The purpose described above, other purposes, features, and advantages will further be clear from the preferable embodiments described below and the accompanying drawings listed below.

[0010] [FIG. 1] FIG. 1 is a perspective view showing an example of a check valve according to a first embodiment of the present invention.

[FIG. 2] FIG. 2 is a longitudinal cross-sectional view taken along a main axis direction of the check valve in a closed state according to the first embodiment.

[FIG. 3] FIG. 3 is a longitudinal cross-sectional view taken along the main axis direction of the check valve in an open state according to the first embodiment.

[FIG. 4] FIG. 4A is a velocity distribution chart at a time when a fluid flows through the check valve according to the first embodiment. FIG. 4B is the same chart as the chart in FIG. 4A with indications of regions A to D.

[FIG. 5] FIG. 5A and 5B present other velocity distribution charts at a time when the fluid flows through the check valve according to the first embodiment.

[FIG. 6] FIG. 6 is a rear view of a valve casing in the check valve according to the first embodiment. The exterior shape of a valve shaft is shown with a dotted line.

[FIG. 7] FIG. 7A is a drawing of a lower end cylinder part according to the first embodiment as seen from the rear. FIG. 7B is a drawing of a lower end part of the valve shaft according to the first embodiment as seen from the rear.

[FIG. 8] FIG. 8A is a partial exploded view of the valve body according to the first embodiment as seen from the rear. FIG. 8B is a longitudinal cross-sectional view of the valve body and the valve shaft.

[FIG. 9] FIG. 9 is a perspective view of the check valve according to a second embodiment of the present invention.

[FIG. 10] FIG. 10 is a longitudinal cross-sectional view taken along a main axis direction of a check valve in a closed state according to the second embodiment.

[FIG. 11] FIG. 11 is a longitudinal cross-sectional view taken along the main axis direction of the check valve in an open state according to the second embodiment.

[FIG. 12] FIG. 12 is a velocity distribution chart at a time when a fluid flows through the check valve according to the second embodiment.

[FIG. 13] FIG. 13A and FIG. 13B present other velocity distribution charts at a time when the fluid flows through the check valve according to the second embodiment.

[FIG. 14] FIG. 14 is rear view of a valve casing in the check valve according to the second embodiment. The exterior shape of a valve shaft is shown with a dotted line.

DESCRIPTION OF EMBODIMENTS

[0011] The various constituent elements of the check valve of the present invention need not be independent of each other. There may be allowable cases such that a plurality of constituent elements are formed as a single member, one constituent element is formed with a plurality of members, one constituent element is a part of another constituent element, or a part of one

constituent element is a duplicate of a part of another constituent element.

[0012] The following will describe embodiments of the present invention on the basis of the drawings. In the drawings, corresponding constituent elements will be referred to by using the same reference characters, and explanations thereof will not be repeated.

The present embodiments will be described while the front, rear, left, right, up, and down directions are defined as shown in the drawings. In the present embodiments, the front-rear direction corresponds to a main axis direction (explained later). Further, the left-right direction may be referred to as the width direction of a check valve 1. However, these directions are conveniently defined in order to simply explain relative relationships among constituent elements and are not intended to limit the directions at the time of manufacturing or using the products embodying the present invention. The up-and-down direction is not necessarily the vertical direction and denotes a direction orthogonal to the main axis direction and the width direction. For example, when the check valve 1 is attached to a pipe while being placed on a horizontal plane, the up-and-down direction is the vertical direction; however, when the check valve 1 is attached to a plane tilted with respect to a horizontal plane or an upright plane perpendicular

to a horizontal plane, the up-and-down direction is not the vertical direction.

Further, in the present invention, a flat surface denotes a shape that is physically formed while aiming to obtain a flat surface and, needless to say, may not necessarily be a perfectly flat surface geometrically.

[0013] <First Embodiment>

(Check Valve)

FIG. 1 is a perspective view showing an example of the check valve 1 according to a first embodiment of the present invention. FIG. 2 is a longitudinal cross-sectional view of the check valve 1.

[0014] To begin with, an outline of the check valve 1 of the present embodiment will be explained.

As shown in FIG. 2, the check valve 1 is a check valve of a straight pipe joint type and of an oblique lift type, in which a fluid 200 (see FIG. 4) flows from an upstream side to a downstream side.

The check valve 1 includes a valve seat 12, a moving body 30, a valve casing 10, a primary flow path 40, and a secondary flow path 50.

The moving body 30 is a member capable of linearly reciprocating between a closed state of being in close contact with the valve seat 12 and an open state of being separated from the valve seat 12. The valve casing 10 is a member including a valve cylinder 14. To the valve casing 10, the valve seat 12 is fixed. The valve

cylinder 14 is a member which extends in a moving direction of the moving body 30 and in which the moving body 30 moves.

The primary flow path 40 is positioned on the upstream side relative to the valve cylinder 14 and uses the main axis direction being a straight line (the direction shown by a dot-dashed chain line I in FIG. 2) as an axis thereof. The secondary flow path 50 is positioned on the downstream side relative to the valve cylinder 14 and uses the main axis direction as an axis thereof.

As shown in FIG. 4A and FIG. 4B, the flowing direction of a first main flow of the fluid 200 (a main flow of the fluid 200 shown in region A or region B in FIG. 4B) passing through the inside of the valve cylinder 14 from the upstream side toward the downstream side has a larger component in the moving direction of the moving body 30 than a component in the main axis direction. By combining the shapes and positioning of various elements constituting the check valve 1, it is possible to realize the first main flow having a larger component in the moving direction of the moving body 30 than the component in the main axis direction. A method for realizing this configuration will be explained later in detail.

Because the flowing direction of the first main flow being a main flow of the fluid 200 passing through the inside of the valve cylinder 14 has the larger component

in the moving direction of the moving body 30 than the component in the main axis direction, the first main flow principally flows in a direction of pushing up the moving body 30 (a valve body 32 explained later) in the moving direction (in particular, toward the ceiling side in the moving direction). Because the first main flow principally flows in the direction of pushing up the valve body 32 in the moving direction, the fluid 200 keeps colliding with the valve body 32 in the direction of pushing up the valve body 32. With this configuration, it is possible to easily maintain the state in which the valve body 32 is pushed upward.
[0015] Next, the check valve 1 of the present embodiment will be explained in detail.

The check valve 1 is a member that is installed at a non-end position of a pipe in order to allow fluid to pass in one direction from the upstream side toward the downstream side and is for preventing the fluid from flowing backward from the downstream side toward the upstream side. As described above, the check valve 1 of the present embodiment is of a straight pipe joint type and of an oblique lift type. The check valve 1 of a straight pipe joint type denotes a check valve in which a pipe (a downstream side pipe) connected to the downstream side of the check valve 1 extends on an extension line of a pipe (an upstream side pipe) connected to the upstream side of the check valve 1. In other words, for check

valves of a straight pipe joint type, an outflow direction is positioned on an extension line of an inflow direction. In the present embodiment, in the check valve 1, the upstream side pipe and the downstream side pipe are connected together in such a manner that the upstream side pipe and the downstream side pipe are coaxially disposed. Further, the check valve 1 of an oblique lift type denotes a check valve in which the valve body moves in an oblique direction with respect to the main axis direction (explained later).

The closed state of the check valve 1 denotes a state in which, as shown in FIG. 2, moving of the fluid from the upstream side toward the downstream side of the check valve 1 is restricted by the moving body 30 (explained later). In the closed state, the moving of the fluid 200 does not necessarily need to be restricted completely, and it is acceptable as long as the moving of the fluid 200 is sufficiently restricted in accordance with purposes. In the closed state of the present embodiment, the moving body 30 is seated on the valve seat 12 as explained later. As a result, a flow path of the fluid 200 is narrowed by the moving body 30, so that the moving of the fluid 200 is restricted. The open state of the check valve 1 denotes a state in which, as shown in FIG. 3, the moving of the fluid 200 is less restricted than in the closed state of the check valve 1. More specifically, in the open state of the check valve

1, the valve seat 12 is separated from the moving body 30, and there is a gap between the valve seat 12 and the moving body 30. The fluid 200 is able to move from the upstream side toward the downstream side through the gap. In the open state, the moving body 30 may be pushed up to the highest position, or the moving body 30 may be positioned at a non-end position of a valve shaft 34. In other words, in the open state of the check valve 1, the moving of the fluid 200 from the upstream side toward the downstream side may slightly be restricted. It should be noted that, however, the restriction on the moving of the fluid 200 in the open state of the check valve 1 is smaller than the restriction on the moving of the fluid 200 in the closed state of the check valve 1.

[0016] FIG. 2 is a longitudinal cross-sectional view of the check valve 1.

The valve casing 10 is a housing in which a fluid flows. The valve casing 10 accommodates the moving body 30 therein. The housing is structured with wall parts 19. In this situation, the wall parts 19 include a pipe wall part 19a, a valve cylinder wall part 19b, and a ceiling part 15 (explained later).

In the present embodiment, the valve casing 10 includes a pipe part 11 and the valve cylinder 14. The pipe part 11 is a part in which the fluid 200 principally flows from the upstream side toward the downstream side. In other words, the pipe part 11 is a part connecting an

inflow path (the primary flow path 40) to an outflow path (the secondary flow path 50) of the fluid. More specifically, the pipe part 11 extends in a direction (the left-right direction in FIG. 2, which is the direction indicated with the dot-dashed chain line) connecting the center of an inflow port 11a of the check valve 1 to the center of an outflow port 11b thereof. In this situation, the axis (the axis indicated with the dot-dashed chain line in FIG. 2) connecting the center of the inflow port 11a to the center of the outflow port 11b will be referred to as a main axis. The extending direction of the main axis will be referred to as the main axis direction. The pipe part 11 is formed by a wall part 19 (the pipe wall part 19a) disposed so as to cover the surroundings of the main axis while using the main axis as an axial center.

At two ends of the pipe part 11 in the main axis direction, collar parts 17 each protruding in a direction orthogonal to the main axis direction are provided.

The valve cylinder 14 is a part of the valve casing 10 accommodating the moving body 30 on the inside thereof. The valve cylinder 14 extends in the moving direction (an oblique direction connecting the top left to the bottom right in the drawing of FIG. 2) of the moving body 30. The valve cylinder 14 is formed by a wall part 19 (the valve cylinder wall part 19b) disposed so as to cover the axis while using the moving direction

of the moving body 30 as an axial center. More specifically, the valve cylinder 14 is formed by the valve cylinder wall part 19b disposed so as to cover the surroundings of the valve shaft.

In an upper end part of the valve cylinder 14, the space inside the valve cylinder 14 is closed by the ceiling part 15. The upper end part of the valve cylinder 14 is one end part of the valve cylinder 14 on the upper side in the moving direction. In this situation, the upper side denotes the side where the valve cylinder is provided in the valve casing 10 while the main axis is used as a reference. The upper side may be referred to as a top face side.

In a lower end part of the valve cylinder 14, an internal space of the valve cylinder 14 communicates with an internal space of the pipe part 11. The lower end part of the valve cylinder 14 denotes one end part of the valve cylinder 14 on the lower side in the moving direction. The lower side may be referred to as a bottom face side.

In the present embodiment, the ceiling part 15 also serves as a lid part of the valve cylinder 14. In other words, as a result of opening the ceiling part 15, the internal space of the valve cylinder 14 becomes communicable to the outside. The ceiling part 15 is fixed by a fastener 15b to the valve cylinder wall part 19b so as not to open.

[0017] The valve seat 12 is a part fixed to the valve casing 10 in the check valve 1 and is a part that is in contact with the moving body 30 while the check valve 1 is in the closed state. The valve seat 12 in the present embodiment is a protrusion part protruding toward the inside of the valve casing 10 from a wall part 19 (the pipe wall part 19a or the valve cylinder wall part 19b). More specifically, the valve seat 12 protrudes from the wall part 19 inwardly in the radial direction of the valve cylinder 14. The radial direction of the valve cylinder 14 denotes the direction radially directed from the valve shaft 34 (explained later) toward the circumferential edge (the valve cylinder wall part 19b) of the valve cylinder 14, as seen from the moving direction of the moving body 30. The inward direction in the radial direction of the valve cylinder 14 denotes the direction directed from the circumferential edge (the valve cylinder wall part 19b) of the valve cylinder 14 toward the valve shaft 34, as seen from the moving direction of the moving body 30. The valve seat 12 is a member different from the valve casing 10 (the wall parts 19) and may be fixed to the valve casing 10 through bonding, welding, or other methods, or may integrally be formed with the valve casing 10.

The valve seat 12 in the present embodiment extends so as to circle around the valve shaft 34. In other words, the valve seat 12 extends in the circumferential

direction of the pipe part 11 and is disposed so as to make a full circle in the circumferential direction. As a result, the valve seat 12 is capable of being in contact with the entire circumferential edge of the moving body (a seal part 36, in particular) explained later.

The valve seat 12 in the present embodiment has a surface facing upward in the moving direction of the moving body 30. The moving body 30 is capable of making surface contact with the surface.

[0018] The moving body 30 is a member capable of moving in predetermined moving directions. By moving downward in a moving direction, the moving body 30 is capable of being in contact with the valve seat 12. By moving upward in a moving direction, the moving body 30 is capable of separating from the valve seat 12.

The moving body 30 has a sufficient diameter for restricting the flow of the fluid 200 from the upstream side toward the downstream side. In the present embodiment, the diameter of the moving body 30 (a maximum diameter of the moving body 30 as seen from the moving direction of the moving body 30) is larger than the inside diameter of the valve seat 12 (a maximum diameter as seen from the moving direction of the moving body 30). With this configuration, when the moving body 30 comes into contact with the valve seat 12 while the check valve 1 is in the closed state, the moving body 30 is capable

of being in contact with the valve seat 12 over the entire circumference of the circumferential edge of the valve seat 12. Accordingly, the moving body 30 is able to sufficiently restrict the moving of the fluid 200. Alternatively, the diameter of the moving body 30 may be equal to the inside diameter of the valve seat 12 or may be smaller than the inside diameter of the valve seat 12. [0019] As shown in FIG. 2, in the present embodiment, the moving body 30 includes the valve body 32 and the valve shaft 34.

The valve body 32 is a member supported by the valve seat 12 while the check valve 1 is in the closed state. The valve body 32 being supported by the valve seat 12 denotes a state in which the valve body 32 is placed on the valve seat 12, and at least a part of the dead weight of the valve body 32 is on the valve seat 12. As a result of the valve body 32 moving in the moving direction of the moving body 30, the check valve 1 transitions from the closed state into the open state or from the open state into the closed state.

The valve shaft 34 is a member for assisting the moving of the valve body 32. More specifically, in the present embodiment, the valve body 32 is fixed to the valve shaft 34, and as explained later, at least one end part of the valve shaft 34 is inserted in a cylinder part 16. Accordingly, as a result of the valve shaft 34 moving or sliding along the cylinder part 16, the valve

body 32 is able to move in the predetermined moving direction. As an alternative to the present embodiment, another configuration is also acceptable in which the valve body 32 is not fixed to the valve shaft 34, so that the valve shaft 34 assists the moving of the valve body 32 as a result of the valve body 32 sliding on the valve shaft 34.

In the present embodiment, the valve shaft 34 is a member extending from the valve body 32 to both sides in the moving direction. The valve shaft 34 extending from the valve body 32 to both sides in the moving direction may denote that the valve shaft 34 extends from the valve body 32 to each of both sides in the moving direction in at least one of the following states: the check valve 1 is in the closed state, is in the open state, or is in a state of transitioning from the closed state into the open state. In the present embodiment, the valve body 32 is fixed to the valve shaft 34, and the positional relationship between the valve body 32 and valve shaft 34 is fixed. The valve body 32 is disposed at a non-end position in the length direction of the valve shaft 34. In other words, the valve shaft 34 extends from the valve body 32 to both sides in the moving direction, in any of the following states: the check valve 1 is in the closed state, is in the open state, or is in a state of transitioning from the closed state into the open state. As an alternative to the present embodiment, when the

valve shaft 34 is not fixed to the valve body 32, it is sufficient if the valve shaft 34 extends from the valve body 32 to both sides in the moving direction, at least when the check valve 1 is in the state of transitioning from the closed state into the open state. In the closed state or the open state of the check valve 1, the valve shaft 34 may extend from the valve body 32 to both sides in the moving direction or may extend from the valve body 32 only to one side in the moving direction.

In the present embodiment, the valve shaft 34 is a shaft member disposed at the center of the valve cylinder 14 in the moving direction of the moving body 30 (the valve body 32) and is a member penetrating the valve body 32. However, possible embodiments are not limited to this example. The valve shaft 34 may be a tubular member disposed on the outer side in the radial direction of the valve cylinder 14 relative to the valve body 32. The valve body 32 may move or slide inside the valve shaft 34 along the valve shaft 34.

[0020] In the present embodiment, as described above, the valve body 32 is fixed to the valve shaft 34. More specifically, as shown in FIG. 8B, the valve body 32 is fixed to the valve shaft 34 by a threaded screw 35. The valve shaft 34 has a screw reception part 34d being a protrusion part that protrudes on the circumferential surface of the valve shaft 34. Certain parts (a first grip part 38 and a second grip part 39 explained later)

of the valve body 32 are disposed so as to be sandwiched between the threaded screw 35 and the screw reception part 34d. As a result of the threaded screw 35 being threadedly engaged with a screw groove provided on the circumferential surface of the valve shaft 34 and being positioned close to the screw reception part 34d, the screw reception part 34d and the threaded screw 35 are able to grip the valve body 32.

[0021] As shown in FIG. 2, the ceiling part 15 includes a ceiling cavity 15a capable of accommodating therein a part (an upper end part 34b) of the valve shaft 34. In the present embodiment, a part of the ceiling part 15 protrudes upward in the moving direction of the moving body 30, the part being hollow inside.

Because it is possible to accommodate the upper end part 34b in the ceiling cavity 15a, the valve shaft 34 is able, in the open state, to be positioned on a sufficiently upper side in the moving direction of the moving body 30.

[0022] In the present embodiment, both of the end parts (the upper end part 34b and a lower end part 34a) of the valve shaft 34 are supported by the wall parts 19 of the valve casing 10. In the present embodiment, the upper end part 34b of the valve shaft 34 is supported by the ceiling part 15, whereas the lower end part 34a of the valve shaft 34 is supported by the pipe wall part 19a or the valve cylinder wall part 19b. Both of the end parts

of the valve shaft 34 being supported by the wall parts 19 of the valve casing 10 denotes a state in which both of the end parts of the valve shaft 34 are each in contact with the valve casing 10 or a member fixed to the valve casing 10, while at least part of the dead weight of the valve shaft 34 is on the valve casing 10 at each of both of the end parts. It is acceptable when the valve shaft 34 is in contact with the wall parts 19 of the valve casing 10 so that the dead weight of the valve shaft 34 is directly on the wall parts 19. It is also acceptable when the valve shaft 34 is in contact with another member fixed to the wall parts 19 of the valve casing 10 so that the dead weight of the valve shaft 34 is indirectly on the wall parts 19 via said another member.

Further, in the present embodiment, a part of the dead weight of the valve shaft 34 is also supported by a spring body 37 (explained later). More specifically, the valve shaft 34 is disposed across an upper end cylinder part 16b fixed to the ceiling part 15 and the valve body 32. Also, as explained later, the spring body 37 biases both the ceiling part 15 and the valve body 32 in the moving direction of the moving body 30. As a result of the spring body 37 biasing both the ceiling part 15 and the valve body 32, the valve shaft 34 disposed across the upper end cylinder part 16b and the valve body 32 is held

in an orientation following along the moving direction of the moving body 30.

More specifically, the lower end part 34a (the end part of the valve shaft 34 on the bottom face side of the check valve 1) and the upper end part 34b (the end part of the valve shaft 34 on the top face side of the check valve 1) of the valve shaft 34 are each inserted in the cylinder part 16 (the lower end cylinder part 16a and the upper end cylinder part 16b) fixed to the valve casing 10.

The lower end cylinder part 16a in which the lower end part 34a is inserted is fixed to a wall part 19 (the pipe wall part 19a or the valve cylinder wall part 19b) of the valve casing 10. More specifically, as shown in FIG. 6, the lower end part 34a of the valve shaft 34 is supported by support parts 18 (first support parts 18a and second support parts 18b). The support parts 18 in the present embodiment extend toward the lower end part 34a while protruding from a wall part 19 (the pipe wall part 19a or the valve cylinder wall part 19b) of the valve casing 10. More specifically, as shown in FIG. 6, the support parts 18 extend toward a ring part 18c at the center of the pipe part 11. The ring part 18c and the support parts 18 are integrally formed. Further, a part of the lower end cylinder part 16a (see FIG. 2) is inserted in the ring part 18c and is linked to the ring part 18c. In the present embodiment, the lower end part

34a is supported by the two or more (four) support parts 18. The four support parts 18 are disposed in a cross-shaped (+) formation. Also, as shown in FIG. 2, in the present embodiment, each of the second support parts 18b protrudes from a peak part of a protruding part 11e or a peak part of a second protruding part 11f (explained later).

In addition, as shown in FIG. 2, the upper end cylinder part 16b into which the upper end part 34b is inserted is fixed to the ceiling part 15. More specifically, the upper end cylinder part 16b is fixed to the ceiling part 15 so that the inside of the upper end cylinder part 16b communicates with the ceiling cavity 15a. The internal space of the upper end cylinder part 16b is positioned side by side with the ceiling cavity 15a in the moving direction of the moving body 30. In the present embodiment, the upper end cylinder part 16b is fitted to and fixed to the ceiling part 15.

[0023] When the check valve 1 transitions from the open state into the closed state, or when the check valve 1 transitions from the closed state into the open state, the valve shaft 34 slides on the inner walls of the lower end cylinder part 16a and the upper end cylinder part 16b.

As shown in FIG. 2, while the check valve 1 is in the closed state, the upper end part 34b of the valve shaft 34 is inserted in the upper end cylinder part 16b

(in particular, the lower end part thereof), whereas the lower end part 34a of the valve shaft 34 penetrates the lower end cylinder part 16a and the ring part 18c. In that situation, the lower end part 34a of the valve shaft 34 is positioned close to the pipe wall part 19a. In the present embodiment, the separation distance between the lower end part 34a and the pipe wall part 19a (the distance between the lower end part 34a and the pipe wall part 19a in the moving direction of the moving body 30) is shorter than an insertion depth of the upper end part 34b into the upper end cylinder part 16b (the length of the part of the upper end part 34b that is inserted in the upper end cylinder part 16b, which is the length in the moving direction of the moving body 30). While the check valve 1 is in the closed state, because the valve shaft 34 extends downward to such an extent that the valve shaft 34 becomes extremely close to the pipe wall part 19a, the valve shaft 34 is able to be inserted in the lower end cylinder part 16a with a sufficient insertion depth while the check valve 1 is in the open state. Meanwhile, while the check valve 1 is in the closed state, because the insertion depth of the valve shaft 34 into the upper end cylinder part 16b is sufficiently large, the valve shaft 34 is sufficiently supported by the upper end cylinder part 16b during the closed state.

In contrast, as shown in FIG. 3, while the check valve 1 is in the open state, the upper end part 34b of the valve shaft 34 penetrates the upper end cylinder part 16b. Also, a certain part of the upper end part 34b protruding upward from the upper end cylinder part 16b is disposed inside the ceiling cavity 15a. Meanwhile, the lower end part 34a of the valve shaft 34 is inserted in the lower end cylinder part 16a (in particular, an upper end part thereof). It is desirable, in the open state, that the insertion depth of the lower end part 34a of the valve shaft 34 into the lower end cylinder part 16a (the length of the part of the lower end part 34a that is inserted in the lower end cylinder part 16a, which is the length in the moving direction of the moving body 30) is longer than the separation distance between the lower end part 34a and the pipe wall part 19a during the closed state of the check valve 1 (see FIG. 2). With this configuration, the lower end part 34a of the valve shaft 34 is sufficiently supported by the lower end cylinder part 16a.

[0024] As shown in FIG. 8B, the valve body 32 in the present embodiment includes the seal part 36, the first grip part 38, and the second grip part 39. As shown in FIG. 2, the seal part 36 is a member that is in close contact with the valve seat 12 during the closed state. The first grip part 38 is a member disposed at a certain part of the seal part 36 corresponding to the top face

side of the valve cylinder 14. The second grip part 39 is a member disposed at a certain part of the seal part 36 corresponding to the bottom face side of the check valve 1. The seal part 36 is sandwiched between the first grip part 38 and the second grip part 39 in the moving direction. In other words, the valve body 32 in the present embodiment is formed while the second grip part 39, the seal part 36, and the first grip part 38 are sequentially stacked from the bottom to the top.

In the present embodiment, the seal part 36 is a packing and is formed by using a resin. In contrast, the first grip part 38 and the second grip part 39 are formed by using metal.

In the present embodiment, a central part of the second grip part 39 has a recessed part 39a formed so as to be recessed toward the upper side in the moving direction of the moving body 30. Similarly, a central part of the first grip part 38 has a recessed part 38a formed so as to be recessed toward the upper side in the moving direction of the moving body 30. As shown in FIG. 2, while the check valve 1 is in the closed state, it is possible to accommodate at least a part of the lower end cylinder part 16a on the inside of the recessed part 38a and the recessed part 39a (see FIG. 8B).

As shown in FIG. 8B, in the present embodiment, the wall part defining the recessed part 39a is separated from the valve shaft 34 in the radial direction of the

valve cylinder 14. In other words, in the radial direction of the valve cylinder 14, a lower end hollow part 39b being a hollow part is positioned between the valve shaft 34 and the second grip part 39. Further, the wall part of the first grip part 38 defining the recessed part 38a is separated from the wall part of the second grip part 39 defining the recessed part 39a. In the radial direction of the valve cylinder 14, an intra-valve-body hollow part 38b being a hollow part is positioned between the first grip part 38 and the second grip part 39.

In a lower part of the valve body 32, the lower end hollow part 39b which opens at the bottom is formed. Thus, a part of the fluid 200 flowing in from the upstream side may stagnate inside the lower end hollow part 39b or in the vicinity thereof. For this reason, while the check valve 1 is in the open state, a valve opening degree is easily maintained.

[0025] As shown in FIG. 2, in the present embodiment, the surface of the valve body 32 facing the upstream side (a lower face 39d of the valve body 32 which, at the second grip part 39, faces the lower side in the moving direction of the moving body 30) is a bulging surface having a shape bulging toward the upstream side. In the present embodiment, the lower face 39d has a relatively large curvature radius. More specifically, as seen from the width direction (the left-right direction) of the

check valve 1, the extending direction of a certain part of the lower face 39d positioned on the upstream side (the part of the lower face 39d from the center of the lower face 39d to the distal end of the lower face 39d on the upstream side) has a component in the main axis direction and a component in the radial direction of the valve cylinder 14, and further, the component in the radial direction is larger than the component in the main axis direction. The extending direction of the part of the lower face 39d positioned on the upstream side as seen from the left-right direction may be the extending direction of a line connecting the center of the lower face 39d to the distal end of the lower face 39d on the upstream side as seen from the left-right direction. Because the lower face 39d of the valve body 32 has the bulging surface, it is possible to change the flowing direction of the first main flow with smaller pressure loss, even when the first main flow has arrived in the moving direction of the moving body 30 (explained later), as compared to the situation where the lower face 39d had a flat surface expanding along the radial direction of the valve cylinder 14.

Further, in the present embodiment, as shown in FIG. 8A, the second grip part 39 is formed so as to include at least one hollow part 39c. More specifically, a plurality of hollow parts 39c are disposed side by side so as to surround the valve shaft 34. The hollow parts

39c are partitioned by partitions extending in the moving direction of the moving body 30. The partitions make it easy for the valve body 32 to maintain the shape thereof, even when the valve body 32 repeatedly comes into pressure contact with the valve seat 12.

As an alternative to the present embodiment, a single hollow part 39c extending in the circumferential direction of the valve cylinder 14 may be disposed inside the second grip part 39.

[0026] As shown in FIG. 2 and FIG. 3, the moving body 30 in the present embodiment includes the spring body 37. More specifically, the spring body 37 is a coil spring of which the axis corresponds to the moving direction of the moving body 30. The spring body 37 is disposed between the ceiling part 15 and the valve body 32 in the moving direction of the moving body 30 and biases both the ceiling part 15 and the valve body 32.

In the present embodiment, both of the end faces of the spring body 37 are positioned along a plane (a plane expanding in the radial direction of the valve cylinder 14) which expands orthogonal to the moving direction of the moving body 30. More specifically, the end faces of a metal wire structuring the coil spring expand in a direction orthogonal to the moving direction of the moving body 30. Alternatively, the end faces of the metal wire structuring the coil spring expand on a plane expanding in the radial direction of the valve cylinder

14. In other words, end parts of the metal wire structuring the coil spring extend along the circumferential direction of the valve shaft 34. With this configuration, the two end faces of the spring body 37 are able to make surface contact with the ceiling part 15 and the valve body 32, respectively. As a result, the spring body 37 is able to bias both the ceiling part 15 and the valve body 32 in a straight manner in the moving direction of the moving body 30.

When the check valve 1 transitions from the closed state into the open state, the spring body 37 is compressed in the moving direction of the moving body 30. Accordingly, while the check valve 1 is in the open state, the spring body 37 biases the valve body 32 downward in the moving direction of the moving body 30, so that the spring body 37 biases the valve body 32 to bring the check valve 1 into the closed state. In addition, when the check valve 1 is in the closed state also, the spring body 37 biases the valve body 32 downward in the moving direction of the moving body 30. Accordingly, during the closed state of the check valve 1, the valve body 32 is in pressure contact with the valve seat 12.

[0027] Next, a flow of the fluid 200 when the fluid 200 passes through the check valve 1 of the present embodiment will be explained.

FIG. 4A is a velocity distribution chart expressing a distribution of velocities of the fluid 200 when the check valve 1 is installed at a non-end position of a pipe, and the fluid 200 is caused to flow through the pipe positioned on the upstream side of the check valve 1 at a flow velocity of 4.0 m/s. Further, the lines illustrated in the fluid 200 indicate the directions in which the fluid 200 is flowing.

The velocity distribution charts in FIG. 4A and FIG. 4B are generated by creating a 3D model of a check valve corresponding to the shape of the check valve 1 of the present embodiment and a 3D model of the pipes on the upstream side and the downstream side connected to the check valve, so as to calculate the flow velocity of the fluid flowing through the check valve 1 by performing a simulation based on computational fluid dynamics. The simulation is performed on the premise that the fluid 200 is caused to flow at a mass flow rate corresponding to a predetermined flow velocity, while the position of the valve body 32 (corresponding to the valve opening degree explained later) is fixed. The abovementioned simulation similarly applies to FIG. 5A, FIG. 5B, FIG. 12, FIG. 13A, and FIG. 13B.

The valve opening degree in FIG. 4A and FIG. 4B is approximately 80%. The valve opening degree is an index indicating the opening/closing degree of the valve body 32. The state in which the valve body 32 is seated on

the valve seat 12 is expressed as a valve opening degree of 0%, whereas the state in which the lower end of the valve body 32 in the up-and-down direction (a bottom left part of the valve body 32 in FIG. 4A) is positioned at the same height as the upper face of the pipe part 11 in the up-and-down direction is expressed as a valve opening degree of 100%. In other words, when the valve opening degree is 0%, the moving of the fluid 200 from the primary flow path 40 to the secondary flow path 50 is not substantially performed. In contrast, when the valve opening degree is 100%, the moving of the fluid 200 from the primary flow path 40 to the secondary flow path 50 of the pipe part 11 is not substantially obstructed by the valve body 32. While using, as a reference, the position of the valve body 32 at the valve opening degree 0% and the position of the valve body 32 at the valve opening degree 100%, the valve opening degree expresses positions of the valve body 32 in the up-and-down direction in the range of 0% to 100%. It should be noted, however, in the present embodiment, the valve opening degree corresponding to the time when the valve body 32 is at the highest position is 80%. In other words, in the check valve 1 of the present embodiment, the lower end of the valve body 32 does not rise to the position at the same height as the upper face of the pipe part 11 in the up-and-down direction. A maximum value of the valve opening degree is 80%, and the valve opening degree will

not exhibit a value larger than 80%. More specifically, when the valve body 32 has moved upward in the moving direction of the moving body 30 up to the position corresponding to the valve opening degree 80%, because the upper end part 34b of the valve shaft 34 comes into contact with the ceiling part 15 (more specifically, the upper face defining the ceiling cavity 15a), the valve shaft 34 and the valve body 32 are not able to move to a position higher than the position corresponding to the valve opening degree 80%.

[0028] While the check valve 1 is in the open state, the fluid 200 principally flows through the pipe part 11 from the primary flow path 40 toward the secondary flow path 50. More specifically, the fluid 200 flows from the primary flow path 40 into the valve cylinder 14 and flows out of the valve cylinder 14 into the secondary flow path 50.

As explained above, the flowing direction of the first main flow of the fluid 200 passing through the inside of the valve cylinder 14 from the upstream side (the primary flow path 40) toward the downstream side (the secondary flow path 50) has a larger component in the moving direction of the moving body 30 than the component in the main axis direction. The flowing direction of the first main flow denotes an average flowing direction within the first main flow.

In this situation, the first main flow denotes a primary part of the fluid 200, within the fluid 200 which, on the inside of the valve cylinder 14, flows from the primary flow path 40 and is to flow out to the secondary flow path 50. In other words, the first main flow denotes the part of the fluid 200 that flows in to the inside of the valve cylinder 14 from the primary flow path 40 and that flows out to the secondary flow path 50 without flowing backwards. In other words, the first main flow does not include the fluid 200 that flows into the valve cylinder 14 from the primary flow path 40, but flows in the direction from the secondary flow path 50 toward the primary flow path 40 in the main axis direction. More specifically, on the inside of the valve cylinder 14, a part of the fluid 200 (the part of the fluid 200 indicated in region A in FIG. 4B) flowing on the lower side in the moving direction of the moving body 30 relative to the valve body 32 may be the first main flow. In the present embodiment, in region A of FIG. 4B, a part of the fluid 200 positioned on the upstream side (the right side) relative to the valve shaft 34 has a swirling flowing direction. Meanwhile, in region A of FIG. 4B, a part of the fluid 200 (the part of the fluid 200 indicated in region B in FIG. 4B) on the downstream side (the left side) relative to the valve shaft 34 has a flowing direction toward the secondary flow path 50. Accordingly, the first main flow in the present

embodiment may be the part of the fluid 200 indicated in region B.

The first main flow that has flowed in from the primary flow path 40 to the lower end part of the valve cylinder 14 flows in such a direction (the direction toward the top left of the drawing in FIG. 4A) that the flow has a larger component in the moving direction of the moving body 30. Subsequently, the first main flow flows out to the secondary flow path 50 through the position between the valve body 32 and the valve seat 12. [0029] FIG. 5A and FIG. 5B are longitudinal cross-sectional views at a time when the check valve 1 is installed at a non-end position of a pipe and indicate distributions of velocities of the fluid 200 in the situations where the fluid 200 is caused to flow through the pipe on the upstream side of the check valve 1 at a flow velocity of 2.0 m/s and a flow velocity of 3.0 m/s, respectively. The valve opening degree in FIG. 5A is approximately 50%, whereas the valve opening degree in FIG. 5B is approximately 70%.

In the present embodiment, the larger the valve opening degree is, the larger component in the moving direction of the moving body 30 is present in the flowing direction of the first main flow. In other words, the higher the flow velocity of the fluid 200 flowing into the check valve 1 is, the larger component in the moving

direction of the moving body 30 is present in the flowing direction of the first main flow.

The larger the valve opening degree is, the more compressed the spring body 37 is. Thus, to maintain the open state of the valve body 32, it is necessary to apply, to the valve body 32, a larger force in the upward direction in the moving direction. As explained above, because the flowing direction of the first main flow has the larger component in the moving direction when the valve opening degree is larger, the open state of the valve body 32 is easily maintained. Further, when the valve opening degree is small, and the open state of the valve body 32 is maintained relatively easily, because the flowing direction of the first main flow has a larger component in the main axis direction as compared to the situation where the valve opening degree is large, it is easier for the fluid 200 to flow smoothly from the upstream side toward the downstream side.

Further, when the valve opening degree is equal to or more than 30%, the component in the moving direction of the moving body 30 present in the flowing direction of the first main flow is stably larger than the component in the main axis direction. When the valve opening degree is equal to or more than 50%, the component in the moving direction of the moving body 30 present in the flowing direction of the first main flow is more stably larger than the component in the main axis direction.

Furthermore, when the valve opening degree is equal to or more than 80%, the component in the moving direction of the moving body 30 present in the flowing direction of the first main flow is even more stably larger than the component in the main axis direction.

[0030] In the present embodiment, the feature where the flowing direction of the first main flow has a larger component in the moving direction of the moving body 30 than the component in the main axis direction is realized as a result of the check valve 1 having a flowing direction guidance unit that guides the fluid 200 so as to flow in the moving direction of the moving body 30. The flowing direction guidance unit of the present embodiment is a predetermined structure.

For example, the abovementioned flowing direction of the first main flow is realized by providing at least a part, preferably at least two or more, and more preferably at least three or more of the following structures. However, as represented by the structure in Patent Document 1 (explained later), even when at least a part of the following structures is included, if a certain structure which inhibits the first main flow from flowing in the moving direction of the moving body 30 is included, the abovementioned flowing direction of the first main flow may not be realized in some situations.

As a first structure, in the present embodiment, the valve shaft 34 extends downward from the valve body 32 in

the moving direction of the moving body 30 as described above. With this configuration, the fluid 200 having flowed in to the inside of the valve cylinder 14 from the primary flow path 40 is able to flow along the valve shaft 34 in a direction having the moving direction of the moving body. In particular, in the present embodiment, while the check valve 1 is in the open state, the valve shaft 34 extends from the valve body 32 in the moving direction of the moving body 30 to the lower end cylinder part 16a and the ring part 18c. With this configuration, the fluid 200 is able to easily have a flowing direction along the valve shaft 34 regardless of the valve opening degree.

As a second structure, in the present embodiment, while the check valve 1 is in the closed state, the lower end part 34a of the valve shaft 34 protrudes to the lower side relative to the ring part 18c in the moving direction of the moving body 30. In other words, while the check valve 1 is in the closed state, the lower end part 34a of the valve shaft 34 is disposed on the upstream side in the main axis direction relative to the ring part 18c. With this configuration, it is possible to urge the flowing direction of the fluid 200 having arrived from the upstream side to change into the direction along the moving direction of the moving body 30. In particular, in the present embodiment, the lowermost end of the valve shaft 34 in the closed state

of the check valve 1 is disposed on the lower side in the longitudinal direction relative to the peak of the protruding part 11e. Furthermore, in the present embodiment, as explained in detail separately, the closer the lower end part 34a of the valve shaft 34 gets to the bottom face of the pipe wall part 19a, the longer the lower end part 34a of the valve shaft 34 extends downward from the ring part 18c in the moving direction. With this configuration, the fluid 200 is able to change the flowing direction thereof into the direction along the moving direction of the moving body 30 in a more excellent manner.

As a third structure, in the present embodiment, as explained later, the width direction of one of the support parts 18 (in particular, the support part 18 being a part of the second support parts 18b disposed on the lower side relative to the valve shaft 34) has a component in the moving direction. Thus, the flowing direction of the fluid 200 having passed through the vicinity of the support part 18 changes, so that the fluid 200 is able to flow in the predetermined direction.

As a fourth structure, as explained in detail separately, the start point of an upward slope 11c is positioned on the downstream side relative to the lowermost end of the lower end cylinder part 16a or the ring part 18c. With this configuration, the fluid 200 having arrived from the upstream side collides, on the

downstream side relative to the lowermost end or the ring part 18c, with the upward slope 11c. That is to say, the fluid 200 flows in to the inside of the valve cylinder 14 from the primary flow path 40, principally past the lowermost end or the ring part 18c. In other words, the flowing direction of the fluid 200 flowing in the main axis direction changes more drastically as compared to the situation in which the start point of the upward slope 11c were positioned on the upstream side relative to the lowermost end or the ring part 18c. In other words, the fluid 200 flowing in the main axis direction is able to change the flowing direction thereof into a direction having a larger component in the moving direction of the moving body 30, as compared to the situation in which the start point of the upward slope 11c were positioned on the upstream side relative to the lowermost end or the ring part 18c.

As a fifth structure, as explained later, the lengthwise direction of one of the support parts 18 (in particular, the support part 18 being a part of the second support parts 18b disposed on the lower side relative to the valve shaft 34) is a direction slightly tilted with respect to the radial direction of the valve cylinder 14. More specifically, the support part 18 is tilted in such a manner that the support part 18 is directed toward the lower side in the moving direction of the moving body 30, as the support part 18 approaches the

center of the valve cylinder 14. With this configuration, the closer a part of the fluid 200 is to the central side as seen in the main axis direction (a part of the fluid 200 having a higher flow velocity), the earlier the part of the fluid 200 comes into contact with the second support parts 18b. Accordingly, the fluid 200 is able to change the flowing direction thereof into a direction having the moving direction of the moving body 30 in a more excellent manner.

The flowing direction guidance unit is not limited to the first to the fifth structures described above set forth in the present embodiment. For example, one of the members (except for the valve shaft 34) extending in the moving direction of the moving body 30 may be disposed in the valve cylinder 14. A protruding object for changing the flowing direction of the fluid 200 such as a valve may be disposed on the primary flow path 40 or in the valve cylinder 14.

Preferably, the check valve 1 may have the third structure and the fifth structure described above. More preferably, the check valve 1 may have the second structure in addition to the third structure and the fifth structure described above. Alternatively, more preferably, the check valve 1 may have the fourth structure in addition to the third structure and the fifth structure described above.

As another example, preferably, the check valve 1 may have the first structure, the second structure, and the fourth structure. More preferably, the check valve 1 may have the third structure described above, in addition to the first structure, the second structure, and the fourth structure described above. In yet another example, the check valve 1 may have the fifth structure described above, in addition to the first structure, the second structure, and the fourth structure described above.

In the check valve of Patent Document 1, whether the valve opening degree is small or large, the flowing direction of the first main flow does not have a larger component in the moving direction of the moving body (the disc (16)) than in the main axis direction. More specifically, it is clearly indicated that, in the check valve of Patent Document 1, the passage of the fluid is substantially a straight line from one side to the other side of the valve (Patent Document 1, page 1, lines 90 to 100). More specifically, the check valve of Patent Document 1 does not partially have the first structure described above, and does not particularly have the second structure. In Patent Document 1, the valve body (the disc (16)) is not fixed to the valve shaft (the stem (17)), and the valve body is disposed at the lowermost end of the valve shaft in the closed state. Accordingly, the valve shaft does not extend downward from the valve

body in the closed state. Further, the check valve of Patent Document 1 does not have the third to the fifth structures described above, either. In addition, as shown in FIG. 3 of Patent Document 1, in the check valve of Patent Document 1, the width direction of a blade (21) provided for the valve seat (15) is in a direction intersecting the moving direction of the valve body (the disc (16)). With this configuration, the fluid having collided with the blade (21) is guided so as to flow in the direction intersecting the moving direction of the valve body (the disc (16)). In other words, in Patent Document 1, the first main flow does not easily flow along the moving direction of the moving body (the disc (16)), and as a result, the first main flow in Patent Document 1 linearly flows from the upstream side toward the downstream side, as described in the document.

[0031] As described above, it is preferable that, while the flowing direction of the first main flow has a large component in the moving direction of the moving body 30, the pressure loss while the fluid 200 passes through the check valve 1 is kept small.

In the present embodiment, the first main flow flows through the vicinity of the main axis. More specifically, as shown in FIG. 4A and FIG. 4B, when the valve opening degree is equal to or more than 30%, the first main flow flows so as to traverse the main axis (the axis indicated with the dot-dashed chain line in

FIG. 4A). It is possible to realize this configuration because the lower end (which is also the peak of the protruding part 11e) of the valve cylinder 14 is positioned on the bottom face side in the longitudinal direction relative to the main axis, and the valve body 32 is positioned on the top face side in the longitudinal direction relative to the main axis. Because the first main flow flows through the vicinity of the main axis, the pressure loss caused before and after flowing through the check valve 1 is kept small.

[0032] Further, in the present embodiment, a certain part (the region in the right half of region B) of the fluid 200 in the first main flow being close to the valve shaft 34 flows in a direction having a large upward component. Another part (the region in the left half of region B) of the fluid 200 in the first main flow being closer to the secondary flow path 50 than the certain part flows in a direction having a large leftward component. More specifically, the flowing direction of the fluid in the certain part (the region on the upstream side (the right side) in region B) of the first main flow being close to the valve shaft 34 has a larger component in the moving direction than the flowing direction of the fluid 200 in the other part (the region on the downstream side (the left side) in region B) of the first main flow being closer to the secondary flow path 50 than the certain part.

Further, in the present embodiment, the flow velocity of the fluid 200 in the certain part (the region in the right half of region B) of the first main flow being close to the valve shaft 34 is lower than the flow velocity of the fluid 200 in the other part (the region in the left half of region B) of the first main flow being closer to the secondary flow path 50 than the certain part. In other words, the part on the valve shaft 34 side flowing toward the moving direction of the moving body 30, in particular, has a relatively low flow velocity. The part separated from the valve shaft 34 flowing toward the main axis direction, in particular, has a relatively high flow velocity. As a result, the fluid 200 is able to flow principally in the main axis direction from the upstream side toward the downstream side, while pushing up the valve body 32 upward in the moving direction of the moving body 30. With this configuration, it is possible to keep small the pressure loss caused before and after flowing through the check valve 1.

[0033] In the present embodiment, as described above, the maximum value of the valve opening degree is 80%. In other words, the position of the lower end of the valve body 32 when the check valve 1 has the largest opening is a position lower than the position of the upper face of the pipe part 11 in the up-and-down direction. When the fluid 200 flows in to the inside of the valve cylinder 14

from the primary flow path 40, a part of the fluid 200 flows in the moving direction of the moving body 30. Because the lower end of the valve body 32 is positioned lower than the position of the upper face of the pipe part 11, the fluid 200 having flowed in to the inside of the valve cylinder 14 collides with the valve body 32 at a position lower than the upper face of the pipe part 11. As a result, the fluid 200 changes the flowing direction thereof at a position lower than the upper face of the pipe part 11, and the fluid 200 after the collision is able to flow through a substantially central part of the pipe part 11 along the main axis direction. In this manner, because the fluid 200 having flowed in to the inside of the valve cylinder 14 flows out to the substantially central part which is not easily impacted by friction with the inner wall of the pipe part 11, the fluid 200 is able to pass through the check valve 1 with small pressure loss.

[0034] In the present embodiment, as shown particularly in FIG. 5A, a second main flow (a main flow of the fluid 200 in region C of FIG. 5A) of the fluid that flows out from the valve cylinder 14 into the secondary flow path 50 flows toward a direction obliquely tilted toward the bottom face of the check valve with respect to the main axis direction. In other words, the second main flow flows obliquely downward with respect to the main axis direction. As a result, because the second main flow

flows along the downward slope of a downstream side flow path, it is possible to inhibit a turbulent flow (a flow of the fluid that splashes back on the downward slope) in the vicinity of the downward slope.

Of the fluid 200 flowing out from the inside of the valve cylinder 14 into the secondary flow path 50, the second main flow denotes a primary part of the fluid 200.

In the present embodiment, the flowing direction of the second main flow has a component in the main axis direction and a component in the up-and-down direction. In the present embodiment, the flowing direction of the second main flow has a larger component in the main axis direction than a component in the up-and-down direction.

In the present embodiment, the smaller the valve opening degree is, the larger is a downward direction component present in the second main flow. More specifically, as shown in FIG. 5B, even when the valve opening degree is approximately 70%, the flowing direction of the second main flow has a downward direction component, similarly to the situation shown in FIG. 5A.

[0035] The second main flow has a width in longitudinal directions. The longitudinal directions denote, while using the main axis direction as a reference, directions toward the top face side (the upper side) being the side provided with the valve cylinder 14 in the valve casing 10 and toward the bottom face side (the lower side) which

is the opposite side of the top face side. In other words, the longitudinal directions correspond to the up-and-down directions of the present embodiment.

In the present embodiment, of the second main flow, the flow velocity in a lower flow region positioned on the bottom face side relative to the center in the longitudinal direction is higher than the flow velocity in an upper flow region on the top face side relative to the center. With this configuration, as described above, even when the direction of the fluid flowing out of the valve cylinder (the flowing direction of the second main flow) is obliquely downward, because the flow velocity of the lower flow region is higher, the flowing direction of the main flow of the fluid 200 easily returns to a horizontal direction naturally. This type of distribution of the flow velocity may be realized by an amount of protrusion of the protruding part 11e (see FIG. 2) in the valve casing 10 as explained later or may be realized by other structures. For example, the abovementioned distribution of the flow velocity may be realized by the position of the valve shaft 34 or the lower end cylinder part 16a.

More specifically, an average flow velocity in the lower half region (the lower flow region) of region C indicated in FIG. 4B is higher than an average flow velocity in the upper half region (the upper flow region) of region C. More specifically, in region C, the region

having higher flow velocity (the region having a flow velocity equal to or higher than 6.5 m/s; region D) is distributed unevenly in the lower half of region C.

[0036] In the present embodiment, the bottom face of the pipe part 11 protrudes toward the top face side (upward) in the longitudinal direction. More specifically, on the bottom face of the pipe part 11, a part including the valve seat 12 protrudes upward. Even more specifically, the bottom face of the pipe part 11 includes an upward slope 11c and a downward slope 11d. The upward slope 11c is a partial bottom face extending as being tilted obliquely upward from the upstream side toward the valve seat 12 on the primary flow path 40 side. The downward slope 11d is a partial bottom face extending as being tilted obliquely downward from the valve seat 12 toward the downstream side on the secondary flow path 50 side. The part of the bottom face of the pipe part 11 protruding upward will be referred to as the protruding part 11e. The protruding part 11e may also be considered as a mountain-shaped part formed by the upward slope 11c and the downward slope 11d on a longitudinal cross-sectional plane of the check valve 1. In the present embodiment, the peak part of the protruding part 11e or the vicinity thereof is also a part of the valve seat 12.

In the present embodiment, the peak of the protruding part 11e is positioned on the bottom face side

in the longitudinal direction of the pipe part 11 relative to the main axis.

In the present embodiment, as shown in FIG. 2, a part (one or both of the ring part 18c and the lower end cylinder part 16a) supporting the lower end part of the valve shaft 34 within the valve casing 10 is positioned on the top face side (the upper side in the up-and-down direction) in the longitudinal direction relative to the protruding part 11e. In other words, the part is positioned on the upper side relative to a lower end part (a part of the ring-shaped valve seat on the lower side in the up-and-down direction) of the valve seat 12. That is to say, as seen in the main axis direction (the front-rear direction), at least a part of the ring part 18c or the lower end cylinder part 16a is disposed inside the annular-shaped valve seat 12. With this configuration, when the fluid 200 moves from the primary flow path 40 to the secondary flow path 50, the part does not easily obstruct the moving. Further, because there is little obstruction as stated above, the flow velocity in the lower flow region of the second main flow does not easily get reduced. In other words, the flow velocity in the lower flow region of the second main flow easily increases.

[0037] In the present embodiment, the extending direction of the upward slope 11c as seen from the width direction (the left-right direction) of the check valve 1 has a

larger component in the main axis direction than a component in the longitudinal direction. In other words, the upward slope 11c is a gradual upward slope. In this manner, because the upward slope 11c extends along the main axis direction, the amount of protrusion of the protruding part 11e is kept small, which keeps the inside diameter of the valve seat 12 large and makes the moving of the fluid 200 smoother. In this situation, when the upward slope 11c has a curved surface, the extending direction of the upward slope 11c as seen from the left-right direction denotes a direction connecting, with a straight line, the start point of the upward slope 11c (the lowermost part of the upward slope 11c, which is also the part of the upward slope 11c positioned on the most upstream side) and the peak of the upward slope 11c (the uppermost part of the upward slope 11c, which is also the part of the upward slope 11c positioned on the most downstream side).

Further, in the present embodiment, the start point of the upward slope 11c is positioned on the downstream side in the main axis direction relative to at least a part of a certain part (the ring part 18c or the lower end cylinder part 16a) supporting the lower end part 34a of the valve shaft 34 within the valve casing 10. With this configuration, the moving of the fluid 200 guided by the upward slope 11c upward in the moving direction of

the moving body 30 does not easily get obstructed by the ring part 18c or the lower end cylinder part 16a.

Further, in the present embodiment, the peak (a boundary part between the upward slope 11c and the downward slope 11d) of the protruding part 11e is positioned on the downstream side relative to the lower end cylinder part 16a in the main axis direction. More specifically, the peak of the protruding part 11e is positioned on the downstream side relative to the entire lower end cylinder part 16a in the main axis direction. With this configuration, the moving of the fluid 200 guided by the upward slope 11c upward in the moving direction of the moving body 30 does not easily get obstructed by the lower end cylinder part 16a.

[0038] As shown in FIG. 2, in the present embodiment, the upper face (the wall part 19 on the top face side in the longitudinal direction) of the pipe part 11 defining the primary flow path 40 has a second protruding part 11f protruding toward the bottom face side (downward). In the present embodiment, the peak part of the second protruding part 11f or the vicinity thereof is also a part of the valve seat 12. The surface of the second protruding part 11f includes a sloped surface 11g tilted downward from the upstream side to the downstream side. In the present embodiment, the extending direction of the sloped surface 11g as seen from the width direction of the check valve 1 includes a larger component in the main

axis direction than a component in the longitudinal direction. Because the sloped surface 11g extends along the main axis direction in this manner, the amount of protrusion of the second protruding part 11f is kept small, which keeps the inside diameter of the valve seat 12 large and makes the moving of the fluid 200 smoother.

Further, in the present embodiment, the peak (a part of the second protruding part 11f protruding most downwardly) of the second protruding part 11f is positioned on the upstream side in the main axis direction relative to at least a part of the certain part (the ring part 18c or the lower end cylinder part 16a) supporting the lower end part 34a of the valve shaft 34 within the valve casing 10.

Further, in the present embodiment, the peak of the second protruding part 11f is positioned on the top face side in the longitudinal direction relative to the certain part (the ring part 18c or the lower end cylinder part 16a) supporting the lower end part 34a of the valve shaft 34 within the valve casing 10. More specifically, the peak of the second protruding part 11f is positioned on the top face side in the longitudinal direction relative to the entire ring part 18c or the entire lower end cylinder part 16a.

[0039] As explained above, the lower end part of the valve shaft 34 is supported by support parts 18. As shown in FIG. 6, in the present embodiment, the support

parts 18 include first support parts 18a and second support parts 18b. The first support parts 18a and the second support parts 18b each extend from the ring part 18c along the radial direction of the valve cylinder 14 toward the wall part 19 of the valve cylinder 14.

In the present embodiment, the first support parts 18a extend along the width direction of the check valve 1 and extend orthogonal to the moving direction. Meanwhile, as shown in FIG. 2, the second support parts 18b extend along the longitudinal direction (the up-and-down direction) and extend toward the lower end part 34a of the valve shaft 34 while being tilted in the direction toward the bottom face side of the check valve 1 (toward the bottom right of the drawing) in the moving direction of the moving body 30, with respect to the direction (the radial direction of the valve cylinder 14) orthogonal to the moving direction of the moving body 30. In this situation, the second support parts 18b extending along the up-down direction denotes that the extending direction of the second support parts 18b has a component in the up-and-down direction. The second support parts 18b being tilted in the direction toward the bottom face side of the check valve 1 in the moving direction of the moving body 30 with respect to the radial direction of the valve cylinder 14, toward the lower end part 34a of the valve shaft 34 denotes that the second support parts 18b extend in the direction tilted with respect to the

radial direction of the valve cylinder 14 and that the second support parts 18b are tilted with respect to the radial direction in such a manner that the second support parts 18b become closer to the lower side in the moving direction of the moving body 30 as the second support parts 18b approach the lower end part 34a.

With this configuration, it is possible to prevent the valve shaft 34 or the valve body 32 and the like from being damaged as a result of the fluid 200 colliding with the valve shaft 34 or the valve body 32 and the like, while firmly holding the valve shaft 34. More specifically, first of all, because the first support parts 18a extending in the horizontal direction are positioned orthogonal to the valve shaft 34, it is possible to allow the support parts 18 to sufficiently exert the function of firmly supporting the lower end part 34a of the valve shaft 34. In addition, because one end of each of the second support parts 18b positioned on the central side of the flow path is positioned so as to protrude toward the upstream side, the fluid 200 at the flow path center having the fastest flow is slowed down by the second support parts 18b as a result of colliding with the one ends of the second support parts 18b. It is therefore possible to prevent the fluid 200 from rapidly flowing into the valve cylinder 14.

[0040] In the present embodiment, the support parts 18 each have a plate-like shape. More specifically, the

plate-like support parts 18 extend in the lengthwise direction and the width direction as explained later. The support parts 18 are each a long member in a predetermined direction, and the predetermined direction is the lengthwise direction. The lengthwise direction of the support parts 18 coincides with the direction in which the support parts 18 extend from the wall part 19 to the lower end part 34a. The width direction denotes the direction orthogonal to the plate thickness direction and the lengthwise direction.

FIG. 2 indicates the exterior shape of a cross-section of the first support parts 18a with a dotted line. In the present embodiment, the width direction of the first support parts 18a extends along the main axis direction (the front-rear direction). Further, the width direction of the second support parts 18b extends along the moving direction. In this situation, the width direction of the support parts 18 extending along a predetermined direction denotes that the width direction has a component in the predetermined direction. More specifically, the width direction of the support parts 18 has a larger component in the predetermined direction than a component in the direction orthogonal to the predetermined direction.

With the above configuration, it is possible to guide, with the second support parts 18b, the fluid 200 upward in the moving direction of the valve body 32,

while guiding, with the first support parts 18a, the fluid 200 along the main axis direction from the upstream side toward the downstream side. In other words, it is possible to maintain the flowing direction so that the valve body 32 is able to easily continue to keep the open state moderately, while suppressing pressure loss.

[0041] In the present embodiment, as shown in FIG. 6, the thickness direction of the first support parts 18a corresponds to the longitudinal direction (the up-and-down direction), whereas the thickness direction of the second support parts 18b corresponds to the width direction (the left-right direction) of the check valve 1. With this configuration, it is possible to keep the area of the support parts 18 small as seen from the rear. As a result, the moving of the fluid 200 flowing in from the upstream side does not easily get obstructed by the support parts 18.

[0042] In the present embodiment, as shown in FIG. 7A, groove parts 16d each extending in the moving direction of the moving body 30 (the up-and-down direction in the drawing) may be formed in a part (a region of a cylinder part inner wall 16c facing the top face side) of the inner wall (the cylinder part inner wall 16c) of the cylinder part 16 (the lower end cylinder part 16a) positioned on the bottom face side of the check valve 1. With the groove parts 16d formed in this manner, the

valve shaft 34 is able to slide straight without twisting in the moving direction of the valve body 32.

In the present embodiment, two groove parts 16d are formed in the cylinder part inner wall 16c; however, a single groove part 16d may be formed or three or more groove parts 16d may be formed in the cylinder part inner wall 16c. Further, in the present embodiment, the groove parts 16d are formed only in a part on the lower end side of the cylinder part inner wall 16c and are not formed in a part on the upper end side of the cylinder part inner wall 16c. Alternatively, the groove parts 16d may extend from the upper end to the lower end of the cylinder part inner wall 16c.

In the present embodiment, as shown in FIG. 7B, the surface (the outer circumferential surface) of the lower end part 34a has formed groove parts 34c each extending in the moving direction (the up-and-down direction in the drawing) of the moving body 30.

It is acceptable to form both the groove parts 16d in the cylinder part inner wall 16c and the groove parts 34c on the surface of the lower end part 34a. Alternatively, it is also acceptable not to form the groove parts 16d in the cylinder part inner wall 16c, while having the groove parts 34c formed on the surface of the lower end part 34a. In the present embodiment, the groove parts 34c are formed only in a part of the surface of the lower end part 34a positioned on the lower

end side and are not formed in a part of the surface on the upper end side.

Further, similarly to the groove parts 16d formed in the lower end cylinder part 16a, a groove part (not shown in the drawings) extending in the moving direction of the moving body 30 may be formed in a part of the inner wall of the upper end cylinder part 16b positioned on the bottom face side of the check valve 1.

Similarly to the groove parts 34c formed on the surface of the lower end part 34a, a groove part (not shown in the drawings) extending in the moving direction of the moving body 30 may also be formed on the surface (the outer circumferential surface) of the upper end part 34b of the valve shaft 34.

[0043] In the present embodiment, as shown in FIG. 8A and FIG. 8B, the seal part 36 has a seal recessed part 36a formed in a central part of a lower face 36b facing the bottom face side of the check valve 1. The seal recessed part 36a denotes a recessed part being recessed toward the inside of the seal part 36 relative to an outer circumferential part of the lower face 36b of the seal part 36. The depth dimension D1 of a part of the seal recessed part 36a on the bottom face side may be larger than the depth dimension of another part. For example, the depth dimension D1 may be larger than a depth dimension D2 of a part of the seal recessed part 36a on the ceiling side. As another example, the depth

dimension D1 may be larger than the depth dimension of a part of the seal recessed part 36a on the right side or the left side. In FIG. 8A and FIG. 8B, the magnitude relationship among the depth of the seal recessed part 36a, the depth dimension D1, and the depth dimension D2 is illustrated in an exaggerated manner. The depth of the seal recessed part 36a or the difference between the depth dimension D1 and the depth dimension D2 may be smaller than those illustrated in FIG. 8A or FIG. 8B.

Because the seal recessed part 36a is formed in the seal part 36, and the seal recessed part 36a in the part on the bottom face side is formed to be deeper, it is possible to prevent, in an excellent manner, the situation where the seal part 36 and the second grip part 39 are brought out of alignment by the fluid 200 flowing out from the valve cylinder 14 at a high velocity.

In the present embodiment, as seen in the moving direction of the moving body 30, the seal recessed part 36a is formed so as to surround the valve shaft 34. As an alternative to the present embodiment, the seal recessed part 36a may be formed only in a region on the lower side (the bottom face side) of the lower face 36b as seen in the moving direction of the moving body 30.

[0044] <Second Embodiment>

FIG. 9 is a perspective view showing an example of the check valve 1 according to the present embodiment. Further, FIG. 12 to FIG. 13B express distributions of

velocities of the fluid 200 in the situations where the check valve 1 is installed at a non-end position of a pipe, and the fluid 200 is caused to flow through a pipe on the upstream side of the check valve 1 at a flow velocity of 4.0 m/s, 2.0 m/s, and 3.0 m/s, respectively.

To begin with, an outline of the check valve 1 of the present embodiment will be explained.

In the present embodiment, as shown in FIG. 12, the flowing direction of the first main flow (in the present embodiment, the main flow of the fluid shown in region B of FIG. 12) of the fluid 200 passing through the inside of the valve cylinder 14 from the upstream side toward the downstream side has a larger component in the moving direction of the moving body 30 than a component in the main axis direction.

[0045] Next, the check valve 1 of the present embodiment will be explained in detail.

The check valve 1 of the present embodiment is different from the first embodiment for the structure of the valve casing 10 supporting the lower end part 34a of the valve shaft 34.

[0046] In the present embodiment, as a result of the check valve 1 having the following structure in particular, the flowing direction of the first main flow of the fluid 200 has a larger component in the moving direction of the moving body 30 than a component in the main axis direction.

In a first example, in the present embodiment, the valve shaft 34 extends from the valve body 32 downward in the moving direction of the moving body 30. Further, while the check valve 1 is in the closed state, the lower end part 34a of the valve shaft 34 protrudes to the lower side relative to the ring part 18c in the moving direction of the moving body 30. In addition, the width direction of one of the support parts 18 (in particular, the support part 18e disposed on the lower side relative to the valve shaft 34) has a component in the moving direction. Further, the start point of the upward slope 11c is positioned on the downstream side relative to the lowermost end of the lower end cylinder part 16a or the ring part 18c.

[0047] First of all, in the present embodiment, as shown in FIG. 10 and FIG. 14, the lower end cylinder part 16a is supported by two support parts 18. More specifically, the two support parts 18 (the upper support part 18d and the lower support part 18e) extend from the ring part 18c linked to the lower end cylinder part 16a, in each of the up-and-down directions. In the present embodiment, the support parts 18 are not disposed on either side of the ring part 18c in the width direction (the left-right direction) of the check valve 1, and the fluid 200 is able to pass through the regions on either side.

More specifically, the upper support part 18d protrudes from the upper face (the second protruding part

11f having the valve seat 12 formed) of the pipe part 11 toward the ring part 18c. Also, the lower support part 18e protrudes from a non-end part of the upward slope 11c in the main axis direction toward the ring part 18c. In other words, the lower support part 18e protrudes toward the ring part 18c from a position on the upward slope 11c that is on the upstream side relative to the peak part of the protruding part 11e.

[0048] As shown in FIG. 10 or FIG. 11, similarly to the first embodiment, the upper support part 18d and the lower support part 18e each have a plate-like shape. The thickness direction of the upper support part 18d and the lower support part 18e corresponds to the left-right direction. The lengthwise direction of the lower support part 18e corresponds to a direction (the radial direction of the valve cylinder 14) orthogonal to the moving direction of the moving body 30. In contrast, the lengthwise direction of the upper support part 18d is tilted with respect to the radial direction of the valve cylinder 14. More specifically, toward the lower end part of the valve shaft 34, the lengthwise direction of the upper support part 18d is tilted with respect to the radial direction of the valve cylinder 14 in the direction toward the lower side in the moving direction of the moving body 30.

[0049] In the present embodiment, the peak (a part of the valve seat 12 on the bottom face side in the longitudinal

direction) of the protruding part 11e is not disposed on the lower side relative to a part (the ring part 18c, or the like) of the valve casing 10 supporting the lower end part 34a of the valve shaft 34. More specifically, the peak of the protruding part 11e is disposed on the upper side in the longitudinal direction relative to a part of the ring part 18c.

[0050] In the present embodiment, the face (the lower face of the valve body 32 which, at the second grip part 39, faces the lower side in the moving direction of the moving body 30) of the valve body 32 facing the upstream side is a flat surface expanding in the radial direction of the valve cylinder 14. In the present embodiment, the second grip part 39 is formed to be hollow.

[0051] The check valve 1 of the present embodiment has the following features similarly to the first embodiment.

The second main flow of the fluid 200 flowing out from the valve cylinder 14 into the secondary flow path 50 flows toward the direction obliquely tilted with respect to the main axis direction toward the bottom face of the check valve 1.

Of the second main flow, the flow velocity in a lower flow region on the bottom face side relative to the center in the longitudinal direction is higher than the flow velocity in an upper flow region on the top face side relative to the center.

Further, both of the end parts (the upper end part 34b and the lower end part 34a) of the valve shaft 34 are supported by the wall parts 19 of the valve casing 10.

The width direction of the support parts 18 (the upper support part 18d and the lower support part 18e) in the present embodiment extends along the moving direction of the moving body 30.

Further, a part of the inner wall of the lower end cylinder part 16a positioned on the bottom face side of the check valve 1 has formed the groove parts 16d extending in the moving direction of the moving body 30.

In addition, in the central part of the lower face 36b of the seal part 36, the seal recessed part 36a is formed. The depth dimension of the part of the seal recessed part 36a positioned on the bottom face side is larger than the depth dimension of another part.

[0052] The present invention is not limited to the embodiments described above and includes various modes of modifications, improvements, and the like as long as the purpose of the present invention is achieved.

The following modification examples may be combined as appropriate.

[0053] The above embodiments include the following technical concepts:

(1) A check valve of a straight pipe joint type and of an oblique lift type in which a fluid flows from an upstream side to a downstream side, the check valve comprising:

a valve seat;

a moving body capable of linearly reciprocating between a closed state of being in close contact with the valve seat and an open state of being separated from the valve seat;

a valve casing to which the valve seat is fixed, the valve casing including a valve cylinder extending in a moving direction of the moving body, in which the moving body moves;

a primary flow path positioned on the upstream side relative to the valve cylinder and using a main axis direction being a straight line as an axis; and

a secondary flow path positioned on the downstream side relative to the valve cylinder and using the main axis direction as an axis, wherein

a flowing direction of a first main flow of the fluid passing through the inside of the valve cylinder from the upstream side toward the downstream side has a larger component in the moving direction of the moving body than a component in the main axis direction.

(1-1) The check valve according to (1) in which the flowing direction of a certain part of the fluid in the first main flow being close to the valve shaft has a larger component in the moving direction than the flowing direction of another part of the fluid in the first main flow being closer to the secondary flow path than the certain part.

(1-2) The check valve according to (1-1) in which the flow velocity of the certain part of the fluid in the first main flow being close to the valve shaft is lower than the flow velocity of said another part of the fluid in the first main flow being closer to the secondary flow path 50 than the certain part.

(2) The check valve according to (1), wherein a second main flow of the fluid flowing out from the valve cylinder into the secondary flow path flows toward a direction obliquely tilted toward a bottom face of the check valve with respect to the main axis direction.

(2-1) The check valve according to (2) in which the smaller the valve opening degree is, the larger component in a direction connecting the top face side to the bottom face side of the check valve is present in the second main flow.

(3) The check valve according to (2), wherein the second main flow has a width in a longitudinal direction oriented toward a top face side and a bottom face side, the top face side being a side on which the valve cylinder is provided in the valve casing while the main axis direction is used as a reference, and the bottom face side being an opposite side of the top face side, and

as for the second main flow, a flow velocity in a lower flow region on the bottom face side relative to a center of the longitudinal direction is higher than a

flow velocity in an upper flow region on the top face side relative to the center.

(4) The check valve according to any one of (1) to (3), wherein

the moving body includes a valve body supported by the valve seat in the closed state; and a valve shaft extending from the valve body to both sides in the moving direction, and

both of end parts of the valve shaft are supported by a wall part of the valve casing.

(5) The check valve according to (4), wherein

a lower end part of the valve shaft being an end part positioned on the bottom face side of the check valve is supported by two or more support parts each protruding from the wall part of the valve casing and extending toward the lower end part,

a first one of the support parts extends along a width direction of the check valve and is orthogonal to the moving direction,

a second one of the support parts extends along a longitudinal direction oriented toward a top face side and a bottom face side, the top face side being a side on which the valve cylinder is provided in the valve casing while the main axis direction is used as a reference, and the bottom face side being an opposite side of the top face side, and

toward the lower end part, the second one of the support parts is tilted in a direction toward the bottom face side of the check valve in the moving direction, with respect to a direction orthogonal to the moving direction.

(6) The check valve according to (5), wherein

the support parts each have a plate-like shape,

the support parts extend in a lengthwise direction extending from the wall part to the lower end part and in a width direction orthogonal to a plate thickness direction and the lengthwise direction,

the width direction of the first one of the support parts extends along the main axis direction, and

the width direction of the second one of the support parts extends along the moving direction.

(6-1) The check valve according to (6) in which the thickness direction of the first support part is the longitudinal direction, whereas the thickness direction of the second support part is the width direction of the check valve.

(7) The check valve according to any one of (4) to (6), wherein

a lower end part of the valve shaft being an end part positioned on the bottom face side of the check valve is inserted in a cylinder part fixed to the wall part of the valve casing, and

a groove part extending in the moving direction is formed in a part of an inner wall of the cylinder part positioned on the bottom face side of the check valve.

(7-1) The check valve according to (7) in which the groove part extending in the moving direction of the moving body is formed on the outer circumferential surface of the lower end part.

(8) The check valve according to any one of (4) to (7), wherein

the valve body includes:

a seal part being in close contact with the valve seat in the closed state;

a first grip part disposed at a certain part of the seal part corresponding to the top face side of the valve cylinder,

a second grip part disposed at a certain part of the seal part corresponding to the bottom face side of the check valve, wherein

the seal part is sandwiched between the first grip part and the second grip part in the moving direction,

in a central part of a lower face of the seal part facing toward the bottom face side of the check valve, a seal recessed part is formed so as to be recessed toward an inside of the seal part relative to an outer circumferential part of the lower face, and

a depth dimension of a part of the seal recessed part positioned on the bottom face side is larger than a depth dimension of another part.

(9) The check valve according to any one of (4) to (8) in which the upper end part of the valve shaft being the end part on the top face side of the check valve is inserted in the upper end cylinder part fixed to the ceiling part of the valve casing, and

while the check valve is in the closed state, the separation distance in the moving direction between the lower end part of the valve shaft and the pipe wall part defining the pipe part extending in the main axis direction is shorter than the insertion depth of the upper end part of the valve shaft into the upper end cylinder part.

(10) The check valve according to any one of (4) to (9) in which, while the check valve is in the open state, the inserting depth of the lower end part of the valve shaft into the lower end cylinder part is greater than the separation distance between the lower end part of the valve shaft in the closed state of the check valve and the pipe wall part defining the pipe part extending in the main axis direction.

(11) The check valve according to any one of (1) to (10) in which the larger the valve opening degree is, the larger component in the moving direction of the moving

body is present in the flowing direction of the first main flow.

(12) The check valve according to any one of (1) to (11) in which the higher the flow velocity of the fluid flowing into the check valve is, the larger component in the moving direction of the moving body is present in the flowing direction of the first main flow.

(13) The check valve according to any one of (4) to (10) citing (3) in which the valve casing has the pipe part extending in the main axis direction,

the bottom face of the pipe part includes the protruding part protruding toward the top face side in the longitudinal direction, and

a part of the valve casing supporting the lower end part of the valve shaft is disposed on the top face side in the longitudinal direction relative to the protruding part.

(14) The check valve according to any one of (4) to (10) in which the valve casing has the pipe part extending in the main axis direction,

the bottom face of the pipe part includes the upward slope tilted upward toward the top face side in the longitudinal direction, from the upstream side toward the downstream side, and

the start point of the upward slope is positioned on the downstream side in the main axis direction relative to at least a part of the certain part of the valve

casing supporting the lower end part of the valve cylinder.

(15) The check valve according to (13) in which the peak of the protruding part is positioned on the downstream side in the main axis direction relative to the lower end cylinder part.

(16) The check valve according to any one of (4) to (10) in which the valve casing has the pipe part extending in the main axis direction,

as for the pipe part defining the primary flow path 40, a part of the pipe part positioned on the top face side includes the second protruding part protruding toward the bottom face side in the longitudinal direction, and

the peak of the second protruding part is positioned on the upstream side in the main axis direction relative to at least a part of the certain part of the valve casing supporting the lower end part of the valve shaft.

(17) The check valve according to (1) in which the valve shaft extends from the valve body toward the bottom face side of the check valve in the moving direction.

(18) The check valve according to (1) or (17) in which, while the check valve is in the closed state, the lower end part of the valve shaft protrudes to the lower side relative to the ring part in the moving direction of the moving body.

(19) The check valve according to any one of (1), (17), and (18) in which the width direction of one of the support parts has a component in the moving direction.
(20) The check valve according to any one of (1), (17), (18), and (19) in which the start point of the upward slope in the pipe wall part is positioned on the downstream side relative to the one end of the lower end cylinder part positioned on the downstream side or the ring part.
(21) The check valve according to any one of (1), (17), (18), (19), and (20) in which one of the support parts is tilted toward the bottom face side of the check valve in the moving direction of the moving body, as the support part approaches the center of the valve cylinder.
(22) The check valve according to (4) in which the valve shaft extends from the valve body toward the bottom face side of the check valve in the moving direction,

while the check valve is in the closed state, the lower end part of the valve shaft protrudes to the lower side relative to the ring part in the moving direction of the moving body, and

the start point of the upward slope in the pipe wall part is positioned on the downstream side relative to the one end of the lower end cylinder part positioned on the downstream side or the ring part.

(23) The check valve according to (4) in which the width direction of one of the support parts has a component in the moving direction, and

the one of the support parts is tilted toward the bottom face side of the check valve in the moving direction of the moving body, as the support part approaches the center of the valve cylinder.

(24) The check valve according to (4) in which the valve shaft extends from the valve body toward the bottom face side of the check valve in the moving direction, and

the start point of the upward slope in the pipe wall part is positioned on the downstream side relative to the one end of the lower end cylinder part positioned on the downstream side or the ring part.

(25) The check valve according to (4) in which the valve shaft extends from the valve body toward the bottom face side of the check valve in the moving direction, and

while the check valve is in the closed state, the lower end part of the valve shaft protrudes to the lower side relative to the ring part in the moving direction of the moving body.

(26) The check valve according to (4) in which the valve shaft extends from the valve body toward the bottom face side of the check valve in the moving direction,

while the check valve is in the closed state, the lower end part of the valve shaft protrudes to the lower

side relative to the ring part in the moving direction of the moving body, and

one of the support parts is tilted toward the bottom face side of the check valve in the moving direction of the moving body, as the support part approaches the center of the valve cylinder.

REFERENCE SIGNS LIST

[0054] 1: check valve

10: valve casing

11: pipe part

11a: inflow port

11b: outflow port

11c: upward slope

11d: downward slope

11e: protruding part

11f: second protruding part

11g: sloped surface

12: valve seat

14: valve cylinder

15: ceiling part

15a: ceiling cavity

15b: fastener

16: cylinder part

16a: lower end cylinder part

16b: upper end cylinder part

16c: cylinder part inner wall

16d: groove part

17: collar part

18: support part

18a: first support part

18b: second support part

18c: ring part

18d: upper support part

18e: lower support part

19: wall part

19a: pipe wall part

19b: valve cylinder wall part

30: moving body

32: valve body

34: valve shaft

34a: lower end part

34b: upper end part

34c: groove part

34d: screw reception part

35: threaded screw

36: seal part

36a: seal recessed part

36b: lower face

37: spring body

38: first grip part

38a: recessed part

38b: intra-valve-body hollow part

39: second grip part

39a: recessed part

39b: lower end hollow part

39c: hollow part

40: primary flow path

50: secondary flow path

200: fluid

CLAIMS

[Claim 1]

A check valve of a straight pipe joint type and of an oblique lift type in which a fluid flows from an upstream side to a downstream side, the check valve comprising:

a valve seat;

a moving body capable of linearly reciprocating between a closed state of being in close contact with the valve seat and an open state of being separated from the valve seat;

a valve casing to which the valve seat is fixed, the valve casing including a valve cylinder extending in a moving direction of the moving body, in which the moving body moves;

a primary flow path positioned on the upstream side relative to the valve cylinder and using a main axis direction being a straight line as an axis; and

a secondary flow path positioned on the downstream side relative to the valve cylinder and using the main axis direction as an axis, wherein

a flowing direction of a first main flow of the fluid passing through the inside of the valve cylinder from the upstream side toward the downstream side has a larger component in the moving direction of the moving body than a component in the main axis direction.

[Claim 2]

The check valve according to claim 1, wherein

a second main flow of the fluid flowing out from the valve cylinder into the secondary flow path flows toward a direction obliquely tilted toward a bottom face of the check valve with respect to the main axis direction.

[Claim 3]

The check valve according to claim 2, wherein

the second main flow has a width in a longitudinal direction oriented toward a top face side and a bottom face side, the top face side being a side on which the valve cylinder is provided in the valve casing while the main axis direction is used as a reference, and the bottom face side being an opposite side of the top face side, and

as for the second main flow, a flow velocity in a lower flow region on the bottom face side relative to a center of the longitudinal direction is higher than a flow velocity in an upper flow region on the top face side relative to the center.

[Claim 4]

The check valve according to any one of claims 1 to 3, wherein

the moving body includes a valve body supported by the valve seat in the closed state; and a valve shaft extending from the valve body to both sides in the moving direction, and

both of end parts of the valve shaft are supported by a wall part of the valve casing.

[Claim 5]

The check valve according to claim 4, wherein

a lower end part of the valve shaft being an end part positioned on the bottom face side of the check valve is supported by two or more support parts each protruding from the wall part of the valve casing and extending toward the lower end part,

a first one of the support parts extends along a width direction of the check valve and is orthogonal to the moving direction,

a second one of the support parts extends along a longitudinal direction oriented toward a top face side and a bottom face side, the top face side being a side on which the valve cylinder is provided in the valve casing while the main axis direction is used as a reference, and the bottom face side being an opposite side of the top face side, and

toward the lower end part, the second one of the support parts is tilted in a direction toward the bottom face side of the check valve in the moving direction, with respect to a direction orthogonal to the moving direction.

[Claim 6]

The check valve according to claim 5, wherein

the support parts each have a plate-like shape,

the support parts extend in a lengthwise direction extending from the wall part to the lower end part and in a width direction orthogonal to a plate thickness direction and the lengthwise direction,

the width direction of the first one of the support parts extends along the main axis direction, and

the width direction of the second one of the support parts extends along the moving direction.

[Claim 7]

The check valve according to any one of claims 4 to 6, wherein

a lower end part of the valve shaft being an end part positioned on the bottom face side of the check valve is inserted in a cylinder part fixed to the wall part of the valve casing, and

a groove part extending in the moving direction is formed in a part of an inner wall of the cylinder part positioned on the bottom face side of the check valve.

[Claim 8]

The check valve according to any one of claims 4 to 7, wherein

the valve body includes:

a seal part being in close contact with the valve seat in the closed state;

a first grip part disposed at a certain part of the seal part corresponding to the top face side of the valve cylinder;

a second grip part disposed at a certain part of the seal part corresponding to the bottom face side of the check valve, wherein

the seal part is sandwiched between the first grip part and the second grip part in the moving direction,

in a central part of a lower face of the seal part facing toward the bottom face side of the check valve, a seal recessed part is formed so as to be recessed toward an inside of the seal part relative to an outer circumferential part of the lower face, and

a depth dimension of a part of the seal recessed part positioned on the bottom face side is larger than a depth dimension of another part.