(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 001 036 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.03.2016 Bulletin 2016/13

(51) Int Cl.:
F04B 53/10 *(2006.01)* ***F16K 11/048*** *(2006.01)*

(21) Application number: **15180380.6**

(22) Date of filing: **10.08.2015**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA

(30) Priority: **20.09.2014 JP 2014192056**

(71) Applicant: **Sugino Machine Limited**
Uozu city Toyama 937-8511 (JP)

(72) Inventor: **Itou, Kouichi**
Uozo city Toyama 937-8511 (JP)

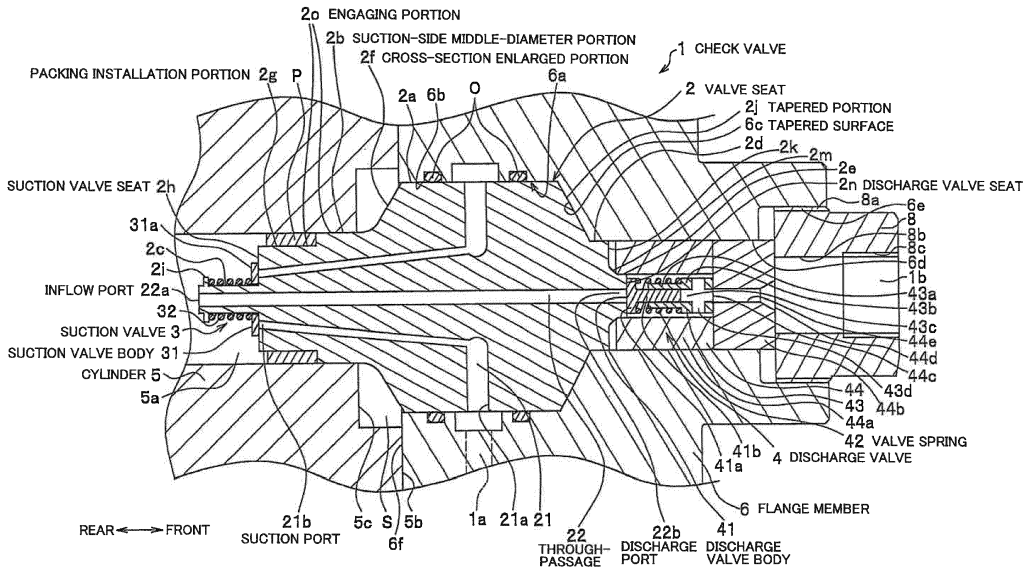
(74) Representative: **V.O.**
P.O. Box 87930
2508 DH Den Haag (NL)

(54) **FLUID COUPLING**

(57) To provide a fluid coupling that reduces the load on the main body of the fluid coupling so as to improve the durability.

A fluid coupling (1) disposed in a pressure container (5) includes: a main body (2) having a through-passage (22) that is communicated with the pressure container (5) and allows flow of fluid; and a receiving member (6) disposed in the pressure container (5) to support this main body (2). The main body (2) has: an engaging portion (2o) that is formed on one side of the through-passage (22) and is disposed to be engaged inside the pressure container (5); and a conical surface (2j) formed on another side. The receiving member (6) has: a receiving portion (6b, 6c) having a tapered surface 6c with a groove angle identical to that of the conical surface (2j); and a circulation passage (6e, 6d) communicated with the other side of the through-passage (22). The conical surface (2j) of the main body (2) abuts on the tapered surface 6c of the receiving member (6) such that the receiving member (6) supports the main body (2).

Fig. 2



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Description

BACKGROUND

1. Field of the Invention

[0001] The present invention relates to a fluid coupling usable for a check valve, in particular, to a fluid coupling appropriate for ultrahigh pressure.

2. Description of the Related Art

[0002] Conventionally, there is known, for example, a pump disclosed in Japanese Unexamined Patent Application Publication No. 2006-509171 (FIG. 2) as a non-return valve (check valve) used in an ultrahigh-pressure generating apparatus for very high pressure fluid. A non-return valve element 14 of the check valve includes, in its center portion, a flange portion whose diameter expands rapidly. The non-return valve element 14 is combined with a pump housing 35 by being sandwiched, and has a poppet 19 approximately in a cylindrical shape.

[0003] The non-return valve element constituting the conventional check valve is secured to the pump housing while its flange portion is sandwiched. Accordingly, the stress concentrates on the rapidly expanded portion of the cross-sectional surface. This stress becomes a tensile stress. Accordingly, a problem has arisen in that the conventional valve seat causes cracking starting from the stress concentration part and is likely to be damaged.

[0004] A similar problem has occurred in a fluid coupling, which couples a pipe to the pressure container, as a common problem. In particular, a high pressure container at high pressure or a high pressure container at high pressure amplitude and frequency has caused a problem where the main body of the coupling is likely to be damaged.

[0005] A suction valve or a discharge valve has caused a problem where the valve element repeats to open and close the valve and thus the valve seat surface is likely to be damaged. When the valve seat surface is once damaged so as to cause leakage of fluid from the damaged part, the leaked fluid causes wear of the valve seat surface or the valve element due to the fast flow rate of the leaked fluid. Additionally, a problem has arisen in that the leakage of the fluid causes cavitation in the upper stream of the valve so as to damage the flow passage inside the non-return valve element.

[0006] The present invention has been made in view of the above-described circumstances, and it is an object of the present invention to provide a fluid coupling that reduces the load on the main body of the fluid coupling so as to improve the durability.

SUMMARY

[0007] To solve the above-described problem, a fluid coupling according to the present invention, a fluid coupling is disposed in a pressure container. The fluid coupling includes: a main body having a through-passage that is communicated with the pressure container and allows flow of fluid; and a receiving member disposed in the pressure container to support the main body. The main body has: an engaging portion that is formed on one side of the through-passage and disposed to be engaged inside the pressure container; and a conical surface formed on another side. The receiving member has: a receiving portion having a tapered surface with a groove angle identical to a groove angle of the conical surface; and a circulation passage communicated with the other side of the through-passage. The conical surface of the main body abuts on the tapered surface of the receiving member such that the receiving member supports the main body.

[0008] According to the fluid coupling, the pressure inside the pressure container acts on the main body from one direction side, and the receiving member receives the force multiplied by the cross-sectional area of the portion inserted into the pressure container of the main body. With this configuration, in the fluid coupling, the conical surface of the main body and the tapered surface of the receiving portion have the identical groove angles. Accordingly, the force by the pressure inside the pressure container is received by the entire tapered surface of the receiving member. As its reaction, the receiving member applies the force, which is perpendicular to the conical surface of the main body and uniform, to the main body from the peripheral area toward the center portion. On the other hand, the through-passage is affected by the pressure identical to that inside the pressure container. The pressure applied to the inside of the through-passage pushes out the main body from the center to the radially outer peripheral direction. The force acting from the outer peripheral portion and the force acting from the inside cause an approximately uniform compressive stress acting on the entire main body. The fluid coupling has no portion where the cross-sectional surface of the main body expands rapidly. This reduces the occurrence of the stress concentration.

[0009] The following configuration is preferred. The main body has an enlarged diameter portion between the engaging portion and the conical surface. The enlarged diameter portion is radially enlarged relative to the engaging portion.

[0010] This configuration does not cause contact between the enlarged diameter portion and the inner surface of the pressure container. The main body receives the force obtained by a product of the pressure inside the pressure container and the cross-sectional area of the pressure container. This force acts from the tapered portion of the main body via the tapered surface of the receiving member in the direction for removing the receiving member from the pressure container, that is, to the other side. The receiving member is combined with the pressure container using a combining force larger than this force. In the case where the fluid pressure inside

the pressure container is significantly high, this combining force can be a force to the extent that can deform the main body. The enlarged diameter portion is not in contact with the inner surface of the pressure container. Accordingly, the combining force between the receiving member and the pressure container does not act on the main body. Accordingly, in the fluid coupling, only the internal stress generated by the fluid pressure acts on the main body. This improves the durability of the main body.

[0011] The following configuration is preferred. The engaging portion includes: a first cylinder portion internally fitted to an inner surface of the pressure container; a packing installation portion having a diameter smaller than a diameter of the first cylinder portion; and a packing disposed in the packing installation portion.

[0012] With this configuration, the main body can be assembled by internally fitting the first cylinder portion, which is formed on the suction port side, to the inner surface of the pressure container, so as to cause the state where the main body and the inner surface of the pressure container are coaxially disposed. In the main body, the packing installation portion, which has a diameter smaller than that of the first cylinder portion and inserted into the inner surface of the pressure container, is formed on the suction port side, so as to allow disposing the packing in the packing installation portion. Accordingly, in the center portion of the main body on the discharge side of the portion where the packing installation portion of the main body is formed, the pressure by the ultrahigh-pressure fluid internally accumulated in the pressure container is stopped by the packing so as not to act. The ultrahigh-pressure fluid inside the pressure container is blocked by the packing. The cross-sectional area in contact with the ultrahigh-pressure fluid corresponds to the outer diameter of the packing, that is, the inner diameter of the pressure container. The ultrahigh-pressure fluid does not act on the enlarged diameter portion of the main body having a cross-sectional area larger than the inner diameter of the pressure container. This allows reducing the forward force by the pressure received by the main body. This force acts on the receiving member so as to allow reducing the force for combining the receiving member.

[0013] The following configuration is preferred. The main body has a second cylinder portion in a forward end portion on the other side of the main body. The receiving member has a housing portion to which the second cylinder portion is fitted by insertion, and uses the housing portion to restrict the second cylinder portion so as to support the main body.

[0014] With this configuration, in the fluid coupling, the second cylinder portion of the main body is fitted to the housing portion of the receiving member so as to allow disposing the main body and the receiving member in accurate positions. The main body and the receiving member are accurately disposed such that the point of action of the resultant force of the forces that the main body receives from the receiving member coincides with the point of action of the force that the main body receives from the pressured fluid. In the fluid coupling, the accurate coincidence of the point of action causes the action that more uniformly distributes the compressive stress acting on the inside of the main body so as to improve the durability of the main body.

[0015] The following configuration is preferred. The pressure container is a cylinder of a piston pump. The main body has: a supply port for supplying the fluid; and a suction port on one side, for discharging the fluid supplied from the supply port into the cylinder. The through-passage has: an inflow port on the one side, for causing inflow of the fluid pressured inside the cylinder; and a discharge port on the other side, for discharging the fluid. The through-passage includes a suction valve disposed in the suction port and a discharge valve disposed in the discharge port.

[0016] With this configuration, the fluid coupling can be applied to a check valve used for the cylinder of the piston pump.

[0017] The following configuration is preferred. The main body includes: a valve seat of the suction valve formed on the one side of the main body; and a valve seat of the discharge valve formed on the other side of the main body.

[0018] With this configuration, the main body includes the valve seat. This allows forming a fluid coupling as a check valve that has a simple structure and high durability.

[0019] The following configuration is preferred. The discharge valve includes: a discharge valve element having a flat valve portion; and a discharge-valve-body guiding portion slidably supporting the discharge valve element. The suction valve includes a suction valve element having a flat valve portion; and a suction-valve-body guiding portion slidably supporting the suction valve element. The discharge valve and the suction valve have respective planar valve seat surfaces.

[0020] With this configuration, the discharge valve element is supported by the discharge-valve-body guiding portion, and the suction valve element is supported by the suction-valve-body guiding portion. Accordingly, the discharge valve element and the suction valve element stably slide to open and close the valves. The valve element is formed such that the flat valve portion has a thinned thickness to be likely to warp. This allows improving the close contact property to have close contact with the valve seat surface formed by the planar surface.

[0021] The following configuration is preferred. The flat valve portions of the suction valve element and the discharge valve element are formed having respective thicknesses equal to or more than 15% and equal to or less than 45% of outer diameters of the flat valve portions.

[0022] With this configuration, the flat valve portions of the suction valve and the discharge valve are formed by flat valves formed in thin flat plate shapes having respective thicknesses equal to or more than 15% and equal to

or less than 45% of the outer diameters of the flat valve portions, and abut on the valve seat surfaces formed by planar surfaces in the main body. The flat valve portion has a valve thickness thinner than that of a conventional valve element, and thus the valve element is likely to deform along the shape of the valve seat. This allows increasing the close contact property of the valve element to the valve seat. As a result, the flat valve portion of the valve element is in close contact with the valve seat surface. This allows preventing the leakage from the valve element also in the case where the valve seat starts to wear. Additionally, the valve seat surface becomes less likely to be damaged, so as to prolong the life of the main body.

[0023] The fluid coupling according to the present invention allows improving the durability. Accordingly, this fluid coupling can be appropriately used for, in particular, a pressure container used in a region of high pressure (350 to 700 MPa).

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Non-limiting and non-exhaustive embodiments of the present embodiments are described with reference to the following FIGURES, wherein like reference signs refer to like parts throughout the various views unless otherwise specified.

Fig. 1 is a schematic cross-sectional view illustrating one example of a check valve according to an embodiment of the present invention.

Fig. 2 is an enlarged cross-sectional view of the main part of the check valve illustrated in Fig. 1.

Fig. 3A is an enlarged cross-sectional view of the main part illustrating a closed state of the suction valve.

Fig. 3B is an enlarged cross-sectional view of the main part illustrating an open state of the suction valve.

Fig. 4A is an enlarged cross-sectional view of the main part illustrating a closed state of a discharge valve.

Fig. 4B is an enlarged cross-sectional view of the main part illustrating an open state of the discharge valve.

Fig. 5A is an enlarged cross-sectional view illustrating a suction valve element.

Fig. 5B is an enlarged cross-sectional view illustrating a discharge valve element.

DETAILED DESCRIPTION

[0025] The following describes a check valve as a fluid coupling according to an embodiment of the present invention with reference to the accompanying drawings. For convenience of explanation, in a check valve 1, one side (a suction side) where a suction valve 3 is disposed is referred to as a rear side as necessary, and another side (a discharge side) where a discharge valve 4 is disposed is referred to as a front side as necessary.

[0026] The check valve 1, which is disposed in a cylinder 5 of a piston pump as a pressure container, includes: a valve seat 2, which is a main body having a discharge flow passage 22 (a through-passage) that is communicated with the cylinder 5 and allows flow of fluid; and a flange member 6, which is a receiving member disposed in the cylinder 5 to support the valve seat 2. The valve seat 2 has: an engaging portion 2o that is formed on the rear side of the discharge flow passage 22, which is the through-passage, and is disposed to be engaged inside the cylinder 5; and a tapered portion 2j, which is a conical surface formed on the front side. The flange member 6 has: a tapered surface 6c, which is a receiving portion having an inclination as a groove angle, identical to that of the tapered portion 2j; and a discharge-valve installation portion 6d (a housing portion), which is a circulation passage communicated with the front side of the discharge flow passage 22; and a female thread portion 6e. In the flange member 6, the tapered portion 2j of the valve seat 2 abuts on the tapered surface 6c of the flange member 6 such that the flange member 6 supports the valve seat 2.

[0027] The valve seat 2 includes a large-diameter portion 2a, which is an enlarged diameter portion between the engaging portion 2o and the tapered portion 2j (the conical surface). The enlarged diameter portion is radially enlarged relative to the engaging portion 2o.

[0028] The engaging portion 2o includes : a suction-side middle-diameter portion 2b (a first cylinder portion) internally fitted to the inner surface of the cylinder 5; a packing installation portion 2g having a diameter smaller than that of the first cylinder portion; and a packing P disposed in this packing installation portion 2g.

[0029] The valve seat 2 has a discharge-side middle-diameter portion 2d, which is a second cylinder portion, in a forward end portion on its front side. The flange member 6 has the discharge-valve installation portion 6d to which the discharge-side middle-diameter portion 2d is fitted by insertion, and uses the discharge-valve installation portion 6d to restrict the discharge-side middle-diameter portion 2d so as to support the valve seat 2.

[0030] The valve seat 2 has a supply port 21a for supplying the fluid; and a suction port 21b on the rear side for, discharging the fluid supplied from the supply port 21a into the cylinder 5.

[0031] The discharge flow passage 22 (the through-passage) has: an inflow port 22a on the rear side (one side) for causing inflow of the fluid pressured inside the cylinder 5; and a discharge port 22b on the front side (the other side) for discharging the fluid. The suction valve 3 is disposed in the suction port 21b. The discharge valve 4 is disposed in the discharge port 22b.

[0032] The valve seat 2 includes: a suction valve seat 2h formed on its rear side; and a discharge valve seat 2n formed on its front side.

[0033] The discharge valve 4 includes: a discharge

valve element 41 having a flat valve portion 41a; and a discharge-valve-body guiding portion 43a slidably supporting the discharge valve element 41. The suction valve 3 includes: a suction valve element 31 having a flat valve portion 31a; and a suction-side small-diameter portion 2c, which is a suction-valve-body guiding portion slidably supporting the suction valve element 31. The discharge valve seat 2n and the suction valve seat 2h have respective planar seating surfaces.

[0034] The flat valve portions of the suction valve element 31 and the discharge valve element 41 are formed to have respective thicknesses t equal to or more than 15% and equal to or less than 45% of the outer diameters of the flat valve portions 31a and 41a.

[0035] An inlet 1a is disposed on the outer peripheral side of the flange member 6, and couples to a fluid supply unit, which supplies fluid to the check valve 1 via a control valve (not illustrated), via a pipe. An outlet 1b is communicated with a supply destination to which a high-pressure fluid is supplied.

<Main Body (Valve Seat)>

[0036] As illustrated in Fig. 2, the valve seat 2 is a member that has: a supply flow passage 21, which causes flow of the fluid from the outer peripheral portion toward the suction port 21b formed on the one side (suction side); and the discharge flow passage 22 (the through-passage), which causes flow of the fluid from the inflow port 22a toward the discharge port 22b formed on the other side (the discharge side). The valve seat 2 includes the suction valve 3, which opens and closes the suction port 21b, disposed on the rear side; and the discharge valve 4, which opens and closes the discharge port 22b, disposed on the front side.

[0037] The valve seat 2 has: the large-diameter portion 2a (the enlarged diameter portion), which is formed in the center outer peripheral portion; a cross-section enlarged portion 2f, the engaging portion 2o, and the suction-side small-diameter portion 2c, which are formed on the rear side of the large-diameter portion 2a; and the tapered portion 2j, the discharge-side middle-diameter portion 2d (the second cylinder portion) and a discharge-side small-diameter portion 2e, which are formed on the front side of the large-diameter portion 2a. The entire valve seat 2 is formed in an approximately shogi-piece shape (an approximately pear shape).

[0038] On the suction side of the valve seat 2, the cross-section enlarged portion 2f, which is formed between the large-diameter portion 2a and the suction-side middle-diameter portion 2b, the engaging portion 2o, which is formed continuously with the rear side of the cross-section enlarged portion 2f, the suction valve seat 2h, which is formed continuously with the rear side of the engaging portion 2o, and a spring receiving portion 2i, which is formed in the rear end portion of the suction-side small-diameter portion 2c, are formed.

[0039] On the discharge side of the valve seat 2, the tapered portion 2j, which is formed between the large-diameter portion 2a and the discharge-side middle-diameter portion 2d, a stepped surface 2k, which is formed continuously with the front side of the discharge-side middle-diameter portion 2d, a reduced diameter portion 2m, which is formed in the shaft-center-side base end portion of the stepped surface 2k, and the discharge valve seat 2n, which is formed on the front end surface of the discharge-side small-diameter portion 2e, are formed.

[0040] The valve seat 2 intervenes between the cylinder 5 (the pressure container) and the flange member 6 in the state where the suction-side middle-diameter portion 2b (the first cylinder portion) on the suction side is internally fitted to the inner wall of a cylinder chamber 5a while the large-diameter portion 2a, the tapered portion 2j, and the discharge-side middle-diameter portion 2d on the discharge side are internally fitted to a through-hole 6a.

[0041] The supply flow passage 21 is a flow passage for feeding the fluid supplied to the inlet 1a of the check valve 1 to the suction port 21b through the inside of the valve seat 2. The supply flow passage 21 extends from the supply port 21a, which is formed on the outer peripheral surface of the large-diameter portion 2a of the valve seat 2, toward the shaft center direction, then is folded or bent in an L-shape on the near side in the vicinity of the discharge flow passage 22, and formed along the discharge flow passage 22 toward the suction port 21b of the suction valve seat 2h.

[0042] The supply port 21a is disposed in communication with the inlet 1a of the flange member 6, and is coupled to a fluid supply source (not illustrated) by a tube and similar member via the flange member 6 and the inlet 1a.

[0043] As illustrated in Figs. 3A and 3B, the suction port 21b is disposed in an opened state in the cylinder chamber 5a inside the cylinder 5. Movement in the front-rear direction (the arrow i and j directions) of a plunger 7 (see Fig. 1) causes the suction valve element 31 to move backward and forward (in the arrow h and g directions) against the spring force of a valve spring 32 so as to open and close the valve.

[0044] As illustrated in Fig. 2, the discharge flow passage 22 (the through-passage) is a flow passage for feeding the fluid inside the cylinder chamber 5a to the discharge port 22b. The discharge flow passage 22 is formed in a straight line from the inflow port 22a in the center of the rear end portion of the valve seat 2, along the axis center line, toward the discharge port 22b in the center of the forward end portion of the valve seat 2.

[0045] The inflow port 22a is an opening portion into which the fluid pressured by the plunger 7 (see Fig. 1) inside the cylinder chamber 5a is fed, and is formed in the rear end of the suction-side small-diameter portion 2c in a cylindrical shape to be opened toward the cylinder chamber 5a inside the cylinder 5.

[0046] The discharge port 22b is an opening portion from which the fluid fed into the discharge flow passage

22 from the inflow port 22a by the plunger 7 (see Fig. 1) is discharged. The discharge port 22b is disposed in the state opened toward the space inside a valve-body housing portion 44a of a valve-body housing member 44, and is opened and closed by the discharge valve element 41. In the peripheral edge portion of the discharge port 22b, the discharge valve seat 2n of the discharge valve 4 is formed.

[0047] The large-diameter portion 2a (the enlarged diameter portion) is a cylinder portion having the largest outer diameter in the valve seat 2, and is formed in the center portion of the valve seat 2 in the axial direction. The large-diameter portion 2a is formed between the engaging portion 2o (the small-diameter portion) and the tapered portion 2j (the conical surface) to be radially enlarged relative to the engaging portion 2o. In the front-rear direction of the supply port 21a formed in the large-diameter portion 2a, a sealing member O disposed in the flange member 6 is installed in the abutting state.

[0048] The cross-section enlarged portion 2f is a portion formed in a taper shape whose cross-sectional surface is gradually radially enlarged toward the discharge-side direction from the front end of the suction-side middle-diameter portion 2b to the rear end of the large-diameter portion 2a, and is formed on the rear side of the valve seat 2. In a cross-sectional view, the cross-section enlarged portion 2f is formed such that its outer diameter does not expand or is not reduced rapidly, so as to reduce the stress concentration. Between the cross-section enlarged portion 2f and the end surface of the cylinder 5 adjacent to the rear side of the cross-section enlarged portion 2f, a clearance S is formed by disposing a cutout part 5c of the cylinder 5.

[0049] In the cross-section enlarged portion 2f, the presence of the clearance S eliminates the fastening force of fastening bolts B to the valve seat 2 from a front end surface 5b of the cylinder 5 when the flange member 6 is fastened with the fastening bolts B to a housing (not illustrated) via the valve seat 2 and the cylinder 5.

[0050] The engaging portion 2o is the portion where a part of the suction side of the valve seat 2 is inserted into the cylinder 5, and includes the suction-side middle-diameter portion 2b (the first cylinder portion), the packing installation portion 2g, and the packing P. The length of the engaging portion 2o is formed longer than the depth of the insertion of the engaging portion 2o into the cylinder 5.

[0051] The suction-side middle-diameter portion 2b is a cylindrically-shaped portion internally fitted to the inner surface of the cylinder chamber 5a, and is formed continuously with the rear side of the cross-section enlarged portion 2f.

[0052] The packing installation portion 2g is a portion on which the packing P externally fitted to the valve seat 2, and is formed continuously with a stepped shape slightly smaller than the thickness of the packing P on the rear side of the suction-side middle-diameter portion 2b. In other words, the packing installation portion 2g is formed on the front side (the suction port side) of the cylinder 5.

[0053] The valve seat 2 (the main body) can be assembled by internally fitting the suction-side middle-diameter portion 2b, which is formed on the suction port side, to the inner surface of the cylinder 5, so as to cause the state where the valve seat 2 and the inner surface of the cylinder 5 (the pressure container) are coaxially disposed. In the valve seat 2, the packing installation portion 2g, which has a diameter smaller than that of the suction-side middle-diameter portion 2b and inserted into the inner surface of the cylinder 5, is formed on the suction port side, so as to allow disposing the packing P in the packing installation portion 2g. Accordingly, in the center portion of the valve seat 2 on the discharge side of the portion where the packing installation portion 2g of the valve seat 2 is formed, the pressure by the ultrahigh-pressure fluid internally accumulated in the cylinder 5 is stopped by the packing P so as not to act.

[0054] The discharge-side middle-diameter portion 2d (the second cylinder portion) is a cylindrical portion where the discharge valve 4 is disposed from the base end portion of the tapered portion 2j on the reduced diameter side and that is formed toward the front side. The discharge-side middle-diameter portion 2d is internally fitted to the discharge-valve installation portion 6d formed inside the through-hole 6a of the flange member 6.

[0055] In the check valve 1, the discharge-side middle-diameter portion 2d (the cylinder portion) of the valve seat 2 (the main body) is fitted to the discharge-valve installation portion 6d (the housing portion) of the flange member 6 (the receiving member) so as to allow disposing the valve seat 2 and the flange member 6 in accurate positions. The valve seat 2 and the flange member 6 are accurately disposed such that the point of action of the resultant force of the forces that the valve seat 2 receives from the flange member 6 coincides with the point of action of the force that the valve seat 2 receives from the pressured fluid. In the check valve 1, the accurate coincidence of the points of action causes the action that more uniformly distributes the compressive stress acting on the inside of the valve seat 2 so as to improve the durability of the valve seat 2.

[0056] The stepped surface 2k is a portion formed flat from the front end of the discharge-side middle-diameter portion 2d toward the shaft center direction. The rear end surface of the valve-body housing member 44 in a cylindrical shape is disposed to face this stepped surface 2k.

[0057] The reduced diameter portion 2m is a portion formed in a taper shape from the shaft-center-side base end portion of the stepped surface 2k to the rear end of the discharge-side small-diameter portion 2e. On the reduced diameter portion 2m, the rear end of the valve-body housing member 44 is installed in the abutting state.

[0058] The discharge-side small-diameter portion 2e is a portion in a cylindrical shape to which the rear end portion of the valve-body housing member 44 is externally fitted, and is formed from the front end of the reduced diameter portion 2m to the peripheral edge of the dis-

charge valve seat 2n.

<Flange Member>

[0059] As illustrated in Fig. 1, the flange member 6 (a valve-seat receiving member, the receiving member) is a supporting member that holds the valve seat 2, where the suction-side middle-diameter portion 2b is internally fitted to the forward end portion inside the cylinder chamber 5a, from the inner surface side on the front side. In the flange member 6, the through-hole 6a is formed. The through-hole 6a includes the receiving portion, which houses the large-diameter portion 2a and the tapered portion 2j of the valve seat 2 on the axis center line, and the circulation passage. Additionally, bolt insertion holes 6g, which allow insertion of the fastening bolts B for fastening the flange member 6 to the housing (not illustrated), are formed. Here, the "circulation passage" in the appended claims means the flow passage in communication with the front side of the discharge flow passage 22 (the through-passage).

[0060] As illustrated in Fig. 2, the valve seat 2, the valve-body housing member 44, and a coupling member 8 are coaxially inserted into the circulation passage. In the through-hole 6a, a stepped surface 6f, a valve-seat internally disposing portion 6b (the receiving portion), the tapered surface 6c (the receiving portion), the discharge-valve installation portion 6d, and the female thread portion 6e are formed. The stepped surface 6f is disposed abutting on the inserted front end surface 5b of the cylinder 5. To the valve-seat internally disposing portion 6b, the large-diameter portion 2a of the valve seat 2 is internally fitted. The tapered surface 6c is disposed to face and fit the tapered portion 2j. To the discharge-valve installation portion 6d, the valve-body housing member 44 forming the outer peripheral portion of the discharge valve 4 is inserted. To the female thread portion 6e, the coupling member 8 is secured.

[0061] Here, the "receiving portion" described in the appended claims includes the valve-seat internally disposing portion 6b and the tapered surface 6c.

[0062] The coupling member 8 is a supporting member that has a male thread portion 8a screwed to the female thread portion 6e so as to obstruct the forward end portion side of the valve-body housing member 44. In the coupling member 8, the male thread portion 8a, which is formed in the outer peripheral portion, a coupling hole 8b, which forms the outlet 1b of the flow passage formed on the axis line, and a female thread portion 8c, which is formed on the opening end side inside the coupling hole 8b, are formed. To the female thread portion 8c, a coupling tool is screwed.

<Housing>

[0063] The housing (not illustrated) is a member that houses the cylinder 5 and to which the flange member 6 is fastened, and is, for example, formed by a pump housing such as a high pressure pump.

<Cylinder>

[0064] As illustrated in Fig. 1, the cylinder 5 (the pressure container) is a cylindrically-shaped member that forms the cylinder chamber 5a to which the plunger 7 is inserted movably forward and backward, and is internally disposed in the housing (not illustrated). The cylinder 5 has the cylinder chamber 5a on the shaft center portion side, and has the cutout part 5c on the shaft center portion side of the front end surface 5b. In the forward end portion of the cylinder 5, the front end surface 5b abuts on the stepped surface 6f of the flange member 6.

<Plunger>

[0065] As illustrated in Fig. 1, the plunger 7 is a member that reciprocates using an oil pressure or similar pressure. The plunger 7 achieves the function of a plunger pump, which moves backward to suction the suction valve element 31 against the valve spring 32 and to suction the fluid inside the supply flow passage 21 into the cylinder chamber 5a and which moves forward to press the fluid inside the cylinder chamber 5a so as to feed the fluid from the inflow port 22a into the discharge flow passage 22.

<Suction Valve>

[0066] As illustrated in Figs. 3A and 3B, the suction valve 3 is a valve that opens and closes the suction port 21b. The suction valve 3 is formed by a normally closed valve that includes: the suction port 21b; the suction valve seat 2h, which is formed on the peripheral edge of the suction port 21b; the suction valve element 31, which obstructs the suction port 21b; the valve spring 32, which biases the suction valve element 31 to the valve closing side; the suction-side small-diameter portion 2c (the valve-body guiding portion), which supports the suction valve element 31 and the valve spring 32; and the spring receiving portion 2i of the valve spring 32.

[0067] The suction valve element 31 is formed of an annular plate material that is disposed to be biased by the valve spring 32 and obstruct the suction port 21b, and closes and opens the suction port 21b. The suction valve 3 opens when the fluid supplied to the supply flow passage 21 presses the suction valve element 31 to the rear-side direction using the force equal to or more than the spring force of the valve spring 32, and closes when the fluid supplied to the supply flow passage 21 presses the suction valve element 31 to the front-side direction using a force less than the spring force of the valve spring 32. The suction valve element 31 has the flat valve portion 31a abutting on the valve seat surface, and is disposed slidably along the suction-side small-diameter portion 2c (a valve-body guiding portion) supporting this suction valve element 31. As illustrated in Figs. 5A and 5B, the

flat valve portions 31a and 41a of the suction valve element 31 and the discharge valve element 41 described later are formed to have respective thicknesses t equal to or more than 15% and equal to or less than 45% of the outer diameters of the flat valve portions 31a and 41a, and are formed of, for example, stainless steel formed thinner than the conventional valve element.

[0068] As illustrated in Fig. 3A, the valve spring 32 is a spring member that constantly presses the suction valve element 31 in the valve-closing direction (the arrow g direction) using a preliminarily set spring force, and is formed of a helical compression spring.

[0069] The suction valve seat 2h is a portion where a valve seat is formed. The valve seat includes the suction port 21b and the suction valve element 31, which opens and closes the suction port 21b. The suction valve seat 2h is formed by the planar surface formed in a radial fashion around this suction-side small-diameter portion 2c from the front-end-side base end portion of the suction-side small-diameter portion 2c toward the outer periphery.

[0070] The suction-side small-diameter portion 2c (the suction-valve-body guiding portion) is a portion that telescopically supports and guides the valve spring 32 of the suction valve 3, and is formed having a diameter smaller than the outer diameter of the suction-side middle-diameter portion 2b and the inner diameter of the valve spring 32. The suction-side small-diameter portion 2c is formed of a cylindrical-shaped protrusion disposed to protrude from the suction valve seat 2h toward the rear side, and includes the discharge flow passage 22 formed inside and the spring receiving portion 2i formed in the outer rear end portion.

[0071] The spring receiving portion 2i is a portion that receives the rear end of the valve spring 32 formed of a helical compression spring, and is formed, for example, in an annular shape (a flange shape) formed integrally with the rear end portion of the suction-side small-diameter portion 2c. Here, the spring receiving portion 2i only needs to achieve a function that receives the valve spring 32, and may be a member that is mountable on the suction-side small-diameter portion 2c, for example, a retaining ring separate to the valve seat 2.

<Discharge Valve>

[0072] As illustrated in Fig. 2, the discharge valve 4 is a valve that opens and closes the discharge port 22b of the valve seat 2. The discharge valve 4 includes: the discharge valve seat 2n, which is formed in the peripheral edge portion of the discharge port 22b; the discharge valve element 41, which opens and closes the discharge port 22b; a valve spring 42, which causes the discharge valve element 41 to abut on the discharge valve seat 2n so as to close the discharge port 22b; a valve-body supporting member 43, which supports the discharge valve element 41; and the valve-body housing member 44, which houses the discharge valve element 41, the valve spring 42, and the valve-body supporting member 43.

[0073] As illustrated in Figs. 4A and 4B, the discharge valve element 41 is formed of a bar-attached flat valve that includes the flat valve portion 41a in a flat circular plate shape and a rod-shaped portion 41b disposed to protrude in the flat valve portion 41a, and is formed of, for example, stainless steel.

[0074] The flat valve portion 41a is formed in a circular flat plate shape having a thin plate thickness, and is the portion that abuts on the valve seat surface to close the discharge port 22b. The discharge valve seat 2n is formed by the planar surface formed on the front end surface of the valve seat 2.

[0075] The rod-shaped portion 41b is slidably inserted into the valve-body supporting member 43 having the discharge-valve-body guiding portion 43a, which is formed in a pipe shape to support the discharge valve element 41.

[0076] The valve spring 42 is a spring member for pressing the flat valve portion 41a against the discharge valve seat 2n, and is formed of a helical compression spring. The valve spring 42 is telescopically and freely fitted to the discharge-valve-body guiding portion 43a, and has the rear end supported by the discharge valve element 41 while having the front end supported by a spring receiving portion 43b formed on the discharge side (the front side) of the discharge-valve-body guiding portion 43a.

[0077] The valve-body supporting member 43 is a member that achieves: a function that supports the discharge valve element 41; a function that supports the valve spring 42; and the function of a flow passage to discharge the fluid inside the valve-body housing portion 44a from the outlet 1b. In the valve-body supporting member 43, the discharge-valve-body guiding portion 43a, the spring receiving portion 43b, a shaft center hole 43c, which is formed by penetration in the axial direction, and a lateral hole 43d penetrated perpendicularly to this shaft center hole 43c, are formed.

[0078] The valve spring 42 is externally fitted to the outer side of the discharge-valve-body guiding portion 43a, and the rod-shaped portion 41b of the discharge valve element 41 is inserted into the shaft center hole 43c to be housed in the valve-body housing portion 44a of the valve-body housing member 44.

[0079] As illustrated in Figs. 4A and 4B, the discharge-valve-body guiding portion 43a is a cylindrical portion extending from the center of the rear end portion of the spring receiving portion 43b toward the rear-side direction. The discharge-valve-body guiding portion 43a supports the rod-shaped portion 41b movably forward and backward inside this the discharge-valve-body guiding portion 43a (in the shaft center hole 43c), and telescopically supports the valve spring 42 in the front-rear direction outside the discharge-valve-body guiding portion 43a.

[0080] The spring receiving portion 43b is a portion that is integrally formed with the front end side of the dis-

charge-valve-body guiding portion 43a while having an outer diameter larger than the outer diameter of the discharge-valve-body guiding portion 43a and that supports the valve spring 42. In the spring receiving portion 43b, the shaft center hole 43c and the lateral hole 43d forming the flow passage of the fluid are formed. The spring receiving portion 43b is biased by the valve spring 42 and disposed in the state pressed to the rear end surface of a housing-member flow passage portion 44b of the valve-body housing member 44.

[0081] Here, the spring receiving portion 43b can be formed on the rear end surface of the housing-member flow passage portion 44b.

[0082] The shaft center hole 43c is formed from the rear end surface to the front end surface of the valve-body supporting member 43 along the shaft center. The shaft center hole 43c has a rear side forming a supporting portion inserted into the rod-shaped portion 41b and has a front side forming a flow passage that causes flow of the fluid inside the lateral hole 43d to the housing-member flow passage portion 44b.

[0083] The lateral hole 43d is a flow passage formed from the outer peripheral portion on one side of the spring receiving portion 43b through the shaft center hole 43c to the outer peripheral portion on the other side, and is formed to feed a flow of the fluid inside the valve-body housing portion 44a to the shaft center hole 43c.

[0084] As illustrated in Fig. 2, the valve-body housing member 44 is a pipe-shaped member that includes: the valve-body housing portion 44a having the space formed to house the discharge valve 4 inside; and the housing-member flow passage portion 44b where a flow passage is formed. The valve-body housing member 44 may be formed by a member where the valve-body housing portion 44a and the housing-member flow passage portion 44b are integrated, but the valve-body housing portion 44a and the housing-member flow passage portion 44b are preferred to be formed as mutually independent members.

[0085] The valve-body housing member 44 is internally disposed in the discharge-valve installation portion 6d (the housing portion) of the flange member 6, has the rear end into which the discharge-side small-diameter portion 2e of the outer periphery of the discharge valve seat 2n is internally fitted in the state where the rear end abuts on the reduced diameter portion 2m, and has the front side in the state abutting on the coupling member 8.

[0086] The housing-member flow passage portion 44b has a cylindrical shape where a flow passage 44e is formed. Through the flow passage 44e, the fluid inside the valve-body housing portion 44a passes toward the outlet 1b. A flow-passage inlet 44c is communicated with the shaft center hole 43c. A flow-passage outlet 44d may be formed in a taper shape expanded to the front side. The front-side end surface of the housing-member flow passage portion 44b abuts on the rear-side end surface of the coupling member 8.

<Action>

[0087] The following describes the action of the check valve according to the embodiment of the present invention with reference to the accompanying drawings.

[0088] When the reciprocating plunger 7 moves in the rear-side direction (the arrow i direction in Fig. 1), as illustrated in Fig. 3B, the plunger 7 opens the suction valve element 31 of the suction valve 3 and suctions the fluid inside the supply flow passage 21 to the cylinder chamber 5a side. At this time, the pressures of the fluids inside the supply flow passage 21, inside the cylinder chamber 5a, and inside the discharge flow passage 22 are, for example, 0.4 MPa.

[0089] The fluid inside the supply flow passage 21 is suctioned by the plunger 7 so as to flow to the direction (the arrow b direction) of the cylinder chamber 5a, and presses the suction valve element 31 closing the suction port 21b against the valve spring 32 rearward (in the arrow h direction) so as to open the suction valve element 31. The annular suction valve element 31 is freely fitted to the suction-side small-diameter portion 2c (the valve-body guiding portion) together with the valve spring 32 to be guided, and thus stably slides along the suction-side small-diameter portion 2c so as to open and close the valve. That is, the movement of the flat valve portion 31a becomes stable.

[0090] The suction valve element 31 decreases in rigidity due to thinning of the thickness of the flat valve portion 31a, but increases in close contact property to the suction valve seat 2h formed by the planar surface due to occurrence of warping in the flat valve portion 31a by the pressure difference. The suction valve seat 2h gradually wears due to opening and closing of the suction valve element 31. However, despite the wear of the suction valve seat 2h, the high close contact property of the flat valve portion 31a to the suction valve seat 2h allows preventing leakage from the suction valve 3.

[0091] When the plunger 7 (see Fig. 1) moves rearward, as illustrated in Fig. 4A, the discharge valve 4 is closed in the state where the flat valve portion 41a of the discharge valve element 41 is pressed against the discharge valve seat 2n by the spring force of the valve spring 42. At this time, the pressure of the fluid inside the discharge flow passage 22 is, for example, 0.4 MPa. The pressure of the fluid inside the valve-body housing portion 44a is, for example, 500 MPa.

[0092] When the plunger 7 moves in the front-side direction (the arrow j direction in Fig. 1), the plunger 7 presses the fluid inside the cylinder chamber 5a in the front-side direction to close the suction port 21b and causes, as illustrated in Fig. 3A, flow of the fluid inside the cylinder chamber 5a in the direction (the arrow c direction) inside the discharge flow passage 22. At this time, the pressure of the fluid inside the supply flow passage 21 is, for example, 0.4 MPa. The pressure of the fluid inside the discharge flow passage 22 is, for example, 500 MPa.

[0093] The fluid inside the cylinder chamber 5a flows

from the inflow port 22a into the discharge flow passage 22, as illustrated in Fig. 4B, presses the flat valve portion 41a of the discharge valve element 41 against the valve spring 42 forward (in the arrow m direction) so as to open the discharge valve element 41, and flows into the valve-body housing portion 44a. Then, the fluid passes from the inside of the valve-body housing portion 44a through the lateral hole 43d and the shaft center hole 43c of the valve-body supporting member 43, a flow passage 44e of a housing-member flow passage portion 44b, and the coupling hole 8b of the coupling member 8 illustrated in Fig. 2, and comes out from the outlet 1b.

[0094] As illustrated in Fig. 4B, when the discharge valve 4 opens, the discharge valve element 41 where the rod-shaped portion 41b is inserted into the discharge-valve-body guiding portion 43a of the valve-body supporting member 43 slides and the valve spring 42 is also compressed while being supported by the discharge-valve-body guiding portion 43a. At this time, the pressures of the fluids inside the discharge flow passage 22 and inside the valve-body housing portion 44a are, for example, 500 MPa.

[0095] The discharge valve element 41 stably slides along the discharge-valve-body guiding portion 43a to open and close the valve.

[0096] The discharge valve element 41 decreases in rigidity due to thinning of the thickness of the flat valve portion 41a, but increases in close contact property to the discharge valve seat 2n formed by the planar surface due to occurrence of warping in the flat valve portion 41a by the pressure difference. The discharge valve seat 2n gradually wears due to opening and closing of the discharge valve element 41. However, despite the wear of the discharge valve seat 2n, the high close contact property of the flat valve portion 41a to the discharge valve seat 2n allows preventing leakage from the discharge valve 4.

[0097] In the suction valve element 31 and the discharge valve element 41 of the check valve 1 according to the embodiment, the thicknesses of the flat valve portions 31a and 41a are thinned. As a result of experiment, the valve element having a conventional thickness became unable to provide the sealing property at a repeat count of 1.5×10^5 and became unusable. In contrast, the flat valve portions 31a and 41a according to the present invention prolonged the sealing property up to a repeat count of 1×10^6.

[0098] As illustrated in Fig. 4B, when the plunger 7 moves in the front-side direction (the arrow j direction in Fig. 1), the pressure inside the cylinder chamber 5a of the cylinder 5 (the pressure container) acts on the valve seat 2 (the main body). The tapered portion 2j (the conical surface) of the valve seat 2 and the tapered surface 6c of the receiving portion of the flange member 6 have identical groove angles. Accordingly, a force F1 by the pressure inside the cylinder chamber 5a is received by the entire surface of the tapered surface 6c of the flange member 6. As its reaction, the flange member 6 applies a force F2, which is perpendicular to the tapered portion 2j of the valve seat 2 and uniform, to the valve seat 2 from the peripheral area toward the center portion.

[0099] On the other hand, the discharge flow passage 22 is affected by the pressure identical to that of the cylinder chamber 5a. The pressure applied to the discharge flow passage 22 pushes out the valve seat 2 from the center to the radially outer peripheral direction. The force acting from the outer peripheral portion and the force acting from the inside cause an approximately uniform compressive stress acting on the entire valve seat 2.

[0100] In the valve seat 2, the reduced diameter portion 2m is formed to be inclined between the stepped surface 2k and the discharge-side small-diameter portion 2e. Accordingly, there is no portion where the cross-sectional surface of the valve seat 2 expands rapidly. This reduces the occurrence of the stress concentration so as to allow reducing the occurrence of cracking and breakage.

[0101] The valve seat 2 resolves the occurrence of the tensile stress on the root of the flanged portion, thus prolonging the product lifetime.

[0102] In the check valve 1, the thicknesses t of the flat valve portions 31a and 41a of the suction valve element 31 and the discharge valve element 41 are formed to be equal to or more than 15% and equal to or less than 45% of the outer diameters of the flat valve portions 31a and 41a. Accordingly, the suction valve element 31 and the discharge valve element 41 decrease in the thicknesses to the extent that allows the deformation while keeping the strength so as to reduce the rigidity, thus abutting on the suction valve seat 2h and the discharge valve seat 2n while warping. This allows providing a valve element in an appropriate shape having improved close contact property.

[First Modification]

[0103] The present invention is not limited to the foregoing embodiment, and can be changed and modified in various forms within the scope and the spirit of the present invention, and those changed and modified forms are also included in the present invention.

[0104] The check valve 1 described in the above-described embodiment is a valve appropriate for an ultra-high-pressure generating apparatus such as a high pressure pump. However, the installation location is not particularly limited insofar as the installation location is a portion where the suction valve 3 and the discharge valve 4 can be installed.

[0105] Here, while in the above-described embodiment the fluid coupling as the check valve 1 has been described, the present invention can be generally used for a fluid coupling of a pressure container that includes the spinning-top shaped valve seat 2 having the discharge flow passage 22 (the through-passage) and the flanged flange member 6 (the receiving member).

[0106] For example, instead of the cylinder 5, the pressure container may be used while the suction valve 3 or

the discharge valve 4 is removed. In the case where the discharge valve 4 is removed, the valve-body housing member 44 and the housing-member flow passage portion 44b may also be removed. In the case where the suction valve 3 is removed, the supply flow passage 21 is also removed. The discharge flow passage 22 in the above-described embodiment is used as a passage for fluid between the pressure container and the outside.

[0107] This fluid coupling is appropriate particularly for a pressure container sealing the fluid at significantly high pressure or a pressure container at high pressure amplitude and frequency.

Claims

1. A fluid coupling disposed in a pressure container, the fluid coupling comprising:

   a main body having a through-passage that is communicated with the pressure container and allows flow of fluid; and
   a receiving member disposed in the pressure container to support the main body,
   wherein the main body has: an engaging portion that is formed on one side of the through-passage and disposed to be engaged inside the pressure container; and a conical surface formed on another side,
   the receiving member has: a receiving portion having a tapered surface with a groove angle identical to a groove angle of the conical surface; and a circulation passage communicated with the other side of the through-passage, and
   the conical surface of the main body abuts on the tapered surface of the receiving member such that the receiving member supports the main body.

2. The fluid coupling according to claim 1, wherein
   the main body has an enlarged diameter portion between the engaging portion and the conical surface, the enlarged diameter portion being radially enlarged relative to the engaging portion.

3. The fluid coupling according to claim 2, wherein
   the engaging portion includes:

   a first cylinder portion internally fitted to an inner surface of the pressure container;
   a packing installation portion having a diameter smaller than a diameter of the first cylinder portion; and
   a packing disposed in the packing installation portion.

4. The fluid coupling according to any one of claims 1 to 3, wherein
   the main body has a second cylinder portion in a forward end portion on the other side of the main body, and
   the receiving member has a housing portion to which the second cylinder portion is fitted by insertion, and uses the housing portion to restrict the second cylinder portion so as to support the main body.

5. The fluid coupling according to any one of claims 1 to 4, wherein
   the pressure container is a cylinder of a piston pump,
   the main body has: a supply port for supplying the fluid;
   and a suction port on one side, for discharging the fluid supplied from the supply port into the cylinder,
   the through-passage has: an inflow port on the one side, for causing inflow of the fluid pressured inside the cylinder;
   and a discharge port on the other side, for discharging the fluid, and
   the through-passage includes:

   a suction valve disposed in the suction port; and
   a discharge valve disposed in the discharge port.

6. The fluid coupling according to claim 5, wherein
   the main body includes:

   a valve seat of the suction valve formed on the one side of the main body; and
   a valve seat of the discharge valve formed on the other side of the main body.

7. The fluid coupling according to claim 5 or 6, wherein
   the discharge valve includes: a discharge valve element having a flat valve portion; and a discharge-valve-body guiding portion slidably supporting the discharge valve element,
   the suction valve includes: a suction valve element having a flat valve portion; and a suction-valve-body guiding portion slidably supporting the suction valve element, and
   the discharge valve and the suction valve have respective planar valve seat surfaces.

8. The fluid coupling according to claim 6 or 7, wherein
   the flat valve portions of the suction valve element and the discharge valve element are formed having respective thicknesses equal to or more than 15% and equal to or less than 45% of outer diameters of the flat valve portions.

Fig. 1

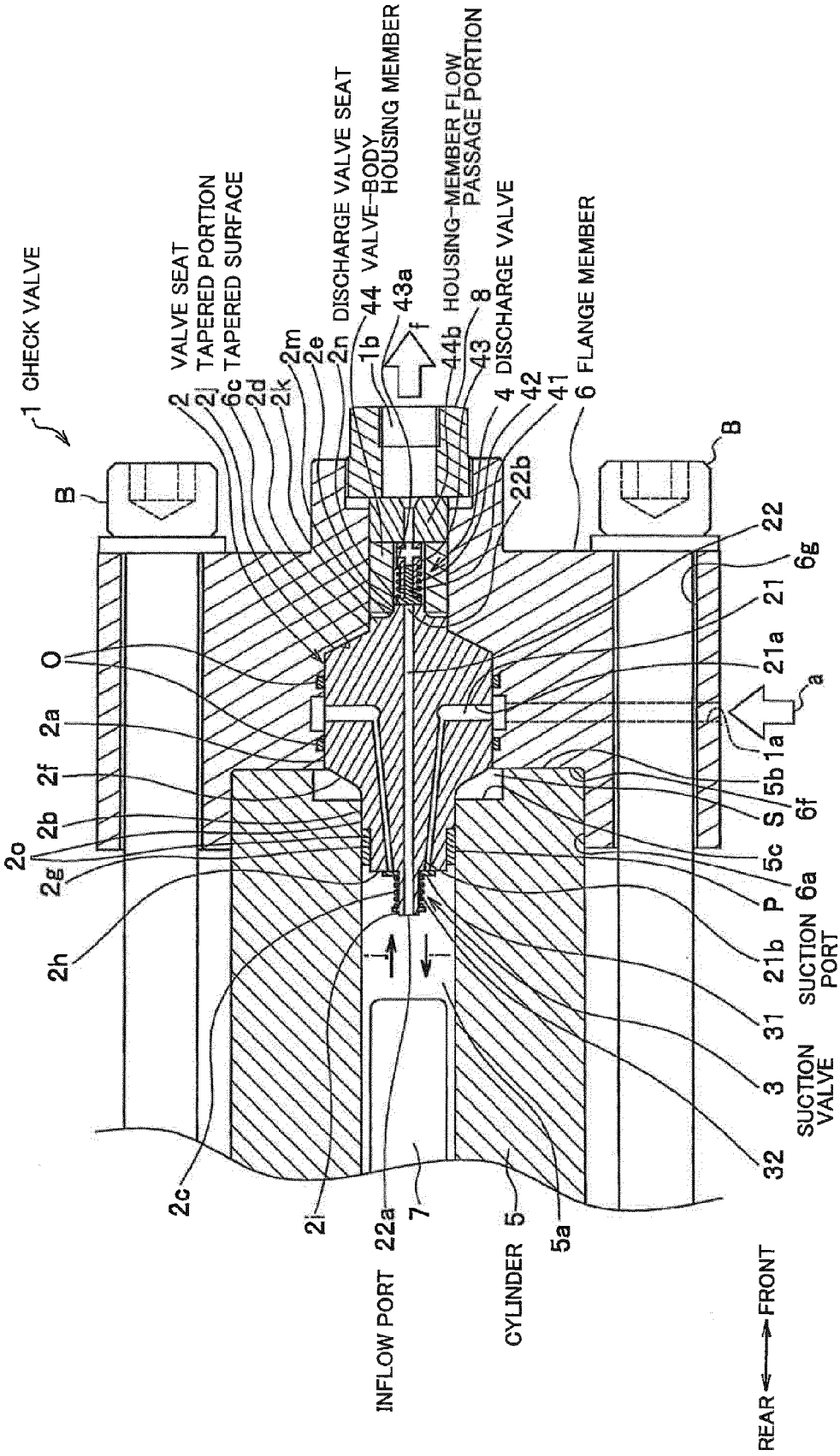
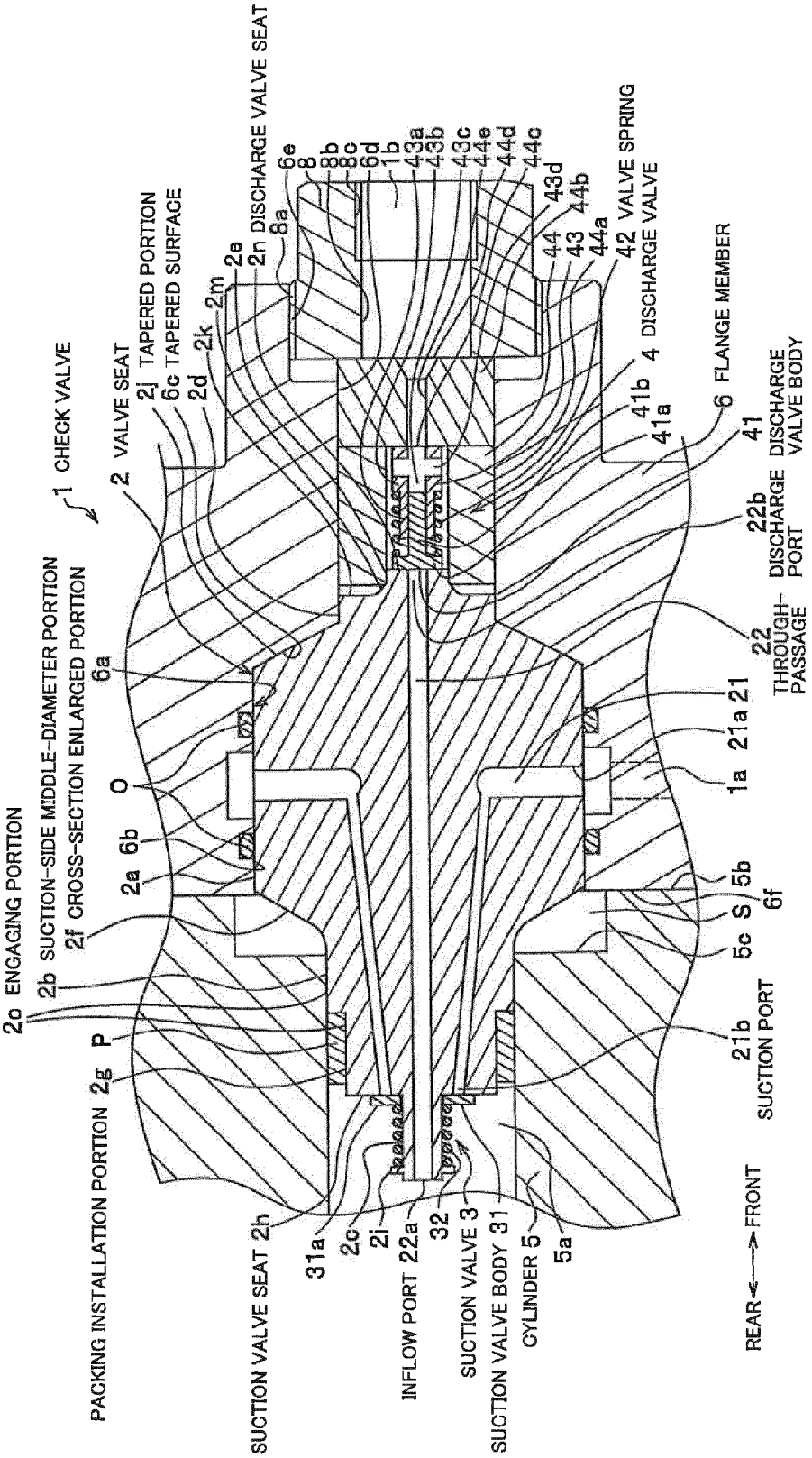

1 CHECK VALVE
2 VALVE SEAT
2j TAPERED PORTION
6c TAPERED SURFACE
2d
2k
2m
2e
2n DISCHARGE VALVE SEAT
1b
44 VALVE-BODY HOUSING MEMBER
43a
f
44b HOUSING-MEMBER FLOW PASSAGE PORTION
43
8
4 DISCHARGE VALVE
42
41
6 FLANGE MEMBER
B
B
22b
22
6g
21
21a
a
1a
5b
6f
S
5c
6a
P
21b
SUCTION PORT
31
3
SUCTION VALVE
32
O
2a
2f
2b
2o
2g
2h
2c
2i
22a
INFLOW PORT
7
5
CYLINDER
5a
REAR
FRONT

Fig. 2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2 VALVE SEAT
2j TAPERED PORTION
6c TAPERED SURFACE
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2k
2m
2a
2n DISCHARGE VALVE SEAT
8a
6e
8
8b
8c
6d
1b
43a
43b
43c
44e
44d
44c
43d
44b
44
43
44a
42 VALVE SPRING
4 DISCHARGE VALVE
41b
41a
6 FLANGE MEMBER
41
DISCHARGE VALVE BODY
22b
DISCHARGE PORT
22
THROUGH-PASSAGE
21
21a
1a
5b
6f
S
5c
21b
SUCTION PORT
2o ENGAGING PORTION
2b SUCTION-SIDE MIDDLE-DIAMETER PORTION
2f CROSS-SECTION ENLARGED PORTION
6a
O
6b
2a
P
2g PACKING INSTALLATION PORTION
SUCTION VALVE SEAT 2h
31a
2c
2i
INFLOW PORT 22a
32
SUCTION VALVE 3
SUCTION VALVE BODY 31
CYLINDER 5
5a
REAR
FRONT

Fig. 3A

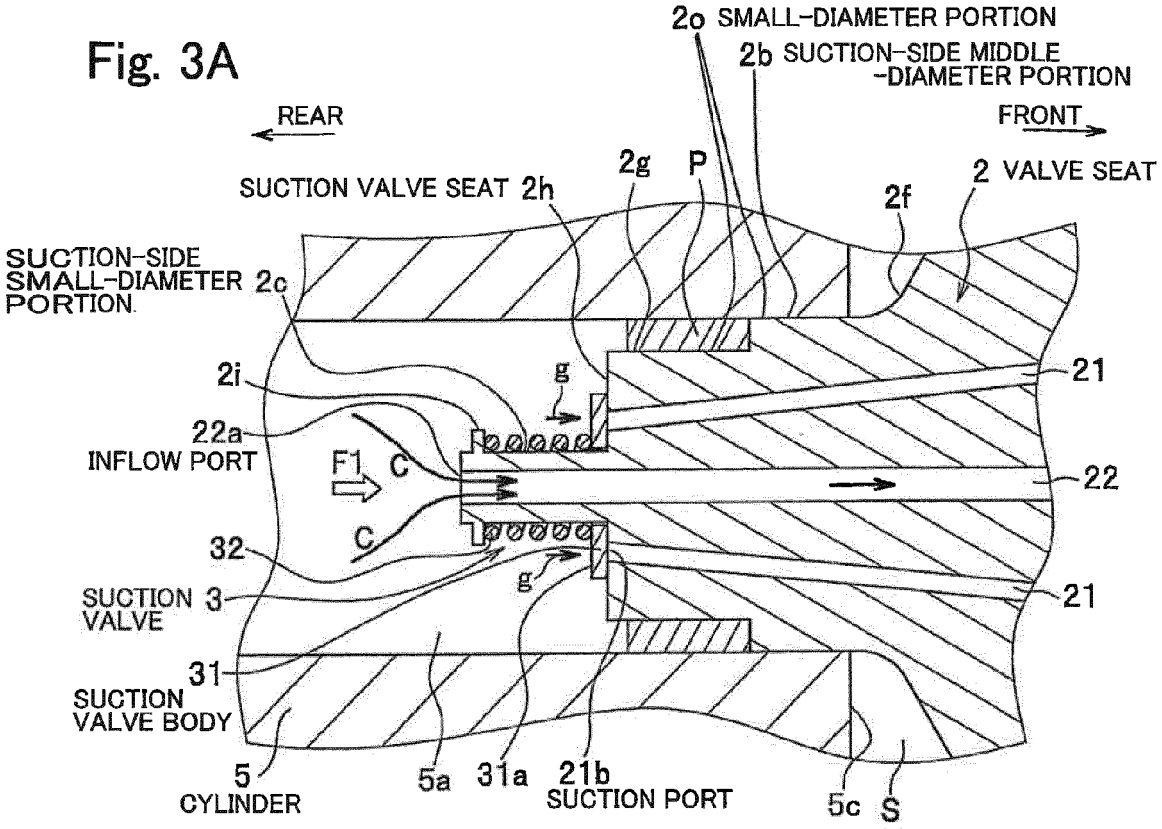
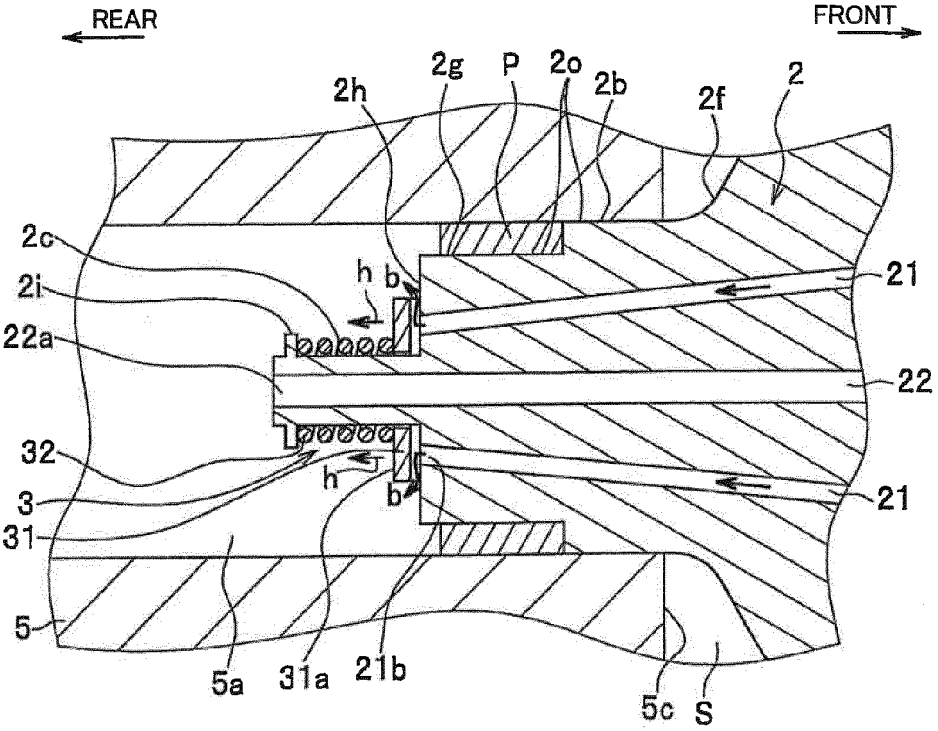

2o SMALL-DIAMETER PORTION
2b SUCTION-SIDE MIDDLE -DIAMETER PORTION
REAR
FRONT
SUCTION VALVE SEAT 2h
2g
P
2f
2 VALVE SEAT
SUCTION-SIDE SMALL-DIAMETER PORTION 2c
2i
g
21
22a
INFLOW PORT
F1
C
C
22
32
g
21
SUCTION VALVE 3
31
SUCTION VALVE BODY
5
CYLINDER
5a
31a
21b
SUCTION PORT
5c
S

Fig. 3B


REAR
FRONT
2h
2g
P
2o
2b
2f
2
2c
h
b
21
2i
22a
22
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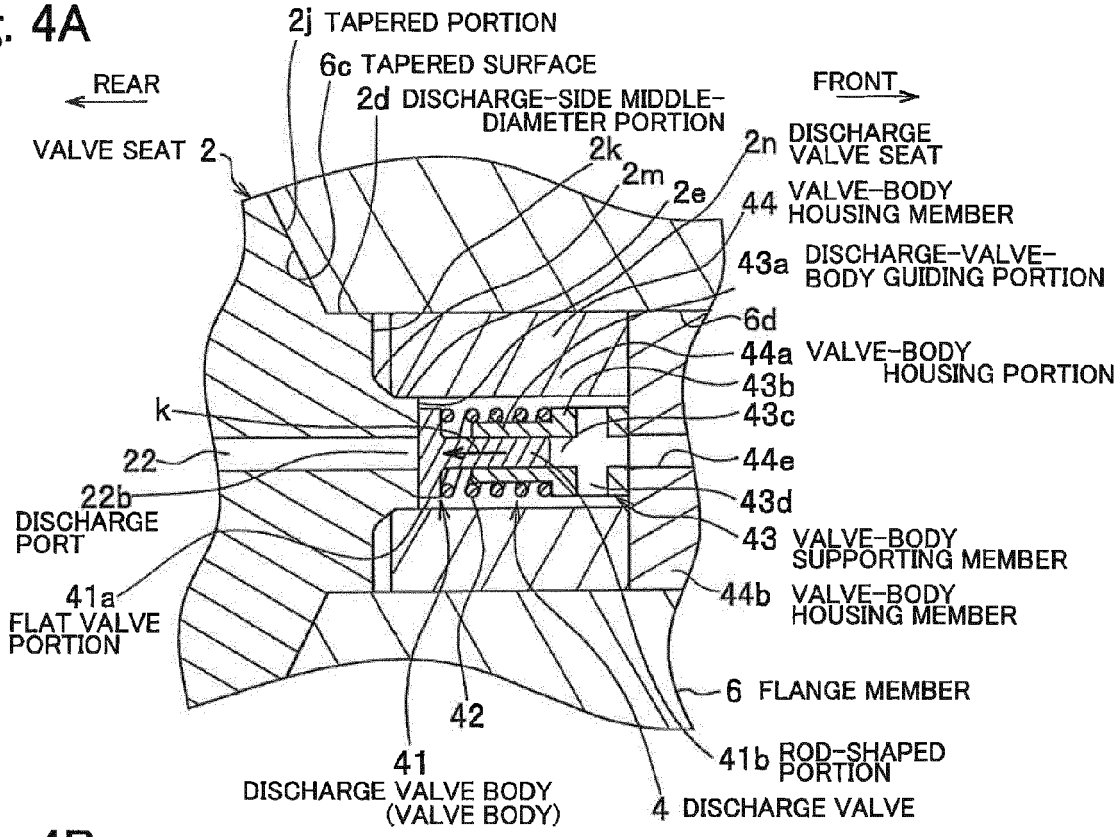
21
31
5
5a
31a
21b
5c
S

Fig. 4A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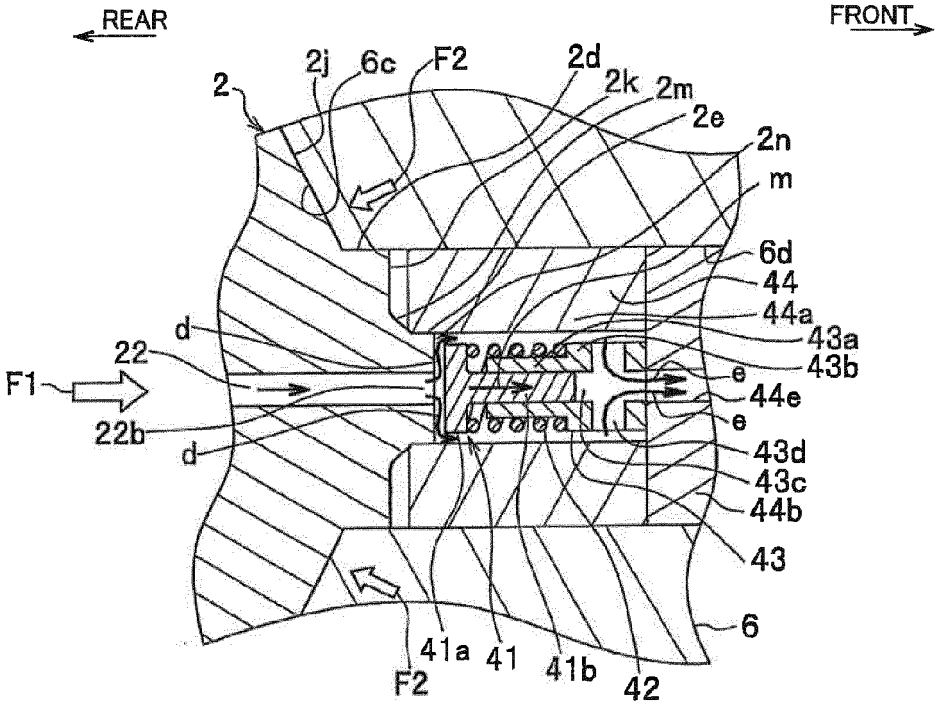
6c TAPERED SURFACE
REAR
FRONT
2d DISCHARGE-SIDE MIDDLE-DIAMETER PORTION
VALVE SEAT 2
2k
2m
2e
2n DISCHARGE VALVE SEAT
44 VALVE-BODY HOUSING MEMBER
43a DISCHARGE-VALVE-BODY GUIDING PORTION
6d
44a VALVE-BODY HOUSING PORTION
43b
k
43c
22
44e
22b
43d
DISCHARGE PORT
43 VALVE-BODY SUPPORTING MEMBER
41a
44b VALVE-BODY HOUSING MEMBER
FLAT VALVE PORTION
6 FLANGE MEMBER
42
41b ROD-SHAPED PORTION
41
DISCHARGE VALVE BODY (VALVE BODY)
4 DISCHARGE VALVE

Fig. 4B


REAR
FRONT
2
2j
6c
F2
2d
2k
2m
2e
2n
m
6d
44
44a
43a
d
22
43b
F1
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43c
44b
43
6
41a
41
41b
42
F2

Fig. 5A

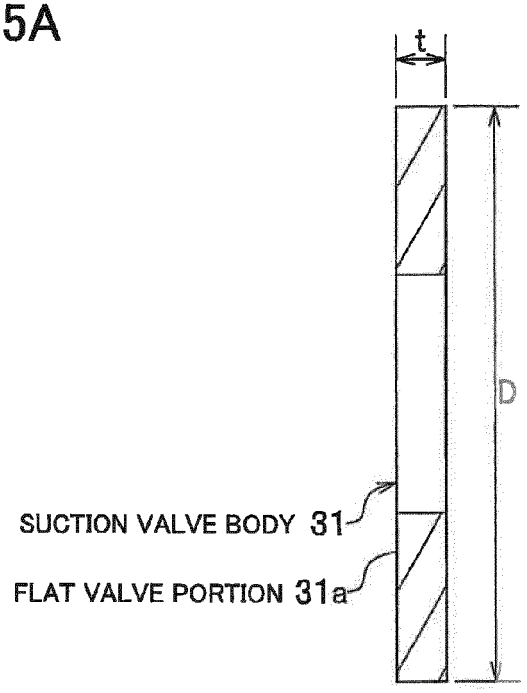
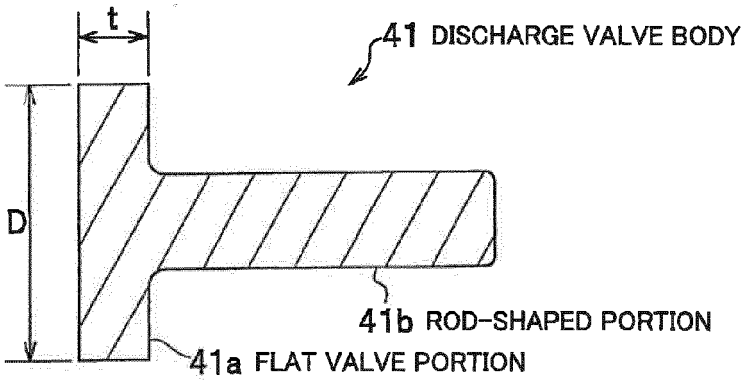

t
D
SUCTION VALVE BODY 31
FLAT VALVE PORTION 31a

Fig. 5B


t
41 DISCHARGE VALVE BODY
D
41b ROD-SHAPED PORTION
41a FLAT VALVE PORTION

Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 15 18 0380

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2003/072661 A1 (GREIFF UWE [DE] ET AL) 17 April 2003 (2003-04-17) * paragraphs [0038] - [0044]; figures 2-6 *	1-8	INV. F04B53/10 F16K11/048
X	US 4 412 792 A (LABORDE RUSSELL G [US] ET AL) 1 November 1983 (1983-11-01) * column 1, line 13 - column 5, line 22; figures 1-6 *	1-8	
X	US 6 231 323 B1 (JEZEK PAUL D [US]) 15 May 2001 (2001-05-15) * page 1, line 45 - page 4, line 54; figures 1-5 *	1-8	

TECHNICAL FIELDS SEARCHED (IPC)
F04B
F16K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 February 2016	Jurado Orenes, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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